Challenger+
RP2350 NB-IoT

Development Board

LTE Cat NB2 (NB-IoT) · GNSS · RP2350 · Challenger+ Form Factor

- √ RP2350 Dual-Core Cortex-M33 / RISC-V
- √ 8 MB Flash + 8 MB PSRAM
- √ Up to DL 127 kbps / UL 159 kbps
- √ LiPo charger + USB-C
- √ Arduino / MicroPython / CircuitPython
- √ LTE Cat NB2, 3GPP Release 15
- √ GNSS: GPS + Galileo + A-GNSS
- √ Wi-Fi positioning (802.11b)
- √ eDRX & PSM support
- √ GCF, RED & RED-DA certified module

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iLabs Electronics | ilabs.se

1 Product Description

1.1 Overview

The **Challenger+ RP2350 NB-IoT** is a high-performance IoT development board in an elongated iLabs' Challenger form factor. It combines the **Raspberry Pi RP2350** dual-core microcontroller with the **STMicroelectronics ST87M01-1301** certified NB-IoT module, delivering a complete platform for asset tracking, smart metering, smart city infrastructure, and industrial IoT applications that demand long battery life and reliable low-power cellular connectivity.

The ST87M01-1301 variant includes GNSS localisation (GPS and Galileo), Wi-Fi positioning via nearby 802.11b access points, and additional ADC inputs. The module is certified to GCF, RED, and RED-DA (cybersecurity) standards, significantly reducing regulatory effort for end-product designers.

1.2 Form Factor & Power

The board deviates some from the standard Challenger/Feather layout by beeing 6mm longer: it is however still breadboard-friendly and pin-compatible with Adafruit Feather accessories. A 1.25 mm JST (PicoBlade-compatible) LiPo connector and onboard charger enable fully autonomous battery-powered operation. Power may also be supplied via the USB-C connector or the VUSB pin (5 V).

1.3 Typical Applications

- Asset tracking and logistics
- Smart metering (water, gas, electricity)
- Smart city infrastructure and street lighting control
- Industrial IoT monitoring and factory automation
- Environmental sensing with long-interval reporting
- Remote alarm and event notification systems

2 Key Specifications

2.1 Microcontroller - Raspberry Pi RP2350

Parameter	Specification
Architecture	Dual Arm Cortex-M33 + dual Hazard3 RISC-V cores (2 active simultaneously)
Clock Speed	Up to 150 MHz
On-chip SRAM	520 KB
External Flash	8 MB high-speed QSPI
External RAM	None
ADC	4 x 12-bit channels, 500 kSa/s
PWM	24 channels
UART / SPI / I2C	2 x UART, 2 x SPI, 2 x I2C

PIO State Machines	12 (3 blocks of 4)
USB	USB 1.1 host/device via USB-C connector
Security	Arm TrustZone, SHA-256 acceleration, TRNG, 8 KB OTP
Supply Voltage	3.3 V I/O; 3.3 V core
Board Operating Temp.	-20 degC to +70 degC

2.2 NB-IoT Module - ST87M01-1301

Parameter	Specification
Standard	LTE Cat NB2, 3GPP Release 15
Certified Bands	B1, B3, B5, B8, B20, B28 (GCF certified)
HW Band Support	B1-B5, B8, B12, B13, B17-B20, B25, B26, B28, B65, B66, B70, B71, B85
Max Downlink Speed	127 kbps (extended TBS, 2 HARQ)
Max Uplink Speed	159 kbps (extended TBS, 2 HARQ)
Single-Tone DL / UL	26 kbps / 16 kbps
Multi-Tone DL / UL	26 kbps / 66 kbps
TX Power	Class 3: +23 dBm
Sleep Current	1.2 uA typical
Power-Off Current	0.5 uA typical
Power Saving	PSM (Power Saving Mode) + eDRX
GNSS	GPS L1 + Galileo, concurrent mode, A-GNSS
Wi-Fi Positioning	IEEE 802.11b hot-spot scanning (3rd-party geocoding required)
Embedded Protocols	TCP/IP (IPv4/IPv6), TLS/DTLS, CoAP, LwM2M, MQTT, HTTP/HTTPS, PDU SMS
SIM	External nano-SIM (1.8 V only)
Firmware Update	DFOTA over LwM2M; UART host mode; ext. SPI flash (production)
AT Commands	3GPP + STMicroelectronics extended AT command set
Certifications	GCF, RED (EU), RED-DA cybersecurity
Module Package	LGA-51, 10.6 x 12.8 x 2.4 mm, 660 mg
Module Operating Temp.	-40 degC to +85 degC (industrial grade)

2.3 Power Supply

Source	Voltage / Detail
USB-C connector	5 V input, onboard 3.3 V Switch Mode regulator
VUSB pin	5 V input (alternative to USB-C)
LiPo battery	3.7 V nominal, 1.25 mm JST (PicoBlade) connector
LiPo charger	Integrated; charges from USB-C or VUSB
VIO (board I/O)	3.3 V
VIO (module)	3.3 V
VPMU / VDCDC / VPA (module)	2.5 V

3 Pin Assignment

Pin assignments follow the standard Challenger / Feather layout. UART1 of the RP2350 is dedicated to AT-command communication with the ST87M01 NB-IoT module and is not exposed on the external headers. All other pins remain fully available.

3.1 External Header Pins

Pin Label	RP2350 GPIO	Function	Notes
TXD	GPIO12	UART0 RX	Primary serial receive
RXD	GPIO13	UART0 TX	Primary serial transmit
D5	GPIO23	GPIO / PWM	Generic GPIO
D6	GPIO24	GPIO / PWM	Generic GPIO
D9	GPIO25	GPIO / PWM	Generic GPIO
D10	GPIO2	GPIO / PWM	Generic GPIO
D11	GPIO3	GPIO / PWM	Generic GPIO
D12	GPIO6	GPIO / PWM	Generic GPIO
D13	GPIO7	GPIO / PWM	Generic GPIO
SS/A5	GPIO17	SPI0 SS	SPI Slave Select
SCK	GPIO18	SPI0 CLK	SPI clock
MOSI	GPIO19	SPI0 TX	SPI data out
MISO	GPIO16	SPI0 RX	SPI data in
SDA	GPIO20	I2C0 SDA	I2C data
SCL	GPIO21	I2C0 SCL	I2C clock

A0	GPIO26	ADC0	Analog input 0
A1	GPIO27	ADC1	Analog input 1
A2	GPIO28	ADC2	Analog input 2
A3	GPIO29	ADC3	Analog input 3
A4	GPIO1	GPIO / PWM	Generic GPIO (Not analog input)
Aref	-	ADC_AVDD	Analolog reference voltage
3V3	-	Power out	3.3 V regulated supply output
GND	-	Ground	2 pins
VUSB	-	Power in	5 V input / USB VBUS sense
VBAT	-	Battery voltage	Connected to V+ on battery
EN	-	Enable	Pull low to disable 3.3 V regulator
RST	-	Reset	RP2350 reset, active low

3.2 Internal NB-IoT Module Connections

Signal	RP2350 GPIO	ST87M01 Pin	Description
NB-IoT TX	GPIO4	UART0_RX (pin 15)	RP2350 transmit to module
NB-IoT RX	GPIO5	UART0_TX (pin 16)	Module transmit to RP2350
NB-IoT INT	GPIO8	UART0_RTS (Pin 19)	Ring output to RP2350
Module RESET	GPIO9	RESETn (pin 38)	Active-low hardware reset
Module WAKEUP	GPIO10	WAKE_UP (pin 39)	Wake module from sleep
GNSS Bias Enable	GPIO11	Connected to LDO enable	Enabled the GNSS bias voltage
NB-IoT Ant.	-	RF_ANT (pin 35)	Via onboard matching network to U.FL
GNSS Ant.	-	GNSS_ANT (pin 31)	Dedicated GNSS U.FL connector

Note: UART1 of the RP2350 is reserved for NB-IoT AT-command communication and is not available on the external header pins.

4 NB-IoT & GNSS Connectivity

4.1 Cellular Connectivity

The ST87M01-1301 implements LTE Cat NB2 per 3GPP Release 15, offering extended Transport Block Size (TBS) and 2 HARQ processes. The embedded protocol stack supports TCP/IP (IPv4 and IPv6), TLS/DTLS for encrypted transport, CoAP and LwM2M for constrained device management, MQTT for publish/subscribe messaging, and HTTP/HTTPS for RESTful web services. PDU-mode SMS is also available.

4.2 Power Saving Modes

Mode	Description	Typical Current
PSM (Power Saving Mode)	Module enters deep sleep between reporting intervals. Paging is disabled; the device is unreachable until it wakes on a configured timer.	1.2 uA
eDRX (Extended Discontinuous Rx)	Module wakes periodically to check for downlink data. Provides a balance between reachability latency and current consumption.	~5 uA average

4.3 GNSS Positioning

The onboard GNSS receiver (ST87M01-1301) supports GPS (L1) and Galileo constellations in an optimised concurrent mode for fast, accurate position fixes. Assisted GNSS (A-GNSS) reduces time-to-first-fix by downloading ephemeris data over the NB-IoT link. A dedicated GNSS antenna U.FL connector is available on the board edge.

4.4 Wi-Fi Positioning

When a GNSS fix is unavailable (e.g. indoors), the ST87M01-1301 can scan nearby IEEE 802.11b access points and report their MAC addresses to a third-party geocoding API (such as Google Maps Geolocation) over the NB-IoT link to derive an estimated position. This requires no active Wi-Fi association and consumes minimal power.

5 Software & Development

5.1 Supported Environments

Environment	Status	Notes
Arduino IDE (arduino-pico)	Supported	Via Earle F. Philhower's arduino-pico core; RP2350 boards included
Raspberry Pi Pico SDK (C/C++)	Supported	Native RP2350 SDK support; CMake-based build
MicroPython	Supported	Official RP2350 MicroPython firmware
CircuitPython	Supported	Adafruit CircuitPython for RP2350
PlatformIO	Supported	Via arduino-pico platform package

5.2 NB-IoT AT Command Interface

The ST87M01 is controlled via the standard 3GPP AT command set extended with STMicroelectronics-specific commands. The default baud rate is 115200 bps (configurable). Firmware updates can be performed via Differential FOTA (DFOTA) over LwM2M, or locally over UART / external SPI flash in factory mode.

5.3 Debugging

A BConnect SWD debug connector is located easily accessable on the top side of the board and is compatible with the iProbe from iLabs. The debug TXD signal on the BSWD connector is connected to pin GPIO14 of the RP2350 and can be configured as a Software UART pin. UART0 (D0/D1 header pins) can also be used as serial debug output for user application code.

6 Electrical Characteristics

Parameter	Min	Typ	Max	Unit
USB-C / VUSB input voltage	4.5	5.0	5.5	V
LiPo battery voltage	3.0	3.7	4.2	V
3.3 V output (max. current)	-	3.30	-	V
NB-IoT module VIO	1.8	3.3	3.3	V
NB-IoT TX power (max)	-	-	+23	dBm
Module sleep current	-	1.2	-	uA
Module power-off current	-	0.5	-	uA
Board operating temperature	-20	25	+70	degC
Module operating temperature	-40	25	+85	degC

7 Certifications & Compliance

7.1 ST87M01-1301 Module Certifications

Certification	Coverage	Standards
GCF	FDD B1, B3, B5, B8, B20, B28	3GPP TS 36.521-1/3, 36.523-2, 36.124
RED (EU)	FDD B1, B3, B8, B20, B28	EN 301 908-13, EN 301 489-1/-19/-52, EN 303 413
RED-DA Cybersecurity	Articles 3.3.d & 3.3.e	EN 18031-1:2024, EN 18031-2:2024
RoHS	Full compliance	Directive 2011/65/EU + delegated 2015/863
RF Exposure (MPE)	Module level	EN 62311:2020
Electrical Safety	Module level	EN 62368-1:2014/AC:2015

Note: *The certified NB-IoT module simplifies regulatory approval for end products. Terminal manufacturers remain responsible for application-specific compliance and for communicating safety information to end users.*

8 Mechanical Information

Dimension / Feature	Value
Board length	56.9 mm (Elongated Challenger+ standard)
Board width	22.9 mm (Feather standard)
Board height	Approx. 4.5 mm including components (no battery attached)
Header pitch	2.54 mm (100 mil), through-hole, single row both sides

Battery connector	1.25 mm JST / PicoBlade, side-mount
USB connector	USB Type-C
NB-IoT antenna conn.	U.FL / IPEX, board edge
GNSS antenna conn.	U.FL / IPEX, board edge (separate from NB-IoT)
PCB stackup	4-layer FR4, ENIG (Electroless Nickel Immersion Gold) finish
Weight (approx.)	8 g without battery

9 Ordering Information

Order Code	Description
98-00374-1	Challenger+ RP2350 NB-IoT - board only (no antennas)
98-00374-2	Challenger+ RP2350 NB-IoT - board + NB-IoT antenna + GNSS antenna
98-00374-3	Challenger+ RP2350 NB-IoT - board + antenna kit + 1NCE SIM card

Note: *For volume pricing, custom SIM provisioning, or OEM enquiries please contact sales@ilabs.se or visit ilabs.se.*

10 Safety & Regulatory Notes

RF Interference

This board transmits radio-frequency energy. Do not use near sensitive medical equipment without prior risk assessment. Follow all applicable local regulations regarding RF emissions.

Aviation

The NB-IoT radio must be disabled during aircraft flight. Follow all airline crew instructions regarding the use of electronic devices.

Explosive Environments

Do not operate this board in areas with risk of explosion unless the complete end system has been specifically rated for such environments.

Emergency Communication

NB-IoT connectivity cannot be guaranteed under all network conditions. Do not rely on this board as the sole means of emergency communication.

Battery Safety

Only connect single-cell LiPo batteries rated at 3.7 V nominal. Never short-circuit the battery terminals. Dispose of batteries in accordance with local regulations.

Electrostatic Discharge (ESD)

Handle the board with standard ESD precautions. Sensitive components may be permanently damaged by electrostatic discharge.

11 Revision History

Version	Date	Changes
1.0	March 2026	Initial release