TpB-IO-A16

TapBus IO Analog (16 Inputs)

Datasheet

21 May 2024
Version 1.1

Contents

1 Introduction

TapBus IO AI16 provides:

- Wired connection via RS485 (Modbus-RTU) to TapBus Power.
- Wireless connection via NFC.
- Analog Input: 4-20mA, 0-10V, 0-2V, 2 or 3 wires resistances (Pt100, Pt1000 …).

Part Numbers

Part Number	Wireless protocol	Wire protocol	Interface Type	Casing	Power
TpB-IO-LI12LO4	NFC	RS-485	Logic	DIN Rail	5V-12V
TpB-IO-LI14LO8TC	NFC	RS-485	Logic	DIN Rail	5V-12V
TpB-IO-AI16	NFC	RS-485	Analog	DIN Rail	5V-12V
TpB-IO-W6	NFC	RS-485	Wattmetter	DIN Rail	5V-12V
TpB-IO-WT6	NFC	RS-485	Wattmetter	DIN Rail	5V-12V

Radio channels

- Near Field Communication (NFC) Type5 tag (ISO/IEC 15693)

Modbus RTU (over RS485)

- TapBus IO module acts as a Modbus RTU server (client) and provides acces to specific addresses or address ranges in its memory space to the TapBus Power (client/master) on the bus.

Security features

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

Casing

- Din Rail case (size4).

Electrical characteristics

- DC Input voltages: 5V or 12V
- Power consumption:
  - 5VDC: from 33.6 to 45 mA at 12VDC
  - 12VDC: from 15.1 to 19.8 mA at 5VDC

Temperature ranges

- Operating temperature: [-20°C, +70°C]
- Storage temperature: [-20°C, +70°C]

Acceptance

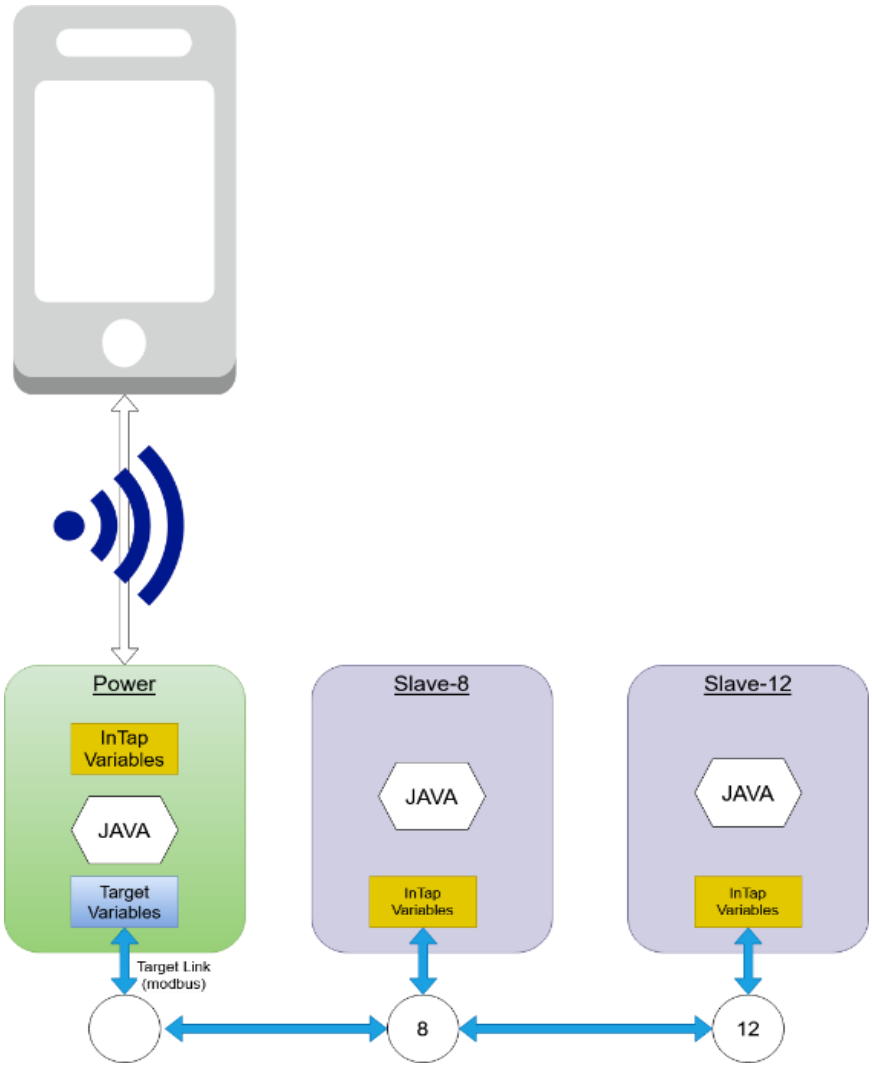
- RF certification: *(In testing)* CE (Europe), FCC (USA), IC (Canada).
- Green certification: REACH and RoHS compliant

2 Architecture

A TapBus-IO module is supposed to be one element among others in a complete TapBus system. But, thanks to its high flexibility, it could be also used outside such a system.

2.1 Typical application diagram

The TapBus system acquires, processes and transmits data to a mobile application or to a server on the Cloud. In this architecture, TapBus IO can be considered as an acquisition module connected by a Modbus-RTU link to the TapBus Power or by NFC.



This configuration is the most common, but not the only solution. For example, we could also consider:

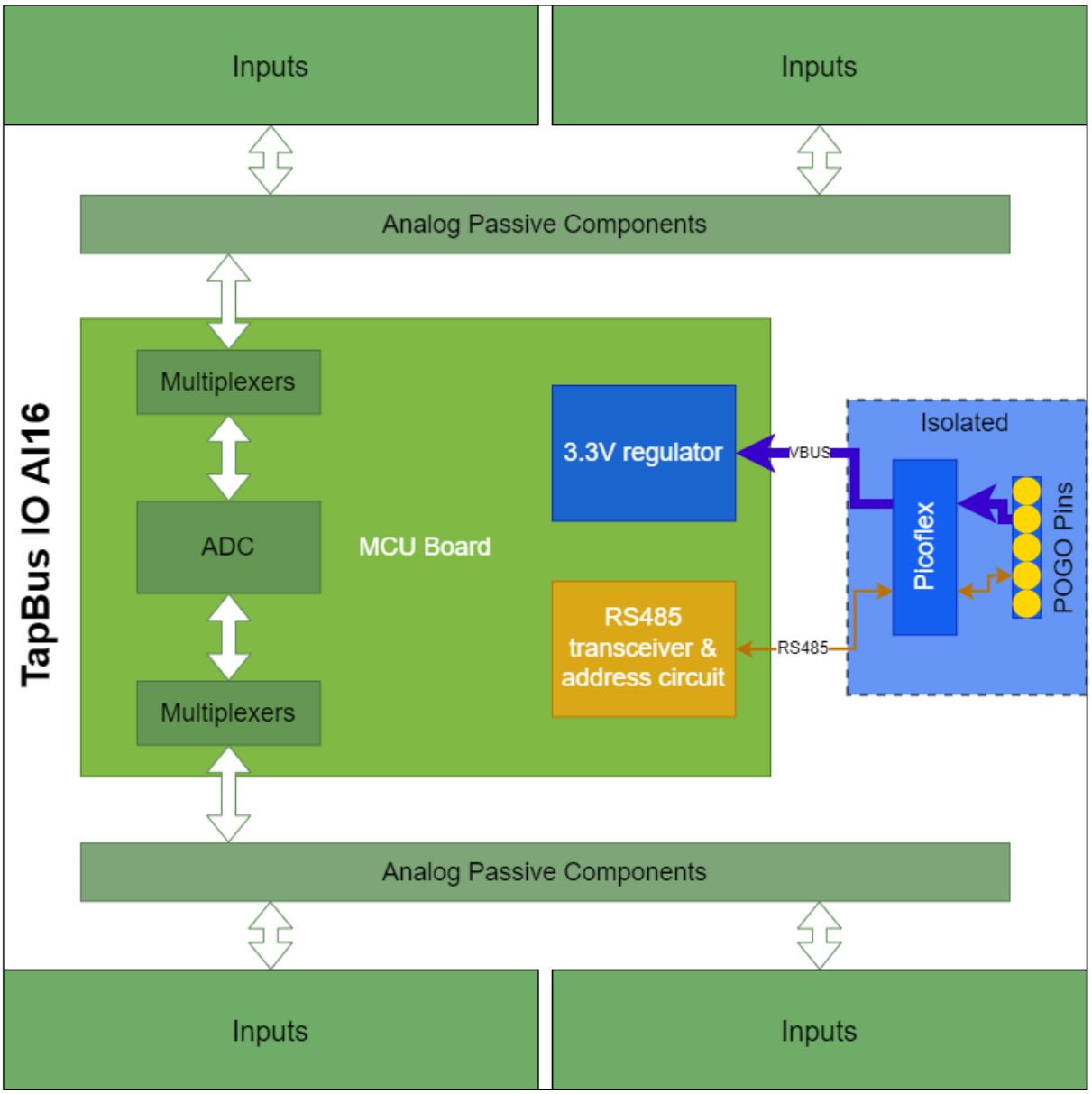
- A single acquisition module (with its NFC interface). Note that a single module would require a power source (either 5V or 12V).
- On the contrary, a TapBus Power module could be used a simple gateway (like a Tapioca) connected, for example, to various sensors via Modbus, without any TapBus acquisition modules.

But in most cases, the above configuration will be the preferred one. In this case, we distinguish two types of modules:

- TapBus Power module: it is the central unit that manages:
  - power supply (DC 24V or AC 230V input),
  - relations with the Cloud and/or mobile applications (via wireless connectivity)
  - an optional backup battery (12V).
- TapBus IO input/output modules (acquisition and control). Different types of TapBus IO modules will be developed according to demand. The modules below are already available:

Reference	Features	Description
TpB-IO-LI12LO4	12 logic inputs 4 logic outputs	Inputs: state, counters, timers or frequency meter. Outputs: state, pulses or PWM.
TpB-IO-LI4LO8TC	4 logic inputs 8 logic outputs 1 TIC	Inputs: state, counters, timers or frequency meter. Outputs: state, pulses or PWM. TIC = Enedis Information Signal (Enedis is the French Electricity Network operator)
TpB-IO-AI16	16 analog inputs	Inputs: 4-20mA, 0-10V, 0-2V, 2 or 3 wires resistances (Pt100, Pt1000 or resistor value).
TpB-IO-W6	6 current inputs 1 voltage input	Single-phase power/energy measurement
TpB-IO-WT6	3x2 current inputs 3 voltage inputs	Three-phase power/energy measurement

2.2 TapBus IO AI16 diagram



2.3 Wire connectivity

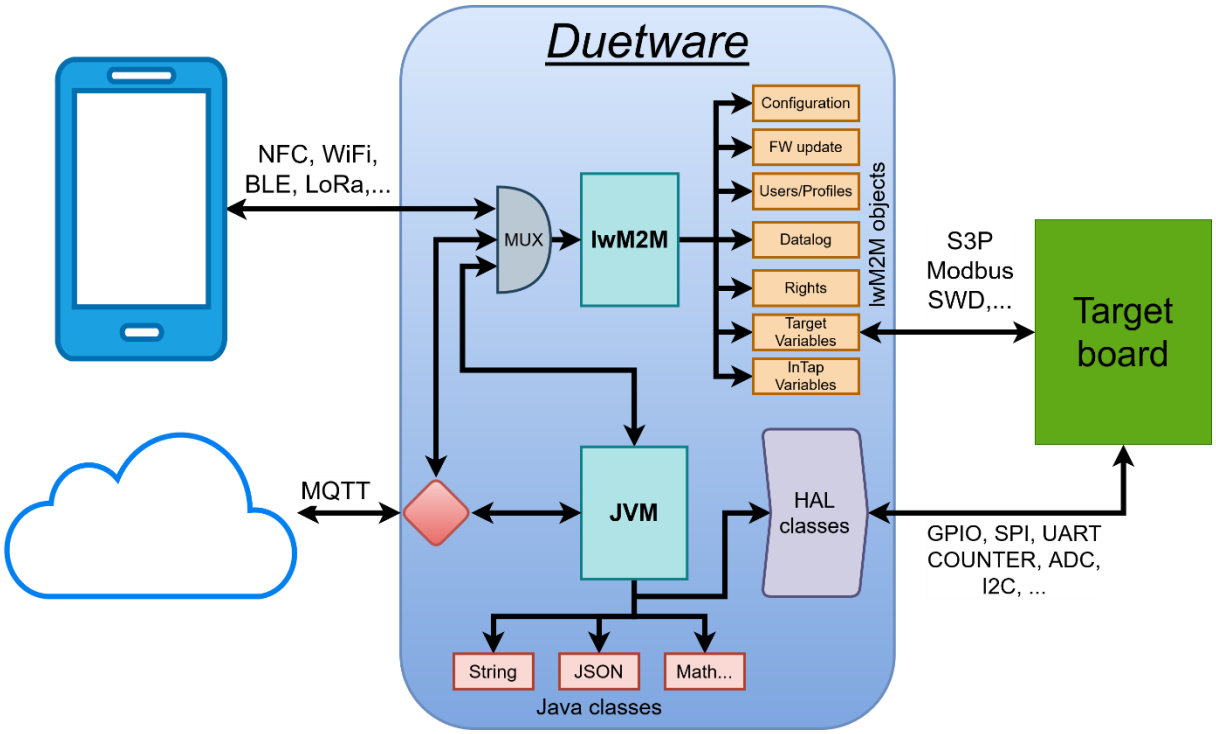
2.3.1 RS485 (Modbus RTU)

In the standard Embedded code, TapBus IO acts as ModBUS slave. In other words, variables can be considered as being in the TapBus IO memory and are accessible from the TapBus Power.

2.4 Duetware architecture

All TapBus contains the embedded software 'Duetware'. This software is essentially composed of two 'engines':

- The lwM2M which executes queries from the outside such as:
  - TapBus Power: reading the modbus registers of the slaves on the bus.
  - TapBus IO: reading the I/Os.
- The JVM that provides flexibility and decision-making power: it is the JVM that will ensure the control of the battery, or that will manage the alarm or datalog functions.



3 Description

TapBus IO AI16 acts as a analog input telemetry unit.

In addition to the analog inputs, TapBus-IO also acts as a communication gateway to a mobile app. It can communicate directly with mobiles, tablets, and PCs via NFC. Users can use IoTize's app or their own custom apps to read/write target system data.

In addition to local communications using NFC, TapBus IO can be accessed by the TapBus Power (Mobus RTU). The TapBus Power 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 module to send alarms to the cloud at any time.

Refer to the TapBus Systems User Guide to use the communication features.

3.1 Analog interface

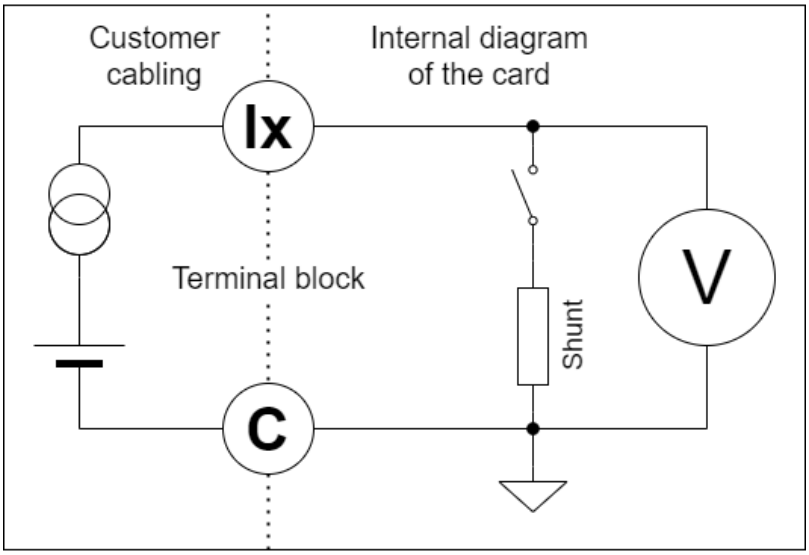
3.1.1 Modes

- 4-20 mA input
- Voltage input (0-2V or 0-10V)
- 2-wire resistance input (PT1000, PT100 or resistor value)
- 3-wire resistance input (PT1000, PT100 or resistor value)

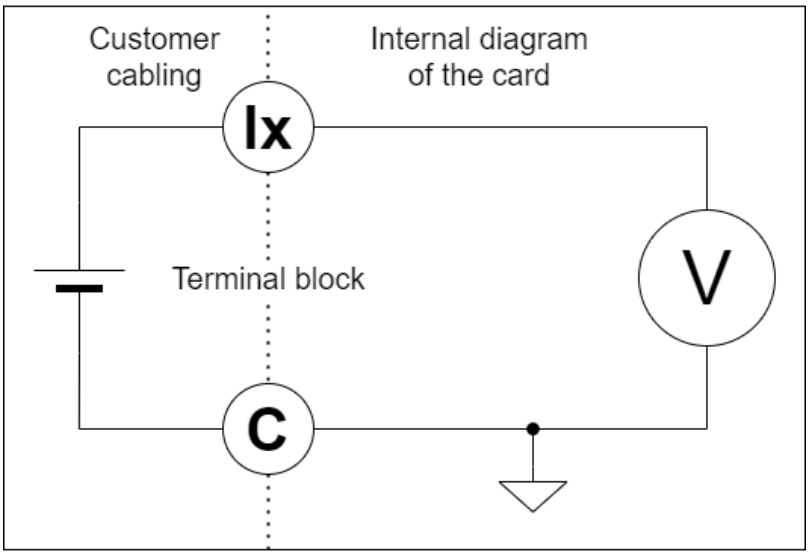
3.1.2 Features

- Selection of input mode (current or voltage) by configuration:
  - In Voltage input mode:
    - Impedance: > 100 kΩ
  - In 4-20 mA input mode:
    - Impedance: 49.9 Ω
- Protection: against 24 Vdc surge
- Precision: 0.01% of full scale at 25°C
- Resolution: 24 bits
- Insulation voltage:
  - channel-bus: 1.5 kV
  - between channels: No

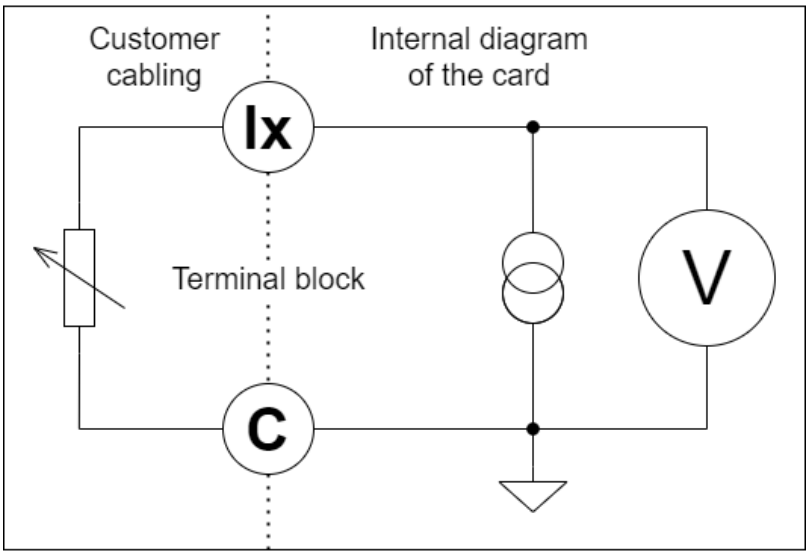
3.1.3 4-20 mA input



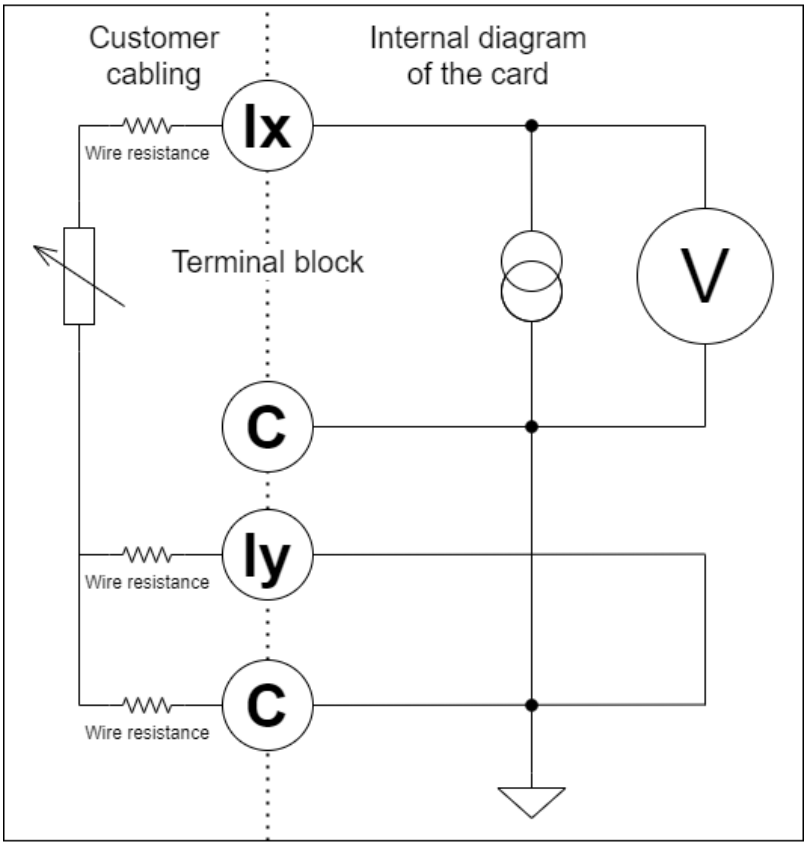
3.1.4 Voltage input (0-2V or 0-10V)



3.1.5 2-wire resistance input (PT1000, PT100 or resistor value)



3.1.6 3-wire resistance input (PT1000, PT100 or resistor value)



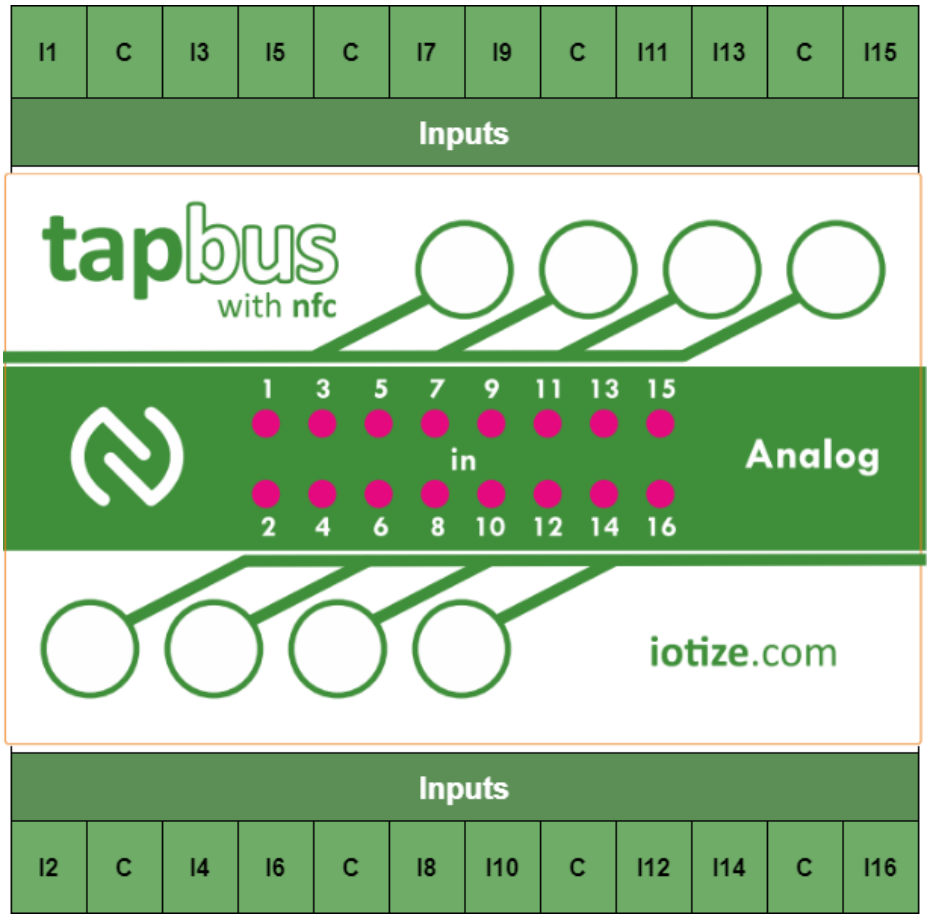
For 3 wire resistance inputs two analog inputs are used:

- The first one for the resistor measurement (same as for two-wire resistors).
- The second one for the wire resistance measurement. The value of the wire resistance is subtracted from the resistor value measured on first line.

Please find bellow the list of input peers for this mode:

Resistor IO signal	Wire resistance IO signal	IO Common
I1	**I3**	**C (GNDA)**
I2	**I4**	**C (GNDA)**
I5	**I7**	**C (GNDA)**
I6	**I8**	**C (GNDA)**
I9	**I11**	**C (GNDA)**
I10	**I12**	**C (GNDA)**
I13	**I15**	**C (GNDA)**
I14	**I16**	**C (GNDA)**

3.1.7 Input configuration



TapBus IO pin number	IO Type	IO Common	IO Signal
1	Analog Input	**C (GNDA)**	**I1**
2	Analog Input	**C (GNDA)**	**I2**
3	Analog Input	**C (GNDA)**	**I3**
4	Analog Input	**C (GNDA)**	**I4**
5	Analog Input	**C (GNDA)**	**I5**
6	Analog Input	**C (GNDA)**	**I6**
7	Analog Input	**C (GNDA)**	**I7**
8	Analog Input	**C (GNDA)**	**I8**
9	Analog Input	**C (GNDA)**	**I9**
10	Analog Input	**C (GNDA)**	**I10**
11	Analog Input	**C (GNDA)**	**I11**
12	Analog Input	**C (GNDA)**	**I12**
13	Analog Input	**C (GNDA)**	**I13**
14	Analog Input	**C (GNDA)**	**I14**
15	Analog Input	**C (GNDA)**	**I15**
16	Analog Input	**C (GNDA)**	**I16**

3.2 Radio communication channels

3.2.1 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.

Notes:

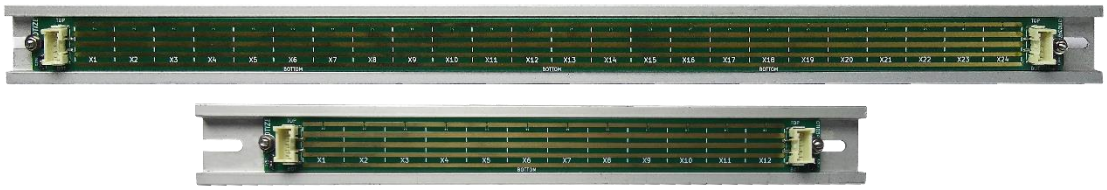
1. *Average speed while acquiring 1000 times 220 bytes from the target.*
2. *Measure line-of-site in an environment free of obstructions and rebound effects..*

3.3 Wired communication channel

For TapBus IO the following wired communication channels are available.

3.3.1 RS485 (modbus)

The communication between TapBus Power and the TapBus IO modules can be carried either by ribbon cables or by RailBus PCBs that are installed (screw fastening or gluing) directly at the bottom of a DIN rail. These modules are available in two lengths (250mm for 3 modules or 475mm for 6 modules). They can be easily chained:

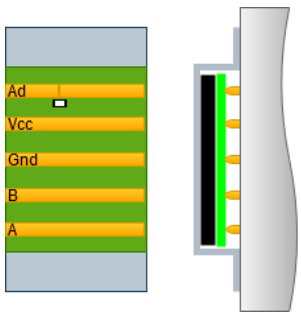


The RS-485 interface of the TapBus IO module has the following characteristics:

- Baud rate: up to 250 kbps (default: 115 kbps)
- Input Hysteresis: 100mV
- ESD protection:
  - Human-Body Model: +/-15kV
  - Air-gap discharge (IEC 61000-4-2): +/-15kV
  - Contact discharge (IEC 61000-4-2): +/-8kV

3.3.1.1 POGO pins

The POGO pins allows automatic connection to the TapBus fieldbus when a RailBus PCB is used. Double pins are used for the power supply at the TapBus Power side.

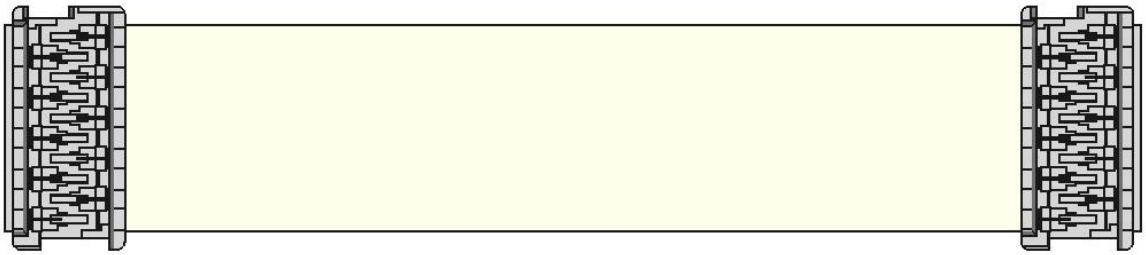


POGO pin number	RailBus signal
1	RS485_ADDR
2	VBUS
3	GND
4	RS485_B-
5	RS485_A+

3.3.1.2 Ribbon cable

This cable is an alternative to the RailBus PCB:

Type: Picoflex® PF-50 Standard Cable Harness
10 pos 1.27mm ribbon cable
Recommended P/N: 0923151010



Picoflex pin number	RailBus signal
1	GND
2	GND
3	RS485_A+
4	RS485_B-
5	VBUS
6	VBUS
7	NC
8	NC
9	RS485_ADDR
10	NC

3.4 Electrical characteristics

3.4.1 Power supply

The TapBus IO can be powered with a DC source:

- Maximum DC supply voltage: 12V
- Minimum DC supply voltage: 5V
- Standard DC supply voltage: 5V or 12V

3.4.2 Power consumption

The TapBus IO units are NFC Only products thus the power consumption does not depend on wireless communication but on I/O states and RS485 communications. The power consumption can differ greatly from one TapBus IO variant to another, please take this into account when specifying a TapBus bus. The TapBus voltage “VBUS” also has a significant impact on power consumption and must be chosen wisely.

Please note that the power consumption values below are average values and that brief power consumption peaks of several mA are to be expected.

The table below shows the power consumption for each functionality activated (I/O, peripherals, MCU mode) on the TapBus IO AI16:

Operating Mode	5V	12V
Factory reset[1]	33.6 mA	15.1 mA
Standby[2]	34.6 ~ 35 mA	15.3 mA
Idle[3]	40 ~ 40.6 mA	17.7 mA
Bus Exploration	40.5 ~ 43 mA	17.7 ~ 18.7 mA
RS485 Tx/Rx	40.5 ~ 45 mA	18 ~ 19.8 mA
Voltage Input	40 ~ 40.6 mA	17.7 mA
4-20 mA Input	40 ~ 40.6 mA	17.7 mA
2 wire resistance Input	41 ~ 42.5 mA	17.7 ~ 18.2 mA
3 wire resistance Input	41 ~ 42.5 mA	17.7 ~ 18.2 mA

Notes:

1. *The factory reset operating mode is defined by:*
    a. *MCU in run mode with no duetware configuration.*
    b. *No RS485 Tx/Rx.*
    c. *No analog input activated.*
2. *The standby operating mode is defined by:*
    a. *MCU in deep-sleep mode.*
    b. *No RS485 Tx/Rx.*
    c. *No analog input activated.*
3. *The ilde operating mode is defined by:*
    a. *MCU in run mode.*
    b. *No RS485 Tx/Rx.*
    c. *No analog input activated.*

3.5 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

3.6 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 both smaller than 48KB.

3.7 Low power modes

TapBus IO can be switched to low power mode. For now, only standby mode is available.

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

3.8 Temperature constraints

3.8.1 Operating temperature

The product has been tested to guarantee a correct operation in the range: **[-20°C, +70°C]**.

3.8.2 Storage temperature

The storage temperature range for this product is: **[-20°C, +70°C]**.

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

4 Software environment

Please refer to the 'user guide' available online on the IoTize online documentation. In this guide, you'll find:

- Information dedicated to the 'IoTize Studio' configuration,
- Information specific to the 'TapBus-App' starter application.
- Useful information to create your own mobile application dedicated to a particular environment.
- The information needed to connect a TapBus-Power module with a Cloud platform.

5 Hardware Description

5.1 Overview

Below is a presentation photo of the TapBus IO AI16 electronic boards and casing:

5.2 Electronic boards

Like all the modules, this one has three printed circuits, plus an optional one:

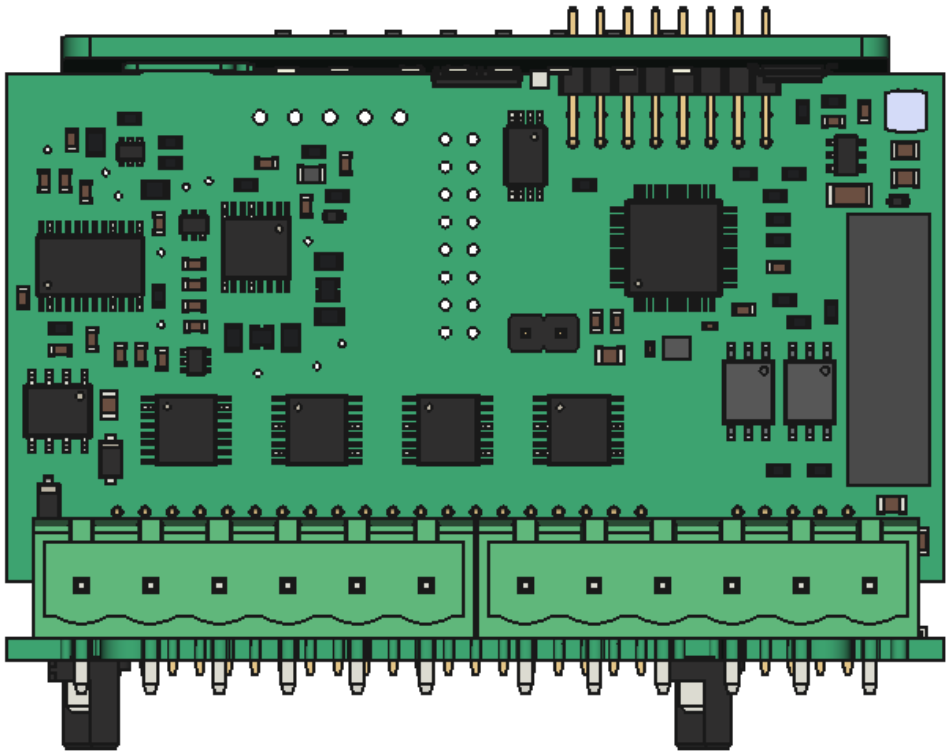
- A backplane board that contains:
  - The I/O and bus connectors.
  - All passive components for the analog inputs.
  - RS485 transceiver and Power generation for the “micro board”.
- A “micro” card which includes:
  - A MCU and a NFC transceiver
  - The ADC and input multiplexers
  - All electronic components to isolate the MCU and ADC the bus.
- A 'front panel' card that support an NFC antenna and the sixteen RGB leds (controlled by the MCU on the “micro” board).

5.2.1 Electronic boards size

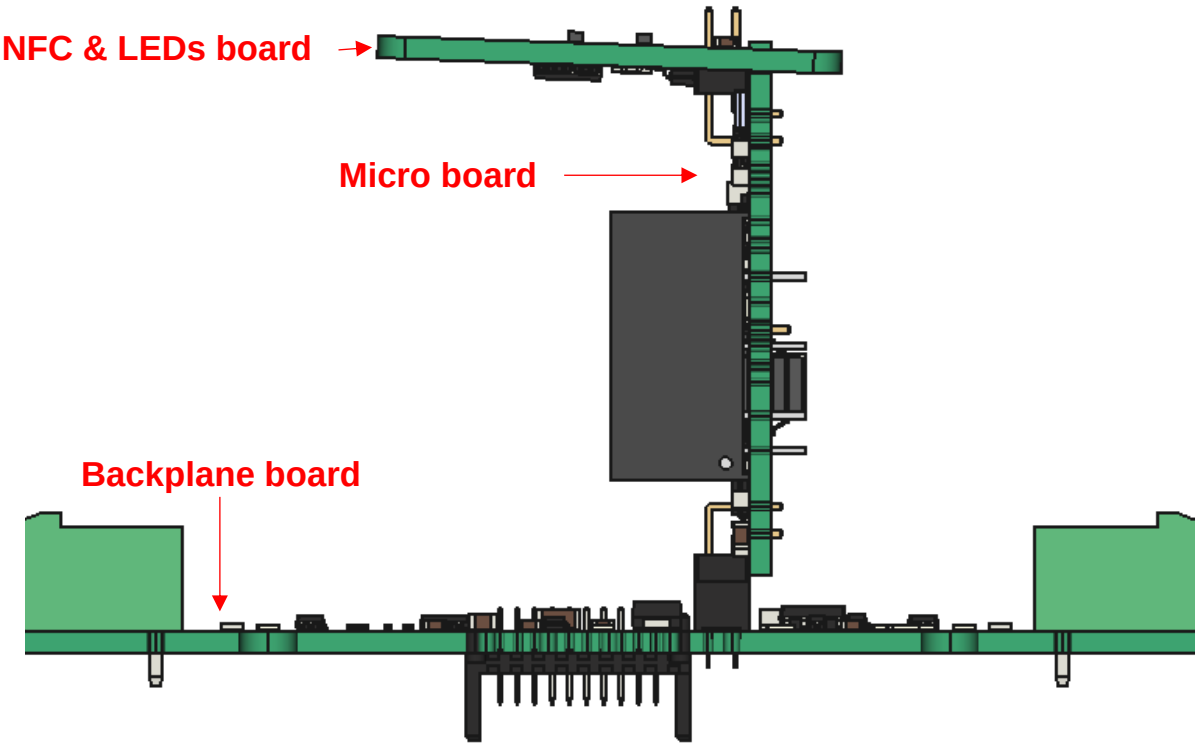
Backplane board:	L = 86.5 mm x W = 68 mm
“Micro” board:	L = 36.7 mm x W = 68 mm
NFC board:	L = 34 mm x W = 60 mm

5.2.2 Electronic boards placement

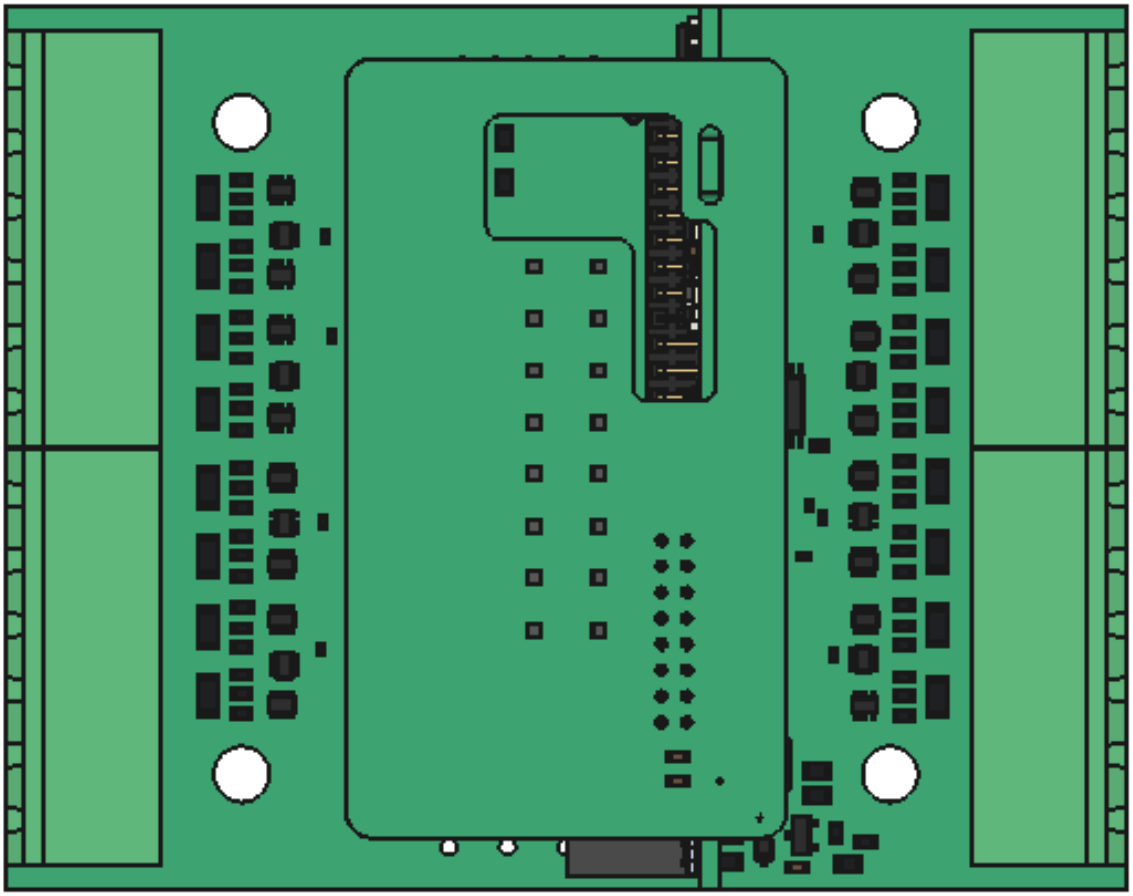
5.2.2.1 Front view



5.2.2.2 Side view



5.2.2.3 Top view



5.3 Hardware factory reset

WARNING: 'Factory Reset' hereafter means the complete erasure of the Duetware configuration. In particular, the file containing the Java code will also be deleted. You will then have to apply a new configuration generated from Iotize Studio.

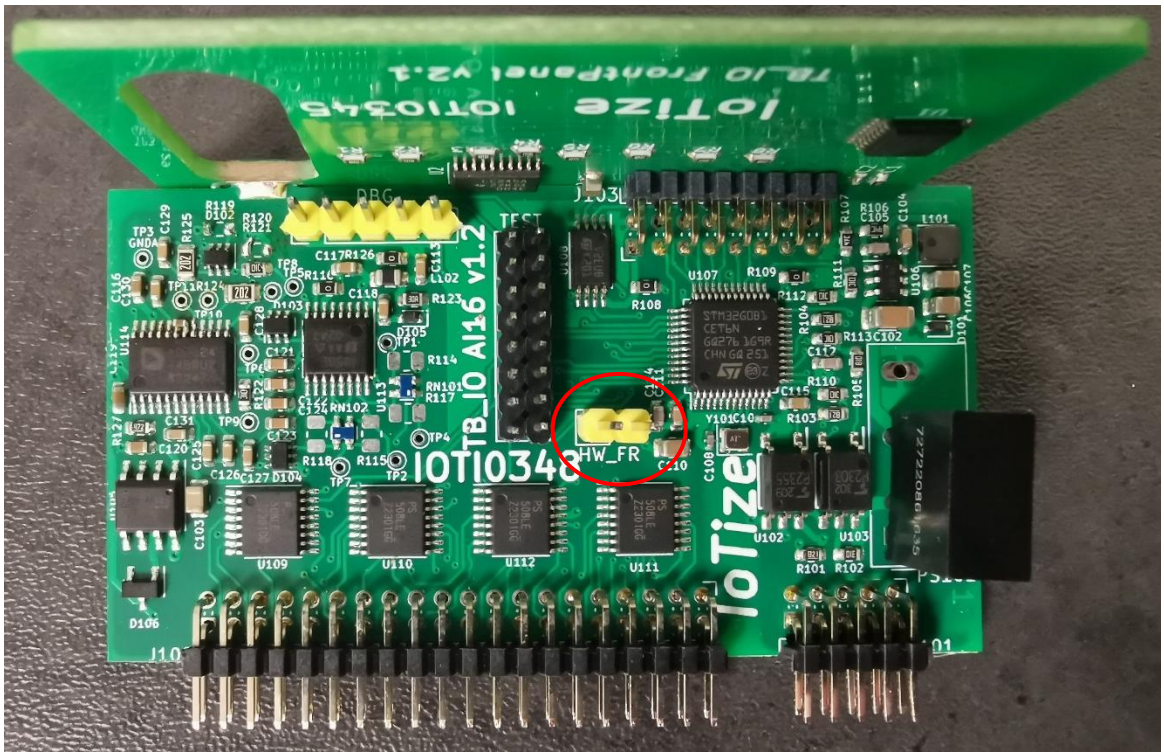
How to proceed?

A jumper is available on TapBus IO AI16 “MCU Board”, by default this jumper is not soldered 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 TapBus IO AI16 “**MCU Board**”:

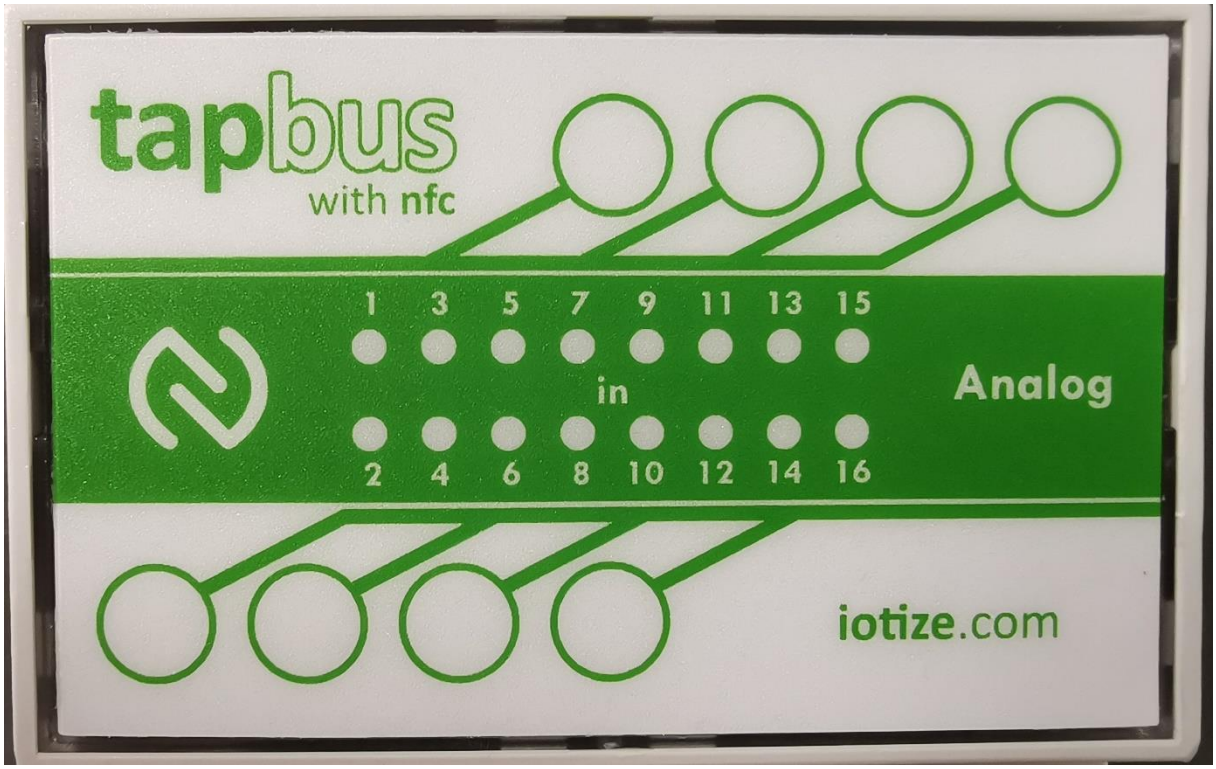


5.4 Configurable RGB LEDs

Sixteen RGB LEDs are available on the TapBus IO top board. These LEDs are not controlled by the firmware but fully configurable from the embedded Java Virtual Machine.

The default IoTize Studio & Java project for TapBus IO AI16 manage these LEDs. Moreover, it is possible to personalize the led management. The leds are used to display information about the corresponding I/O on the TapBus IO.

Below is a picture highlighting the location of the led on the **TapBus IO AI16**:



6 Mechanical characteristics

This case is UL94-V0.

Dimensions:	L = 98.0 mm x W = 71.2 mm x H = 58.0 mm
Weight (without terminal plugs):	138 g

7 Regulatory compliance

7.1 CE certification (Europe)

In testing, to be completed.

7.2 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).

7.3 FCC (USA)

In testing, to be completed.

7.4 IC (CANADA)

In testing, to be completed.

8 Ordering information

Example part number: **TpB-IO-AI16**[1]

Product Line	Product Type	I/O Interfaces
TpB	**IO**	**AI16**

Product Line: **TpB = TapBus**

Product Type:
PW = Power
IO = Input/Output

I/O interfaces:
LI = Logic Input
LO = Logic Output
TC = TIC Input
AI = Analog Input
W = Wattmeter Input
WT = Three Phase Wattmeter Input

Notes:

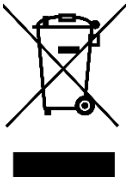
1. *The features of the part number shown in the table are indicated in bold.*

9 Appendices

9.1 EU Declaration of Conformity (DoC)

In testing, to be completed.

9.2 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 History

Date	Version	Author	Modification
May 2024	1.0	ES	Document creation.
May 2024	1.1	ES	Fix schema in Input configuration. Fix schema in Voltage input (0-2V or 0-10V) and 2-wire resistance input (PT1000, PT100 or resistor value).

About IoTize

IoTize is a French company based in Grenoble area:

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