

User Guide

FlatMesh Vibrating Wire Nodes

FM3N-VW11

FM3N-VW41

FM3N-VW81

FM3N-VW17



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Warnings



Warning

Protection provided by the equipment may be impaired if used in a manner contrary to this user manual.



This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

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

Changes or modifications not expressly approved by Senceive Limited could void the user's authority to operate the equipment.

This equipment must be professionally installed.

Only the following antennas are to be used with the equipment:

Order Code	Manufacturer / Part Number		Gain
FA-FM-WPS	Linx	ANT-2.4-CW-QW-SMA	1.1dBi
FA-FM-LPS	Siretta	DELTA8A/x/SMAM/S/S/17	0dBi
FA-FM-ADJ	EAD	FBKR35068-SM-KR	2dBi



This product must not be disposed of in the normal waste stream. It contains a battery pack and electronic components and so should be recycled appropriately.

In accordance with the WEEE guidelines, customers in the European Union may return the product free of charge for recycling at the end of its life. Contact your supplier for details.

Chapter 1

Overview

1.1 The FlatMesh System

A FlatMesh network consists of a number of nodes connecting to one gateway device. In some situations multiple networks may be required on a single site, for example a site in which the number of nodes exceeds the number supported by a single Gateway, or a site where there are a set of separate measurement zones.

A FlatMesh Node is a sensing unit with an integrated wireless mesh radio and battery. It participates in a FlatMesh wireless network, forwarding messages as required by the system, and also takes samples from onboard and/or external sensors. Sampling is done on a periodic schedule which may be either fixed or variable. In addition, a sample may be manually requested via the Gateway.

1.2 FlatMesh Vibrating Wire Nodes

The FlatMesh Vibrating Wire Node family provides an interface to enable the connection of vibrating wire sensors with integrated temperature sensors. The family consists of four different models, each with different input combinations:

- FM3N-VW11 supports a single sensor with one vibrating wire and one temperature sensor
- FM3N-VW41 supports up to four sensors each with one vibrating wire and one temperature sensor
- FM3N-VW81 supports up to eight sensors each one single vibrating wire and one temperature sensor
- FM3N-VW17 supports a single with up to seven vibrating wires and one temperature sensor

Note

Readings can be scheduled anywhere between a few seconds to twelve hours with a time increment of one second, but it should be noted that vibrating wire sensors usually require a delay of at least 30-45 seconds between readings for optimum performance.



Figure 1.1: Photo of FM3N-VW11



Figure 1.2: Photo of FM3N-VW41

1.2.1 Vibrating Wire Sensors

Vibrating wire sensors are class of sensor that are often used in geotechnical or structural monitoring applications.

The sensor contains a steel wire that is attached to a mechanical system which converts the property being measured to an increase or decrease in the length of the steel wire. This change in the length of the wire corresponds to a change in the resonant frequency of the wire.

An electromagnetic coil is located close to the steel wire. To read the resonant frequency of the wire it is electronically 'plucked' by sending a swept sine signal to the coil. This causes the wire to vibrate and the resonant frequency is sensed by measuring the frequency of the voltage induced in the coil.

The ability to read the property from the sensor using frequency means that the signal is resilient to electrical noise, changes in the cable resistance and a number of other problems that affect other types of sensors. The only downside to reading the sensor using frequency is that the mechanical components and the wire itself are typically very sensitive to temperature. To overcome this problem, vibrating wire devices are fitted with integrated temperature sensors to enable accurate temperature compensation.

Vibrating wire sensors support reading many types of environmental and structural values, including:

- Strain Gages
- Crack sensors (linear displacement)
- Strandmeters
- Extensometers
- Settlement Sensors
- Pressure Cells
- Load Cells
- In-Place Inclinometers
- Stress Meters

1.2.2 Compatibility

The FlatMesh Vibrating Wire Nodes have been designed to be sensor agnostic. The system is designed to work with devices that have

a frequency range of 200-6000Hz and can be stimulated using a swept sine wave of 6V peak to peak.

It has been successfully used with a variety of sensor models, including:

- Soil Instruments W9 Piezometer
- Soil Instruments ST1 Spot Weldable Strain Gauge
- Soil Instruments ST2 Arc Weldable Strain Gauge
- Soil Instruments ST4 Embedment Strain Gauge
- Geokon 4500S Piezometer

Contact your technical sales representative for more information.

1.2.3 Sensor Node Selection

The first thing to consider is the type of sensor to be attached. Most vibrating wire sensors (piezometers, extensometers, inclinometers, etc.) contain a single vibrating wire, coil, and temperature sensor. Some larger sensors may contain a number of vibrating wire-coil pairs (typically large load cells containing three, four or six wires), but only a single temperature sensor.

The FM3N-VW17 is the best choice for sensors containing multiple vibrating wires, as it has one connector which supports up to seven vibrating wires with a single temperature sensor.

For simple, single-wire sensors, the only thing to be considered is the number of devices which are to be co-located. The FM3N-VW11, FM3N-VW41 and FM3N-VW81 are designed to support up to one, four or eight sensors respectively.

Often a FM3N-VW11 is used for small load cells, or at the top of a bore hole with a single piezometer. The FM3N-VW41 is typically used for strain monitoring on props where three or four strain gauges are mounted around a prop in close proximity to each other. It can also be used at the top of boreholes where a number of piezometers or other down bore hole sensors are mounted down the same tube. The FM3N-VW81 is also often used at the top of boreholes where a number of piezometers or other down bore hole sensors are installed.

1.2.4 Product and External Identification Labels

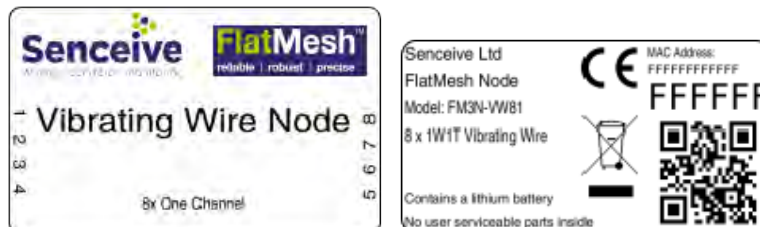
FM3N-VW11



FM3N-VW41



FM3N-VW81



FM3N-VW17



1.3 Product Specifications

1.3.1 FM3N-VW11 and FM3N-VW17 Physical Specification

Dimensions	90 x 90 x 60 mm
Total Mass	0.57 kg (approx.)
Housing Material	Die cast aluminium body
International Protection Marking	IP66/IP67 IP68 at 1m for 24 hours
Mounting Options	Horizontal magnetic / wall mount Vertical wall mount Vertical magnetic mount
Operating Temperature Range	-40°C to +85°C

1.3.2 FM3N-VW41 and FM3N-VW81 Physical Specification

Dimensions	90 x 130 x 50 mm
Total Mass	0.75 kg (approx.)
Housing Material	Die cast aluminium body
International Protection Marking	IP66/IP67 IP68 at 1m for 24 hours
Mounting Options	Horizontal magnetic / wall mount
Operating Temperature Range	-40°C to +85°C

1.3.3 Internal Battery

Battery Type	Lithium Thionyl Chloride, non-rechargeable
Nominal Voltage	3.6V
Nominal Capacity	FM3N-VW11/VW17: 19000mAh FM3N-VW41/VW81: 34400mAh
Typical Battery Life	12-15 years at 20 minute reporting intervals, including when acting as a relay node Consult with Senceive for your application

1.3.4 Channel Combinations

Model	Number of Ports	Port Type
FM3N-VW11	1	1 VW and 1 Thermistor Channel
FM3N-VW41	4	1 VW and 1 Thermistor Channel
FM3N-VW81	8	1 VW and 1 Thermistor Channel
FM3N-VW17	1	7 VW and 1 Thermistor Channel

1.3.5 FlatMesh Radio Specifications

Communication Type	Proprietary FlatMesh v3 Mesh Networking Protocols IEEE 802.15.4 compliant
Frequency Band	2400 - 2485 MHz ISM Band
Maximum Transmit Power	6.5dBm (EN 300 328 v1.8.1)
Maximum Antenna Gain	2.2dBi
Range	Up to 300m depending on the environment and fitted antenna Consult with Senceive for your application
RF Module	Senceive FM3Node

1.3.6 Vibrating Wire Specifications

Frequency Resolution	0.001 Hz
Frequency Repeatability	± 0.02 Hz
Frequency Range	200-6000Hz
Stimulus Type	Swept Sine Wave, 6V peak to peak
Thermistor Type	3k Ω NTC
Temperature Resolution	0.05°C
Temperature Accuracy	$\pm 0.1^\circ\text{C}$
Temperature Range	-40°C to +85°C

Chapter 2

Installation

The nodes will be delivered to you pre-configured. Simply affix the nodes to a structure within the range of the rest of the network.

2.1 Mounting

There are several mounting options for each of the various vibrating wire derivatives. It should be noted that not all mounting options are available for each derivative.



Warning

The Vibrating Wire Node with brackets could have a mass of up to 1.5kg. Please ensure that the object you are fixing to can handle this load.

Ensure that appropriate methods and materials are used when affixing equipment to a wall.

The node should be installed with the antenna oriented in the same direction as the other nodes and the gateway. This is key to ensuring the best radio performance for the FlatMesh network.

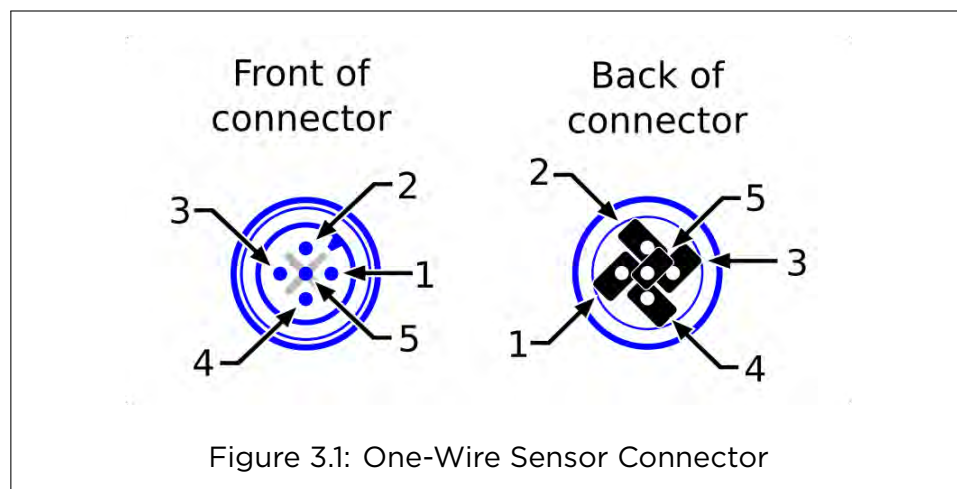
Chapter 3

Sensor Wiring

3.1 One-Wire Sensor Connectors

The FM3N-VW11, FM3N-VW41 and FM3N-VW81 use M12 A coded 5 pole female sockets for each sensor to be attached. The sensor must have a corresponding male plug fitted.

Ask your supplier for sensors with pre-fitted connectors and connector kits.



Pin Number	Pin Description
1	Temperature (+)
2	Temperature (-)
3	Vibrating Wire (+)
4	Vibrating Wire (-)
5	Drain/Ground Wire

3.2 Multi-channel Breakout Box

As the connector for the FM3N-VW17 multi-channel device has a high pin count for the connector size there is no field attachable connector available. Ask your supplier for more details. Sensors with pre-fitted connectors are also available.

Chapter 4

Maintenance

The product should not require any maintenance after installation.

If the need to clean the product should arise, use only a damp cloth and mild detergent. Do not use any solvents as this may damage the enclosure.



Warning

Only service personnel authorised by the manufacturer may open the enclosure.

No user serviceable parts are located inside.

Chapter 5

Support

5.1 Troubleshooting - General

FlatMesh Nodes are sealed units so checking of devices is confined to visual inspection, checking of connections and measurement of basic device parameters.

5.1.1 No new data from node

Check if other nodes on the same gateway have been updating

The FlatMesh Gateway operates a store-and-forward system. It collects data from nodes on its network all the time, and then periodically establishes a connection to the Web Monitor to transfer data.

Check the other nodes on the same gateway for similar problems to rule out a gateway problem. Check that the gateway battery has been charged correctly in the last two weeks. If the problem is being seen on a number of gateways on the same site, there could be a problem with the backhaul (cellular network or other network connection.)

Check for physical damage

Check to ensure that the node's enclosure is whole and undamaged.

The network relies on neighbouring nodes to pass messages along to the gateway. There is no reliance on any one node, but if all nodes in a large stretch of the network are not in working order, this is likely to impact other nodes' ability to communicate with the gateway.

Check that the antenna is tight

The antenna connects to the node through a threaded SMA connection. This should be tightened by hand against the connector on the enclosure. If this connector is loose, the node's signal strength and therefore its ability to connect to the network will be significantly impaired.

Check that the antenna is correctly oriented

The antenna's orientation can also impact its ability to connect to other nodes. Typically, the correct orientation for the antenna is vertical (perpendicular to the ground.) In tunnels or when monitoring a wall, it may be more appropriate to orient the antenna to be perpendicular to the wall surface. Check with Senceive to ascertain the best arrangement for your site.

5.2 Troubleshooting - Vibrating Wire

Vibrating wire sensors are sealed units, so checking of devices is confined to visual inspection, checking of connections and measurement of basic device parameters.

5.2.1 No frequency or temperature readings

Check battery readings

Check if that the node has been reporting a valid voltage of the most recent sampling periods, if not then see the FlatMesh Node troubleshooting section.

Check for physical damage

Check that the node, connectors and cabling for damage or signs of either moisture or water ingress, if there is damage to the sensor refer to the sensors manuals trouble shooting section.

Check that the sensors connector for damage, that it is fully screwed to the node and that it is connected to the correct port on the Node.

Check sensor connections

Open up the connector and check that there is a good contact on the screw terminals and that the temperature and the vibrating

wires are attached to the correct terminals.

Using the free end test harness accessory check that the resistance of both the vibrating wire contact and temperature sensor are within the values as specified in the sensor manual.

If you have an external reader and test harness then attach the sensor to the reader and check that the external reader can read the sensor.

5.2.2 Unusual frequency or temperature readings

If the sensor is reporting readings over the FlatMesh system but the reads are invalid then the following steps should be used to locate the problem.

Check sensor connections

Check that the vibrating wire device for damage or signs of either moisture or water ingress, if there are damage to the device then refer to the sensors manuals trouble shooting section.

Check sensor installation

Check that the sensor is securely attached to the object that is being monitored and that the object doesn't vibrate as this can cause odd readings. Ensure that it is installed in accordance with the manufacturer's instructions.

Check that the physical parameter being measured is within the range of the sensor.

If the sensor is still producing unusual readings then please refer to the sensors user manuals fault finding section.

5.2.3 System Setup

The following information is required to correctly set up a vibrating wire sensor for use on the FlatMesh system.

- Sensor and manufacturer's name
- Frequency sweep start and finish
- Maximum excitation voltage
- Sensor equation and calibration values
- Sensor baseline reading

5.3 Contact Information

For assistance and support, contact your supplier or the manufacturer:

Senceive Limited

Phone: +44 (0) 207 731 8269

Email: support@senceive.com

Web: <http://www.senceive.com>

Appendix A

Import / Export Restrictions

The products described in this user manual contain and use encryption algorithms for data authentication and security. Some countries require registration of these technologies. It is the importer's responsibility to comply with all local regulations. Contact Senceive for more information.

Appendix B

Software Licenses

The firmware used in this product is partly bound to the following licenses. To obtain the source code for the components which are bound to these licenses, please contact the manufacturer:

Senceive Limited
Phone: +44 (0) 207 731 8269
Email: support@senceive.com
Web: <http://www.senceive.com>

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(34) - Jon Beniston (only lm32-* targets)

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