# Pepper C1 EA
# User Manual

Manual version: V2.18[1]
03/07/2024

## Table of Contents

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[1] The newest User manual can be found on our website: https://eccel.co.uk/wp-content/downloads/Pepper_C1/C1_EA_User_manual.pdf
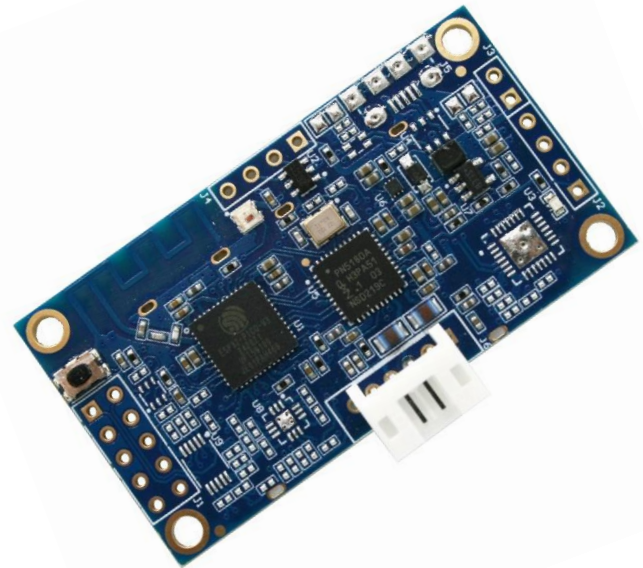
# 1. Introduction

## 1.1 Device Overview

### Features

- Low cost RFID Reader with MIFARE® Classic® in 1K, 4K memory, ICODE, MIFARE Ultralight®, MIFARE DESFire® EV1/EV2, MIFARE Plus® support
- Wireless connectivity:
  - Wi-Fi: 802.11 b/g/n
  - 2.4GHz wireless communication (WPAN)
  - **can be disabled by the user**
- Built-in Web Interface
- Over-The-Air lifetime updates
- Command interface via UART and TCP sockets
- UART baud rate up to 921600 bps
- Configurable RGB LED indicator for RFID events
- 6 configurable GPIOs
- Stand-alone mode (polling)
- IoT interfaces: MQTT, WebSocket, REST API
- High transponder read and write speed
- -25°C to 85°C operating range
- Multiple internal reference voltages
- RoHS compliant
- CE (RED) and UKCA compliant. FCC/ISED/PSE and other approvals easily obtained (see section 6)

### Applications

- Access control
- Monitoring goods
- Approval and monitoring consumables
- Pre-payment systems
- Managing resources
- Contact-less data storage systems
- Evaluation and development of RFID systems



### Description

The Pepper C1 is the first Eccel Technology Ltd (IB Technology) product with wireless connectivity by Wi-Fi 802.11b/g/n and WPAN (2.4GHz). Thanks to this, the customer receives free lifetime Over-the-Air updates, and of course the communication protocol can be used over TCP instead of traditional wired interface. Combining these features with standalone mode provides a ready to use device in many applications "straight out of the box". In standalone mode, the module can be easily integrated with IoT systems thanks to many IoT protocols like MQTT,REST API, TCP sockets and more.

So, this is an ideal design choice if the user wishes to add RFID capability to their design quickly and without requiring extensive RFID and embedded software expertise and time. An advanced and powerful 32-bit microcontroller handles the RFID configuration setup and provides the user with a powerful yet simple command interface to facilitate fast and easy read/write access to the memory and features of the various transponders supported by this module.

# 2. Electrical specification

## 2.1 Absolute maximum ratings

Stresses beyond the absolute maximum ratings listed in the table below may cause permanent damage to the device. These are stress ratings only, and do not refer to the functional operation of the device that should follow the recommended operating conditions.

| Symbol | Parameter | Min | Max | Unit |
|--------|-----------|-----|-----|------|
| $T_S$ | Storage temperature | -40 | +125 | °C |
| $T_A$ | Ambient temperature | -40 | +85 | °C |
| $V_{DDMAX}$ | Supply voltage (USB or J4 header) | 3 | 5.5 | V |

*Table 2-1. Absolute maximum ratings*

## 2.2 Operating conditions

| Symbol | Parameter | Min | Typ. | Max | Unit |
|--------|-----------|-----|------|-----|------|
| $T_S$ | Operating temperature | -25 | 25 | +85 | °C |
| H | Humidity | 5 | 60 | 95 | % |
| $V_{DD}$ | Supply voltage (USB or J4 header) | 3 | 5 | 5.5 | V |

*Table 2-2. Operating conditions*

## 2.3 DC characteristics ($V_{DD}$ = 5 V, $T_S$ = 25 °C)

| Symbol | Parameter | Min | Typ. | Max | Unit |
|--------|-----------|-----|------|-----|------|
| $V_{OUT}$ | Output voltage (regulator output, 3V3 pin on the J1 header) | 3.23 | 3.3 | 3.37 | V |
| $V_{IH}$ | High-level input voltage (J1 header) | 0.75 x $V_{OUT}$ | - | $V_{OUT}$ + 0.3 | V |
| $V_{IL}$ | Low-level input voltage (J1 header) | 0 | - | 0.3 x $V_{OUT}$ | V |
| $V_{OH}$ | High-level output voltage (J1 header) | 0.8 x $V_{OUT}$ | - | - | V |
| $V_{OL}$ | Low-level output voltage (J1 header) | - | - | 0.3 x $V_{OUT}$ | V |
| $V_{ORS232}$ | V output RS232 (J2 header, RS232_TX pin) | - | 5 | - | V |
| $V_{IRS232}$ | V input RS232 (J2 header, RS232_RX pin) | -25 | - | +25 | V |

*Table 2-3. DC characteristics*

## 2.4 Current consumption ($V_{DD}$ = 5V)

| Symbol | | | Parameter | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Wi-Fi enabled | Access Point mode | $I_{PN\_RFOFF\_AP}$ | RF field off (AP) | 150 | 170 | mA |
| | | $I_{PN\_RFON\_AP}$ | RF field on (AP) | 190 | 210 | mA |
| | Station mode | $I_{PN\_RFOFF\_STA}$ | RF field off (STA) | 75 | 95 | mA |
| | | $I_{PN\_RFON\_STA}$ | RF field on (STA) | 130 | 150 | mA |
| Wi-Fi Off | | $I_{PN\_RFOFF}$ | RF field off | 65 | 70 | mA |
| | | $I_{PN\_RFON}$ | RF field on | 120 | 140 | mA |

*Table 2-4. Current consumption*

# 3. Getting started

## 3.1 IO and peripherals



J3 header +5V output

Micro USB socket*
(only USB version)

J4 (UART0)
header

RGB LED

Button

RS232/485 header*
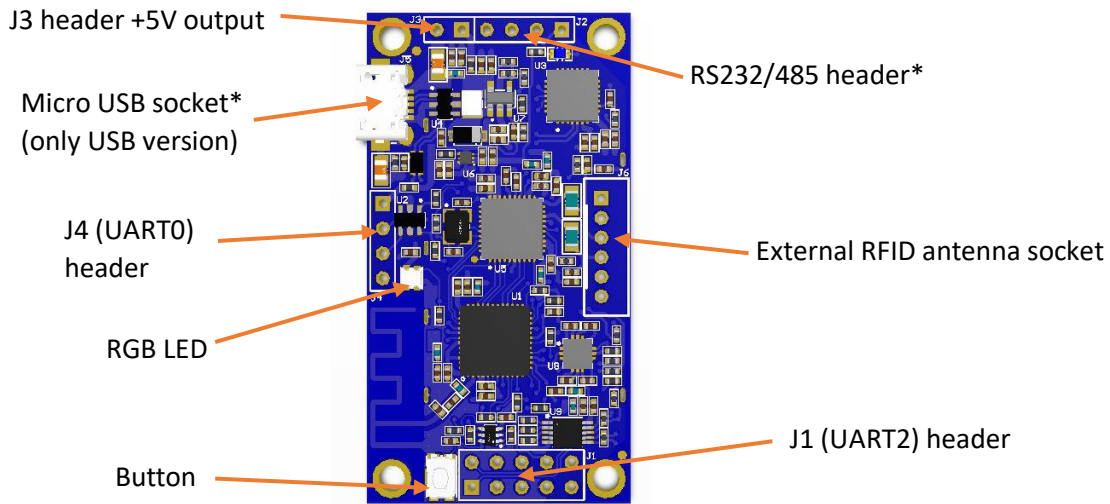
External RFID antenna socket

J1 (UART2) header

*Figure 3-1. Pepper C1 EA (External Antenna)*

*Micro USB socket – *only in USB version. Connected to the built-in USB to TTL converter. This converter is routed to the UART0 header.*
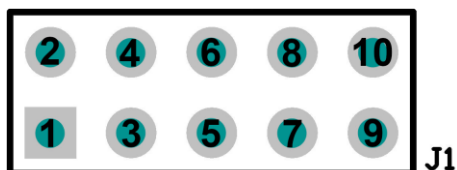*RS232/485 header – *this connection is for optional built in RS232/485 converter. These options are available here:*
https://eccel.co.uk/product/pepper-wireless-c1-ea-rs232/
https://eccel.co.uk/product/pepper-wireless-c1-ea-rs485/

### 3.1.1 J1 header description

Initially, the C1 readers had components on both sides of the PCB which created some SMT assembly issues. So, in 2022 we decided to redesign the PCB and move all components onto the top side. We also changed the MCU from ESP32-D0WDQ6 to ESP32 PICO V3. Because of that, some pins on the J1 headers have different GPIO numbers. All functionalities are still the same – just GPIO numbers are a bit different.

| | Pepper C1 v1.x | Pepper C1 v2.x |
|---|---|---|
| 1 | UART2 TX / GPIO 27 | UART2 TX / GPIO 27 |
| 2 | UART2 RX / GPIO 25 | UART2 RX / GPIO 25 |
| 3 | GPIO 34 / ADC 01 | GPIO 34 / ADC 01 |
| 4 | GPIO 35 / ADC 02 | GPIO 35 / ADC 02 |
| 5 | GPIO 4 | GPIO 2 |
| 6 | GPIO 5 | GPIO 21 |
| 7 | GND | GND |
| 8 | 3.3V Output | 3.3V Output |
| 9 | GPIO 16 | GPIO 32 |
| 10 | GPIO 17 | GPIO 33 |

### 3.1.2 J2 header description (RS232 version only)

1. **Not connected**
2. **Not connected**
3. **RS232 RX** (from host to the C1, max input voltage level ±25V)
4. **RS232 TX** (from the C1 to host, max output voltage level ±5V)

### 3.1.3 J2 header description (RS485 version only)

By default, the Pepper C1 reader is working in full duplex mode using all four wires for RS485 communication. For half duplex communication pins A+Y and B+Z should be connected together.

1. **A** Noninverting Receiver Input
2. **B** Inverting Receiver Input
3. **Z** Inverting Driver Output
4. **Y** Noninverting Driver Output

### 3.1.4 J3 header description

The J3 header is an additional power supply output socket.

1. **+5V output** (100mA)
2. **GND**

### 3.1.5   J4 UART0 header

This is the UART0 header in the TTL standard with 3.3V levels. This is the same UART as it available on the USB port in the USB version.

1. **Vin** – Power supply, 3-5.5Voltage
2. **UART0 TX** – UART TX data from the module
3. **UART0 RX** – UART RX data to the module
4. **GND**

### 3.1.6   J6 External RFID antenna header (Pepper C1 EA)

The user needs to connect an external RFID antenna to the Pepper C1 EA device. Eccel Technology Ltd provides a variety of RFID antennas which the user can use together with this device.

https://eccel.co.uk/product-category/antennas/hf-13-56-mhz-antennas/ (the green ones)

## 3.2   Typical connection

The Pepper C1 EA device can be connected to a host computer using a standard USB micro cable. In the same way it can be powered to operate as a standalone device by using power sources such as a USB charger or power bank.

The computer operating system should recognize this device as a USB to TTL bridge or a USB to Serial port converter and it should appear in Windows device manager as a COM port. By default this COM port can be used for communication using the binary protocol described below.

The Reader also has the UART2 interface (J1 header) where the user can view console logs which contain additional information about temporary executing commands. The default configuration: baud: 115200, Data: 8 bit, Parity: none, Stop bits: 1 bit, Flow Control: none.
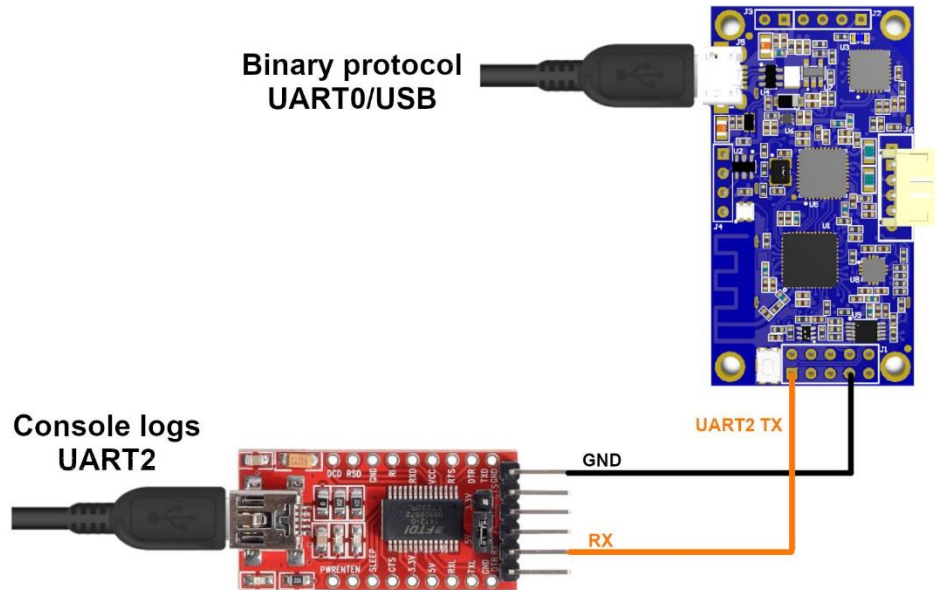
*Figure 3-2. Typical connection to see the console logs on UART2*

**Hint** – *If you don't have a USB-UART converter to see the logs on the UART2 (J1 header), you can temporary change the default log interface from UART2 to UART0 in the Web Interface (Communication->UART tab). Then, the logs should be available on the USB port (in case of the Pepper C1 USB reader).*



*Figure 3-3. Console logs on the UART0/USB port*

*Figure 3-4. Pepper C1 EA UART - typical connection with the USB-UART converter*
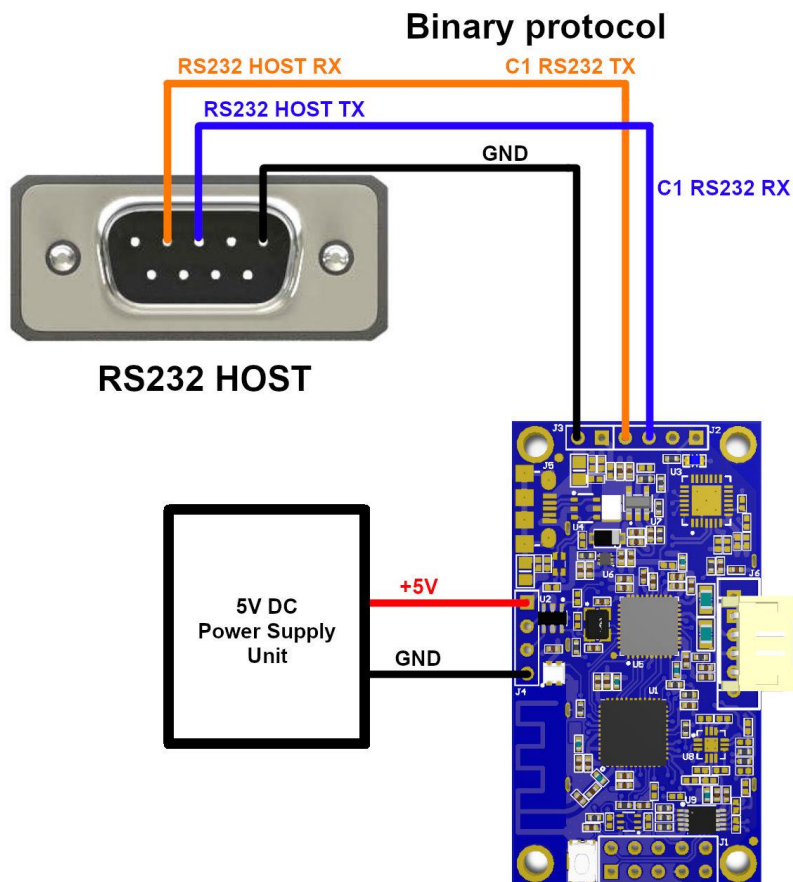


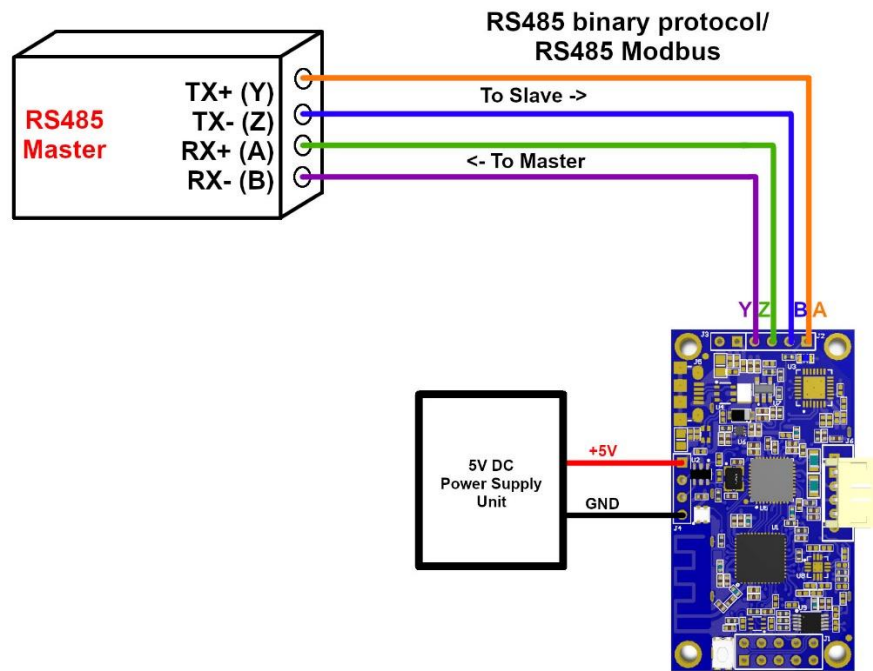*Figure 3-5. Pepper C1 EA RS232 - typical connection with the RS232 host device*

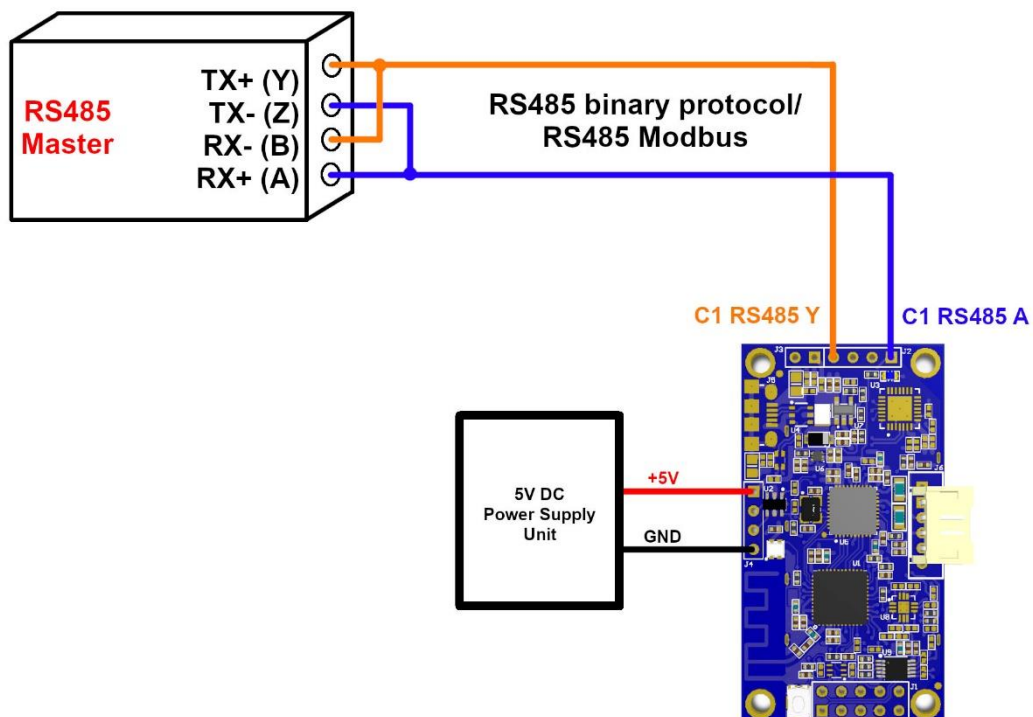*Figure 3-6. Pepper C1 RS485 - Full duplex connection with the RS485 Master device*



*Figure 3-7. Pepper C1 RS485 - half duplex connection with the RS458 Master device*
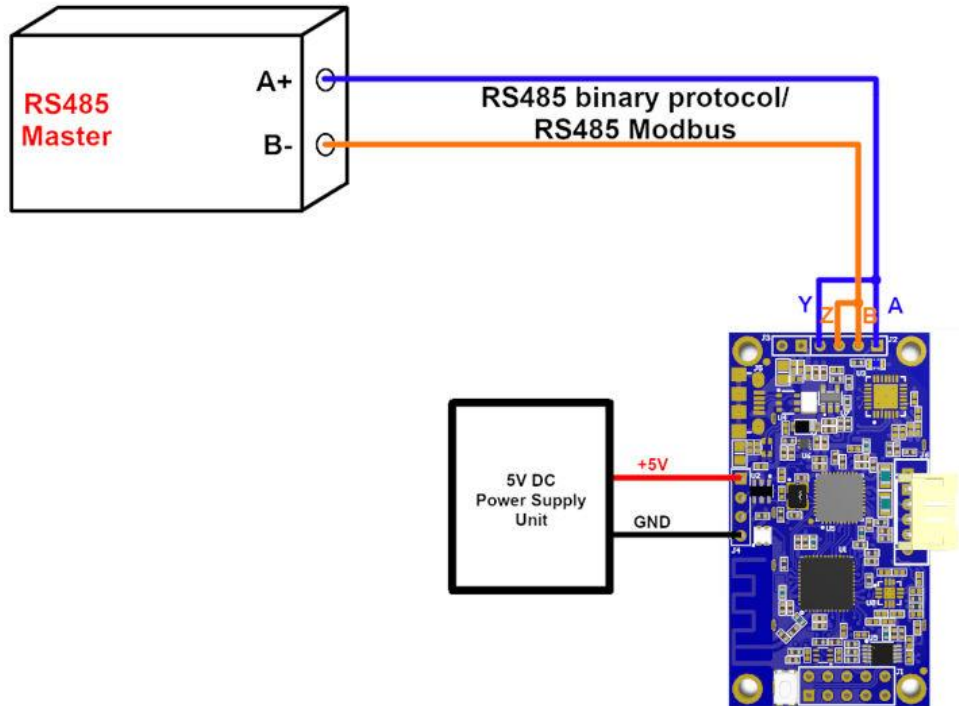
*Figure 3-8. Pepper C1 EA RS485 - half duplex example*

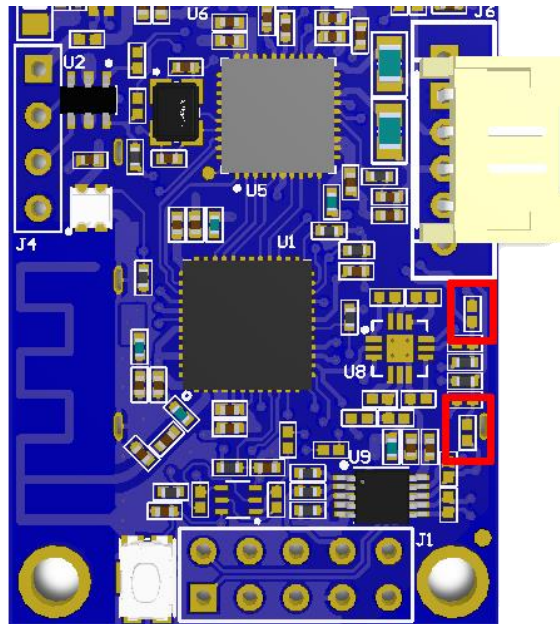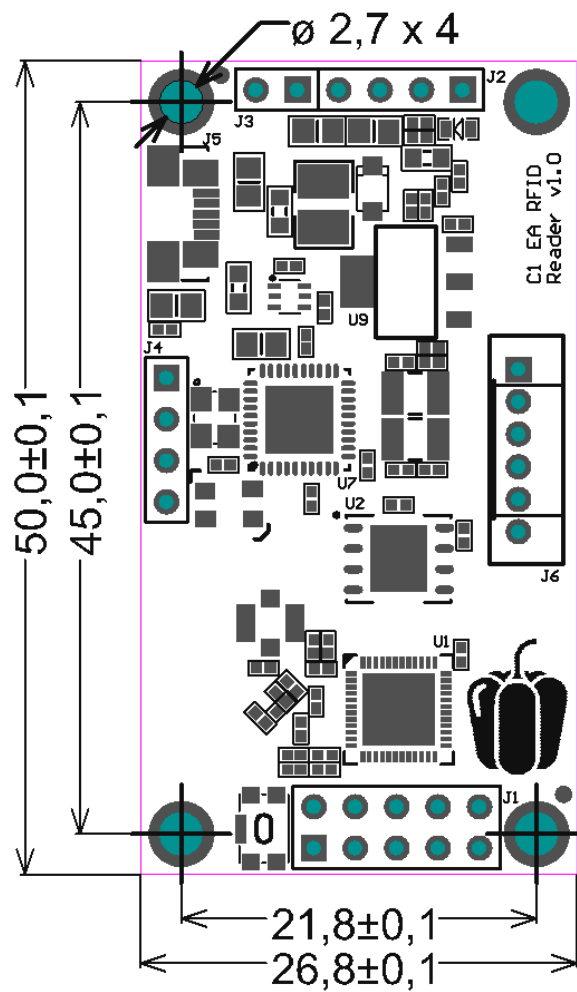The user can make jumpers between A – Y and B – Z pins by placing two 0R resistors here:



*Figure 3-9. Pepper C1 EA RS485 v2 - jumpers between A-Y and B-Z pins*

# 4. Mechanical dimension

All dimensions are in mm.

# 5. Configuration and functional description

Here is the document describing configuration, communication protocol, commands and all functions of the Pepper C1 EA reader:

https://eccel.co.uk/wp-content/downloads/Pepper_C1/C1_software_manual.pdf


Eccel provides a variety of free tools & libraries ready to be downloaded from this link:

https://eccel.co.uk/support-free-libraries/

# 6. RF Emissions and Susceptibility Approvals

Eccel have tested and declare that this product meets all the requirements of the relevant RF directives (RED) to be declared CE (European Union) and UKCA (United Kingdom) compliant.  Please see our declaration of conformity for this on the downloads tab of the product webpage.

This product is designed to be incorporated into products easily and quickly such that those products can pass any national or regional statutory RF requirements and certifications such as FCC (USA), ISED (Canada) and PSE (Japan) for example.

This product is designed to meet all statutory RF requirements applicable worldwide using the most cost effective but robust design methodology.

Eccel is pleased to offer customers very cost-effective certification for their end equipment that incorporate this product. Prices start from £3K per approval/ certification.  Please contact us for more details at sales@eccel.co.uk .

# 7. Revision history

| Revision | Date | Changes |
|----------|------|---------|
| 2.18 | 3-Jul-2024 | Section 1.1 updated |
| 2.17 | 3-Apr-2024 | First release after splitting software and hardware description |

MIFARE, MIFARE Ultralight, MIFARE Plus, MIFARE Classic, and MIFARE DESFire are trademarks of NXP B.V.


**No responsibility is taken for the method of integration or final use of the C1 readers**

More information about the C1 EA reader and other products can be found at the Internet site:

# http://www.eccel.co.uk

or alternatively contact ECCEL Technology (IB Technology) by e-mail at:

# sales@eccel.co.uk