Pepper C1 Module (FCC approved) User Manual

Manual version: V1.5[1]
03/07/2024

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[1] The newest User manual can be found on our website: https://eccel.co.uk/wp-content/downloads/Pepper_C1/Pepper_C1_FCC_Module_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
- 6 configurable GPIOs
- Stand-alone mode (polling)
- IoT interfaces: MQTT, WebSocket, REST API, TCP Client/Server
- High transponder read and write speed
- -25°C to 85°C operating range
- Multiple internal reference voltages
- RoHS compliant
- FCC approved
- CE (RED) and UKCA compliant

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 module is one of the family of Eccel Technology Ltd (IB Technology) products with wireless connectivity by Wi-Fi 802.11 b/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 UART 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 (Pin number 8)	3	3.6	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 (Pin number 8)	3	3.3	3.6	V
V_{RFID}	RFID supply voltage (Pin number 1)	3	3.3/5	5.5	V

Table 2-2. Operating conditions

2.3 DC characteristics (V_{DD} = 3.3V, T_S = 25 °C)

Symbol	Parameter	Min	Typ.	Max	Unit
V_{IH}	High-level input voltage (Any GPIO)	0.75 x V_{DD}	-	V_{DD} + 0.3	V
V_{IL}	Low-level input voltage (Any GPIO)	0	-	0.3 x V_{DD}	V
V_{OH}	High-level output voltage (Any GPIO)	0.8 x V_{DD}	-	-	V
V_{OL}	Low-level output voltage (Any GPIO)	-	-	0.3 x V_{DD}	V

Table 2-3. DC characteristics

2.4 Current consumption (3.3V on pins 1 and 8)

Symbol			Parameter	Typ.	Max	Unit
Wi-Fi enabled	Access Point mode	$I_{PN\_RFOFF\_AP}$	RF field off (AP)	135	155	mA
		$I_{PN\_RFON\_AP}$	RF field on (AP) (500 ms polling)	145	165	mA
			RF field on (AP) (200 ms polling)	155	175	mA
	Station mode	$I_{PN\_RFOFF\_STA}$	RF field off (STA)	60	80	mA
		$I_{PN\_RFON\_STA}$	RF field on (STA) (500 ms polling)	70	90	mA
			RF field on (STA) (200 ms polling)	80	100	mA
Wi-Fi Off		I_{PN_RFOFF}	RF field off	55	75	mA
		I_{PN_RFON}	RF field on (500 ms polling)	60	80	mA
			RF field on (200 ms polling)	65	85	mA
I_{DSM}			Deep Sleep Mode	90	100	uA

Table 2-4. Current consumption

2.5 Current consumption (3.3V on pin 8 and 5V on pin 1)

Symbol			Parameter	V_{DD} = 3.3V		V_{RFID} = 5V		Unit
				Typ.	Max	Typ.	Max	
Wi-Fi enabled	Access Point mode	$I_{PN\_RFOFF\_AP}$	RF field off (AP)	135	155	0*	0*	mA
		$I_{PN\_RFON\_AP}$	RF field on (AP) (500 ms polling)	136	156	12	22	mA
			RF field on (AP) (200 ms polling)	137	157	25	35	mA
	Station mode	$I_{PN\_RFOFF\_STA}$	RF field off (STA)	60	80	0*	0*	mA
		$I_{PN\_RFON\_STA}$	RF field on (STA) (500 ms polling)	62	82	12	22	mA
			RF field on (STA) (200 ms polling)	63	83	25	35	mA
Wi-Fi Off		I_{PN_RFOFF}	RF field off	55	75	0*	0*	mA
		I_{PN_RFON}	RF field on (500 ms polling)	57	77	12	22	mA
			RF field on (200 ms polling)	58	78	25	35	mA
		I_{DSM}	Deep Sleep Mode	90	100	0*	0*	uA

Table 2-5. Current consumption

* 50 nA

3. Getting started

3.1 IO and peripherals

Pin nr 1

External RFID antenna connector

Antenna example:
FLEX ANT1356 40x40

Wi-Fi Antenna connector*

Pin nr 11
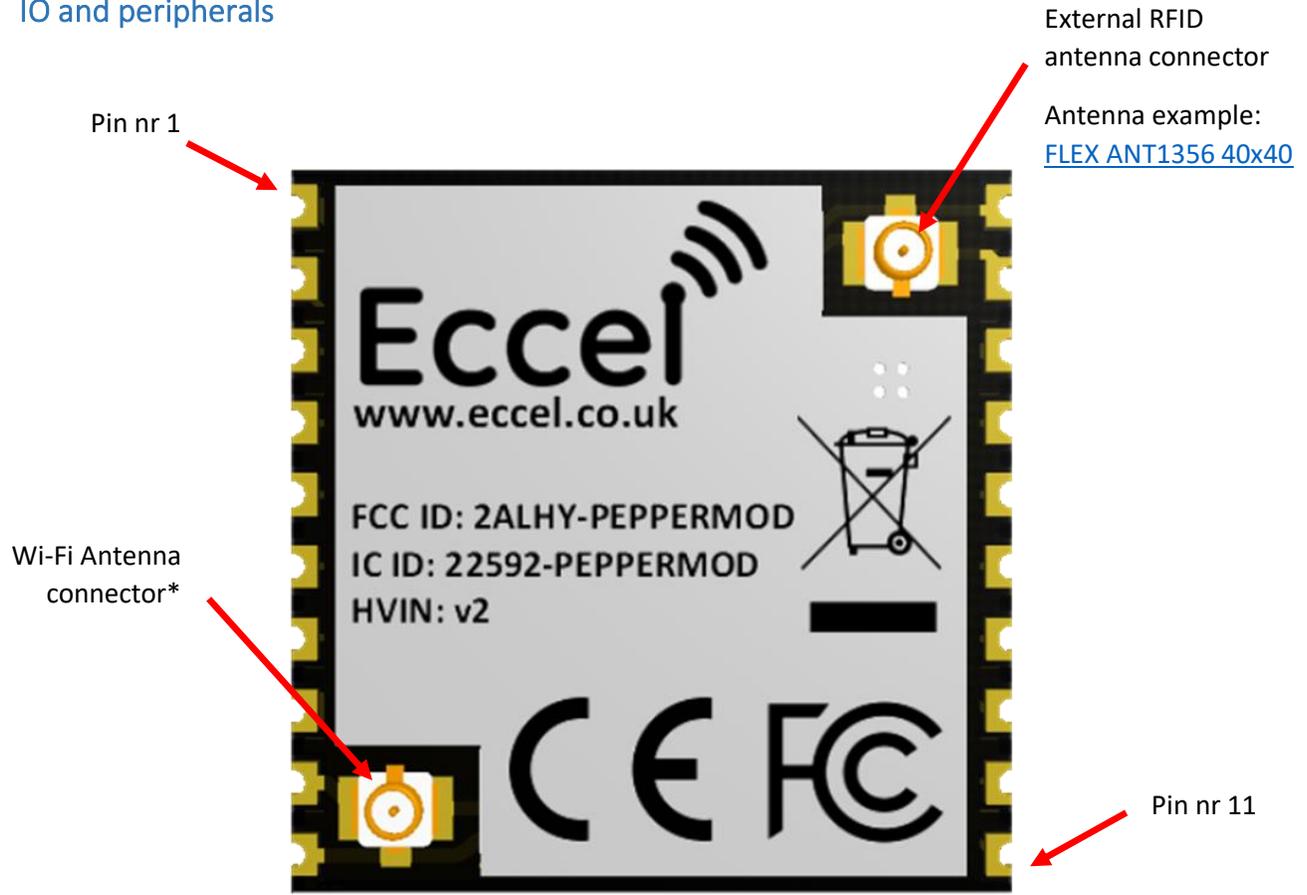
Recommended Wi-Fi antennas are MOLEX P/N: 2069940100 and 1461530250

3.2 Pinout description

Number	Name	Description
1	V$_{RFID}$	RFID section power supply pin. 5V regulated DC supply recommended, 3.3V acceptable.
2	GPIO2	UART2 data transmit pin
3	GPIO0	Button pin
4	GPIO4	UART2 data receive pin
5	TX0	UART0 data transmit pin
6	RX0	UART0 data receive pin
7	RESET	Active low reset pin
8	V$_{DD}$	Main power supply – recommended 3.3V
9	GND	Ground
10	Wi-Fi ANT	Pin for external antenna connection. Do not use when the on-board uFL Wi-Fi antenna connector is used
11	GPI34	General Purpose Input pin 34/Analog/**For future use**
12	GPI35	General Purpose Input pin 34/Analog/**For future use**
13	GPIO26	General Purpose Input Output pin 26
14	GPIO14	General Purpose Input Output pin 14
15	GPIO12	UART2 RS485 DE pin
16	GPIO13	UART2 RS485 RE pin
17	GPIO15	General Purpose Input Output pin 15
18	GND	Ground for RFID Antenna. Can be connected to the main ground when the on-board RFID antenna is used
19	RFID ANT2	RFID antenna connector 2. Do not use when the on-board uFL antenna connector is used
20	RFID ANT1	RFID antenna connector 1. Do not use when the on-board uFl antenna connector is used

3.3 Typical connection and usage

The Pepper C1 FCC Module can be connected to a host (computer or another device) using UART0 or UART2. In order to connect the module to a computer, a USB to UART converter will be required.

By default, this UART0 interface can be used for communication using the binary protocol described below.

The reader has also UART2 available. Using this interface, the user can view output logs which contain additional information about temporary executing commands for debugging purposes. The default configuration for both UARTs is : baud: 115200, Data: 8 bit, Parity: none, Stop bits: 1 bit, Flow Control: none. Data lines can be configured to work using any free GPIO's available on the module.
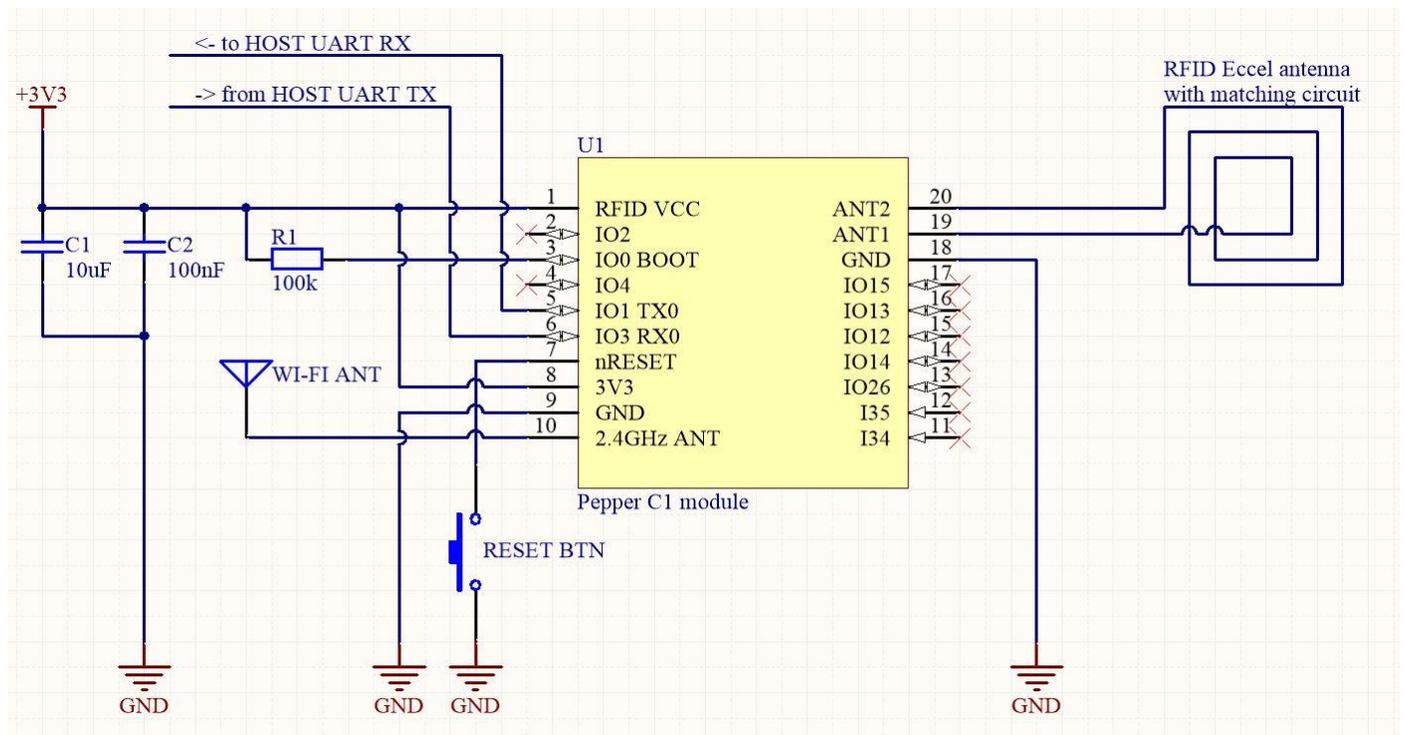

Figure 1. Typical connection

Eccel provides the C1 module baseboard for fast prototyping:
https://eccel.co.uk/product/pepper-c1-module-baseboard/

4. Mechanical dimension
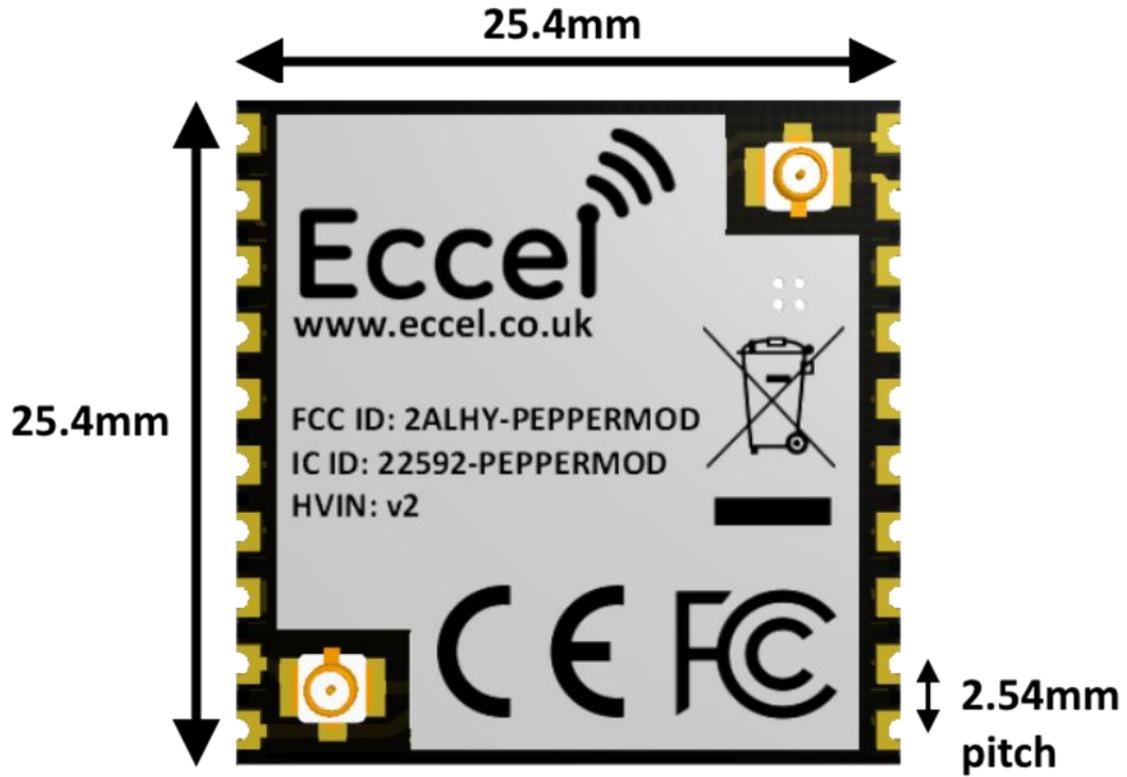
Figure 4-1. Pepper C1 FCC module dimension

All dimensions in mils.
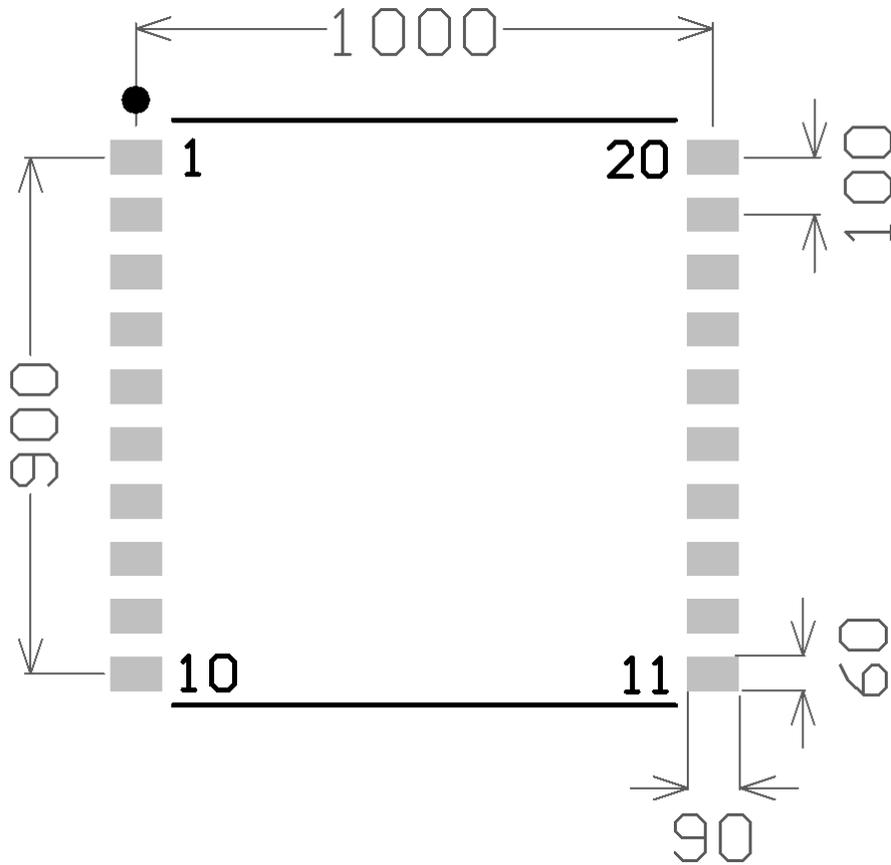
Figure 2. Recommended footprint

The footprint in the Altium Designer / Circuit Studio format can be downloaded from this link:
http://eccel.co.uk/wp-content/downloads/Pepper_C1/Pepper_C1_FCC_module_Altium_lib.zip

5. Configuration and functional description

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

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 20 cm is maintained between the antenna and users, and
2. The transmitter module may not be co-located with any other transmitter or antenna,
3. For all products market in US, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band

by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change. (if modular only test Channel 1-11)

As long as the three conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

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 Labeling

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

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01r01

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-PEPPERMOD** 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 the antenna (Max.)		Frequency range:
			Antenna 0 (Molex 2069940100)	Antenna 1 (Molex 1461530250)	
WPAN	/	FPC Antenna0	3.04dBi	1.70dBi	2402-2480MHz
2.4G Wi-Fi	/	FPC Antenna0	3.04dBi	1.70dBi	2412-2462MHz
NFC0	FLEX ANT1356 40×40-100	External Antenna	0dBi	/	13.56MHz
NFC1	FLEX ANT1356 40×40-250	External Antenna	0dBi	/	13.56MHz
NFC2	NFC-ANT1356-50×50-300	External Antenna	0dBi	/	13.56MHz

NFC3	NFC-ANT1356-50×50-800	External Antenna	0dBi	/	13.56MHz
NFC4	NFC-ANT1356-80×80-300	External Antenna	0dBi	/	13.56MHz
NFC5	NFC-ANT1356-80×80-800	External Antenna	0dBi	/	13.56MHz
NFC6	NFC-ANT1356-10×50-300	External Antenna	0dBi	/	13.56MHz
NFC7	NFC-ANT1356-10×50-800	External Antenna	0dBi	/	13.56MHz
NFC8	NFC-ANT1356-25×25-300	External Antenna	0dBi	/	13.56MHz
NFC9	NFC-ANT1356-25×25-800	External Antenna	0dBi	/	13.56MHz

2.8   Label and compliance information

The final end product must be labeled in a visible area with the following "Contains **FCC ID:2ALHY-PEPPERMOD**".

2.9   Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

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. ISED Statement

- **English:** This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) This device must accept any interference, including interference that may cause undesired operation of the device. The digital apparatus complies with Canadian CAN ICES-3 (B)/NMB-3(B).
- **French:** Le présentappareilestconforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitationestautorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareildoit accepter tout brouillageradi oélectriquesubi, mêmesi le brouillageest susceptible d'encompromettre le fonctionnement.
l'appareil numérique du ciem conforme canadien peut - 3 (b) / nmb - 3 (b).

This device meets the exemption from the routine evaluation limits in section 2.5 of RSS 102 and compliance with RSS 102 RF exposure, users can obtain Canadian information on RF exposure and compliance.

Cet appareil est conforme à l'exemption des limites d'évaluation courante dans la section 2.5 du cnr - 102 et conformité avec rss 102 de l'exposition aux rf, les utilisateurs peuvent obtenir des données canadiennes sur l'exposition aux champs rf et la conformité.

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment. Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé.

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body. Cet équipementdoit être installé et utilisé à une distance minimale de 0 cm entre le radiateur et votre corps.

ISED Modular Usage Statement

NOTE 1: When the ISED certification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use the wording ”Contains transmitter module IC: 22592-PEPPERMOD” or “Contains IC: 22592-PEPPERMOD”.

NOTE 1: Lorsque le numéro de certification ISED n'est pas visible lorsque le module est installé dans un autre appareil, l'extérieur de l'appareil dans lequel le module est installé doit également afficher une étiquette faisant référence au module inclus. Cette étiquetteextérieure peut être libellée Contient le module émetteur

IC: 22592-PEPPERMOD ou Contient IC: 22592-PEPPERMOD.

8. Revision history

Revision	Date	Changes
1.5	03-Jul-2024	Section 1.1 updated
1.4	20-May-2024	3.1.1 section updated, footprint drawing added
1.3	2-Apr-2024	First release after splitting software and hardware description
1.2	29-Mar-2024	Section 2.4 updated, Section 2.5 added
1.1	9-Mar-2023	Section 1 updated
1.0	1-Mar-2021	Initial release

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 modules

More information about the C1 module 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