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Stratus Pro nRF9151

Ultra Low Power DECTNR+, Cellular + GPS Device Platform
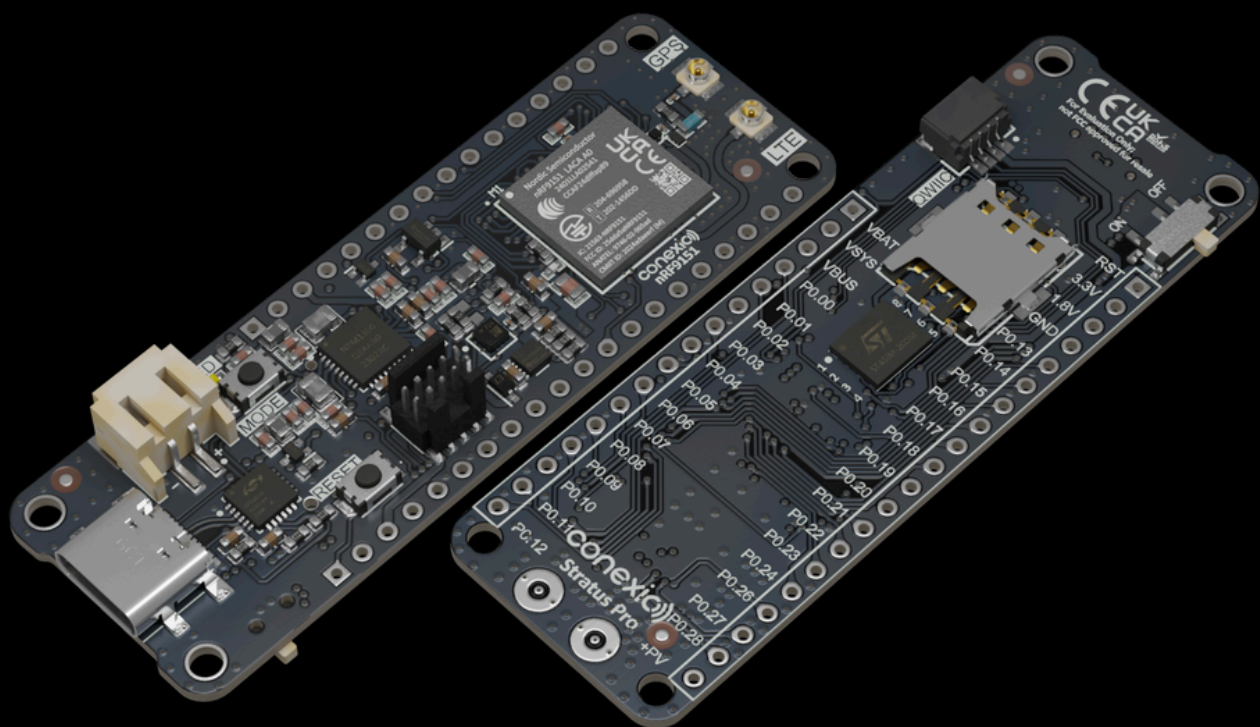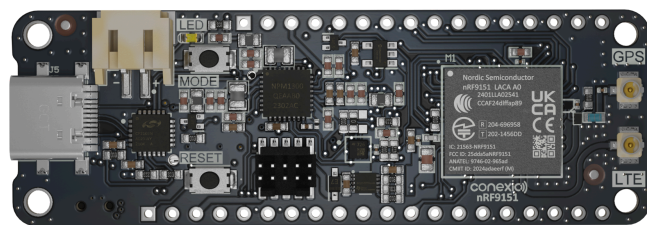
Product Reference Manual

Description

The Conexio Stratus Pro is a powerful cellular-connected module designed for low-cost Internet of Things (IoT) applications. Based on the nRF9151 System-in-package from Nordic Semiconductor®, this board supports DECTNR+, LTE-M, NB-IoT, and Global Positioning System (GPS/GNSS) in a feather form factor. As a low-cost cellular-connected device, the Stratus Pro is an excellent choice for developers looking to create IoT devices and applications on a budget. Whether you are building a smart home device or a connected industrial sensor, the Stratus Pro provides the processing power and connectivity options you need to get the job done.

Target Areas

IoT, factory automation, smart cities, asset tracking, smart grid, machine monitoring, and agriculture

1 Application Examples

Thanks to its high-performance and versatile nRF9151 chipset, the Stratus Pro supports many applications. From industrial applications to rapid prototyping, IoT solutions, and building automation, among many others. Here are some application examples:

- **Industrial Automation:** The Stratus Pro can be implemented as a solution for different industrial applications, such as:

  - **Industrial IoT gateway:** Connect your devices, machines, and sensors to a Stratus Pro gateway. Collect real-time operation data and display them on your choice of Cloud, leveraging end-to-end secure data transmission.
  - **Machine monitoring to track OEE/OPE:** Track Overall Equipment Efficiency (OEE) and Overall Process Effectiveness (OPE) with the Stratus Pro as a standalone IoT node. Collect data and get alerted on machine uptime and unplanned downtime to provide reactive maintenance and improve production rate.

- **Prototyping:** The Stratus Pro can assist IoT and product developers with their prototypes by integrating ready-to-use cellular and GPS connectivity and various peripheral interfaces, including SPI, QWIIC, TWI, UART, and I2C. Moreover, Stratus Pro provides 29 mixed-signal GPIOs for interfacing with external sensors, actuators, and other electronics.
- **Other Applications:** You could use Stratus for fleet management, to track your assets in real-time with seamless global coverage and end-to-end visibility, or for Industry 4.0 applications. Stratus can be used in retail deployments, for smart checkout or supply chain management, or in the healthcare sector, to power mission-critical applications like remote patient monitoring and wearables.

Conexio Stratus Pro also supports platforms like Edge Impulse, Memfault, and Golioth, leveraging machine learning (ML) to provide seamless Over-the-Air (OTA) updates to your devices. ML capabilities are extremely helpful in implementing predictive maintenance in scenarios where uninterrupted operation is particularly important, such as in smart factories. For easy data visualization and dashboard creation, Conexio Stratus Pro also connects to Datacake, a low-code IoT platform that requires no programming, and other cloud platforms such as AWS IoT, Azure, Qubitro, and IoTCreators to name a few.

2 Features

2.1 General Specifications Overview

The Stratus Pro is a powerful cellular-based board designed for low-cost IoT applications. Based on the high-performance nRF9151 System-in-package from Nordic Semiconductor®, it offers a range of key features and a low-power design that make it well-suited for a variety of applications.

Table 1 summarizes the board's main features, and Tables 2, 3, and 4 show more detailed information about the board's microcontroller, its wireless communication, and external memory.

Feature	Description
Microcontroller	64 MHz, Arm® Cortex®-M33 core microcontroller
Internal Memory	1 MB Flash and 256 kB SRAM
External Memory	16 KBit I2C EEPROM memory (24CW160T)
Connectivity	LTE-M, NB-IoT, and DECTNR+
Location	GPS and GNSS
Security	IoT-ready secure element
USB Connectivity	USB-C® port for power, programming, and data (accessible also through the board's header connectors)
Power Supply	Various options for easily powering the board: USB-C® port, single-cell lithium-ion/lithium-polymer battery, and external power supply connected through LiPo JST-styled connectors
Solar Charging	Connect PV through the board's header connector to recharge the single-cell lithium-ion/lithium-polymer battery
Analog Peripherals	six, eight-channel 12-bit analog-to-digital converter (ADC)
Digital Peripherals	GPIO, I2C, UART, SPI, TWI, PWM, I2S
Debugging	JTAG/SWD debug port (accessible through the board's 10-pin header connector)
Dimensions	66.04 mm x 25.40 mm

Table 1: Stratus Pro nRF9151 Main Features

2.2 Microcontroller

Component	Details
nRF9151	Arm® Cortex®-M33 microcontroller, with a maximum operating frequency of 64 MHz
	1 MB of flash memory and 256 KB of RAM
	Several peripheral interfaces, including UART, I2C, SPI, and TWI
	Hardware-based security features, such as a True Random Number Generator (TRNG), ARM CryptoCell, and ARM TrustZone
	Onboard power management features that allow it to operate on low power mode
	Dedicated programmable application processor and memory
	Designed to operate over a wide temperature range, from -40°C to +85°C, making it suitable for use in harsh environments

Table 2: Stratus Pro Microcontroller Features

2.3 Wireless Communication

Component	Details
nRF9151	3GPP release 14 LTE-M/NB-IoT support
	GPS, GNSS support
	DECTNR+ support

Table 3: Stratus Pro Wireless Communication Features

2.4 External Memory

Component	Details
24CW160T	EEPROM memory that can be used for storing data, and configuration settings
	I2C interfaces support, which provide high-speed data transfer rates of up to 1 MHz
	Designed to operate over a wide operating voltage range, from 1.6V to 5.5V
	Onboard power management features, such as a deep power-down mode and standby mode, help to reduce power consumption in battery-powered devices
	High endurance of up to 1, 000,000 program/erase cycles Data retention of >200 years

Table 4: Stratus Pro External Memory Features

3 Ratings

3.1 Recommended Operating Conditions

Table 5 provides a comprehensive guideline for the optimal use of the Stratus Pro, outlining typical operating conditions and design limits. The operating conditions of the Stratus Pro are largely a function based on its component's specifications.

Parameter	Symbol	Min	Typ	Max	Unit
USB Supply Input Voltage	V_{USB}	-0.3	5.0	5.5	V
Battery Supply Input Voltage	V_{USB}	2.3	3.7	4.45	V
Operating Temperature	T_{OP}	-40	-	+85	°C

Table 5: Recommended Operating Conditions

3.2 Current Consumption

Table 6 summarizes the power consumption of the Stratus Pro on different test cases. Notice that the operating current of the board will depend greatly on the application.

Parameter	Symbol	Min	Typ	Max	Unit
Idle Mode Current Consumption[1]	I_{DS}	-	9	-	µA
Active Mode Current Consumption[2]	I_{NM}	-	250	-	mA

Table 6: Board Current Consumption

[1] All peripherals off. [2] All peripherals on, continuous data download via Cellular.

4 Functional Overview

The Stratus Pro board contains several peripherals connected to its microcontroller but the core of the board is nRF9151 SiP from Nordic Semiconductor.

4.1 Pinout
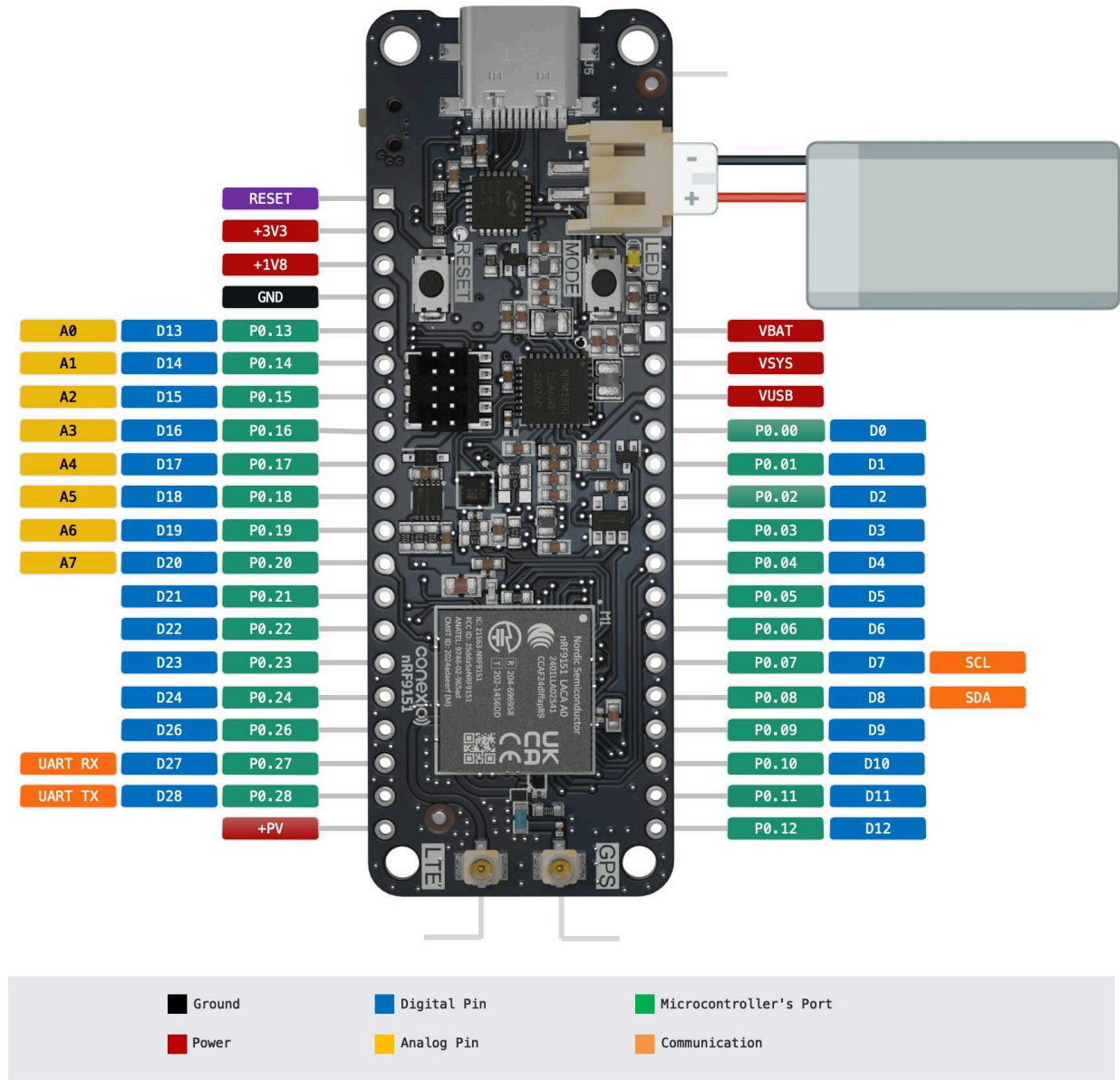
The Stratus Pro nRF9151 pinout is shown in Figure 1.

Figure 1: Stratus Pro pinouts

4.2 Power Supply

The Stratus Pro can be powered through one of these interfaces:

- USB-C® port
- 3.7 V single-cell lithium-ion/lithium-polymer battery, connected through the onboard battery connector
- External power supply connected through the VBAT header pin

The overall board power is managed by nPM1300. nPM1300 supports charging up to 800 mA and delivers up to 500 mA of adjustable regulated voltage. Power is supplied to onboard components from two configurable, dual-mode 200 mA BUCK regulators. The output regulator **VOUT1** supplies 1.8V to the nRF9151 gpios and the output regulator **VOUT2** supplies 3.3V for external components. In addition, an unregulated power rail **VDD_nRF91** delivers up to 1340 mA when powered from a battery, or up to 1.5 A when powered from a USB port configured as DCP. The power options available on the Stratus Pro for the users are:

- 1.8V
- 3.3V
- VBAT (unregulated battery voltage)
- VSYS = VDD_nRF91 (unregulated board voltage)
- VBUS (USB-C voltage)

The battery is connected to the board via a disconnectable JST-style male connector as shown in Figure 1. The battery connector part number is S2B-PH-SM4-TB.

4.3 I2C Ports

System integrators can use the Stratus Pro's header connectors to expand signals of the board to a custom-designed daughter board or carrier. Table 7 summarizes the I2C pins mapping on the board's connectors and shared peripherals/resources. Please refer to Figure 1 for the board's connectors pinout. Any digital pin can be used as an I2C port once configured in the board device tree.

GPIO	Interface	Pins	Status[1]	Shared Peripherals
D7	I2C1	P0.07	Shared	SCL
D8	I2C1	P0.08	Shared	SDA

Table 7: I2C pins mapping of the Stratus Pro

[1]Status column indicates the current status of the pins. "Free" means the pins are not in use by another resource or peripheral of the board and are available for usage, while "Shared" means the pins are used by one or several resources or peripherals of the board.

5 Device Operation

5.1 Getting Started - SDK

If you want to program your Conexio Stratus Pro device you need to first install the [nRF Connect SDK](#). To connect the Stratus Pro to your computer, you will need a USB-C® cable.

5.2 Getting Started - Documentation

Follow the getting started guide provided online at [docs.conexiotech.com](#) on how to configure your SDK and upload your firmware onto the device.

5.3 Sample Examples

Sample application examples for Stratus Pro can be found in the official [GIT repo](#).

5.4 Online Resources

Now that you have gone through the basics of what you can do with the device, you can explore the endless possibilities it provides by checking exciting projects on [Hackster.io](#), and the [nRF Connect Sample Reference](#).

6 Certifications

6.1 Certifications Summary

Certification	Status
CE/RED (Europe)	pending
UKCA (UK)	pending
FCC (USA)	pending
IC (Canada)	pending
MIC/Telec (Japan)	pending
RCM (Australia)	pending
RoHS	pending
REACH	pending
WEEE	pending

6.2 Declaration of Conformity CE DoC (EU)

We declare under our sole responsibility that the products above are in conformity with the essential requirements of the following EU Directives and therefore qualify for free movement within markets comprising the European Union (EU) and European Economic Area (EEA).

6.3 Declaration of Conformity to EU RoHS & REACH 211 01/19/2021

Stratus boards are in compliance with RoHS 2 Directive 2011/65/EU of the European Parliament and RoHS 3 Directive 2015/863/EU of the Council of 4 June 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Substance	Maximum Limit (ppm)
Lead (Pb)	1000
Cadmium (Cd)	100
Mercury (Hg)	1000
Hexavalent Chromium (Cr6+)	1000
Poly Brominated Biphenyls (PBB)	1000
Poly Brominated Diphenyl ethers (PBDE)	1000
Bis(2-Ethylhexyl) phthalate (DEHP)	1000
Benzyl butyl phthalate (BBP)	1000
Dibutyl phthalate (DBP)	1000
Diisobutyl phthalate (DIBP)	1000

Exemptions: No exemptions are claimed.

Stratus Boards are fully compliant with the related requirements of European Union Regulation (EC) 1907 /2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). We declare none of the SVHCs (https://echa.europa.eu/web/guest/candidate-list-table), the Candidate List of Substances of Very High Concern for authorization currently released by ECHA, is present in all products (and also package) in quantities totaling in a concentration equal or above 0.1%. To the best of our knowledge, we also declare that our products do not contain any of the substances listed on the "Authorization List" (Annex XIV of the REACH regulations) and Substances of Very High Concern (SVHC) in any significant amounts as specified by the Annex XVII of Candidate list published by ECHA (European Chemical Agency) 1907 /2006/EC.

6.4 Conflict Minerals Declaration

As a global supplier of electronic and electrical components, Conexio is aware of our obligations concerning laws and regulations regarding Conflict Minerals, specifically the Dodd-Frank Wall Street Reform and Consumer Protection Act, Section 1502. Conexio does not directly source or process conflict minerals such as Tin, Tantalum, Tungsten, or Gold. Conflict minerals are contained in our products in the form of solder, or as a component in metal alloys. As part of our reasonable due diligence, Conexio has contacted component suppliers within our supply chain to verify their continued compliance with the regulations. Based on the information received thus far we declare that our products contain Conflict Minerals sourced from conflict-free areas.

7 FCC Caution

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

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
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter
2. This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment
3. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body

English: User manuals for license-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both. 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

2. This device must accept any interference, including interference that may cause undesired operation of the device.

French: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L' appareil nedoit pas produire de brouillage

2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement

IC SAR Warning:

English: This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

French: Lors de l' installation et de l' exploitation de ce dispositif, la distance entre le radiateur et le corps est d 'au moins 20 cm.

Important: The operating temperature of the EUT can't exceed 85 °C and shouldn't be lower than -40 °C.

Hereby, Conexio Technologies, Inc declares that this product is in compliance with essential requirements and other relevant provisions of Directive 2014/53/EU. This product is allowed to be used in all EU member states.

8 Company Information

Company name	Conexio Technologies, Inc
Company address	1355, North Dearborn, Suite 301, Chicago, IL, USA

9 Document Revision History

Date	Revision	Changes
10/11/2024	1	First release

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Making Device to Cloud Connectivity Simple