# SENSECOM-HPN

**Remote reading with vibrating string (VW) sensors**

## Purpose and device description

**SENSECOM-HPN series** devices are designed for measurement and data transmission with sensors (probes) using the vibrating wire (VW) principle for measuring target physical values such as pressures, displacements, etc., independently of the cable length. The device controls the VW sensor and sends the measured values via an **NB-IoT-wide** network.

They are distinguished by their **high measurement accuracy** with efficient filters and algorithms to suppress the influence of noise from interfering electromagnetic signal sources in the sensor's vicinity. They have very low power consumption. Expected lifetime **is >10 years without battery replacement** when sending 2 messages per day (2-12 measurements per day).

The measured values can be accessed in processed form on the senseparam.com portal with the possibility of forwarding the data to the customer's server or they can be sent directly to the customer's server. The device stores the measured data in memory (datalogger) in case of weak network signal coverage with data forwarding after the connection is restored.

Models differ in the number of sensors to be connected (single or multi-sensor), antenna type and housing:

| SENSECOM-HPN models | HPN1 | HPN1K | HPNCL | HPNCKL | HPNC | HPNCK |
|---|---|---|---|---|---|---|
| Number of connectable VW probes | 1 | 1 | 2 | 2 | 3-8 | 3-8 |
| Antenna type | External | Internal | External | Internal | External | Internal |
| Housing type and lid height | narrow | narrow | wide, low | wide, low | wide, high | wide, high |
| Requires HPNCM module (3 sensors per module) | No | No | No | No | 1-2 | 1-2 |

## Typical areas of application:

**Hydrogeology, mining, dams, etc.**
- Measurement of pore pressures and water levels in boreholes

**High-rise buildings, bridges, engineering structures, etc.**
- Measuring inclinations of structures, slopes
- Measurement of displacement and cracks

**SENSECOM-HPN** is applicable for virtually all types of VW probes, e.g. from manufacturers:
DGSI (Nova Metrix), Encardio, Geosense, Gloetzl, Innovative Geo-technical Instrumentation, Roctest (Nova Metrix), RST Instruments (Terra Insights), SISGEO, Soil Instruments (Nova Metrix), Systel instrumentation etc.

The device is designed so that it can be attached to the bracket and placed even in narrow spaces, e.g. in a borehole casing with a minimum internal **diameter of 130mm**. It is manufactured in a durable plastic (ABS) housing with IP67 protection. Two types of models are available: with built-in antenna or with SMA connector for external antenna, standard hat design or for pole or dipole antenna for NB-IoT.

**NB-IoT** - is the name of a full-area data network of the Low Power Wide Area Network (LPWAN) category that supports the operation of devices with low power consumption, i.e. high battery endurance. The availability of the service in a given location should always be verified on the NB-IoT signal coverage maps of mobile operators.

# Technical parameters

## Measuring part

| Parameter | SENSECOM-HPN1(K) | SENSECOM-HPNC(K) |
|---|---|---|
| Type of connectable probes (sensors) | A probe (sensor) working on the principle of vibration detection of the vibrating wire/string (VW gauge), usually additionally equipped with a thermistor | |
| Number of connectable VW probes (sensors) | 1 | 2<br>3-5 with one SENSECOM-HPNCM expansion module<br>6-8 with two SENSECOM-HPNCM expansion modules |
| Main measurement parameter | VW sensor string oscillation period [ns]. VW frequency range: **0.6-5** kHz (period: 200-1500$\mu$s) | |
| Measurement accuracy of the main parameter | <table><tr><td>VW Range</td><td>Accuracy</td><td>Resolution</td></tr><tr><td>600-1500 Hz</td><td>0,009 %</td><td>0,002 Hz</td></tr><tr><td>1500-3000 Hz</td><td>0,011 %</td><td>0,004 Hz</td></tr><tr><td>3000-5000 Hz</td><td>0,010 %</td><td>0,006 Hz</td></tr></table><br>The accuracy of the measurement is usually limited by the accuracy of the probe itself and its calibration capability. | |
| Secondary measurement parameter and accuracy | The resistance of the thermistor on the probe, the device measures in the range 1k$\Omega$-10k$\Omega$<br>Measurement accuracy: ± **0.5% FS** | |
| Internal sensors in the device | <ul><li>Temperature sensor</li><li>Relative humidity sensor</li><li>Atmospheric pressure sensor (usable for calibration)</li><li>Flood sensor (detection of condensed water or water intrusion into the equipment housing)</li><li>Accelerometer (device manipulation detection)</li></ul> | |
| Probe measurement period | Configurable intervals [min]: 1,2,5,10,20,30,60,120,240,**720**,1440 (1day), 2880, 10080 (1 week)[1], default is 12hr interval (720min) | |
| Measurement period of internal sensors | Adjustable intervals [min]: 1,2,5,10,20,30,60,120,240,720,1440, 2880, 10080 min[1], default interval is the same as the probe measurement interval | |

## Communication part

| Parameter | SENSECOM-HPN1, HPNC | SENSECOM-HPN1K, HPNCK |
|---|---|---|
| Network for data transmission | **NB-Io**T<br>- mobile operators' low-power wide area network (LPWAN)<br>- the flat rate for network traffic is typically 10 years (or annual, possibly 5 years) | |
| Antenna | SMA connector for external NB-IoT antenna (hat, rod, dipole) | Built-in antenna |
| Types of uplink messages | <ul><li>Periodic with values of VW period (ns), thermistor (ohm), noise level at VW</li><li>Initial with measured values</li><li>Configuration (after reset, after configuration change)</li><li>Alarm - device tampering - Accelerometer, temperature, humidity, or leakage (water at the bottom of the device housing) thresholds exceeded [1]</li><li>Keep-Alive 24h - system message on the functionality of the device and the status of the battery, signal, etc.</li></ul> | |
| Downlink message types and upgrades | <ul><li>Configuration change request (when sending a Keep-Alive uplink message, 1x/day) [1]</li><li>Requirement to forward data from datalogger/flash memory (on any uplink message) [1]</li><li>Request to upgrade the control FW or modem FW (on any uplink message) [1]</li></ul> | |
| Period of data sending | Adjustable as a multiple of the VW probe measurement period (default identical, 12h) [1] | |
| Access to data | <ul><li>SENSEPARAM portal (with data normalization), configurable callback for data transfer to customer's database, ad-hoc data download to CSV file.</li><li>Direct transfer of UDP packets to own database (by setting routing to own server)</li></ul> | |
| Datalogger (data storage) | Built-in flash memory for remote or local reading of the last min. 1500 measurements | |

[1]Remotely adjustable

# Device safety and security functions (physical and data)

| Parameter | SENSECOM-HPN1(K), HPNC(K) |
|---|---|
| Manipulation detection | Alarm message when the accelerometer detects shock and tilt of the device. |
| Moisture ingress into the equipment | Alarm message when humidity, temperature and pressure parameters are exceeded or changed, or when condensed moisture is detected at the bottom of the housing |
| Monitoring the probe connection status | The device sends messages about the basic ohmic parameters of the VW probe (VW and thermistor) - its disconnection (possible malfunction) can be determined |
| Monitoring device operation | The device sends at least a system Keep-Alive message every 24h |
| Protection against data loss | The device stores the data (datalogger) from each measurement in memory with a time stamp (min. 1500 last measurements). After a communication failure with the network, it broadcasts the previously unsent data. |
| Integrity of message content | The integrity of message transmission is ensured by the authentication mechanisms of the NB-IoT network. |
| Data encryption | E2E encryption with the AES-256 algorithm can be activated on the device (decryption takes place on the Senseparam server) |

# Design and power supply

| Parameter | SENSECOM-HPN1(K) | SENSECOM-HPNC(K) | SENSECOM-HPNC(K)L |
|---|---|---|---|
| Power | Lithium battery (non-rechargeable) 3,6V, replaceable, size C, type SAFT LSH 14 (5,8 Ah) | Lithium battery (non-rechargeable) 3,6V, replaceable, size D, type SAFT LSH 20 (13 Ah) | |
| Estimated battery life | >10 years in normal operation, i.e. 2 messages sent (up to 12 measurements per day) (possible FW upgrade is equivalent to about 2 months of consumption in normal operation) | | |
| Sensor connection | Through the grommet into the self-locking clamps | | |
| Coverage | IP65 (IP67 with silicone) | | |
| Weight | 200g | | |
| Operating conditions | -25° to +75°C, relative humidity <90%, atmospheric pressure >800kPa (for VW probe may be different conditions, check parameters of the probe manufacturer) | | |
| Housing dimensions (without grommets and handles in the longitudinal direction) | 160x80x60 mm | 171x121x80 mm - with higher lid, for connection with expansion modules (for 3-8 probes) | 171x121x55mm (for 1-2 probes) |
| The minimum diameter of the hole for placing the device | 110mm | 155mm | 140mm |

# HPN1 device case

Housing: material ABS, protection IP65 (with silicone IP67), dimensions without external handles and grommets:
160x80x60 mm, version with 1+1 grommets
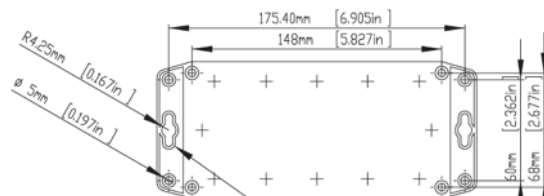
# SENSECOM-HPNC device case

Housing: material ABS, protection IP65 (IP67 with silicone), dimensions without external handles and grommets:
171x121x80 mm version with 1 + 3-8 grommets
171x121x55 mm version with 1 + 2 grommets (reduced lid)
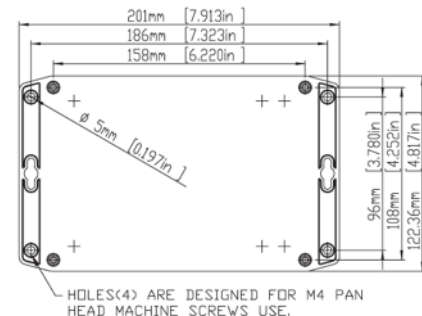
# Hat antenna

Band: NB-IoT
Protection: IP67
Cable: RG58 with SMA-M connector, length 0.75m
as standard (max. 2m on request)
Antenna hat:∅ 143x34mm