nemi Struct

Wireless solution for long-term structural health monitoring (SHM) with live data

Description

nemi Struct is our solution for long-term monitoring applications, particularly on civil engineering structures such as bridges, large structures of wind turbines such as rotor blades and towers, ships, or amusement rides such as roller coasters. At its core, nemi Struct is a weatherproof, robust housing with a self-sufficient long-term power supply that integrates a proven nemione sensor node. Two main variants are available:

- **nemi Struct G+** with integrated nemi G+ nano for measuring **vibrations and inclinations**
- **nemi Struct DAQ** with integrated nemi DAQ nano for acquiring data from **connected sensors** such as strain gauges, potentiometric displacement sensors, temperature sensors or sensors with 0 - 10 V output

Both versions can be combined either with a **battery pack** for continuous live operation lasting more than a year or with a **solar power supply** for long-term, maintenance-free live streaming. Thanks to our highly efficient nemi Link 2400 wireless technology, measurement data is reliably transmitted over distances of up to 350 meters in real-world environments— with minimal energy consumption and maximum battery life. This means you don't have to sacrifice high-resolution live data, even when wirelessly monitoring large structures.

Key Features

- **Two variants in one system:** vibration & inclination (G+) or external sensors (DAQ)
- **Self-sufficient power supply:** battery pack with > 1 year runtime (continuous live-streaming) or solar option for unlimited runtime
- **Weatherproof, robust housing** made of aluminum and polycarbonate with **IP 66** protection
  (216 x 120 x 55) mm
- **Live data over up to 350 m** radio range with nemi Link 2400
- Based on the proven nemione sensor nodes **nemi G+ nano** and **nemi DAQ nano**



Feature Highlights

Power supply and radio (all variants)

- Integrated **battery pack** with two lithium D cells and **more than 1 year runtime** with continuous live measurement
- **nemi Link 2400** - i4M's own robust and flexible **radio technology** in the 2.4 GHz frequency band
- **Solar option** with external solar panel and buffer storage for **unlimited runtime**
- **Long-range** radio coverage of up to **350 m** with nemi Link 2400 XR feature (@ 125 kbit/s)

Variant nemi Struct G+ (vibration and inclination)

- High-resolution, triaxial, capacitive **MEMS accelerometer**; measuring range up to **8 g, 40 g** or **256 g**
- Can be used as a precise, high-resolution **inclination sensor** with a resolution of **10 µm/m**
- **IMU sensor module** for measuring accelerations, rotation rates and magnetic field strengths in and around all 3 axes; ACC up to 16 g; GYR up to 4000 °/s; MAG up to 16 Gauss
- Internal **temperature sensor**; measuring range -20 to 60 °C

Variant nemi Struct DAQ (external sensors)

- Connection of up to **2 (optionally 3) Wheatstone / strain gauge full bridges**
- Connection of up to **2 (optionally 3) potentiometer sensors**
- Connection of up to **2 (optionally 3) temperature sensors** (Pt100 / Pt1000, thermocouples, thermistors)
- Connection of up to **2 (optionally 3) analog sensors** with 0 - 10 V output
- Connection of up to **2 sensors with digital output** with 3.3 - 24 V signal level
- **IMU sensor module** for measuring accelerations, rotation rates and magnetic field strengths in and around all 3 axes

Variants at a Glance

	nemi Struct G+	nemi Struct DAQ
Integrated sensor node	nemi G+ nano	nemi DAQ nano
Main measured variables	Vibrations (accelerations) and inclinations in 3 axes	Signals of connected sensors: strains, displacements, forces, temperatures, 0 - 10 V
Main sensor / inputs	Triaxial MEMS accelerometer, ± 8 g or ± 40 g	2 or 3 analog inputs (24 bit) and 2 digital inputs
Max. live sampling rate	4,000 Hz (main sensor)	6,400 Hz (1 channel); 1,944 Hz (2 channels); 1,296 Hz (3 channels)
Additionally integrated	9-DoF IMU, temperature sensor	9-DoF IMU, temperature sensor
Runtime with battery pack	1.0 years @ 125 Hz continuously	1.2 years @ 100 Hz cont. (2 x strain gauge)
Typical applications	Vibration monitoring, modal analysis, inclination and settlement monitoring	Deflection and load measurement with strain gauges, crack monitoring with displacement sensors

Power Supply

nemi Struct includes long-term power supply options that enable a reliable operating time of more than one year and, under suitable conditions, permanent operation without battery replacement. This is achieved either with a **battery pack** or with a combination of an **industrial lithium-ion power bank and an external solar panel**. Both options are available for both variants (G+ and DAQ).

Power supply options compared

	Battery pack	Solar power supply
Energy storage	2 x lithium thionyl chloride D cell (e.g. Saft LS 33600, 3.6 V)	Industrial lithium-ion power bank, 6,700 mAh
Energy source	Primary cells (not rechargeable)	External solar panel 10 Wp, (223 x 148) mm
Runtime	1.0 - 1.5 years in continuous live operation (see table)	Permanent with suitable panel orientation, also in Central Europe
Suitable for	Shady measuring points and indoor use; precisely predictable runtime	Energy-autonomous outdoor monitoring without maintenance visits

Battery pack

The integrated battery pack consists of two lithium D cells and offers a reliable option with a precisely predictable runtime, even for shady measuring points and indoor use.



nemi Struct with battery pack


Opened housing with two lithium D cells

The following runtimes with the battery pack were determined for typical operating points of nemi Struct:

Runtimes with battery pack

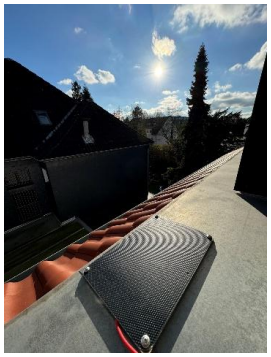
Integrated sensor node	Measured variables	Sampling rate	Runtime
nemi G+ nano	3-axis vibration and inclination sensor	125 Hz, continuous, live	1.0 years
nemi DAQ nano	2 x strain gauges (1000 Ohm), e.g. for deflection measurement	100 Hz, continuous, live	1.2 years
nemi DAQ nano	2 x displacement sensors (potentiometric, 1000 Ohm), e.g. for dynamic crack monitoring	50 Hz, continuous, live	1.5 years

Solar power supply

With suitable orientation, the solar power supply enables a reliable, permanent energy supply, even in Central Europe. The external solar panel charges an industrial lithium-ion power bank inside the housing, which serves as buffer storage for night-time and periods of bad weather.



nemi Struct with solar panel

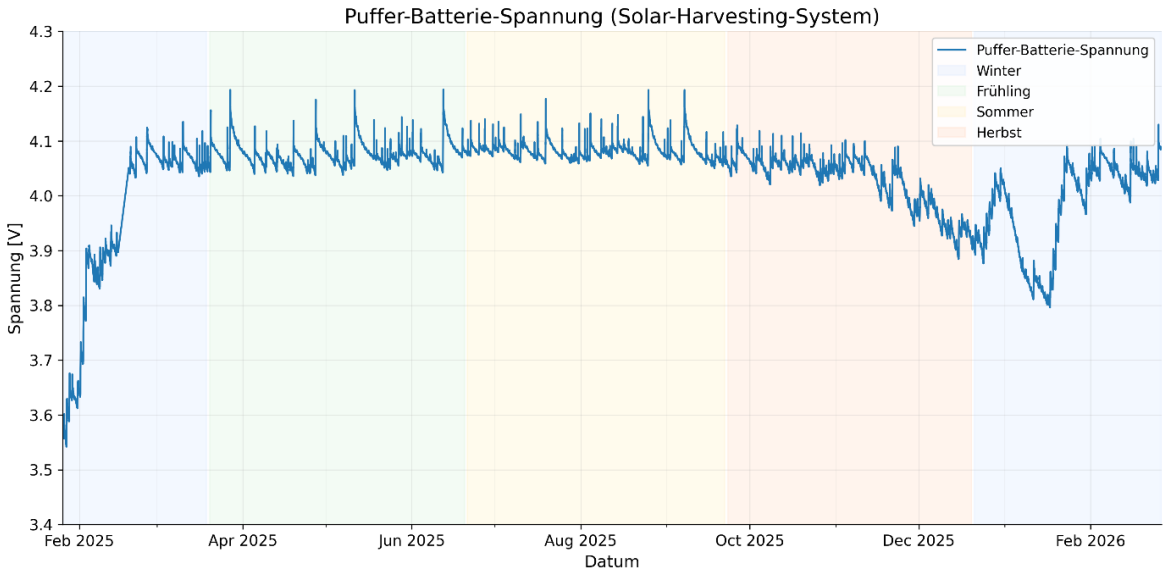

Solar panel in use

We carried out extensive tests to prove the reliable function of the solar power supply. For example, a nemi Struct with solar panel was mounted on an east-facing window sill of a house in western Germany (51° N). The panel was aligned vertically towards the sky, and the house shades approx. 50 % of the sky. The nemi Struct with nemi DAQ nano was operated with one active analog channel at 100 Hz and active IMU (9 DoF) at 104 Hz.

The following graph shows the voltage of the buffer storage between January 2025 and February 2026. The lower limit voltage (empty battery) is approx. 3.3 V, the maximum voltage when fully charged is approx. 4.1 V. The system was started in the middle of winter with a largely

discharged buffer and ran without interruption over the entire period, including the following winter.

Buffer storage voltage in the long-term test with solar power supply

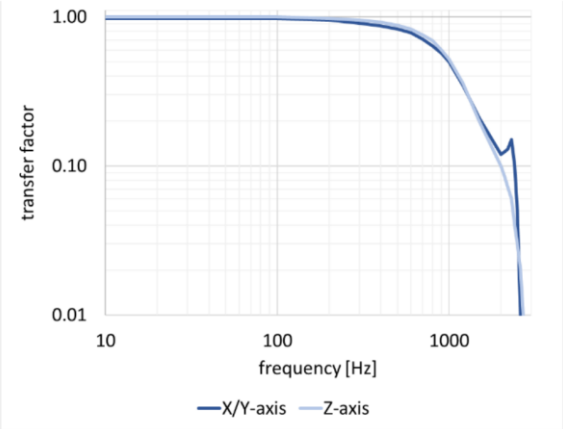


Specifications

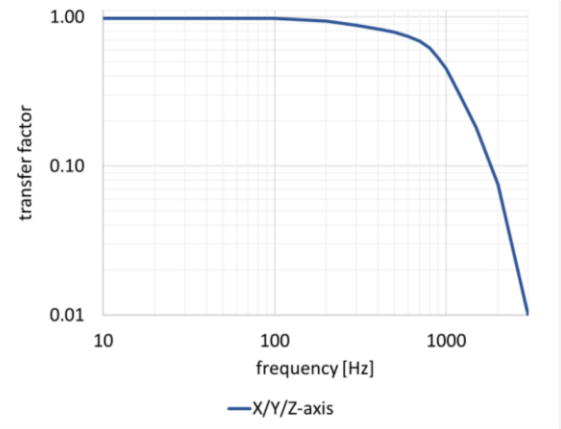
General information (all variants)		
Dimensions (without antenna and cable glands)	216 x 120 x 55	mm
Housing material	Aluminum and polycarbonate	-
Housing protection rating	IP 66	-
Temperature range permitted during operation	-20 to 60	°C
Onboard MCU, usable for edge computing	64 MHz ARM Cortex M4F, 1 MB Flash, 256 KB RAM; various hardware crypto features	-
Radio technology	nemi Link 2400, 2.4 GHz frequency band	-
Radio range	up to 350 (nemi Link 2400 XR @ 125 kbit/s)	m
Optional	Internal flash memory to bridge longer radio interruptions of up to several minutes	-
Power supply		
Battery pack option	2 x lithium thionyl chloride D cell (Saft LS 33600), 3.6 V each	-
Runtime with battery pack (continuous live operation)	1.0 - 1.5 (depending on variant and sampling rate, see runtime table)	years
Solar option: buffer storage	Industrial lithium-ion power bank, 6,700 mAh	-
Solar option: voltage range of buffer storage	approx. 3.3 (empty) to 4.1 (full)	V
Solar option: solar panel	10 Wp; (223 x 148 x 3.6) mm	-
Runtime with solar option	unlimited with suitable panel orientation	-

Variant nemi Struct G+: main sensor (MEMS accelerometer)		
Selectable sampling rates	4,000 / 2,000 / 1,000 / 500 / 250 / 125	Hz
Stability of sampling rate (over the entire temperature range)	± 50	ppm
Realizable signal bandwidths (-3 dB)	800 / 500 / 250 / 125 / 62.5 / 31.25	Hz
Selectable measuring ranges Variant M08 Variant M40 Variant M256	 ± 8 / 4 / 2 ± 40 / 20 / 10 ± 256 / 128 / 64 / 32 / 16 / 8 / 4 / 2	 g g g
Sensor resonance frequency Variant M08 Variant M40 Variant M256	 2,400 5,500 2,400	 Hz Hz Hz
Signal resolution Variant M08 Variant M40 Variant M256	 20 20 16	 bit bit bit
Non-linearity (related to measuring range)	0.1	%
Cross-sensitivity	1.0	%
Static 3D Inaccuracy (related to measuring range) Without calibration With calibration (on request)	 < 8 < 0.1 (M08) / < 1.0 (M40) / < 1.0 (M256)	 % %
Variant nemi Struct G+: additionally integrated 9-DoF IMU and temperature sensor		
Sampling rate IMU and temperature sensor	1/25 of the sampling rate of the main sensor (e.g. 160 Hz at 4,000 Hz)	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 IMU	16	bit
Measuring range / resolution temperature sensor	-20 to 60 / 0.1	°C

Frequency response of the main sensor (variant nemi Struct G+)



Variant M08: measuring range max. ± 8 g



Variant M40: measuring range max. ± 40 g

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Variant nemi Struct DAQ: external analog sensors		
Connectable analog sensors	• Reference voltage sensors (e.g. Wheatstone / strain gauge full bridges, potentiometer sensors or thermocouples (e.g. type K) and thermistors) • Reference current sensors (e.g. Pt100 / Pt1000 resistance thermometers) • Analog sensors with 0 - 10 V voltage output	-
Number of analog channels	max. 2; max. 3 with nemi Struct DAQ 3 Channel	-
Max. sampling rates (with active channels)	6,400 (1 channel); 1,944 (2 channels); 1,296 (3 channels)	Hz
Stability of sampling rate (over the entire temperature range)	± 50	ppm
Selectable signal gains	128 / 64 / 32 / 16 / 8 / 4 / 2 / 1	-
Constant-current feed current	500	µA
Wheatstone bridge supply voltage	2.5	V
Signal resolution	24	bit
Analog measurement error	<< 0.1 (with automatic self calibration)	%
Variant nemi Struct DAQ: external digital sensors		
Examples for digital sensors	Switching displacement, distance, level or angle of rotation sensors, TTL / NPN sensors	-
Number of digital channels	max. 2	-
Signal level	3.3 - 24	V
Variant nemi Struct DAQ: additionally integrated 9-DoF IMU and temperature sensor		
Sampling rates IMU	3,332 / 1,666 / 833 / 416 / 208 / 104 / 52	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 IMU	16	bit
Measuring range temperature sensor	-20 to 60	°C

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Configuration of the sensor inputs (variant nemi Struct DAQ)

The analog inputs of nemi Struct DAQ can be configured as follows:

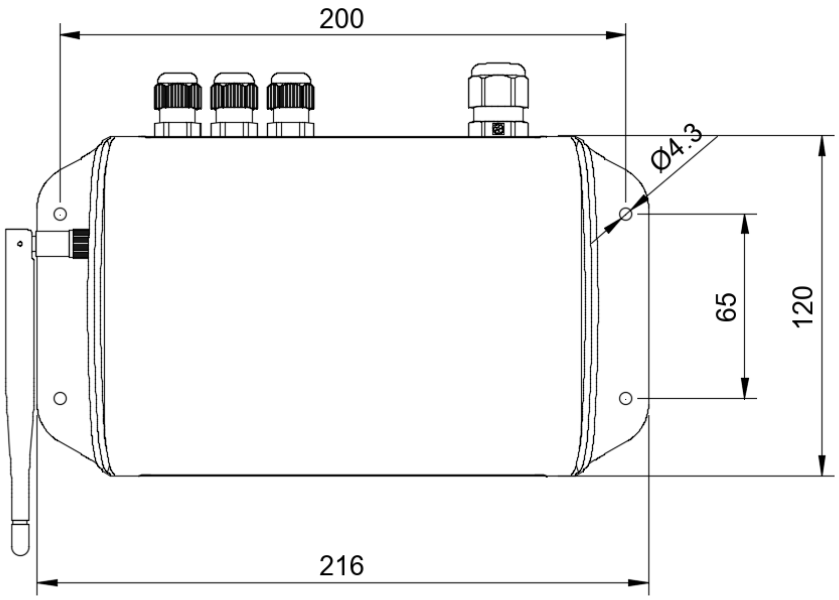
- Up to 2 (with nemi Struct DAQ 3 Channel up to 3) reference voltage sensors (e.g. Wheatstone / strain gauge full bridges, potentiometer sensors or thermocouples (e.g. type K) and thermistors)
- Up to 2 (3) reference current sensors (e.g. Pt100 / Pt1000 resistance thermometers)
- Up to 2 (3) sensors with analog output 0 - 10 V

The configuration of the analog inputs must be defined before delivery. Sampling rate, signal gain and IMU measuring ranges can then be set by the customer via our software. Detailed information on sampling rates, signal gains and measuring ranges can be found in the nemi DAQ nano data sheet.

Dimensions

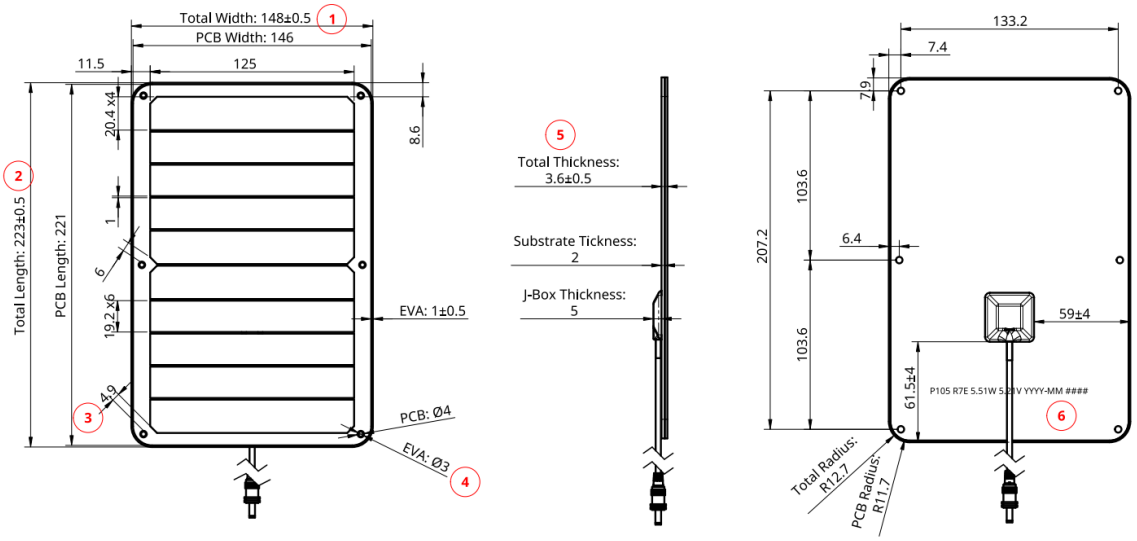
(All dimensions in mm)

nemi Struct outer dimensions



Housing height: 55 mm

Solar panel (solar option)



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Radio technology nemi Link 2400

Our own radio technology nemi Link 2400 is a wireless, battery-powered 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. 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 measurements of a 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 runtime for each application. With the long-range feature nemi Link 2400 XR (125 kbit/s), radio ranges of up to 300 m are possible.

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

Compatible receiver modules in the nemi Link 2400 wireless network

nemi Struct 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

Thanks to its self-sufficient long-term power supply, the weatherproof housing and the highly efficient nemi Link 2400 radio technology, nemi Struct is ideally suited for permanent, wireless structural health monitoring. Complex cable routing and a local power supply are not required. Examples of specific use cases are:

- Vibration, inclination and settlement monitoring on bridges and other civil engineering structures
- Crack and deflection monitoring with displacement sensors or strain gauges
- Long-term monitoring of large wind turbine structures such as rotor blades and towers
- Dynamic monitoring of ships and amusement rides such as roller coasters







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 Struct

Product	Description
nemi Struct G+ / Tilt	**Wireless acceleration and inclination measurement system** with additional 9-DoF IMU and temperature sensor, with integrated battery pack for long-term applications in structural health monitoring Measuring ranges ± 2 / 4 / 8 g or ± 10 / 20 / 40 g (with 20 bit resolution, very low noise) or ± 2 / 4 / 8 / 16 / 32 / 64 / 128 / 256 g (with 16 bit resolution); max. 4.0 kHz live sampling rate, 0.8 kHz bandwidth
nemi Struct G+ / Tilt + int. Flash	As nemi Struct G+ / Tilt, additionally with **internal flash memory** to bridge longer radio interruptions of up to several minutes (e.g. for roller-coaster-monitoring)
nemi Struct DAQ 2 Channel	**Wireless multi-sensor measurement system** with two analog inputs, digital inputs, additional 9-DoF IMU and temperature sensor, with integrated battery pack for long-term applications in structural health monitoring Signal amplification 1 - 128 times, 2.5 V reference voltage, constant current supply for Pt100 / Pt1000; 0 - 10 V option; max. 6.4 kHz live sampling rate, 24 bit resolution, very low noise
nemi Struct DAQ 3 Channel + int. Flash	**Wireless multi-sensor measurement system** with three analog inputs, max. 1,296 Hz live sampling rate with 3 channels (multiplexed), otherwise as nemi Struct DAQ 2 Channel, additionally with **internal flash memory** to bridge longer radio interruptions of up to several minutes
nemi Struct Solar Extension	**Solar power supply for nemi Struct:** replacement of the internal battery pack with an external solar panel and a power bank as buffer storage, for energy-autonomous SHM applications

Contact

nemione® is a trademark of

i4M technologies GmbH
Försterstrasse 5
52072 Aachen
Germany

+49 (0) 241 56 00 22 00
info@nemi.one

www.nemi.one
www.i4M-tech.de

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