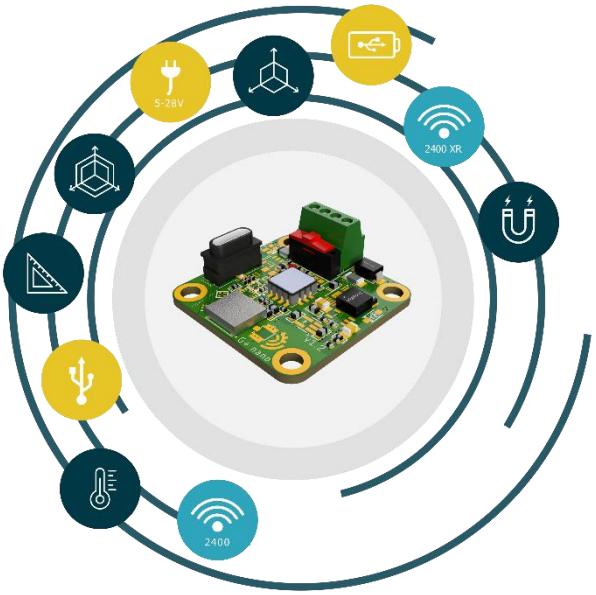
nemi G+ ultra nano (Hardware Rev. 1.2 and later)

Small, wireless, high-performance OEM sensor module for measuring vibration, oscillation, acceleration and angular rate

Description

nemi G+ ultra nano is a compact integrated sensing product in the form of a circuit board for wireless, highly dynamic and broadband measurement of vibration, oscillation and acceleration. A live sampling rate of up to 26.7 kHz enables a signal bandwidth of up to 6.7 kHz (−3 dB). Steep integrated filters allow high bandwidths even at lower sampling rates, for example up to 1.2 kHz at 3.3 kHz sampling rate. This allows the requirements of the standards ISO/DIN ISO 20816 and DIN ISO 2954 to be met. Additionally integrated sensors capture angular rates and magnetic field strengths at the same time and thus the spatial orientation, which can save additional rotation-angle sensors, particularly in rotating applications. Due to the highly efficient and robust nemi Link 2400 radio technology, very long battery runtimes and ranges of up to approx. 100 m are achieved, without missing samples.

Key Features



- **Compact & lightweight design** 30 x 30 x 12 mm, < 10 grams (without connectors: height 6 mm, < 7 grams)
- **High-bandwidth MEMS accelerometer** with a signal bandwidth from 0 Hz (static) up to 6.7 kHz (−3 dB)
- Meets the requirements of **ISO/DIN ISO 20816** and **DIN ISO 2954**
- **Completely wireless and maximized battery life** with microsecond-accurate time synchronization due to radio technology nemi Link 2400
- **Long radio range** of up to approx. 100 m in realistic scenarios
- **Reliable, buffered data transmission** bridges radio interruptions of up to several minutes, no lost samples
- Transmission of **live raw data** or **smart data** pre-evaluated by edge computing
- **Permanent installation** possible with wide range voltage input
- **Weatherproof variant** with enclosure on request

High-speed, low-noise, triaxial, capacitive **MEMS accelerometer**; measuring range up to 16 g; signal bandwidth up to 6.7 kHz

nemi Link 2400 - i4M's robust and **flexible radio technology** in the 2.4 GHz frequency band

IMU sensor module for measuring accelerations and rotation rates in and around all 3 axes; ACC up to 16 g; GYR up to 4000 °/s

Optional Connector for Continuous operation with **wide range voltage input** 3.3 - 30 V DC

Triaxial **magnetometer**; measuring range up to 16 Gauss

Power supply/ battery charging via **micro USB**

Internal **temperature sensor**; measuring range- 20 - 60 °C

Optional Connector for **battery** (with charger)

ESD (Electrostatic Discharge) Sensitive device:



These devices have limited built-in ESD protection and damage may thus occur on devices subjected to high-energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Specifications

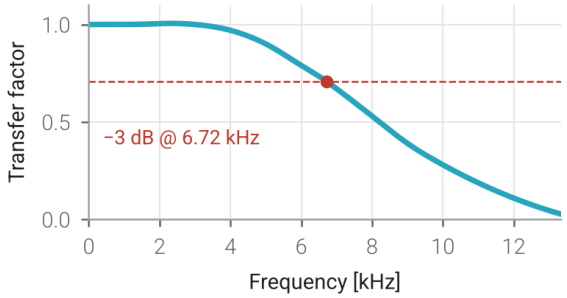
General information		
Dimensions (without connectors)	30 x 30 x 12 (30 x 30 x 4,2)	mm
Weight (with connectors)	6.5	grams
Supply voltage on BAT Pin	3.3 - 4.2 (rechargeable battery) 3.3 - 5 (non-rechargeable battery, power bank, other DC source)	V
Supply voltage on DCIN Pin	> 5 - 30	V
Temperature range permitted during operation	-25 to 85	°C
Onboard MCU, usable for edge computing	64 MHz ARM Cortex M4F, 1 MB Flash, 256 KB RAM; various hardware crypto features	-
Housing protection class	Without housing	-
Main sensor device (MEMS accelerometer)		
Selectable sampling rates	26.666 (one axis) / 13.333 / 6.666 / 3.333	kHz
Stability of the sampling rate (over the entire temperature range)	± 50	ppm
Realizable signal bandwidths (-3 dB)	6.72 / 4.66 / 2.35 / 1.17	kHz
Selectable measuring ranges	**± 16 / 8 / 4 / 2**	**g**
Sensor resonance frequency	**6.9**	**kHz**

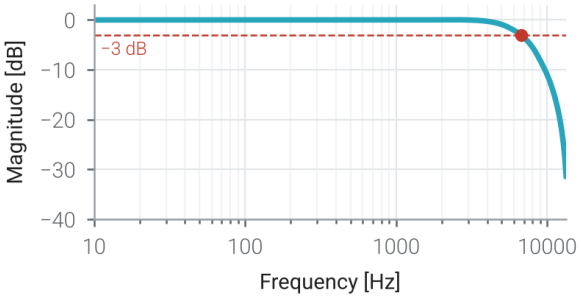
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Signal resolution	16	bit
Static 3D inaccuracy (related to measuring range) Without calibration With calibration (on request)	 < 2 < 0.5	 % %
Additionally integrated 9-DoF IMU 3-axis MEMS accelerometer (ACC) / gyrometer (GYR) / magnetometer (MAG) each		
Sampling rate	104	Hz
Selectable measuring ranges ACC	± 16 / 8 / 4 / 2	g
Selectable measuring ranges GYR	± 4,000 / 2,000 / 1,000 / 500 / 250 / 125	°/s
Selectable measuring ranges MAG	± 16 / 12 / 8 / 4	Gauss
Signal resolution	16	bit
Internal temperature sensor		
Sampling rate	1	Hz
Measuring range	-20 to 60	°C
Signal resolution	0.1	°C
Secondary Battery (rechargable)		
Charging cut-off voltage	4.2	V
Charging current	120	mA

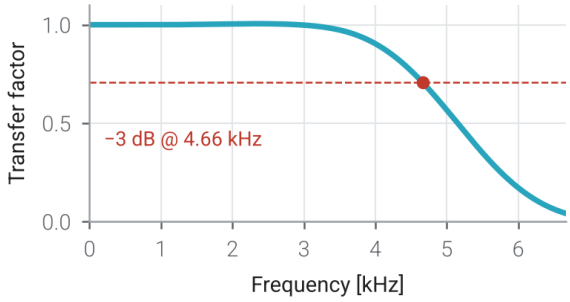
Frequency responses of the main sensor

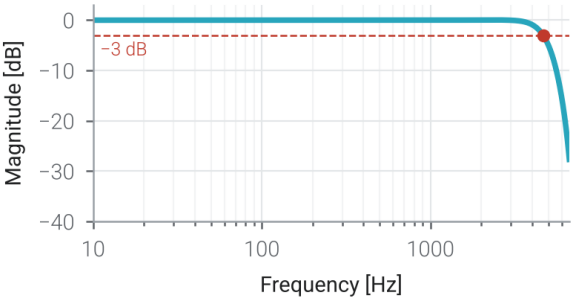
Frequency response at 26.666 kHz sampling rate



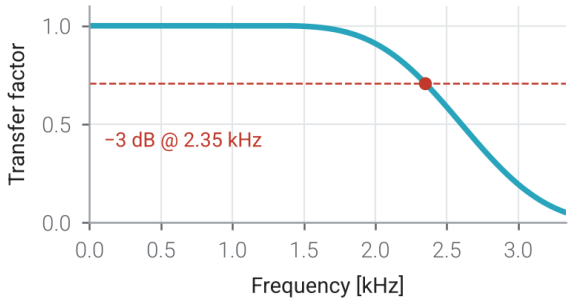


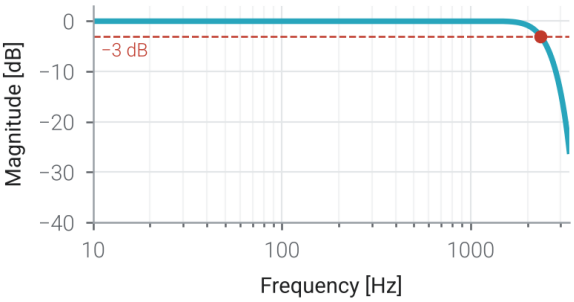
Frequency response at 13.333 kHz sampling rate



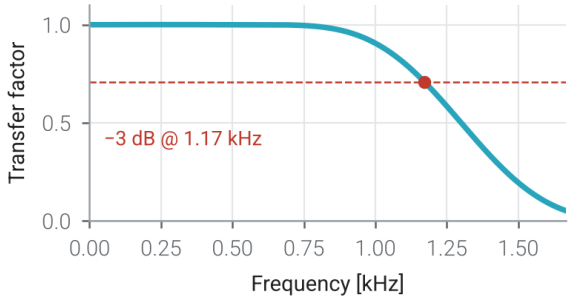


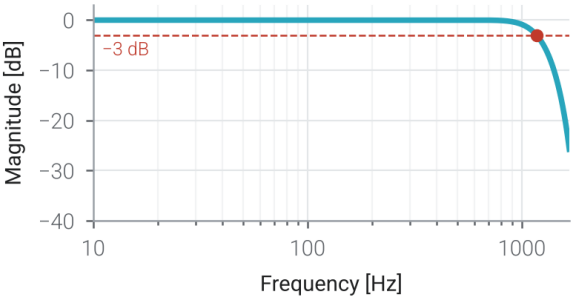
Frequency response at 6.666 kHz sampling rate





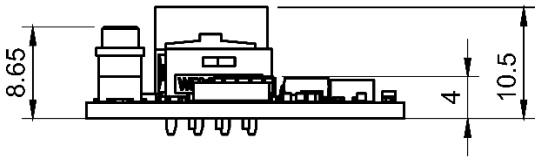
Frequency response at 3.333 kHz sampling rate

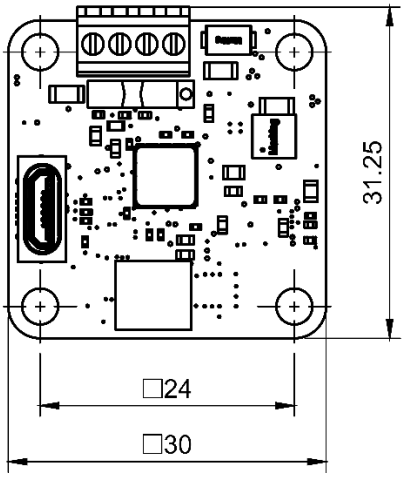




Dimensions

(All dimensions in mm)







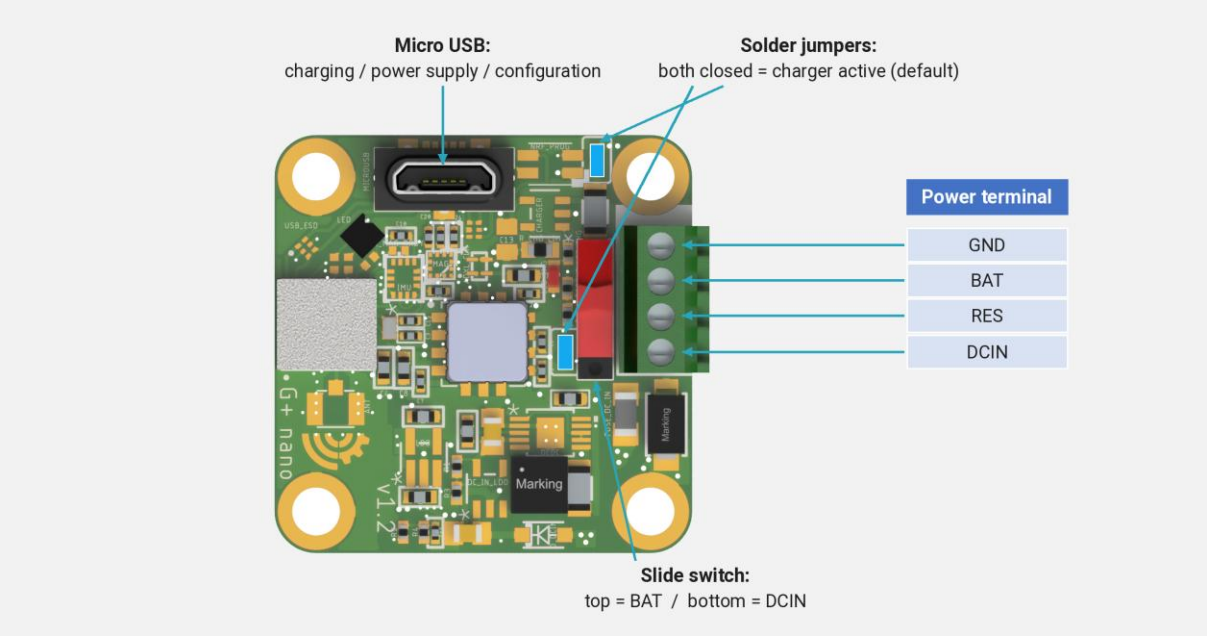
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Power supply

By default, nemi G+ ultra nano 1.2 or later is powered by a rechargeable Li-ion battery. Optionally, **set with solder jumpers to avoid charging of primary cells**, a single non-rechargeable lithium battery ($Li/SOCl_2$) or 3 alkaline batteries in series can be used. The 5 - 30 V DC input is available with every power option. Also, the micro-USB connector can be used as power supply (5 V).

The power supply is configured via two solder jumpers on the top side of the board. Before connecting the power source make sure the solder jumpers are set correctly!

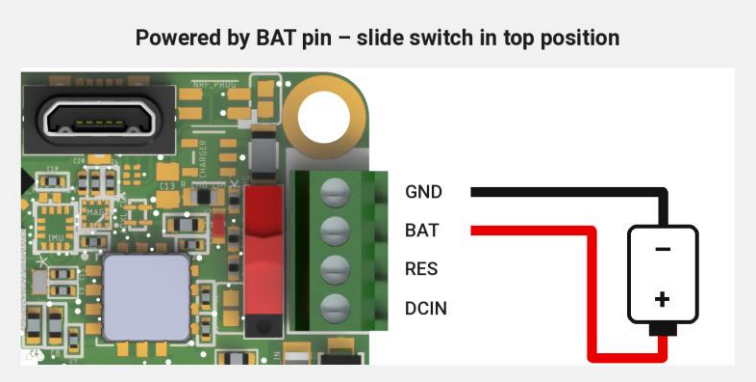
Pin assignment



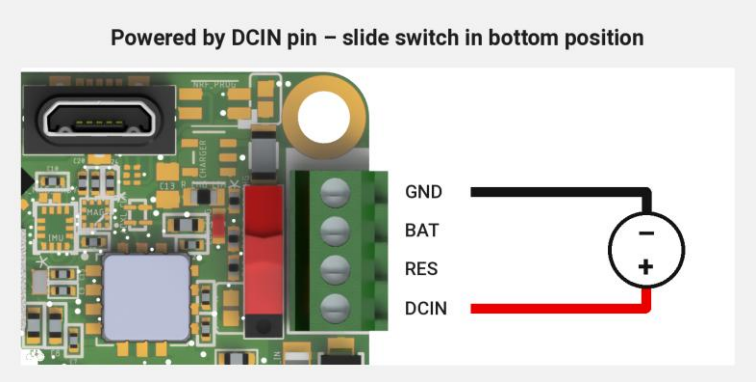
GND ≙ Ground · BAT ≙ Battery 3.3 - 5 V · RES ≙ Reserved · DCIN ≙ DC input 5 - 30 V

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Powered by BAT pin – slide switch in top position. For example: rechargeable Li-ion battery (the battery must have its own protection circuit!), non-rechargeable lithium battery or other DC supply between 3.3 - 5 V.



Powered by DCIN pin – slide switch in bottom position. For example: 24 V DC, 2 - 8 non-rechargeable lithium batteries in series or a 12 V lead-acid battery.



If switched to the other switch position the nemi G+ ultra nano is either off or the switch can be used to change between the two power options if both are connected.

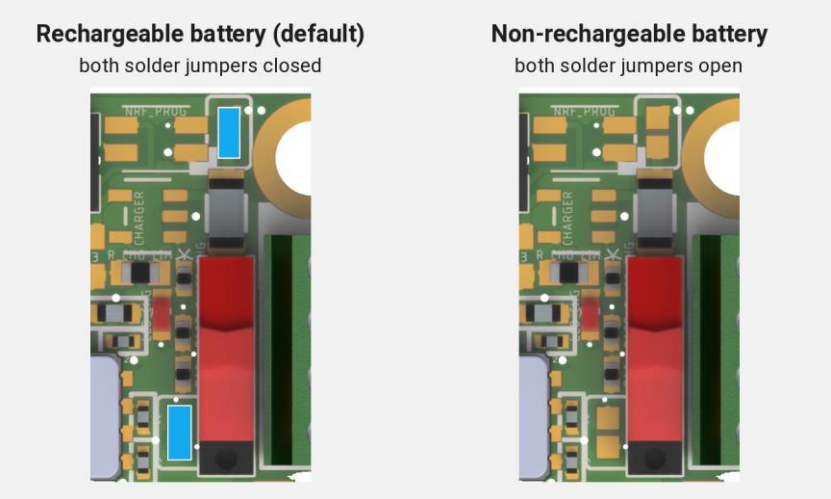
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Solder jumper configuration of the power supply

The power option can be adapted by the customer via two solder jumpers on the top side of the board. If both solder jumpers are closed, the charger is active (default).

Power option	Solder jumpers and function
Rechargeable battery (default)	**Solder jumpers closed:** The BAT pin is connected to the charger IC so that the battery can be charged with the internal charging circuit (via USB). The battery voltage is being measured. Charge characteristic: constant current - constant voltage, 4.2 V, 120 mA.
Non-rechargeable battery	**Solder jumpers open:** The BAT pin is NOT connected to the charger IC (**prevents accidental charging of a non-rechargeable battery**). The battery voltage is being measured. Input range: 3.3 – 5 V.

Position of the solder jumpers (top side of the board, closed solder jumpers are marked in blue):



Power supply examples and expected runtime

Average current consumption of nemi G+ ultra nano on the BAT pin at 3.3 V: 19.2 mA at 26,667 Hz (x axis); 18.5 mA at 13,333 Hz (x and y axes); 15.1 mA at 6,666 Hz (all axes); 10.3 mA at 3,333 Hz (all axes). The following examples use 3,333 Hz with all axes active, i.e. an average of 10.3 mA at 3.3 V (34 mW) on the BAT pin. This is also the baseline for the efficiency calculations.

Example settings: 3,333 Hz sampling rate (all axes), ACC, GYR and MAG active, radio mode 2 MBit/s

Power source	Connected to	Nominal capacity [Wh]	Efficiency at nominal voltage	Effective capacity [Wh]	Projected runtime [days]
1 x Saft LS 14250	GND and BAT	4.3	~89 % (3.6 V)	3.8	5
1 x Saft LS 33600	GND and BAT	61.2	~89 % (3.6 V)	54.5	67
2 x Saft LS 33600 in series	GND and DCIN	122.4	~85 % (7.2 V)	104	127
4 x Saft LS 33600 in series	GND and DCIN	244.8	~81 % (14.4 V)	198	243

Check the solder jumper configuration before connecting the battery!

The capacity used to calculate the expected runtime is the nominal capacity of the battery. The real-life usable capacity depends on the temperature, the discharge rate and other environmental factors.

For Saft Li-$SOCl_2$ non-rechargeable batteries, the voltage can drop below 3.3 V at temperatures below 0 °C. Therefore, a single-battery configuration is not recommended for applications below 0 °C.

Power source examples

Type	Example	Nominal voltage [V]	Capacity [Wh]	Dimensions [mm]
Rechargeable (LiPo)	Renata ICP641620PA	3.7	0.6	7 x 16 x 22
Rechargeable	Panasonic NCR18650B	3.7	12.6	Ø 18 x 69
Non-rechargeable (Li-$SOCl_2$)	Saft LS14250	3.6	4.3	Ø 14 x 25
Non-rechargeable (Li-$SOCl_2$)	Saft LS33600	3.6	61	Ø 33 x 61
Non-rechargeable (lithium primary)	Varta 9 V battery	9	10.8	26 x 49 x 16
Non-rechargeable (alkaline primary)	Varta Industrial Pro 4020 D Mono (3 in series)	4.5	76,5	3 x Ø 34,2 × 61,5

Radio technology nemi Link 2400

Our radio technology nemi Link 2400 is a wireless sensor network in the 2.4 GHz frequency band with star topology and one receiver module. This high-speed network enables the reliable transmission of data at high sampling rates and over long ranges of up to 100 m with nemi G+ ultra nano. The high efficiency of our robust radio technology enables very long battery runtimes of our products. Our wireless sensors synchronize their internal clocks to the clock of the receiver module with extremely small deviations.

To optimize the wireless performance for every use case, nemi Link 2400 offers the possibility to adjust the number of sensor nodes per radio channel and the radio speed to achieve the perfect balance between range, data rate and runtimes for each application.

Please find detailed information in the nemi Link 2400 info sheet.

Compatible receiver modules in the nemi Link 2400 wireless network

nemi G+ ultra nano is compatible with all receiver modules in i4M's nemi Link 2400 network. The following products are available under the nemione® trademark:



nemi EdgeBase



nemi Connect



nemi Log (+ cellular)

Application

Because of the compact and lightweight design, nemi G+ ultra nano can easily be integrated into the smallest installation spaces. It allows you to build your own compact, sealed sensors or turns your components and machines into smart products. It performs particularly well in highly dynamic applications such as NVH (noise, vibration, harshness) measurements, the monitoring of motors and pumps, and on rotating or moving components such as rotor shafts of wind turbines or in test benches. For high-precision tilt measurements, we recommend nemi G+ nano because of its higher resolution and lower noise.

Mounting options

nemi G+ ultra nano can be mounted in three ways. All mounting options are based on the same aluminum baseplate (33 x 33 mm) to which the board is screwed.

Baseplate. nemi G+ ultra nano can be ordered with an aluminum baseplate. The baseplate can be screwed (M4 thread in the center) or glued to the measuring object. The best vibration transmission is realized with a grub screw connection. We recommend using the baseplate because of the THT connections of nemi G+ ultra nano (legs sticking out at the bottom).

Baseplate with cover. A compact cover (33.2 x 33.2 x 14.6 mm, 16.5 mm including terminal block) is placed on top of the baseplate and protects the electronics. Terminal block, slide switch and micro USB connector remain accessible. The sensor axes and the measuring range are marked on the cover.

Waterproof housing. A 3D-printed housing (33 x 33 x 19.4 mm) is placed on the baseplate and encloses nemi G+ ultra nano completely. The housing is potted with resin. The sensor is charged and configured (radio settings) via a magnetic USB connector, so the housing does not have to be opened.



Baseplate



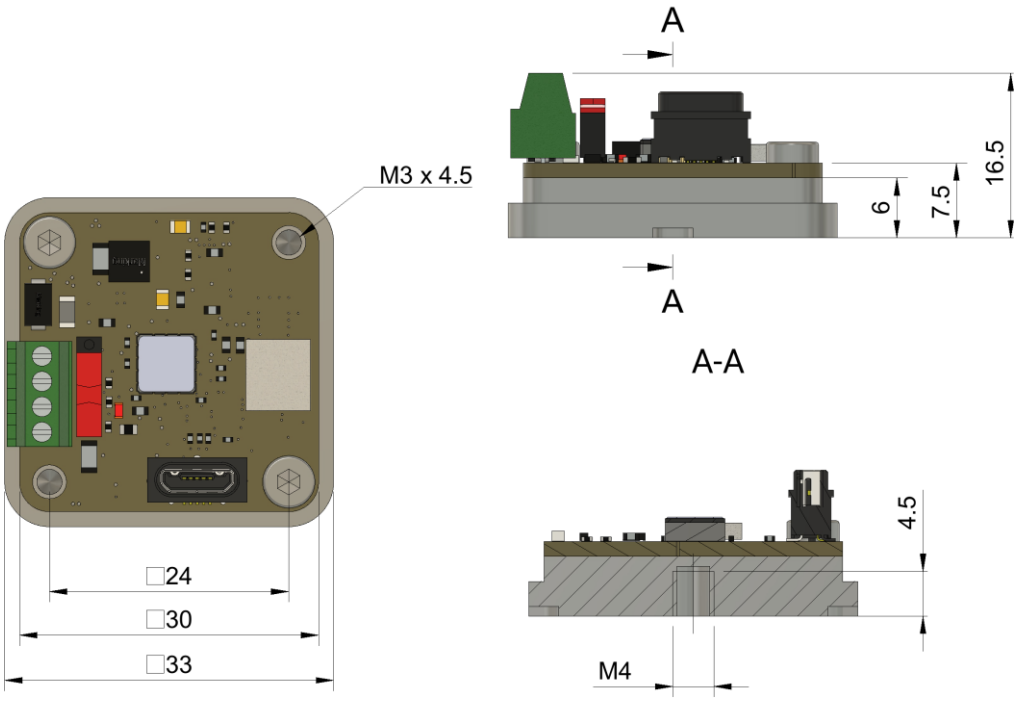
Baseplate with cover



Waterproof housing
(magnetic USB connector)

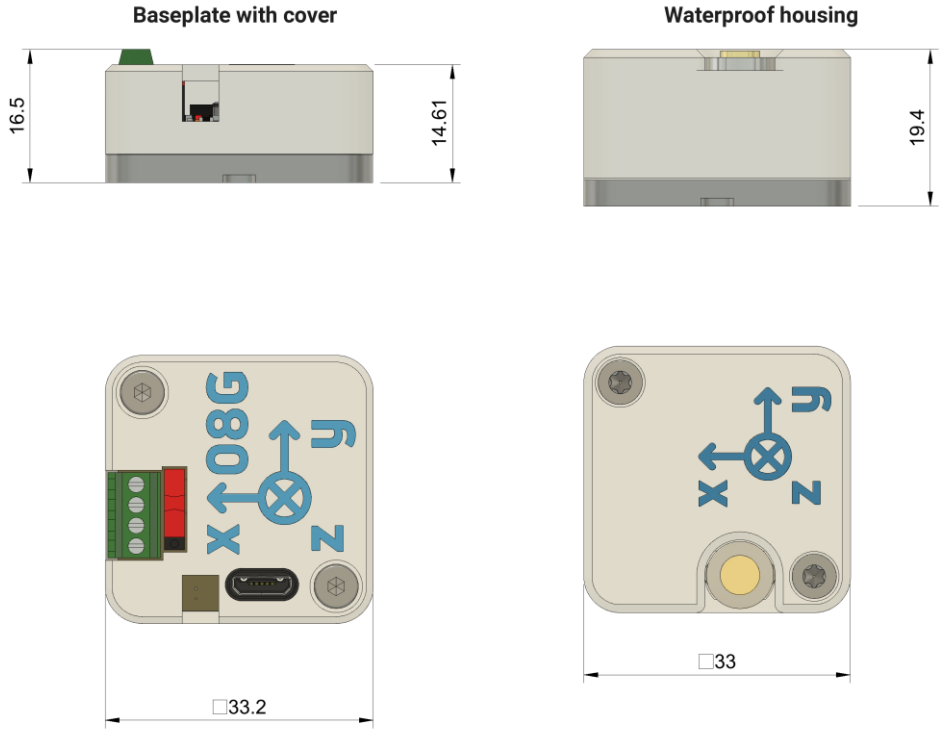
Baseplate dimensions

(All dimensions in mm)



Dimensions of cover and waterproof housing

(All dimensions in mm)



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LED Blink Codes

The nemione® nemi G+ ultra nano has integrated LEDs. Their flashing indicates the various operating states of the sensor node:

Operating Mode	Description
Rapid flashing in the sequence white, green, red, blue	Indicates a restart of the sensor node.
Red LED, continuously	The battery is charging, power supply via USB or wide-range voltage input.
Red LED no longer lights up continuously	The battery is fully charged.
Green lights up continuously, yellow flashes simultaneously	A USB port with a data connection has been detected. The sensor node is waiting for a virtual COM port to open.
Green lights up continuously, blue flashes simultaneously	The virtual COM port has been opened. The sensor node is waiting for new RF parameters or settings from the PC software.
Regular short red flashes for approx. 2 seconds	The sensor node samples and transmits measurement data.
Regular short green flashes all 10 seconds for approx. 1 second	The sensor node is in sleep mode.
Regular short blue flashes for approx. 1 second	The sensor node resynchronizes with the wireless network (time synchronization).
The green LED lights up temporarily or continuously in wireless mode	The internal data memory (ring buffer) is 80 % full as the data could not be transmitted via radio link. There is a risk of data loss.

Data Analysis

Upon request, we will be happy to support you with data analysis. The data analyses can be performed directly in the sensor or in the gateway by edge analytics as well as on the server or measuring computer. A great advantage of edge analytics is the reduction of the transmitted data to the essentials ("smart data"). This reduces storage space and increases battery runtimes.

Based on our knowledge from a multitude of previous projects, we have developed algorithms for data evaluation to generate maximum added value for our customers. We will gladly advise you on this. In addition to our existing algorithms we create individualized scripts upon request.

At the same time, the data remains your capital: We do not rely on big cloud providers but keep the data in your IT ecosystem. Alternatively, you can rely on our nemione® cloud solutions - hosted in the European Union.

Ordering options of nemi G+ ultra nano



For very flat installation spaces, the USB socket and terminal block can be omitted. The radio parameters are then fixed and the power supply is connected via soldered wires. Please state the radio settings with your order.

Contact

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