



PRODUCT DATASHEET

Notecard Datasheet

NOTE-ESP

An affordable, embeddable module for low-power WiFi connectivity.

Blues Notecard® Datasheet: NOTE-ESP

An affordable, embeddable module for low-power WiFi connectivity.

Notecard WiFi is a version of the Blues Notecard dedicated for use on WiFi networks only. The device follows the same M.2 pinout as the cellular Notecards. What's more, Notecard WiFi uses the same powerful JSON-based programming interface, meaning that developers can easily add WiFi as a deployment option for their IoT solutions, with minimal impact to their existing host applications.

Warning

This product remains supported, but is no longer available for individual purchase through the Blues store. It is still available in minimum order quantities (MOQ). See [Back Catalog Products](#) for ordering details.

Functional Description

Notecard is an embeddable device-to-cloud data pump designed to remove the complexity and friction inherent in traditional IoT solutions. The Notecard family includes models supporting secure cellular, WiFi, LoRa, or satellite connectivity, enabling rapid development and iteration at a predictable, low cost. With as little as two lines of code on your host MCU, and no external libraries or dependencies, any Notecard model can securely move data from device to cloud.

Specifically, the Notecard NOTE-ESP is:

- A drop-in embeddable data storage and transport module for [WiFi IoT](#) products, pumping JSON-formatted or binary data ("Notes") bi-directionally between device and cloud:
 - JSON from/to MCU application using I2C, Serial, or USB.
 - JSON to/from your cloud app using HTTPS or MQTT.
 - JSON is auto-tagged with date/time.
- A removable and field-upgradable 30mm x 35mm system-on-a-module (SOM).

Features

- **Low-power.** Designed to operate on battery power, be "always-on", maintain time & location, while drawing as little as $\sim 10\mu\text{A}@5\text{V}$ when configured for Deep Sleep Mode (see [Power Information](#)).
- **MCU-agnostic.** Will support any MCU or single-board computer as your app processor - even low-memory, 8-bit microcontrollers.
- **Secure.** Integrated STSAFE Secure Element with hardware crypto, true hardware random number generator, and a factory-installed ECC P-384 certificate provisioned at chip manufacture. *Note that the certificate is no longer valid after November 16, 2047.*
- **Simple.** Uses a JSON command interface over I2C, UART, or USB. Allows you to connect your 3.3V MCU.
- **Power-conscious.** Onboard LIS2DTW accelerometer for motion awareness, a mostly-offline data sync mode for low power, and always-online mode for low latency.
- **Efficient.** Battery-powered WiFi without the complexity of managing connections, queues, or storage.
- **Integrated.** Utilizes an extremely thin cloud infrastructure that directly routes your data to where it belongs: AWS, Azure, GCP, or your own cloud.
- **Built for data.** Data routing and simple "no code/low code" visual data stream analysis through Notehub.io (SaaS), or host and integrate Notehub functionality into your own app (OSS).

Package Configuration

NOTE-ESP

- Product Name: Notecard WiFi v2
- Module: ESP32-S3-WROOM-1-N8R2
- Radio: 2.4 GHz 802.11b/g/n

[View in Store](#) 

Module Datasheet

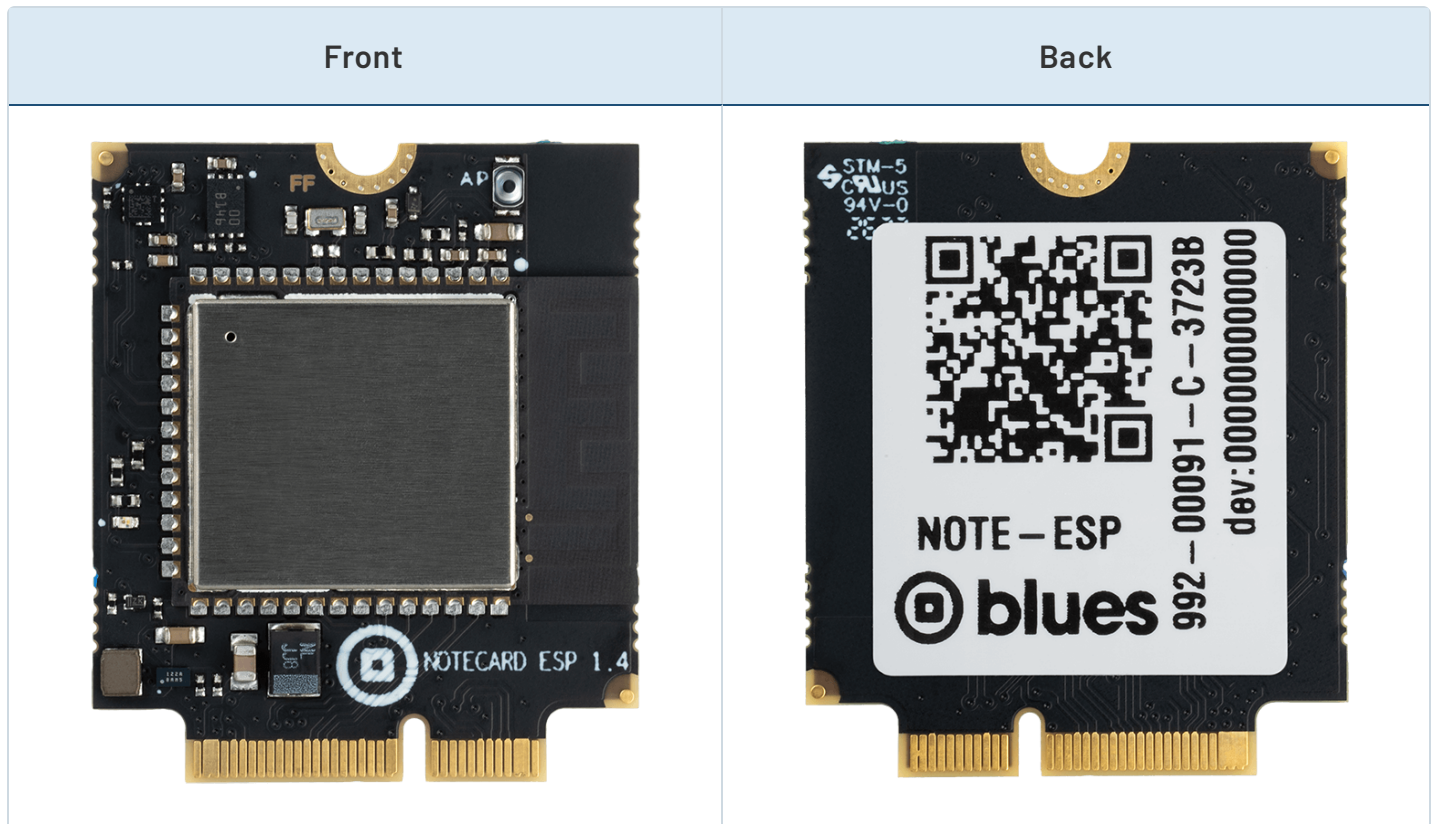
- [ESP32-S3-WROOM-1-N8R2](#) 

Block Diagram

The Notecard WiFi is packaged using a compact removable form factor, 30mm x 35mm.

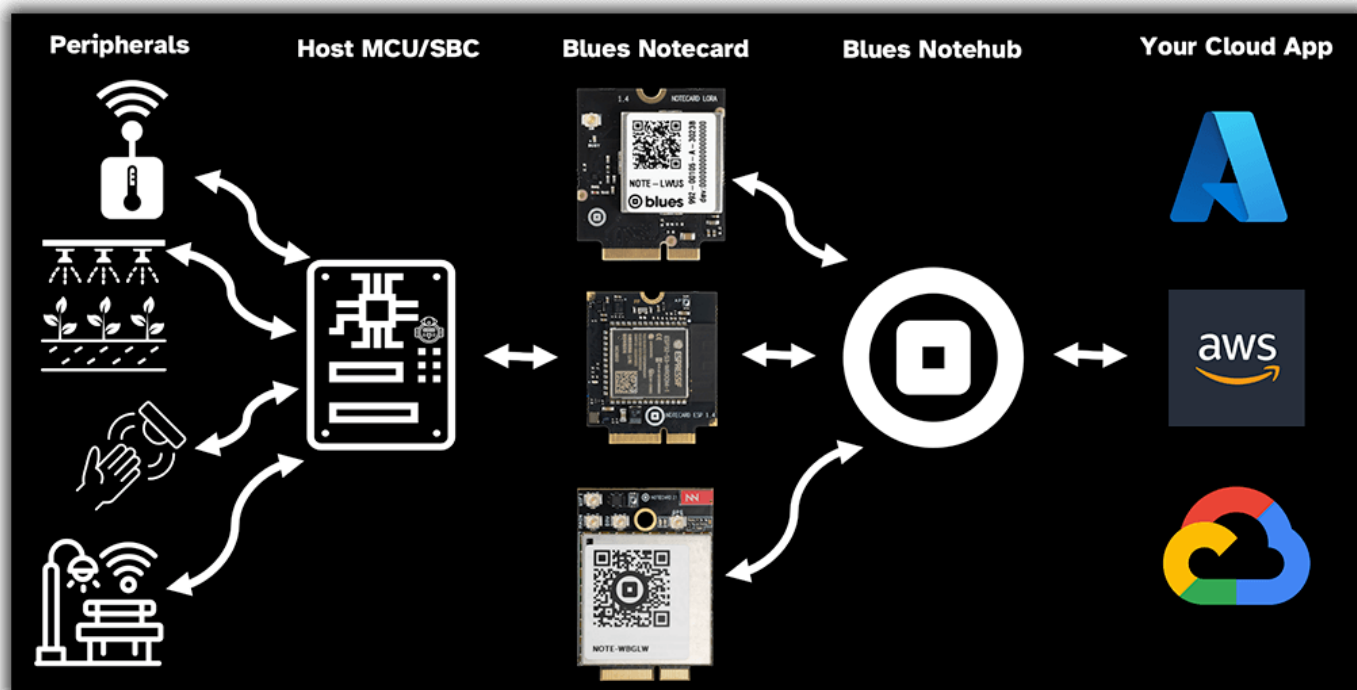
Open hardware schematics for both the Notecard and Notecarrier boards [are available on GitHub](#), making it a straightforward task to embed the Notecard into a broad variety of host device designs.

The Notecard can interface with the host MCU at 3.3v levels.



Typical Application

As shown below, Notecard is not an application processor and hosts no customer application code. It can be used as a data pump peripheral that is focused on bidirectional, asynchronous, secure data staging and transfer of [JSON Notes](#).



Key Features

- **Security**

Modern services require that the cloud and the device perform bidirectional authentication so that neither can be spoofed. For many applications it's important that over-the-air and over-the-wire data is encrypted. For this reason, the Notecard integrates an STSAFE Secure Element which contains symmetric keys manufactured into the chip. Neither the manufacturer of the Notecard nor the manufacturer of the customer's product has any need to handle or manage secure key material. The keys generated by STMicroelectronics for the Notecard use ECC with the NIST P-384 curve, and the signature algorithm is ECDSA-with-SHA384.

- **Low Power Consumption**

The Notecard has sophisticated power control and makes heavy use of variable clock speeds. When configured for Deep Sleep Mode, the Notecard can reach an idle current consumption of $\sim 10\mu\text{A}@5\text{V}$ (see [Power Information](#)).

Power Information

The Notecard's main supply voltage (`VMODEM_P`) is used for the WiFi radio and associated circuitry. The Notecard has on-board regulators designed for direct connection to a battery, so any voltage in the range of 2.5V to 5.5V may be provided.

When configured for [Deep Sleep Mode](#) (not enabled by default — see the Deep Sleep Mode section below), the Notecard WiFi v2 idles at ~10µA@5V until woken.

The Notecard current draw increases to about 80mA@5V when the WiFi radio is active. The module also draws 10's of mA when the CPU is performing session encryption. As such, it's recommended that `VMODEM_P` be directly connected to a battery or other supply that is capable of such brief spikes. It is also recommended that PCB traces for `VMODEM_P` and `GND` be designed to handle such current.

The Notecard's logic voltage (`VIO_P`) is provided by the Notecarrier or host system for digital communication; it will be 3.3V. Although the Notecard typically draws very little current, this supply should be designed with a 150mA budget allocated to the Notecard.

Pin Name	Direction	Pin Numbers	Usage
GND	--	3,5,6,11,18,33,39,45,51,57,71,73	Ground
VIO_P	IN	2,4	3.3V @ 150mA
VUSB	IN	13	USB Serial proxy for "line power", with respect to dynamic line voltage detection
VMODEM_P	IN	70,72,74	2.5V to 5.5V, capable of sustained 500mA draw

Note

In order to take advantage of various Notecard features pertaining to "dynamic line voltage detection" (both now and in the future), or establish a USB Serial connection to the Notecard, you must connect the `VUSB` power pin and support the USB power design aspects of the Notecard.

Features include:

- Continuous mode behavior with the usb flag.
- Triangulate mode behavior with the usb flag.
- Monitor mode behavior.

Deep Sleep Mode on NOTE-ESP

Unlike STM32-based Notecards, NOTE-ESP does not (by default) fall back to a ~10uA current draw when it is idle. This is because the ESP32 doesn't have a `STOP` mode equivalent where the UART and I2C can operate. The ESP32 does have a deep sleep mode that draws ~10µA@5V, which can be configured by following this guide on using [Deep Sleep Mode on Notecard WiFi v2](#).

Reset and Loss of Power

Warning

A power-loss event occurs whenever the Notecard loses power on `VIO_P` or `VMODEM_P`, or the Notecard's `NRST` pin is pulled low.

Upon recovering from any power-loss event, the Notecard initiates a procedure to ensure filesystem integrity. The Notecard also conducts a procedure upon first connection to Notehub after power loss to ensure consistency between Notecard's file system and Notehub's replica copy of those files. This verification procedure is done to protect and ensure the integrity of your product, and you should expect additional use of network bandwidth when these rare events occur.

It is the responsibility of every product designer to ensure that designs utilizing Notecard provide constant power to `VMODEM_P` and `VIO_P`, at the cost of as little as 8 μ A, so as to ensure that power-loss events do not occur as a matter of course from the perspective of the Notecard.

If repeated power failures are expected and unavoidable in a product's use, designs must incorporate a small battery or lithium ion capacitor to provide backup power, and the Notecard firmware should be configured to enter a quiescent state when operating on its backup supply.

Frequent power-loss events will result in the voiding of the Notecard warranty. In addition, since repeated Notecard resets can be indistinguishable from "denial of service" attacks on the Notehub, Blues also reserves the right to deny access to devices that exhibit such behavior.

Antenna Requirements

The Notecard WiFi includes an embedded PCB antenna as part of its ESP32-S3-WROOM-1 module. Notecard WiFi v2 does not include a u.FL connector, and does not support the use of an external antenna.

Cellular Service

This section does not apply to the Notecard WiFi.

Pin Information

Pin Definitions

Pin Name	Pin Description
ATTN_P	Attention pin (requires protection)
AUX_EN_P	Auxiliary serial port enable (requires protection)
AUX_RX_P	Auxiliary UART receive (requires protection)
AUX_TX_P	Auxiliary UART transmit (requires protection)
AUX1	Auxiliary GPIO pin 1
AUX2	Auxiliary GPIO pin 2
AUX3	Auxiliary GPIO pin 3
AUX4	Auxiliary GPIO pin 4
AUX_CHARGING	Charge detection
CTX	GPIO (outputs HIGH when ready to receive request)
GND	Ground
NC	No connection (must be left open)
NRST	Active-low (not) reset*
RTX	GPIO (used to wake ESP32)
RX_P	UART receive

Pin Name	Pin Description
SCL_P	I2C clock
SDA_P	I2C data
TX_P	UART transmit (requires protection)
USB_DN	USB data negative
USB_DP	USB data positive
VIO_P	I/O Voltage (requires protection)*
VMODEM_P	Voltage modem (requires protection)*
VUSB	USB Active indicator from 3V3 to 5V

* See the [power information](#) section for important product design considerations related to reset and loss of power conditions.

Pin Description

Notecard M.2 Key E, Edge Connector Pinout

Pin #	Pin Name	Func. Interface	Func. Interface	Pin Name	Pin #
1	NC		Power	VIO_P	2
3	GND	Power	Power	VIO_P	4
5	GND	Power	Power	GND	6
7	USB_DP	USB Serial		NC	8

Pin #	Pin Name	Func. Interface	Func. Interface	Pin Name	Pin #
9	USB_DN	USB Serial		NC	10
11	GND	Power		NC	12
13	VUSB	USB Serial		NC	14
15	NC			NC	16
17	NC		Power	GND	18
19	NC			NC	20
21	NC			NC	22
23	NC			NC	24
25	NC			NC	26
27	NC			NC	28
29	NC			NC	30
31	NC			NC	32
33	GND	Power		NC	34
35	NC			NC	36
37	NC		Auxiliary Ports	AUX_CHARGING	38
39	GND	Power	I2C Serial	SCL_P	40
41	NC		I2C Serial	SDA_P	42

Pin #	Pin Name	Func. Interface	Func. Interface	Pin Name	Pin #
43	NC			NC	44
45	GND	Power	Auxiliary Ports	AUX1	46
47	RTX		Auxiliary Ports	AUX2	48
49	CTX		Auxiliary Ports	AUX3	50
51	GND	Power	Auxiliary Ports	AUX4	52
53	NC		Attention	ATTN_P	54
55	NC		Auxiliary Ports	AUX_EN_P	56
57	GND	Power	Auxiliary Ports	AUX_RX_P	58
59	NC		Auxiliary Ports	AUX_TX_P	60
61	NC		UART Serial	RX_P	62
63	NC		UART Serial	TX_P	64
65	BOOT			NC	66
67	NRST	Reset		NC	68
69	NC		Power	VMODEM_P	70
71	GND	Power	Power	VMODEM_P	72
73	GND	Power	Power	VMODEM_P	74
75	NC				

Link: [Digi-Key part number of the connector](#) - Both Digi-Key and Mouser have pictures for this part number that show a component with a different key, but both have links to datasheet/drawing/CAD models.

Note

All pins whose **Functional Interface** is marked "Power" must be connected.

All pins named **NC** have no connection on the Notecard and must be left open.

All pins named **RSVD** are reserved for internal use. These pins are electrically connected on the Notecard and **MUST** be left open. Furthermore, any pin not used in a design **MUST** also be left open.

Those pins ending with **_P** may be optionally protected from anomalous external conditions on some Notecarrier designs, depending upon use-case specific requirements.

Technical Details

Host Microcontroller API

Notecard supports a rich, simple API whose syntax is standard JSON. The developer can communicate requests to Notecard, generally by using little more than `printf` functions available in most programming languages.

Serial Communication

JSON requests and responses (the Notecard's Application Programming Interface "API") may be sent over any of the following interfaces:

- USB Serial Interface
- UART Serial Interface
- I2C Interface

Note

If NOT using a [Notecard firmware library](#), you may unintentionally send requests to the Notecard so fast that you overflow the 1500 byte buffer used to receive data (whether it be I2C, Serial, or UART). The solution is to pause 250 ms after every 250 bytes sent and ensure the total size of each [NDJSON](#) object sent is no more than 8KB.

API Reference

For API usage, names, and parameters, please refer to the [Notecard API Reference](#).

USB Serial Interface

The USB Serial Interface appears to the host as a USB 2.0 Full Speed CDC device. You can access it from Linux, Windows, or macOS without a device driver using terminal emulation software. Newline-delimited JSON requests may be sent directly as UTF-8 text over this port, or you may use the open-source Blues libraries for C, Python, Go, and Arduino.

Pin Name	Direction	Pin Number	Usage
USB_DN	I/O	9	USB D- data signal
USB_DP	I/O	7	USB D+ data signal
VUSB	IN	13	+5V from USB
GND	I/O	11	Ground from USB

UART Serial Interface

The UART Serial Interface operates at `VIO_P` at a fixed baud rate of 9600 using eight data bits, no parity bit, and one stop bit. Newline-delimited JSON requests may be sent directly as UTF-8 text over this port, or you may use the open-source Blues libraries for C, Python, Go, and Arduino.

Pin Name	Direction	Pin Number	Usage
RX_P	IN	62	Receive data signal
TX_P	OUT	64	Transmit data signal

I2C Interface

The Notecard acts as an I2C secondary device operating at `VIO_P`, and it implements a simple [Serial-over-I2C protocol](#). You can access it from an embedded host using open-source Blues libraries for C, Python, Go, and Arduino.

Pin Name	Direction	Pin Number	Usage
SCL_P	IN	40	I2C clock
SDA_P	I/O	42	I2C data

Note

Older versions of Notecard WiFi (versions ≤ 3.2) do not have pull-up resistors on the I2C lines.

Host Microcontroller Hardware Interface

Attention Interrupt

Using software, you can optionally configure Notecard to use the `ATTN` output pin to:

- Inform the host MCU of certain asynchronous events (such as incoming data availability, or Notecard motion) in an interrupt-driven manner rather than just polling.
- Place the host MCU into a power-off sleep state and wake it back up again.

Pin Name	Direction	Pin Number	Usage
ATTN_P	OUT	54	Attention pin

Note

This pin operates at `VIO_P`. If it is unused it can be left disconnected.

Auxiliary Ports

An optional Auxiliary UART Serial Interface is available on the `AUX_RX_P` and `AUX_TX_P` pins. This interface is inactive unless enabled by raising the `AUX_EN_P` pin since this UART consumes extra power when in use. It operates at `VIO_P` at a fixed baud rate of 115200 using eight data bits, no parity bit, and one stop bit. If this interface is unused, the three pins can be left disconnected.

The AUX1-4 pins operate at `VIO_P` and can be configured in software to operate in several optional modes such as GPS Tracking Mode, GPIO Mode, and Internet Button Mode. If these pins are unused, they can be left disconnected.

Pin Name	Direction	Pin Number	Usage
AUX_EN_P	IN	56	Enables serial port on <code>AUX_RX_P</code> and <code>AUX_TX_P</code>
AUX_RX_P	IN	58	RX data for serial port enabled by <code>AUX_EN_P</code>
AUX_TX_P	OUT	60	TX data for serial port enabled by <code>AUX_EN_P</code>
AUX1	I/O	46	General Purpose I/O
AUX2	I/O	48	General Purpose I/O
AUX3	I/O	50	General Purpose I/O
AUX4	I/O	52	General Purpose I/O
AUX_CHARGING	I/O	38	Alt. attention pin or charge detection

Note

The auxiliary serial port is normally disabled because it consumes up to 100µA of power when enabled.

SoftAP Button

NOTE-ESP includes an onboard **AP** push button used to activate SoftAP (software enabled access point) mode for WiFi configuration. Press and hold the button for at least one full second, then release, to start SoftAP mode. For more information, see [Connecting to a WiFi Access Point](#). SoftAP mode can also be activated programmatically with a `card.wifi` request.

Reset

Use of this pin is optional. On the Notecard WiFi v2 this pin is an input that drives the enable (`EN`) input of the ESP32 module; the Notecard cannot drive this line itself. Restrictions on this pin are:

- If this pin is not used, it must remain not connected (NC).
- The pin is active-low. It must be held low for at least 50µS for a clean reset.
- The Notecard includes an onboard 10K pull-up resistor on this pin, so no external pull-up is required.
- Some Notecarriers may invert this signal to be active-high.

Pin Name	Direction	Pin Number	Usage
NRST	IN	67	Active-low reset

Network Communication Behavior

The Notecard includes a built-in connection to Notehub.io (specifically `a.notefile.net:8086`) and communicates over SSL. Outbound connections speak directly with the Notehub session load balancer (or "Discovery Service") for provisioning and device authentication. By default, the TLS connection is unidirectional, but can operate bi-directionally, if needed. The keys and certificates for each device are provisioned by STMicrosystems inside the STSAFE secure element present on every Notecard. Once the Discovery Service has provisioned or authenticated a device, it issues a "ticket" and a Handler IP address that the Notecard can use to make subsequent requests.

The Notecard can also connect to the Handler to do a constrained set of remote procedure calls related to synchronization. If the Notecard determines that the data queued for transmission to or from the Handler should be encrypted, it opens a session to the Handler on port `8086`. Otherwise, an unencrypted socket is opened on port `8081`.

The over-the-wire data transmitted on both sockets is highly byte-optimized, which is why raw SSL and TCP sockets are used, and not unoptimized HTTP/HTTPS transactions.

Specifications

General Characteristics

Description	Value
Dimensions	30mm x 35mm
Weight	3 grams

Electrical Characteristics

Absolute Maximum Ratings

Description	Minimum	Maximum	Unit
Storage temperature	-40	90	°C
Ambient operating temperature	-40	85	°C

DC Characteristics

Description	Minimum	Maximum	Unit
Supply Voltage	2.5	5.5	V

Ordering Information

Blues Shop 

Certifications

CE

[CE certification](#) indicates that a product complies with the essential requirements of relevant European health, safety, and environmental protection legislation. It is a mandatory conformity mark for products sold within the European Economic Area (EEA).

Certification	Date
EN 300 328 V2.2.2 (2019-07)	September 2023
EN 55032:2015/A11:2020	September 2023
EN 55035:2017/A11:2020	September 2023
ETSI EN 301 489-1 v2.2.3 (2019-11)	September 2023
ETSI EN 301 489-17 v3.2.4 (2020-09)	September 2023
IEC 62368-1:2018	January 2024
IEC 62368-1:2014	January 2024

FCC

[FCC certification](#) indicates that a product complies with the regulations set forth by the Federal Communications Commission (FCC) in the United States. This certification ensures that electronic devices do not emit electromagnetic interference that could disrupt other electronic devices and communication systems.

Certification	Date
47 CFR FCC Part 15 Subpart B	September 2023
47 CFR Part 15, Subpart C, Section 15.247	October 2023

ISED

[ISED/ISED certification](#)  is issued by Innovation, Science and Economic Development Canada (ISED), formerly known as Industry Canada (IC). This certification ensures that electronic devices comply with Canadian regulations regarding radio frequency (RF) emissions and electromagnetic interference (EMI).

Certification	Date
RSS-247 Issue 2	October 2023
ICES-003 Issue 7	September 2023

Board Errata

- On units shipped where all large black capacitors indicate JJ8, the idle current of the Notecard may measure slightly higher than the expected current draw indicated above.

Terms and Conditions

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Security and Vulnerability Scanning

As a part of our regular audit and scanning process, Blues Inc. performs full vulnerability scanning every six months. Any identified vulnerabilities will be analyzed, reported, and patched in a timely fashion, where appropriate.

Revision History

Author	Date	Summary
Ray Ozzie	2019-2020	Document drafted
John Wiedey	2020	Various improvements
Sean Taylor	2020	Various improvements
Zachary J. Fields	11 SEP 2020	Updated information and translated to markdown
Brandon Satrom	13 APR 2021	Updated Country list based on carrier audit
Carlton Henderson	12 JUL 2021	Update coverage information
Carlton Henderson	12 JUL 2021	Fix block diagram photo
Brandon Satrom	11 NOV 2021	Added Certification Dates
Brandon Satrom	07 JAN 2022	Added RoHS Certification Dates
Brandon Satrom	15 FEB 2022	Add WiFi Notecard Datasheet
Rob Lauer	25 AUG 2022	Added updated certification data
Rob Lauer	27 OCT 2022	Update country coverage information

Author	Date	Summary
Rob Lauer	13 JAN 2023	Added RF performance information
Rob Lauer	2 FEB 2023	Warning re: STM32 light sensitivity
Kimball Johnson	21 SEP 2023	Updated for new Cell+WiFi, LoRa, and WiFi Notecards
Rob Lauer	23 OCT 2023	Update and clarify power consumption values
Rob Lauer	31 JAN 2024	Update Notecard for LoRa datasheet details
Rob Lauer	16 APR 2024	Updated for new Cellular (black PCB) Notecards, MB Cellular Notecards, and Notecard XP
Rob Lauer	6 JUN 2024	Added cell band support for Cellular Notecards
Rob Lauer	23 JUL 2024	Update pin definitions
TJ VanToll	24 SEP 2024	Adding Notecard for LoRa v2.1 information
Rob Lauer	01 NOV 2024	Adding Notecard for LoRa v2.1 castellated pin info
Rob Lauer	06 NOV 2024	Added errata for Notecard Cell+WiFi
Brandon Satrom	06 DEC 2024	Expanded reset and loss of power guidance

Author	Date	Summary
Rob Lauer	20 DEC 2024	Added PTCRB certifications for WBNAN, NBNAN, NBGLN
Rob Lauer	5 MAR 2025	Update AUX5 to AUX_CHARGING
Rob Lauer	22 MAY 2025	Fix labelling of NC pins
Rob Lauer	13 JUN 2025	Update certifications
Rob Lauer	21 JUL 2025	Update certifications for WBNAN, NBNAN, NBGLN
Rob Lauer	28 JUL 2025	Update certifications for all Notecard SKUs
Rob Lauer	17 NOV 2025	Add FCC and IC IDs for all Notecard Cellular SKUs
TJ VanToll	21 JAN 2026	Added Notecard for Skylo
Rob Lauer	23 JUL 2026	Accuracy review vs. hardware design files

Contact Information

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