

MANUAL

EFMH

ATEX WIRELESS STRAIN TRANSMITTER

Installation and user manual



Document	Version	Date	Applies to
Installation and user manual	V00x	10/2026	EFMH

This manual describes the intrinsically safe EFMH radio transmitter for strain gauge sensors: explosion protection, installation, connection, configuration and calibration with the PC software, and the technical data.



Contents

1 About this manual	2
1.1 Notices	3
1.2 Device identification	3
2 Safety and explosion protection	3
2.1 Intended use	3
2.2 Marking and certificates	3
2.3 Specific conditions of use	4
2.4 Entity parameters of the sensor connection	4
2.5 Safety instructions	4
3 Product description	4
3.1 Main features	4
3.2 Receivers	4
4 Radio system basics	5
4.1 Transmitters and receivers	5
4.2 Radio channel and group key	5
4.3 ID and data tag	5
4.4 Transmitter modes of operation	5
4.5 Pairing and soft pairing	6
4.6 Asynchronous operation, bandwidth and repeaters	6
5 Installation	7
5.1 Enclosure and mounting	7
5.2 Opening the case and inserting the cells	7
5.3 Sensor connection	7
5.4 Cables, sealing and antenna	8
6 Commissioning	8
7 PC software and base station	9
7.1 Base station communications	9
7.2 Connecting to the device (pairing)	9
7.3 Pages for every module	9
7.4 Channel monitor and analyser	10
8 Transmitter configuration	11
8.1 Data rates and quality	11
8.2 Calibration	11
8.3 Calibration by certificate	11
8.4 Advanced calibration	11
8.5 Advanced settings	12
9 Diagnosis	12
10 Antenna and radio range	12
10.1 Guidelines for installation	12
10.2 Radio range	13
11 Technical data	13
12 Radio approvals	14
12.1 CE	14
12.2 IC	14
12.3 FCC	15

1 About this manual

This manual is valid for the EFMH ATEX/IECEX radio transmitter for strain gauge sensors. It is to be used together with the manual of the receiver (for example the handheld display EFMI). Read chapter 2 before installing the device in a hazardous area.

Display texts are set in a fixed-width typeface, for example **Error 2**. Buttons and pages of the PC software are written as they appear, for example Pair or Radio Settings.

1.1 Notices

Notice	Meaning
Warning	Safety instruction of the explosion protection or warning of the source documentation, reproduced word for word.
Important	Pay particular attention to the following instruction.
Note	Further information.

1.2 Device identification

	EFMH
Product	ATEX/IECEX radio transmitter for strain gauge sensors, in an IP67 enclosure with two lithium AA cells
Manufacturer type	X24-ACMi-SA, covered by the certificates in section 2.2
Input	strain gauge bridge, 4 wire, ± 3.1 mV/V maximum, nominally 2.5 mV/V

2 Safety and explosion protection

2.1 Intended use

The EFMH measures the input of a strain gauge sensor (load cell or other bridge sensor) and periodically transmits the value by radio. It is approved for use in explosive atmospheres, zone 1 and zone 2, and carries the mining marking group I, category M2 (section 2.2).

According to its certificates, the EFMH is battery powered equipment for fixed installation. It comprises an enclosure with accommodation for two Ex certified AA cells (Baseefa 14ATEX0107U), a component certified data acquisition and transmission module and a printed circuit board antenna, mounted completely within the enclosure. The enclosure is fitted with a single cable gland for all external wiring to the internal connectors, and with a translucent light pipe to permit observation of the internally mounted LED.

2.2 Marking and certificates

Marking as specified in the certificates (the ATEX marking is preceded by the specific marking of explosion protection, Ex in a hexagon):

Certificate	Marking
ATEX, group I	I M2 Ex ib I
ATEX, group II	II 2G Ex ib IIC T4 Gb Ta = -20°C to +50°C
IECEX	Ex ib I Ex ib IIC T4 Gb Ta = -20°C to +50°C

	ATEX	IECEX
Certificate	EU-type examination certificate Sira 15ATEX2344X, Issue 1	IECEX Certificate of Conformity IECEX SIR 15.0124X, Issue No. 0
Date	Issue 1: 15th October 2019 (Issue 0: 08 August 2016)	2016-08-08
Issued by	CSA Group Netherlands B.V., notified body number 2813	SIRA Certification Service, CSA Group
Type of protection	—	Intrinsically Safe
Standards	EN 60079-0:2012/A11:2013 EN 60079-11:2012	IEC 60079-0 : 2011 Edition 6.0 IEC 60079-11 : 2011 Edition 6.0

The EU declaration of conformity names the ATEX directive 2014/34/EU (EN 60079-0:2012+A11:2013, EN 60079-11:2012), the EMC directive 2014/30/EU (EN 61326-2-3:2013, EN 61326-1:2013) and the Radio Equipment Directive 2014/53/EU (EN 300328 V2.1.1). It is available from octogon on request.

2.3 Specific conditions of use

Both certificate numbers end in X: "If the sign 'X' is placed after the certificate number, it indicates that the equipment is subject to Specific Conditions of Use identified in the schedule to this certificate."

Warning ATEX 15.1: The permitted cell type is Energizer Lithium L91, size AA. (Baseefa 14ATEX0107U).

Warning IECEx condition 1: The permitted cell type is Energizer Lithium L91, size AA. (Baseefa 14ATEX0107U)

2.4 Entity parameters of the sensor connection

The equipment has the following entity parameters (sensor connector parameters, Groups I and IIC; identical in the ATEX and IECEx certificates):

Parameter	Value	Parameter	Value
Uo	5.5V	Co	15 μ F
Io	2.25A at 3.66V	Lo	1.38 μ H
Po	1.25W	Ci	43 μ F
		Li	5.64 μ H

2.5 Safety instructions

Warning Use only Energizer L91 cells. Do not change cells in an explosive atmosphere!

Warning T24 modules cannot be used in hazardous areas!

Configuration uses a T24 base station (chapter 7).

3 Product description

The EFMH is an ATEX/IECEx radio transmitter that measures a strain input and periodically transmits the data to receivers. The high accuracy ratiometric input allows calibration and linearisation for pressure, force, torque and weight measurement in explosive atmospheres. It is housed in an environmentally sealed IP67 enclosure with a battery holder for two lithium Energizer L91 AA cells and supports a wide range of bridge sensors — ideal where a wired connection is difficult.

3.1 Main features

- Intrinsically safe electronics, approved for use in explosive atmospheres, zone 1 and zone 2.
- Strain gauge bridge input, 4 wire, 5 V excitation, 85 ... 5000 Ω , ± 3.1 mV/V.
- Calibration and linearisation to engineering units with up to 9 points; system zero.
- Internal resolution 16 000 000 (24 bit); low temperature drift.
- Licence exempt 2.4 GHz radio, 15 channels, group keys; range up to 800 m (chapter 10).
- Low power mode; battery life up to 5 years depending on the transmission interval.

3.2 Receivers

Where	Receiver
Hazardous area	EFMI ATEX/IECEx handheld display
Safe area only	any receiver of the non-certified radio range, for example the handheld display EFMD or the large display EFMG; base station with PC software for configuration and data logging

4 Radio system basics

A few basic radio settings and concepts must be understood to configure, deploy, optimise and troubleshoot the radio system.

4.1 Transmitters and receivers

All modules of the radio system are transceivers, but each mainly works either as a transmitter or as a receiver. Transmitters measure an input, such as strain, and send messages containing the value and status information at a user-defined interval. Receivers use these messages to analyse, display or perform other actions – for example handheld displays, large displays, analogue outputs and relay modules. Receivers can also control transmitters, for example send them to sleep or wake them.

A PC and a base station are only required to configure the modules, although they may be part of a data collection system. Once configured, the modules operate autonomously.

The ATEX/IECEx approved modules – the transmitter EFMH and the handheld display EFMI – belong to the X24 range, the approved members of the larger T24 telemetry range. Systems can be put together using X24 modules in the hazardous area and T24 modules in the safe area. The X24 transmitters can be used with any of the T24 receivers.

Warning T24 modules cannot be used in hazardous areas!

4.2 Radio channel and group key

To communicate, two radio modules must share the radio channel and the group key. Pairing (section 4.5) learns these settings and recovers unknown settings.

Setting	Description
Radio channel	The frequency the radio operates on. The radio band is divided into 15 channels (1 ... 15). Modules must be on the same channel to transfer messages. The default is channel 1.
Group key	Isolates groups of modules even if they operate on the same radio channel. This improves efficiency and offers security: no module can affect another or see its messages unless both share the same group key. The group key is defined by the user, up to 15 alphanumeric characters. Group keys were introduced with radio firmware v3.0 in March 2015; newer modules work with older ones, but then group keys cannot be used (the group key field must be blank).

When you pair to a remote module, the base station adopts the radio channel and group key of the remote module. To set the same group key on several remote modules, either pair to each one in turn and set its radio channel and group key, or configure the base station first (hold the shift key and click Pair on the Home page) and then use the tool on the radio settings advanced page to give each module the radio settings of the base station (chapter PC software and base station).

4.3 ID and data tag

To configure a module, its ID is used in communications: a unique 6-character hexadecimal identifier (numbers 0 ... 9 and letters A ... F, for example FF1234), allocated at the factory.

A transmitter sends its messages without broadcasting its ID; the messages are identified by a data tag – a 4-character hexadecimal number that can be configured by the user. When a module leaves the factory, the data tag is set to the last 4 characters of its ID. Receivers and software identify the messages they want by this data tag.

This allows a transmitter to be replaced without reconfiguring the receivers that use its messages: configure the replacement transmitter with the same data tag, radio channel and group key, and the rest of the system will not notice the difference.

4.4 Transmitter modes of operation

Mode	Description
Operational (low power mode)	Normal mode: take a reading, send a message, then enter a very low power state until the next reading, to maximise battery life. During the low power state the transmitter cannot be communicated with – hence the configuration mode.
Operational (non low power mode)	If battery life is not an issue, the module is externally powered or transmission rates are so high that low power mode is not available, the module does not enter a low power state between transmissions.
Configuration	The module pauses sending its messages and disables its low power state so that it can be configured. This is achieved by pairing with the PC software. When configuration is complete, the module resumes normal operation.

Mode	Description
Sleep	Modules can be sent to sleep by other modules, or go to sleep themselves when their messages are no longer used (sleep delay). Sleeping modules can be woken on demand by other modules or by software via the base station.

Sleep delay

Transmitters have a sleep delay setting (in seconds) that lets them go into sleep mode when their data messages are no longer required, for much longer battery life. A sleep delay of zero disables this function; the module then only sleeps when told to do so.

Most receivers and the software send stay awake messages when they see messages arrive from transmitters. If the sleep delay time has elapsed without a stay awake message, the transmitter enters sleep mode. Stay awake messages are usually sent every 5 seconds, so the sleep delay should be at least 10 seconds; it can be set up to an hour where the receiver is likely to be out of range for a time but the transmitter must stay awake. Usually the sleep delay is set between 30 and 300 seconds.

4.5 Pairing and soft pairing

The radio settings of a module cannot be seen from outside. Pairing determines the radio settings (radio channel and group key) and matches them between two modules, and optionally puts a transmitter into configuration mode. Because modules may be installed where they cannot be reached, pairing is activated by removing and re-applying the module's power.

With the PC software and a base station, pairing connects to a module without knowing anything about it beforehand: remove power from the module, click a Pair button in the software and re-apply power. The base station is automatically configured to match the radio settings of the module and places the module into configuration mode. When configuration is complete, the module returns to normal operation.

Soft pairing: pairing by power cycling is absolute and works under all circumstances. Where the power supply cannot be reached, the software offers soft pairing: configure the base station to the radio channel and group key of the remote module and enter the unique ID of the module. This works well with receivers, as they do not operate in low power modes; with transmitters the software must change them from normal operation into configuration mode, which may not work reliably in high traffic or high noise environments. If no connection can be made, power cycle pairing may be the only option.

4.6 Asynchronous operation, bandwidth and repeaters

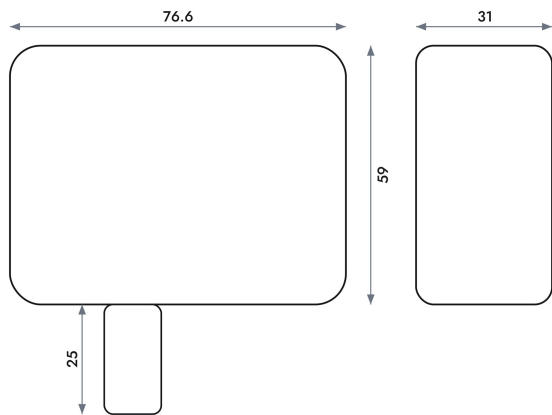
Transmitters send their messages at a fixed user-defined interval, timed from when they were woken or powered on, so the measurements of different transmitters are not synchronised. Logging software records the last value received from each transmitter. If recorded sets of readings must be within a certain time of each other, that time is the maximum message interval to set for the transmitters, regardless of the log interval (which should always be greater than the transmitter message interval). Example: with 10 transmitters at 333 ms message interval, the logged values are only known to be within 333 ms of each other.

Each radio channel (1 ... 15) has a finite capacity. Modules on the same channel – even with different group keys – all share it. Each message takes around 3 ms, so at most 300 messages per second could be transmitted on one channel; in practice the limit is around 200 messages per second per channel. With more transmitters, message collisions and lost messages increase. Example: 2 modules may transmit 100 times per second, or 100 modules once per second. Modules that do not need to communicate with each other can be put on separate channels.

Repeaters retransmit messages to increase the range or to bypass obstacles. A repeater must use the same radio channel and group keys as the modules it repeats. Every module has a repeater subgroup setting (default 0): a repeater repeats messages from all modules whose subgroup is 0 or matches its own; a repeater with subgroup 0 repeats all modules. Changing the subgroup is normally only necessary when the bandwidth is very full.

5 Installation

5.1 Enclosure and mounting



All dimensions in mm
Enclosure dimensions in mm

The enclosure is 76.6 mm × 59 mm and 31 mm deep. The cable gland extends a further 25 mm from one long side. The enclosure has two mounting holes (4.8 mm diameter, 67.0 mm apart). They are external to the seal but still covered by the case lid, to offer fixings with some environmental protection. Mountings can also be made through the back of the case, but then a seal or gasket must be used to maintain the environmental protection.

5.2 Opening the case and inserting the cells

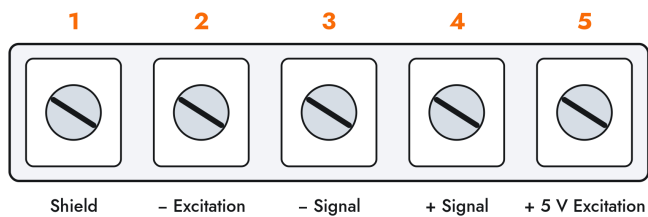
The case lid is secured with 4 × #2 cross head screws: remove the four screws and lift the lid. The enclosure is designed to accept two Energizer L91 AA lithium batteries.

Warning Use only Energizer L91 cells. Do not change cells in an explosive atmosphere!

The sealing gasket resides in the base. When replacing the lid, make sure that there are no dirt particles on the gasket channel or the lid, as this may reduce the sealing capability.

5.3 Sensor connection

The input connections are accessed by lifting the right hand cover plate. This plate incorporates the antenna: when re-assembling, take extra care that the grey UHF cable is attached to the antenna socket.



Do not change cells in an explosive atmosphere
4-wire bridge from 85 Ω - calibration and linearisation with the PC software
Power: 2 × Energizer L91 lithium AA only

Screw terminals inside the enclosure

Screw terminal	Function
1	Shield
2	- Excitation
3	- Signal
4	+ Signal
5	+ 5 V Excitation

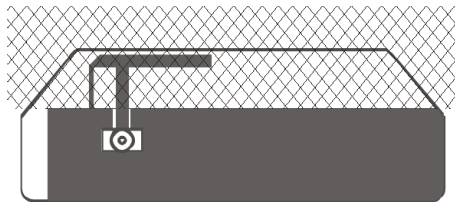
- The strain gauge connection is 4 wire. The bridge resistance can be between 85 and 5000 Ω ; up to four 350 Ω bridges can be connected in parallel, at the expense of reduced battery life.
- The measurement is bi-directional, i.e. tension and compression.
- Keep the cable between the transmitter and the strain gauges below three metres and generally as short as possible: as the measurement is four wire, the voltage drop in a longer cable has more effect on the factory mV/V calibration.
- Observe the entity parameters of the sensor connection (section 2.4).

5.4 Cables, sealing and antenna

The case is environmentally sealed to IP67 when the correct cable diameters are used: the cable diameter can range from 3.0 mm to 6.5 mm. Cables of a smaller diameter may be used if sleeved to increase their diameter. When mounting the enclosure outside, dress the cables to provide a drip loop.

The antenna sits over the wiring access chamber and is covered by the enclosure lid.

Important The antenna feeder cable and load cell connection cable must not be routed over, or near, the cross hatched area on the antenna shown below as this will affect range.



Antenna with the cross hatched area (from the source documentation)

6 Commissioning

Steps for putting a new EFMH into operation:

- Mount the enclosure and connect the sensor (chapter 5).
- Insert two Energizer L91 AA cells (section 5.2) – not in an explosive atmosphere.
- Connect the base station to the PC, start the PC software and pair with the EFMH (chapter 7). Set radio channel and group key of the system if required.
- Set the transmit interval and low power mode, calibrate the input and set the system zero (chapter 8).
- Close the lid with a clean gasket, check the reading on the receiver.

If handheld display and transmitter are purchased at the same time, both default to radio channel 1 and a blank group key. The default transmit interval is 333 ms (approximately 3 readings per second), ideally suited to reading on a handheld; the default sleep delay is 60 seconds.

Note The calibration of a transmitter may be locked; the calibration pages of the software are then not accessible.

7 PC software and base station

The modules are configured with the T24 Toolkit PC software, which is suitable for all versions of Windows. Run the installer and follow the prompts to install the software.

A base station is also required to configure the modules. A USB base station is simply plugged into a USB socket of the PC. For other base stations please contact octogon.

Warning T24 modules cannot be used in hazardous areas!

In the software, all items that can be changed or interacted with are coloured green. Click a green item to change it; a dialog window with a slider, text box or list opens for the new value.

7.1 Base station communications

Select the interface type of the connected base station. For a base station on a serial port, the COM port and the baud rate must be known. The base station address is usually 1; it is only different if it has been changed for multi base station configurations. Click Home to start communication with the base station. If no communication can be established, the software stays on this page: check that the base station is powered and correctly connected to any converters.

7.2 Connecting to the device (pairing)

On the Home page you can now pair with the remote module. Pairing removes the need to know the radio settings of the module and ensures that it is in a suitable state for configuration.

- Remove power from the EFMH: open the lid and take out one cell (section 5.2).
- Click the Pair button in the software.
- You now have 10 seconds to re-apply power: insert the cell again.

Warning Use only Energizer L91 cells. Do not change cells in an explosive atmosphere!

If the connection is successful, the software changes to the Information page. If pairing fails, try again.

Note Pairing does not change the radio settings of the connected module – the radio settings of the base station are changed to match those of the remote module. While the software is connected to a module for configuration, the normal transmission of messages is usually inhibited.

- To connect to and configure the attached base station itself, hold the shift key and click Pair.
- Manual connection: if the power supply of the remote module cannot be reached, click the 'Click Here' link at the bottom of the Home page and follow the prompts (soft pairing).

7.3 Pages for every module

Page	Content
Information	Shown after successful pairing. Name: a short description to recognise the module. Features: supported features are coloured, unsupported ones greyed out – for example calibration protected, group key supported / group key configured, extended range radio fitted.
Battery and radio levels	Transmitters only. Shows the battery voltage and the radio signal levels at the base station and at the transmitter as LQI (link quality indicator, 0 ... 100; communication is still possible within this band, but may become intermittent towards zero). Low Battery Level: the level at which the transmitter reports a low battery; for Energizer L91 cells around 2.7 V. At 2.1 V the module stops working. Below the low battery level the bar is coloured orange.
Battery and radio levels – Advanced	RSSI: received level, from about –30 (good signal) to –98 (weak signal). CV: correlation value, how well the signal can be decoded, from 55 (poor) to 110 (excellent). LQI is calculated from RSSI and CV.
Radio settings	Channel: 1 ... 15, default 1 – the analyser shows a clean channel. Group key: only visible on modules that support group keys; only modules with identical group keys can communicate. To use them with older modules without group keys, the field must be blank. New radio settings take effect only after a reset or power cycle: Reset Module Only (the module adopts the new settings, the base station keeps the old ones, the Home page is shown) or Reset Module and Base Station (both adopt the new settings and the connection is re-established). For the base station itself, changes are immediate.
Radio settings – Advanced	Repeater Subgroup (default 0 – all repeaters repeat this module). Remote Module Radio Settings Tool: gives a batch of remote modules the radio settings of the base station – remove power from the remote module, click the Click Here link, apply power to the remote module. The software stays paired to the module or base station it was paired to.

Page	Content
Save and restore	Save: writes all configuration information including calibration data to a file (extension .tcf). Restore: loads a saved file into the same or a different module; all configuration information including user calibration data is overwritten.

7.4 Channel monitor and analyser

The channel monitor shows a summary of the data sent by transmitters: data tag, total number of messages received, transmission rate, link quality, data value and any error messages. Some base stations also list sleeping modules; they show an ID instead of a data tag.

Important To see any data, the base station must be on the same radio channel as the transmitters and must have a matching group key.

Item	Function
Radio channel tabs	Change the radio channel the base station operates on.
Clear List	Clear all detected messages from the list.
Wake All	Wake all modules on the current radio channel.
Start Logging	Asks for a file name, then logs the received data to a CSV file in the format: Data Tag, Elapsed ms, Value.
View Last Log	Opens the last logged file in the application associated with CSV files.
Move Group Channel	Visible if the base station has a group key set, enabled once at least one module is listed. Asks for a new radio channel; all detected transmitters and all other modules on the same channel and group key, such as handhelds, are moved to it, then the base station itself moves. Only transmitters are listed, so make sure the other receivers of the group are available to be woken — all modules on the same channel and group key are woken before they are moved.

The analyser is a tool for choosing the best channel or diagnosing poor communication. It shows the radio signal levels detected across all channels, which helps to detect noisy areas, for example a Wi-Fi network. Although 16 channels are shown, the modules operate on radio channels 1 ... 15.

8 Transmitter configuration

The PC software provides simple configuration and calibration of the transmitter. Pair to the EFMH (section 7.2) to connect.

8.1 Data rates and quality

Selects the transmission rate and the quality. With low power mode selected and some other information entered, the software estimates the achievable battery life (best case at 20 °C).

Item	Description
Transmit Interval	Transmission rate in milliseconds. Default 333 (approximately 3 per second). Slow it down to achieve longer battery life.
Sample Time	Time in milliseconds the input is sampled before the value is transmitted: 5 ms up to close to the transmit interval. A shorter sample time increases battery life, at the expense of less noise free resolution (section 11).
Low Power Mode	Set to Yes unless the transmitter is not battery powered. Between transmissions the transmitter then enters sleep mode – a massive effect on battery life. A reason for not using it would be a master-slave arrangement with a PC.
Battery Type	Information for the battery life guide only: the certified AA cells or custom capacity. Offers to change the low battery level to suit the chosen battery.
Usable Capacity	Information for the guide only: capacity in Ah. Batteries can only be used down to 2.1 V, for twin AA cells 1.05 V per cell; the usable capacity is generally lower than advertised. Temperature and internal resistance are not taken into account.
Sensor Impedance	Information for the guide only: resistance of the strain gauge in Ω .
Usage Per 24 Hour Period	Hours per 24 hours that the transmitter will be awake and transmitting.

8.2 Calibration

Semi-automated calibration with known inputs, including linearisation, applied automatically. Procedure:

- Decide on how many points you will calibrate over (2 for a linear calibration, 3 ... 9 points for a calibration with linearisation).
- Decide what loads will be applied (in ascending order) at each point.
- Enter for each point the value in engineering units the transmitter shall report, for example 1.67.
- Apply each input in turn, allow it to settle and click Acquire at that point. Continue until all points are completed. Start Again restarts the calibration.

Important The mV/V from the load cell must be ascending through each calibration point.

The bottom of the page shows the input value and the calibrated value; from the second point on, the calibrated value shows the actual calibrated reading.

System Zero: removes a fixed value after calibration, for example the weight of a sling, shackle or load bed. Apply the required input and click System Zero; the current input is removed from subsequent readings. The system zero is stored in non-volatile memory in the transmitter and can be edited on the Advanced page.

8.3 Calibration by certificate

If inputs cannot be applied, the calibration can be entered from the calibration table or certificate of the load cell, without connecting it: enter the number of points (at least 2, up to 9), the input points (mV/V) and the required output values in engineering units, then click Calibrate.

8.4 Advanced calibration

Gains and offsets can be entered directly for each calibration point (1 ... 9), for example calculated from a calibration table. Input Points: input value at which the gain and offset apply; between the points, gain and offset are linearly interpolated; inputs are extrapolated below point 1 and above point 9. System Zero can also be set here, or set to zero to remove its effect. Linearisation: the input value is compared with the points starting from point 1; when the best point has been found, its gain and offset are applied: $\text{Value} = (\text{input} \times \text{Gain}) - \text{Offset}$.

8.5 Advanced settings

These settings do not normally need to be changed.

Item	Description
Sleep Delay	Delay in seconds after which the transmitter returns to deep sleep if no stay awake message is received from a handheld. Default 60 seconds; 0 disables automatic sleeping.
Data Tag	Identifies the transmitted data; by default the last 4 digits of the serial number. If two transmitters on the same channel had the same last 4 characters in their ID, change the data tag of one and pair it again with the handheld.
Startup Time	Delays the measurement after wake-up for sensors with a slow start-up time, at the expense of battery life. For strain gauge inputs set it to zero.
LED Mirror to Digital Output	Yes: the LED flashes to indicate a transmission, the configuration mode or a handheld looking at this transmitter.
Transmit power	0 ... 100 %, default 100 %.

9 Diagnosis

Observation	Cause and remedy
No data at the receiver or in the channel monitor	Receiver or base station must be on the same radio channel and use the same group key as the transmitter. A sleeping transmitter must be woken (Wake All, or a receiver that wakes transmitters).
Error 2 on the handheld display	Input integrity error: the transmitter has found a problem with the input, for example an open or short circuit. Check the sensor wiring (section 5.3).
Error 1 on the handheld display	The transmitter has been placed in shunt calibration mode by an external module.
Low battery reported	The battery voltage is below the low battery level (section 7.3). Replace the cells – Energizer L91 only, not in an explosive atmosphere (section 5.2).
Intermittent communication	Check LQI and RSSI on the battery and radio levels page, choose a clean channel with the analyser, and follow the antenna guidelines (chapter 10).
Pairing fails	Try again. If soft pairing fails in a high traffic or noisy environment, power cycle pairing may be the only option.

10 Antenna and radio range

The EFMH has its antenna already fitted inside the enclosure, so there are no specific mounting requirements. The antenna is a printed circuit antenna (inverted F type, gain 3.0 dBi).

Radio performance at these wavelengths depends very much on the operating environment. Any structure within the operating region of the radios gives rise to three effects:

- Obscuration: an obstruction masks the line of sight between the radios and reduces the range.
- Aberrations to the horizontal and vertical space patterns: structures or objects in the near or intermediate field of the antenna distort the coverage patterns and adversely affect range and link quality.
- Reflection: objects in the line of sight of the transmit antenna make signals arrive by an indirect path (multipath effects), seen as reduced range or poor link quality.

Each of these reduces the RSSI figures, increases the packet loss rate and, in extreme cases, leads to complete loss of signal. If they are considered at the installation stage, a good quality link will be obtained.

10.1 Guidelines for installation

- Maintain line of sight between the modules, and keep objects and structures at least one metre away from the antennas wherever possible.
- Products with this antenna type should be oriented so that the long axis of the antenna is vertical during normal operation, if possible.
- Range under water is only 100 mm or so, depending on the packet rate.

10.2 Radio range

Maximum range in an open field site between two modules, depending on the antenna types of both modules. EFMH and EFMI both have the internal printed circuit antenna.

Antenna of the other module	Range to EFMH / EFMI
Internal printed circuit antenna (as in EFMH and EFMI)	800 m
Integrated chip antenna	600 m

Between two modules with integrated chip antennas the range is 500 m. Tests conducted in an open field site with the transmitter at the top of a 3 m pole; the receiver was mounted 1.5 m off the ground.

11 Technical data

Specification with 1000 Ω bridge, 2.5 mV/V, at 3 V supply at 25 °C.

Measurement	Min	Typical	Max	Unit
Strain gauge excitation system		4 wire		
Strain gauge excitation voltage	4.5	5	5.25	V DC
Strain gauge drive capability	85		5000	Ω
Maximum gauge sensitivity (FR)			± 3.1	mV/V
Offset temperature stability		1	4	ppm/°C
Gain temperature stability		3	5	ppm/°C
Offset stability with time (1)		20	80	ppm of FR
Gain stability with time (2)			30	ppm of FR
Non-linearity before linearisation		5	25	ppm of FR

(1) From original offset at any time. (2) First year.

Resolution	Resolution / bits
Internal resolution	16 000 000 / 24
Noise free, sample time < 10 ms	50 000 / 15.5
Noise free, sample time < 50 ms	65 000 / 16
Noise free, sample time < 100 ms	150 000 / 17.25
Noise free, sample time < 1000 ms	250 000 / 18
Noise free, sample time > 1000 ms	400 000 / 18.75

Parameter	Value
Power supply	
Cells	2 × Energizer L91 lithium AA (only these cells, section 2.3)
Power supply voltage	2.1 ... 3.0 ... 3.6 V DC (min ... typical ... max)
Power supply ripple	max. 50 mV ac pk-pk
Current, standby / low power mode	typical 5 μ A, max. 20 μ A
Current, normal mode (1 k Ω bridge)	typical 60 mA, max. 65 mA; the supply must be capable of 300 mA for 250 μ s (start-up, waking, low power operation)
Battery life, low power mode, 350 Ω load cell	constantly on at 3 Hz: 30 days · 12 sessions of 5 minutes per day at 3 Hz: 2 years · constantly on, transmitting every 20 s: 5 years
Transmission	
Transmission interval	5 ms ... 1 day, default 333 ms
Radio	
Licence	licence exempt
Radio type	transceiver (2 way)
Modulation method	MS (QPSK)
Data rate	250 kbit/s
Radio frequency	2.4000 ... 2.4835 GHz
Power	10 mW
Channels (DSSS)	15
Range	up to 800 m, see section on radio range

Parameter	Value
Environment and mechanics	
Operating temperature	–20 ... +50 °C
Storage temperature	–40 ... +85 °C
Humidity	0 ... 95 % RH
Protection	IP67 with cable diameter 3.0 ... 6.5 mm
Dimensions	76.6 × 59 × 31 mm, cable gland extends 25 mm
Mounting	2 holes 4.8 mm, 67.0 mm apart
Connection	5 screw terminals inside the enclosure, single cable gland
Antenna	internal printed circuit antenna
Explosion protection	see chapter 2

12 Radio approvals

Region	Product conforms to
Europe	CE
USA	FCC
Canada	IC

These approvals do not cover the entire set of standards that must be met in each country. Users assume full responsibility for learning and meeting the requirements of each country in their distribution market.

12.1 CE

Complies with EMC directive 2014/30/EU and the Radio Equipment Directive 2014/53/EU (European Community, Switzerland, Norway, Iceland and Liechtenstein).

This equipment is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU.

The EU declaration of conformity (ATEX directive 2014/34/EU, EMC directive 2014/30/EU, Radio Equipment Directive 2014/53/EU) is available from octogon on request; see also section 2.2.

12.2 IC

IC:7224A-RA24

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter RA24 has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Antenna	Gain (dBi)	Antenna type
Ant A	3	Inverted F
Ant C	2.2	half wave dipole
Integrated	1.3	Chip antenna

Important To comply with Industry Canada RF radiation exposure limits for general population, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 5 cm is maintained between the radiator (antenna) and all persons at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.

12.3 FCC

FCC ID: VHARA24

- This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.
- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.