Pepper C1 MUX User Manual

Manual version: V2.16[1]
2/04/2024

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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_MUX_User_manual.pdf

1. Introduction

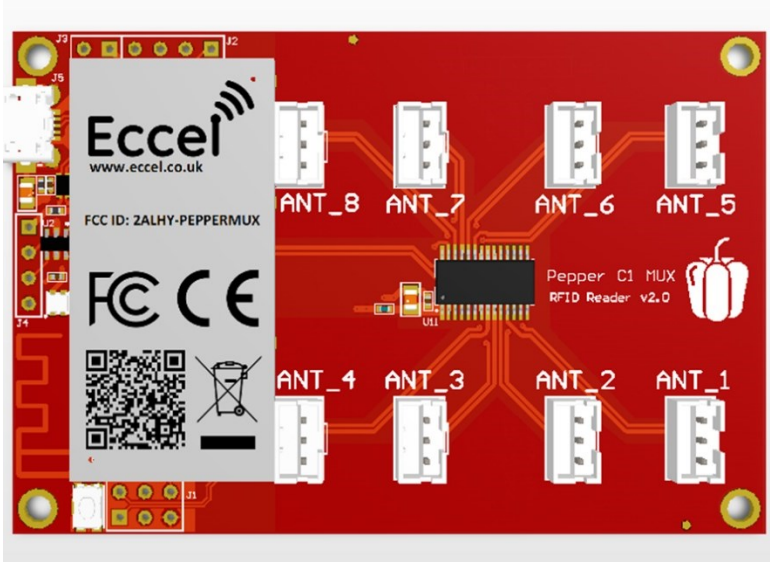
1.1 Device Overview

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
  - Bluetooth SPP profile, BLE HID, and custom BLE service
  - can be disabled by the user
- Built in Web Interface
- Over-the-Air lifetime updates
- UART baud rate up to 921600 bps
- Configurable RGB LED indicator for RFID or Wi-Fi events
- Stand-alone mode (polling) up to 8 external antennas
- Antenna selection by one simple command
- IoT interfaces: MQTT, WebSocket
- 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 15)

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 MUX module is the multiplexed version of the Pepper C1 – the first Eccel Technology Ltd product with wireless connectivity connectivity by Wi-Fi 802.11b/g/n and Bluetooth SPP profile. The user can connect up to 8 external RFID antennas. Thanks to the wireless connectivity, the customer receives free lifetime Over-the-Air updates, and of course the communication protocol can be used over TCP instead of the traditional UART/USB interface. Combining these features with standalone mode provides a “straight out of the box” ready to use device for many application. 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. This facilitates 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
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_{Op}	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	5.4	V
V_{IRS232}	V input RS232 (J2 header, RS232_RX pin)	-25	-	+25	V

Table 2-3. DC characteristics

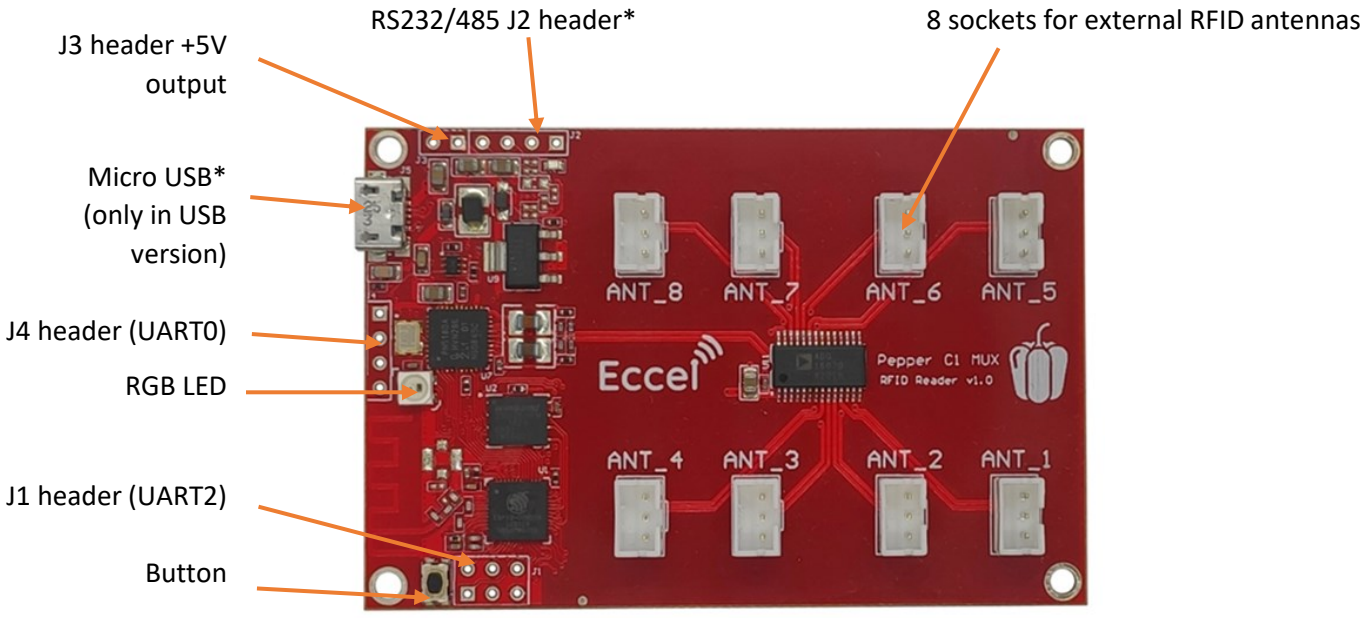
2.4 Current consumption (V_{DD} = 5V)

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 disabled	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

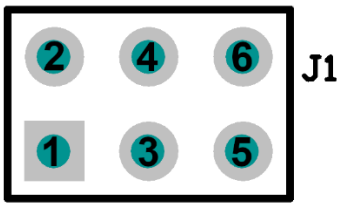
3.1 IO and peripherals



*Micro USB – *only in USB version. Connected internally to the built in USB to TTL converter. This converter is routed to the UART0 header.*

*RS232/RS485 header – *this connection is for optional built in RS232/RS485 converter. These options are available here:*
https://eccel.co.uk/product/pepper-c1-mux-rs232/
https://eccel.co.uk/product/pepper-c1-mux-rs485/

3.1.1 J1 header description



1. **UART2 TX/GPIO27** (3.3V level)
2. **UART2 RX/GPIO25** (3.3V level)
3. **GPI 34** (input only)
4. **GPI 35** (input only)
5. **GND**
6. **3.3V otuput**

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

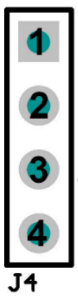
3.1.4 J3 header description

The J3 header is an additional power supply output socket. The maximum output current depends on the power supply connected to the J4 Vin pin, and is estimated as 100mA.

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

3.1.5 J4 UART0 header description

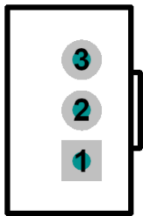
This is the UART0 header in the TTL standard with 3.3V levels. This is the same UART as it available on the USB port in the USB version.



1. **Vin** – Power supply, 3.3V – 5V
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 antenna header

The user has the possibility to work with up to 8 external RFID antennas simultaneously. 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/ (only red ones).



1. **GND**
2. **TX1** – Antenna driver output
3. **TX2** – Antenna driver output

3.2 Typical connection

The Pepper C1 MUX 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 new COM port (for example COM3). By default this COM port can be used for communication using the binary protocol described below.

The Reader also has the UART2 connector (J1 header) where the user can view output 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.

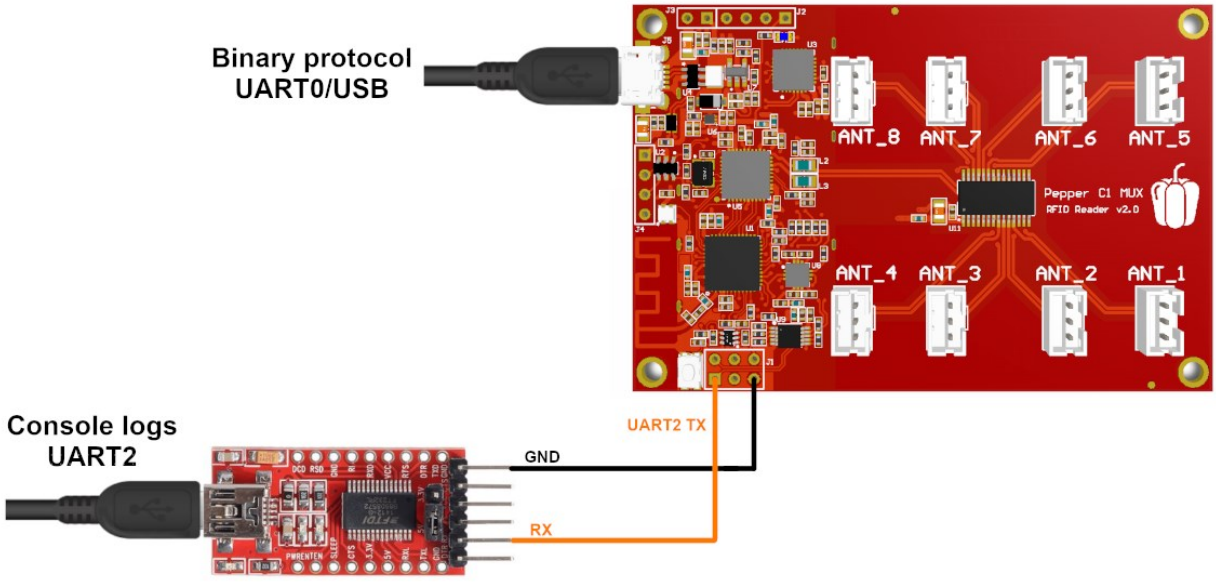


Figure 3-1. Typical connection to see console logs on UART2

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 MUX USB reader).*

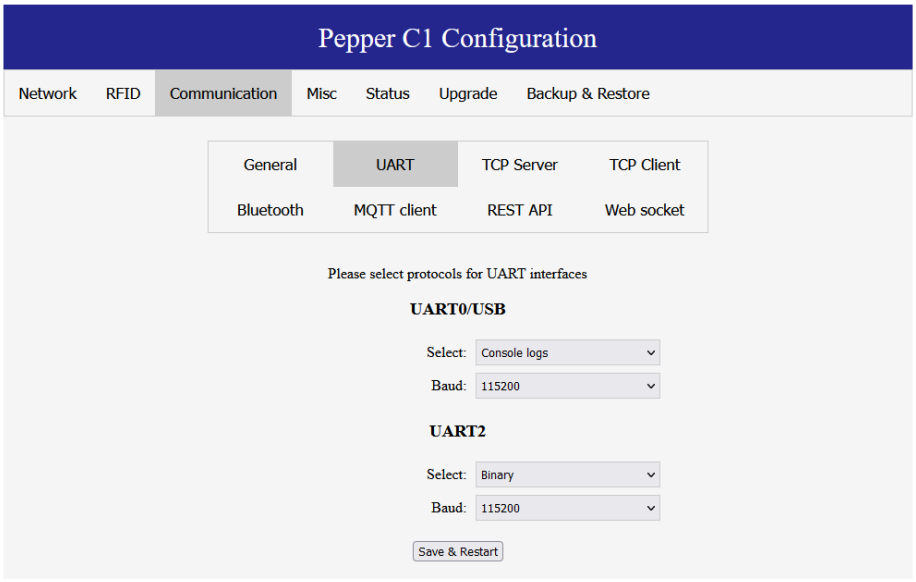


Figure 3-2. Console logs on the UART0/USB

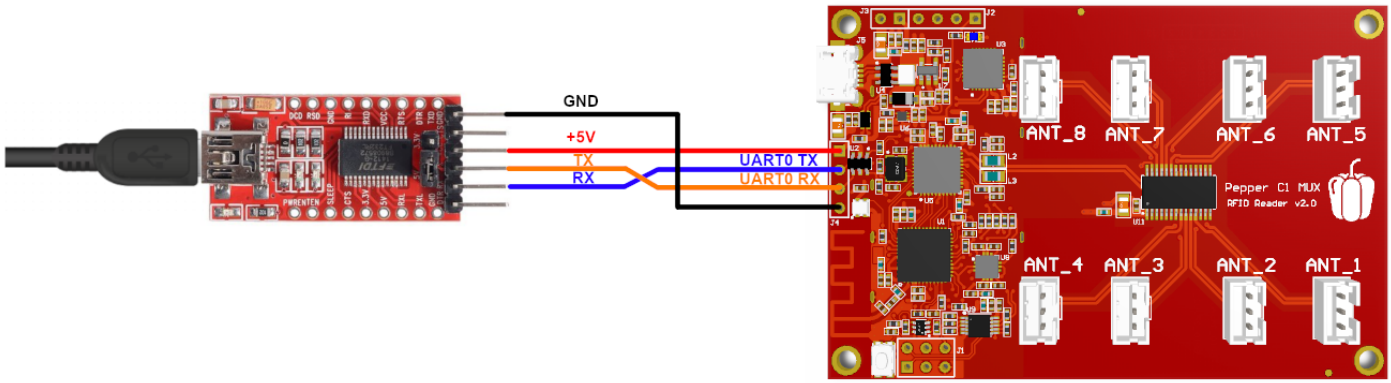


Figure 3-3. Pepper C1 MUX - schematic connection with the USB-UART converter

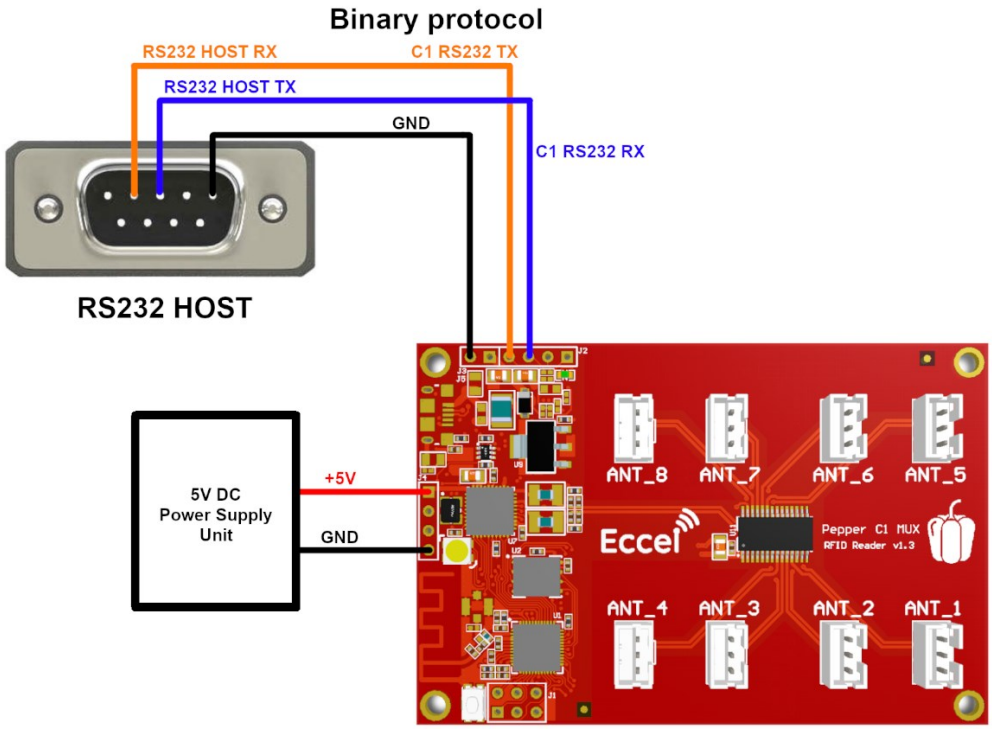


Figure 3-4. Pepper C1 MUX RS232 - typical connection with the RS232 host device

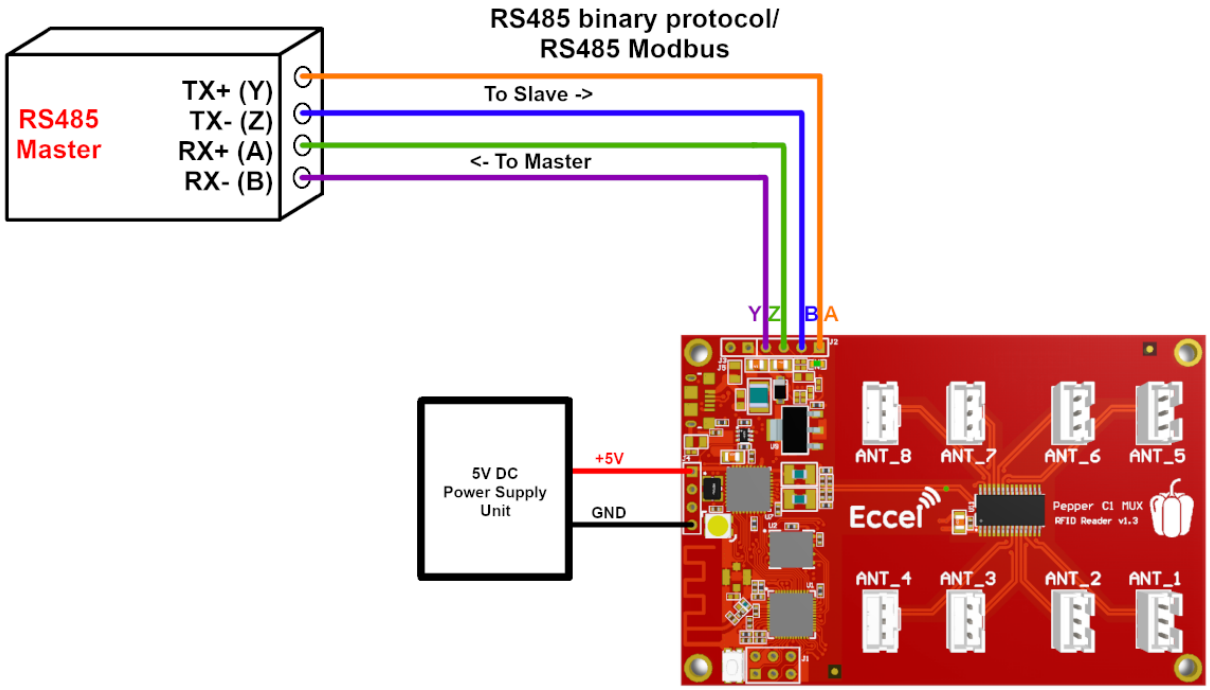


Figure 3-5. Pepper C1 RS485 - full duplex connection example

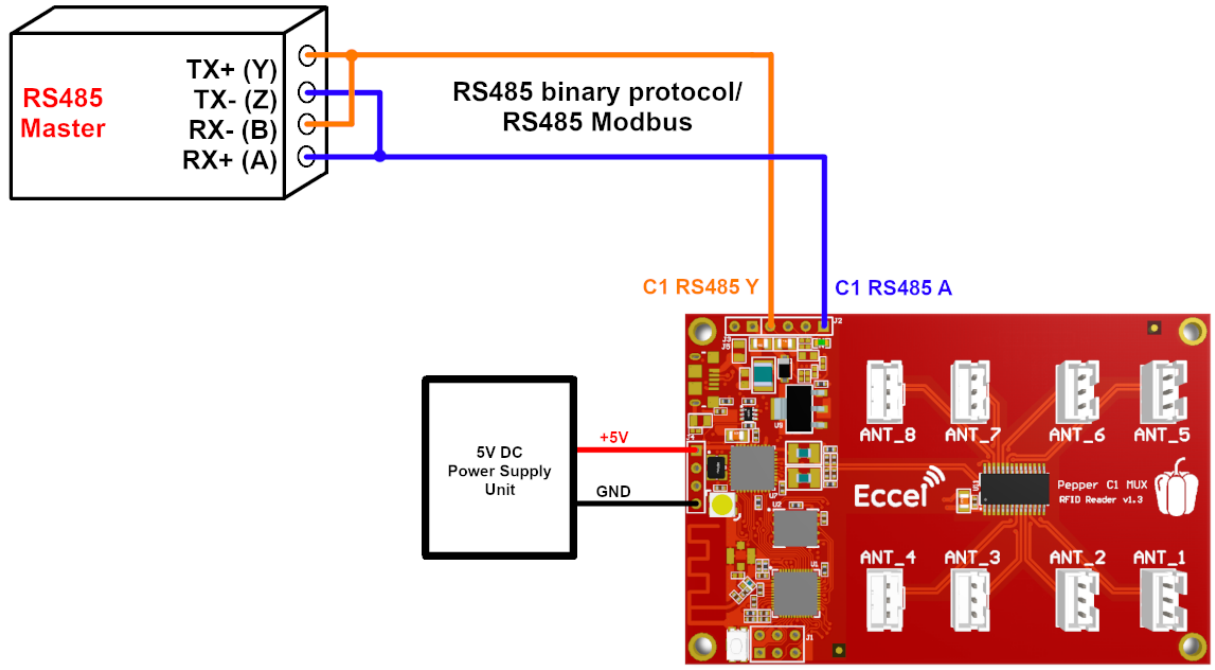


Figure 3-6. Pepper C1 MUX RS485 - half duplex connection schematic

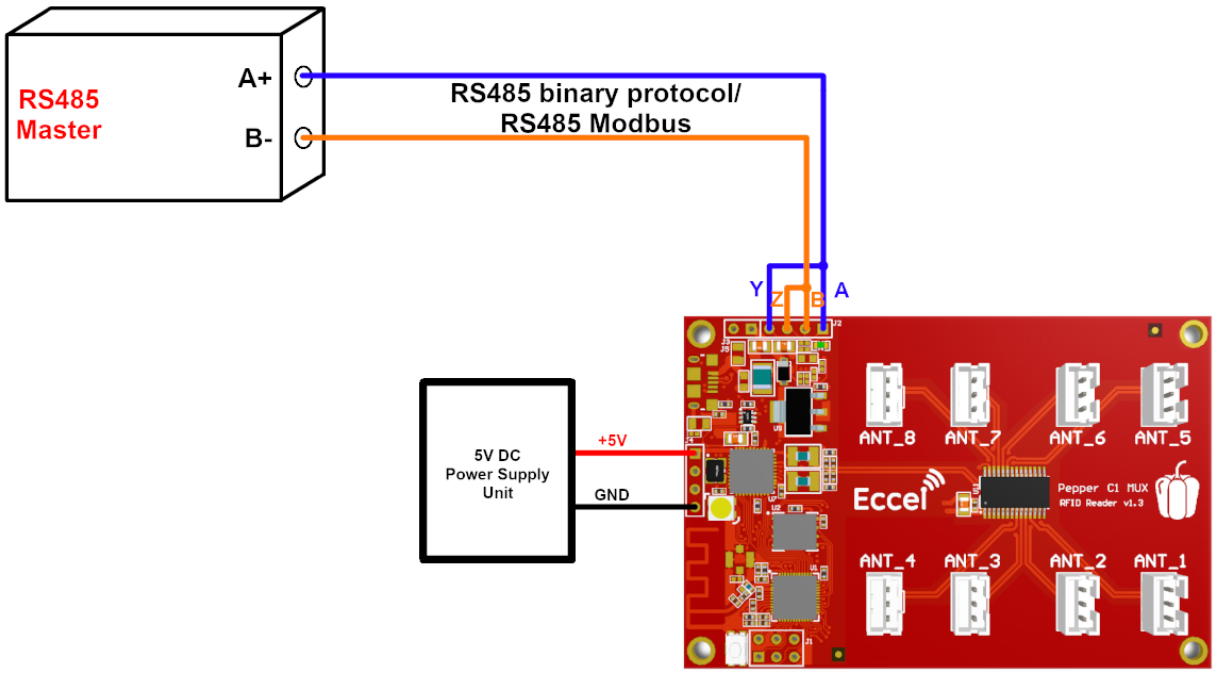


Figure 3-7. Pepper C1 MUX RS485 - half duplex connection schematic

4. Mechanical dimension

All dimensions are in mm.

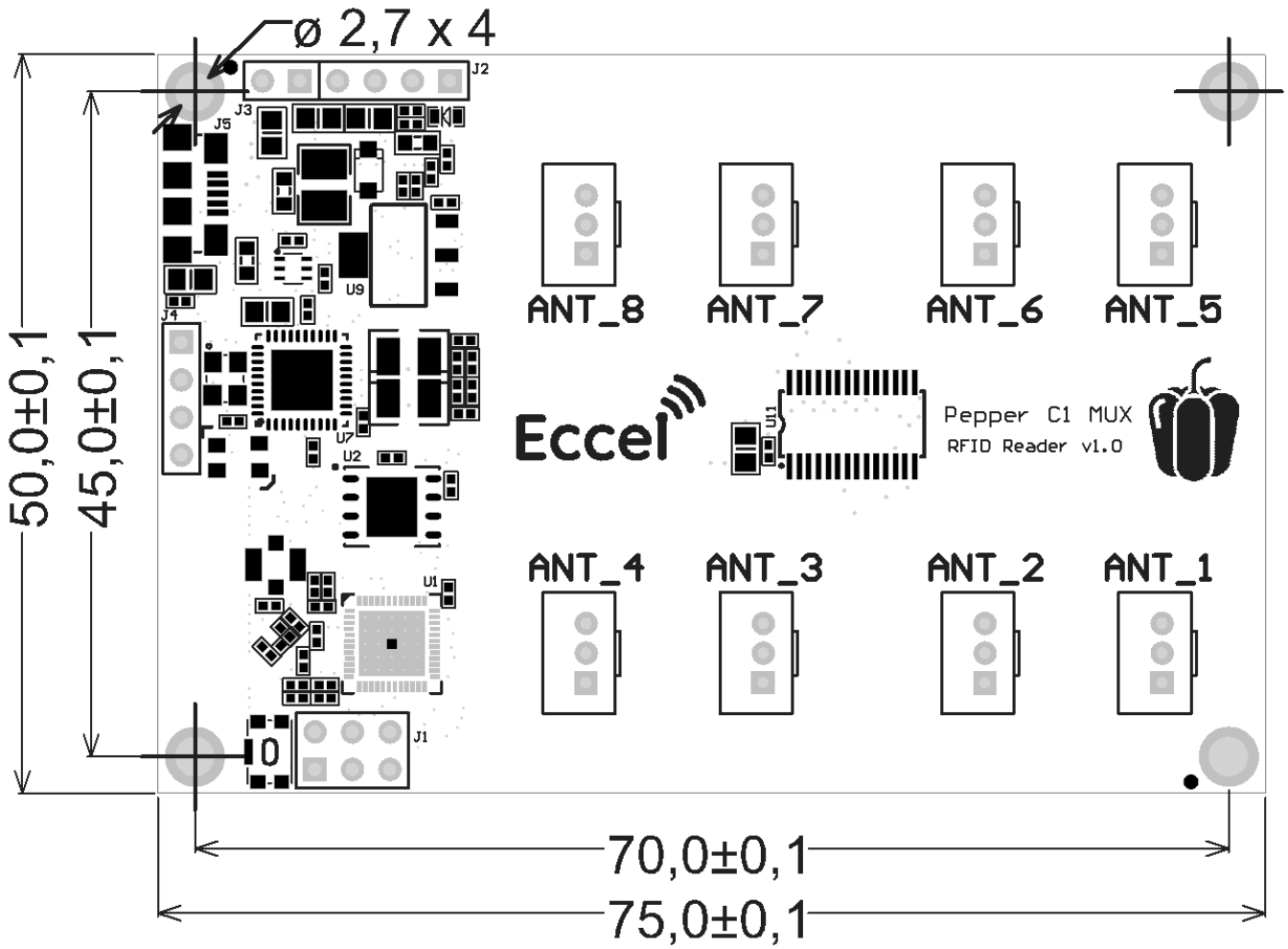


Figure 4-1

5. Configuration and functional description

Here is the document describing configuration, communication protocol, commands and all functions of the Pepper C1 MUX 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. FCC 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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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 the equipment and receiver.
- 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 important announcement Important Note:

Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. Country Code selection feature to be disabled for products marketed to the US/Canada.

This device is intended only for OEM integrators under the following conditions:

1. The antenna must be installed such that 20cm is maintained between the antenna and users, and
2. The transmitter module may not be co-located with any other transmitter or antenna,

Important Note:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labelling

The final end product must be labelled in a visible area with the following" Contains FCC ID: 2ALHY-PEPPERMUX"

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C has been investigated. It is applicable to the modular transmitter

2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

2.4 Limited module procedures
Not applicable

2.5 Trace antenna designs
Not applicable

2.6 RF exposure considerations

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

2.7 Antennas
This radio transmitter **FCC ID:2ALHY-PEPPERMUX** has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna No.	Model no of antenna	Type of antenna	Gain of antenna(dBi)	Frequency range(MHz)
bluetooth	/	PCB Antenna	-13.43	2402-2483.5
2.4G WIFI	/	PCB Antenna	-13.43	2402-2483.5
NFC 1	80x80mm x800	PCB Track Loop Antenna	0	13.56
NFC 2	80x80mm x300	PCB Track Loop Antenna	0	13.56
NFC 3	50x50mm x800	PCB Track Loop Antenna	0	13.56
NFC 4	50x50mm x300	PCB Track Loop Antenna	0	13.56
NFC 5	25x25mm x800	PCB Track Loop Antenna	0	13.56
NFC 6	25x25mm x300	PCB Track Loop Antenna	0	13.56
NFC 7	10x50mm x800	PCB Track Loop Antenna	0	13.56
NFC 8	10x50mm x300	PCB Track Loop Antenna	0	13.56

2.8 Label and compliance information
The final end product must be labeled in a visible area with the following" Contains **FCC ID:2ALHY-PEPPERMUX**".

2.9 Information on test modes and additional testing requirements
Host manufacturer which install this modular with single modular approval should perform the test of radiated emission and spurious emission according to FCC part 15C:15.247, FCC part 15.225 and 15.209 requirement, only if the test result comply with FCC part 15.247, FCC part 15.225 and 15.209 requirement, then the host can be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.

2.11 Note EMI Considerations

Host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

2.12 How to make changes

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. According to the KDB 996369 D02 Q&A Q12, that a host manufacture only needs to do an evaluation (i.e., no C2PC required when no emission exceeds the limit of any individual device (including unintentional radiators) as a composite. The host manufacturer must fix any failure.

7. Revision history

Revision	Date	Changes
2.16	2-Apr-2024	First release after splitting software and hardware description

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

More information about the C1 MUX 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