85X1N SERIES
WIRELESS VIBRATION SENSOR
USER MANUAL

Doc# 20023687-27

Revision 0.1

REVISIONS

DATE	Revision	Change Description	Prepared by	Approver
11/02/2022	Rev 0.1	Initial draft NEW Version		PRS

Contents

1. Introduction

TE Connectivity's 85X1N Series Wireless Vibration Sensors encompass model families 8511N and 8531N. These sensors combine a 1-axis (8511N) or 3-axis (8531N) accelerometer respectively, a data collector, and a radio into one compact unit. The sensors are battery-operated device that measures both vibration and temperature data. The models were designed for hash environment and use BLE communication protocols as the main mean of communication.

85X1N Series incorporate a piezo-electric accelerometer which offers a wide bandwidth to >15kHz, outstanding measurement resolution and superior long-term stability compared to design using MEMS solutions.

All models contains digital signal processing capability that provides an FFT analysis of the sensed vibration. The output data describes signal power and peak to peak information. Because of this feature, 8511N and 8531N models directly provide data most needed to plot trends and monitor changes in the performance and condition of factory machinery.

2. General Description

The 85X1N Series Wireless Vibration sensors have two BLE modes:

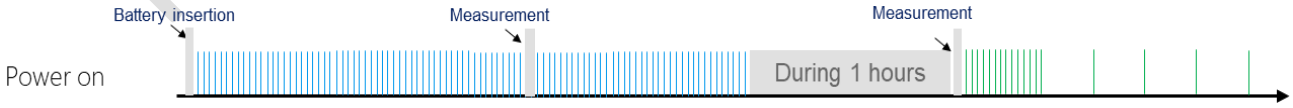
- Advertisement Mode: provides data continuously
- Connected Mode: advanced mode for configuration and special mode. Each advertisement allows the opportunity to user to switch to Connected mode. It's the only way to go into connected mode.

3.1 Advertisement Mode

The products have several advertisement frequencies varying upon time, configuration and hardware event:

3.1.1 At power on

When the device is powered on, a yellow LED blinks to confirm the proper battery insertion. From the sensor startup and for 1 hours, the device advertise every 1 sec. This allows user to configure the product by switching to connected mode. A measurement is performed at measurement interval.



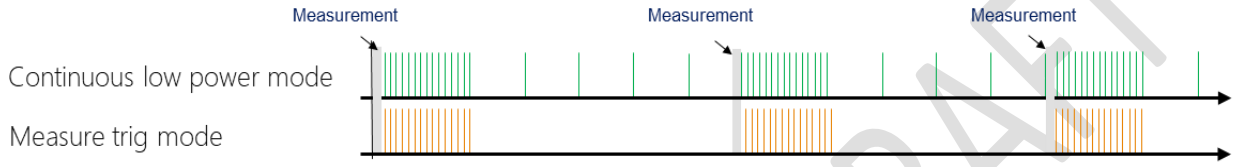
3.1.2 1 hours after power on

After every measurement, the device will advertise at 1s interval for 15 seconds. This will give

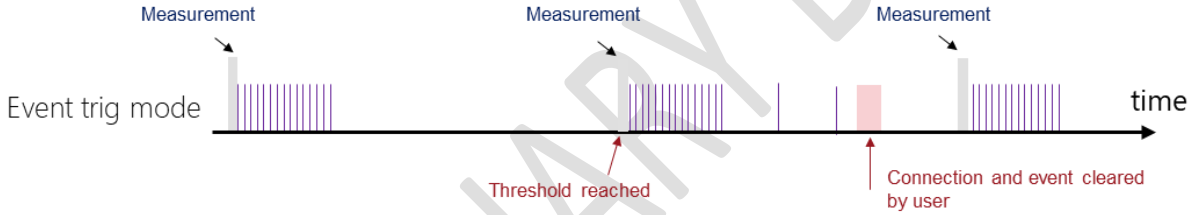
multiple chances to the gateway to connect to the device.

After 15 seconds, the device will advertise at 10s interval till the next measurement. During, this phase, the connection could be more difficult. This “10 seconds” advertisement can be deactivated by user (see Advertising configuration: Measure Trig)

Between two measurements, the data into the advertisement frames is the same. The payload is only updated after every measurement interval.

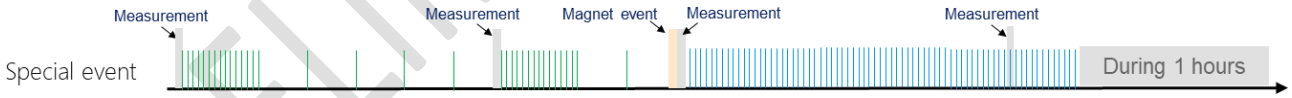


After a measurement, if a threshold is reached, the system will advertise every 10s after the 15s period. Advertisement will stop when user clear the event.



3.1.3 Special event

If the advertisement interval is too long, it could be very difficult to switch to connected mode. So we offer the opportunity to advertise more often when the magnet is used. The magnet event will trig a measurement and the device will advertise every second during 1hour.



3.2 Connected Mode

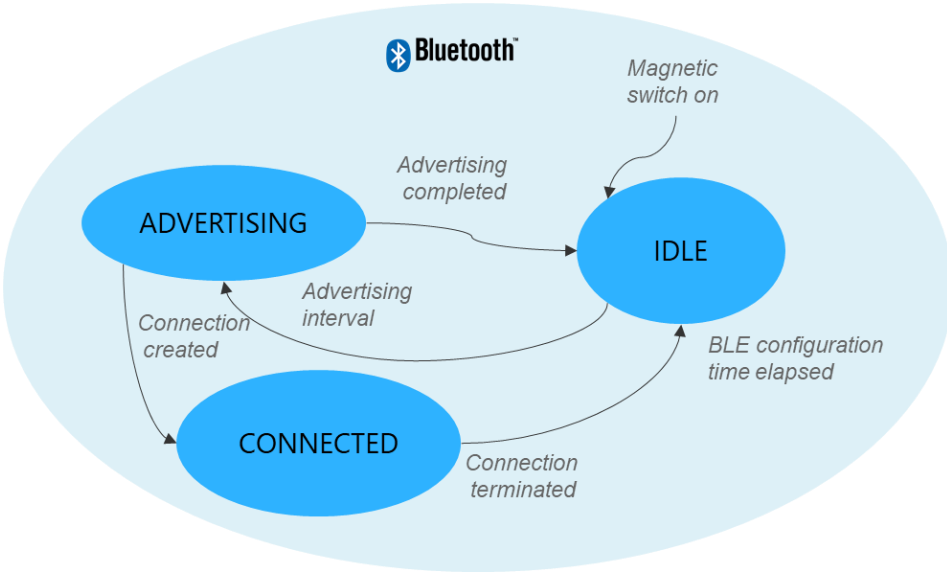
User can connect to the product. It all to configure, get access to special function and update firmware Product comes with 3 different BLE connected modes which are listed below:

Operating mode	Description	Condition
Standard	User mode to configure the sensor and activate some specific function only available when connected	None

DFU	Mode used during FW update.	OTA update
Factory	Mode used by manufacturing. It allows sensor calibration and offer dedicated test-mode functionalities for RF testing, calibration, and current consumption measurements.	Factory entry

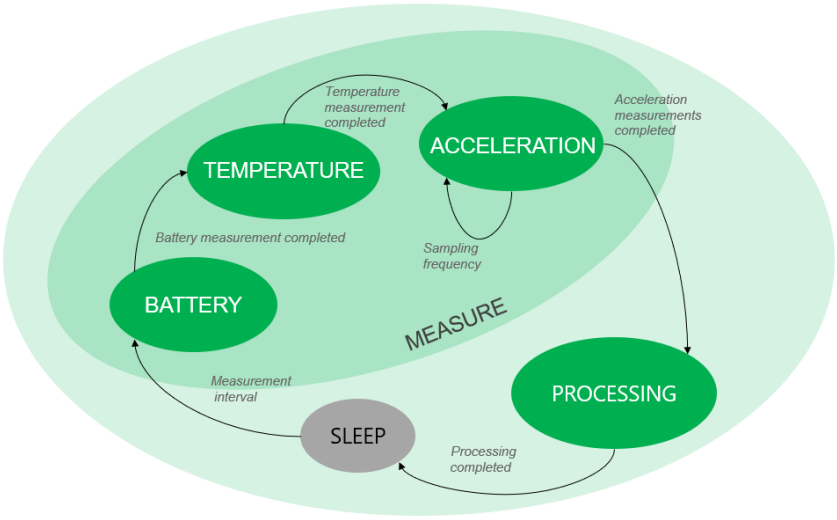
3.3 MODES OF OPERATION

The device operation can be summarized by the following state machine diagram.



3.4 DATA COLLECTION

Sensor measurements are performed and transmitted at a configurable interval from 1 min up to 24 hours. This is driven by the *Measurement interval* parameter.



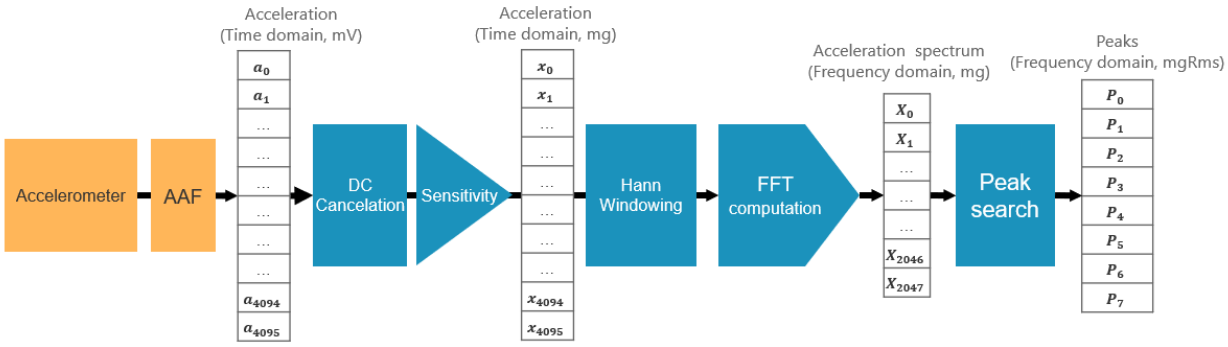
Upon wake-up, the device powers the sensing element and waits for about 3 seconds to let the accelerometer boot and stabilize its output.

A measurement consists of reading the battery level, temperature, and a set of 4096 acceleration values at a configurable rate.

Data	Unit	Accessibility
Battery level	%	BLE
Temperature	°C	BLE
Acceleration	mg	BLE

3.5 DATA PROCESSING

The data processing signal chain transforms the acceleration raw data into frequency peaks.



Acceleration data is collected at a chosen sampling frequency. Raw data passes through an anti-aliasing filter. Once a set of acceleration readings is measured (4096 points), the embedded algorithm removes the DC signal (to remove the bias voltage of the sensing element) and multiplies the results by the sensor element calibration sensitivity (mV/g). The algorithm then applies a Hann window to the signal and converts it into a normalized FFT spectrum. Finally, a peak search algorithm extracts the most significant peaks from the spectrum.

Certain data is saved for each of the peaks:

Parameter	Description
Peak Frequency	Frequency of the peak (Hz)
Peak RMS magnitude	Single frequency peak PMS magnitude (g)
Ratio	Ratio of energy. Maximum peak magnitude plus associated bins divided by total spectrum energy.

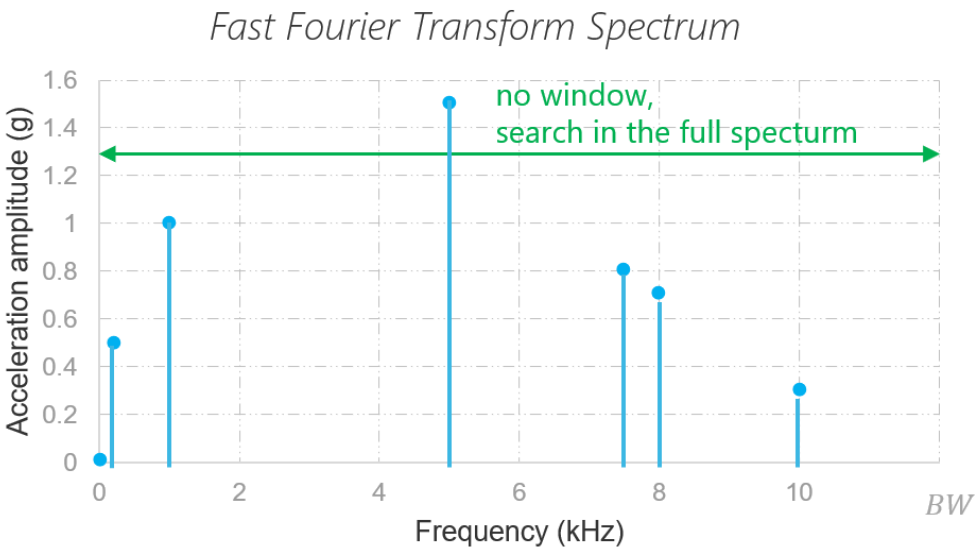
Note that only “Peak values” are accessible by the user. Raw data and raw FFT spectrum are stored for internal computation and are not available outside the sensor.

From this point, several customer defined options are available to further process the data into useful output information.

The customer can establish and configure up to eight windows across the FFT spectrum. For each window, the user can configure the following parameters:

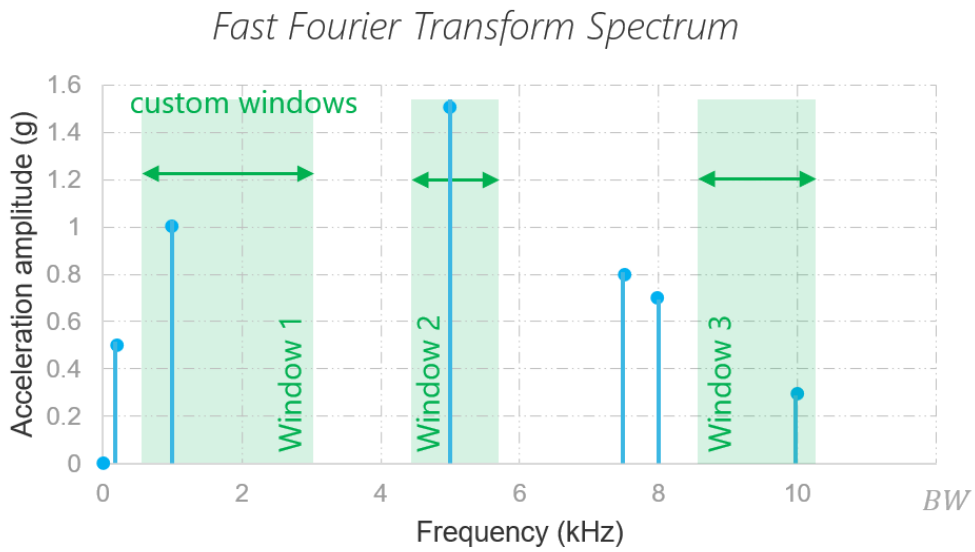
Parameter	Description	
Peak number	Number of peaks to be found (0 to 24)	
Number of bins	Number of bins around the main beam to be integrated into the ratio output. This parameter can be used to filter side lobes and avoid multiple peaks found around the same frequency	
Minimum frequency	Minimum frequency of the search window	These define the bandwidth of each window
Maximum frequency	Maximum frequency of the search window	

By default, no windows have been established or configured. The peak search covers the full spectrum.



Typical FFT spectrum showing the highest eight peaks.

It is possible to program up to 8 custom windows to define several regions of interest. Any peak ouside the windows will be ignored.



Typical FFT spectrum showing eight peaks and 3 windows

3.6 BLUETOOTH LOW ENERGY

The device includes a Bluetooth 5.0 Low Energy compliant interface. This is a low power communication technology which should be used at short distances. It makes the 85X1N a connectable beacon which acts as a peripheral by default and switches to a server role (pairing mode) once a remote device (central) is connected.

The upload interval can be configured by the customer for any time between one minute and 24 hours (in one-minute steps).

Data upload consists of this information:

- Battery status
- Sensor internal temperature
- All FFT data as configured by the user
- Raw sensor data (time domain accelerometer signal) is not available for upload

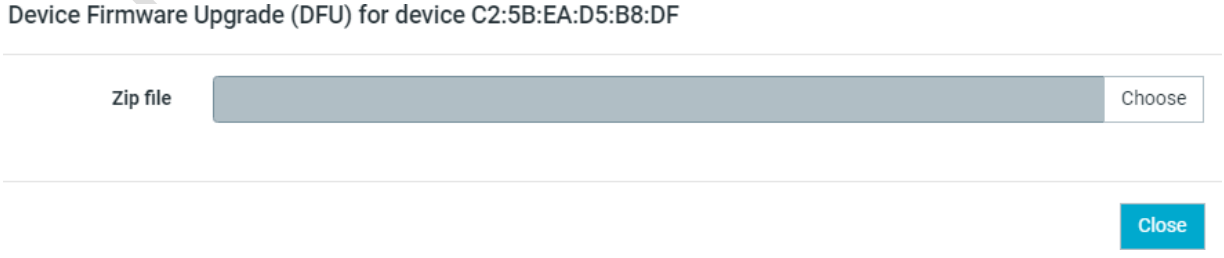
All customer configurable parameters can be adjusted via LoRaWAN™ using a data download:

- Reading/upload interval
- Number of peaks
- Number of bins around the peaks
- Number of windows
- Window minimum frequency
- Window maximum frequency

4 DFU Mode

DFU mode should be used to upgrade the sensor firmware. It is accessible from the standard mode.

The new firmware to be loaded must be signed by TE.



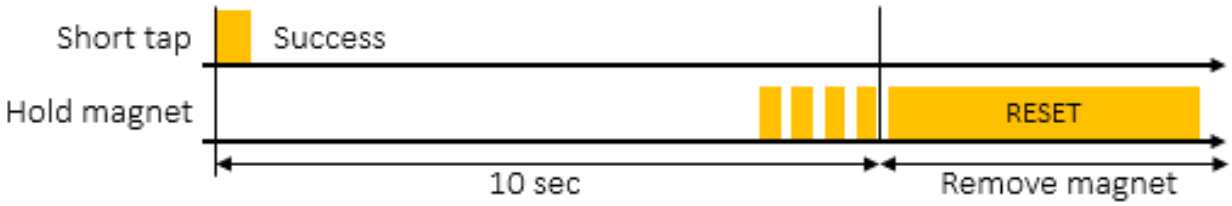
The DFU works with a single bank only. This means that if the firmware update is interrupted (power cut off or BLE disconnection), the application firmware will be corrupted, and the sensor will stay in DFU mode. The user will have to re-try the upgrading process. Note that the DFU MAC address is the sensor MAC address +1.

5 Magnetic Switch

The 85X1N has an internal reed switch. This switch is activated when a strong magnet is close to the magnetic sensor location. The magnetic switch location is indicated by the magnet icon on the plastic housing. The magnet must be of sufficient strength and proximity to create a magnetic field of 25 mT at the switch location.

Two different functions are available depending on the user action:

User action	Function	LED
Short tap	Activates BLE for another one hour plus trigs a new measurement.	One short blink. If user holds the magnet close to the switch for a longer duration, the LED will blink faster. Remove the magnet to only initiate a transmission. Else it going to initiate a sensor reset.
Hold magnet for 10+ seconds	Resets the sensor.	Wait for at least 10 seconds, to see the very fast blink. Release the magnet once a very long orange led appears



LED indicator

6 LED Indicator

The orange LED indicates the state of the 85X1N.

		Led Behavior
Battery insertion		ON during 2s
Magnet event		ON during 200ms
Maintaining Magnet	<3s	Slow blinking
	[3s-10s]	Fast blinking
	>10s	OFF -> reboot

7 Battery

7.1 BATTERY TYPE

To meet various certification requirements, the following battery must be used:

Parameters	Typical value
Manufacturer	SAFT
Reference	LS 17330
Technology	Primary lithium-thionyl chloride (Li-SOCl2)
Nominal voltage	3.6 V
Capacity at 20°C	2100 mA
Operating temperature range	- 60°C/+ 85°C

7.2 BATTERY LIFE

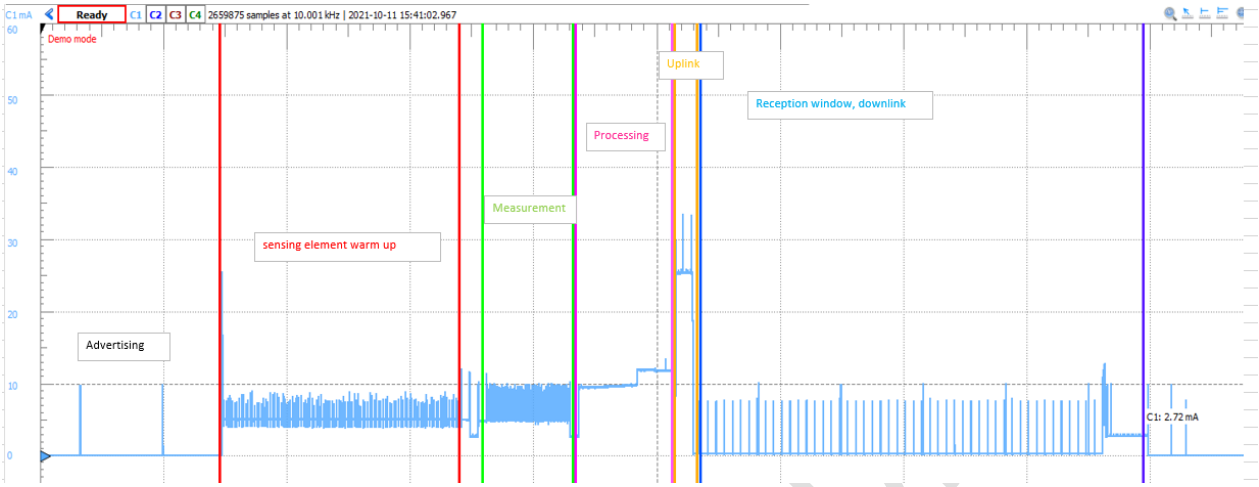
Depending on customer settings (measurement interval) battery life could go up to 10 years. Lower will be the number of measurements per day, higher will be the battery life.

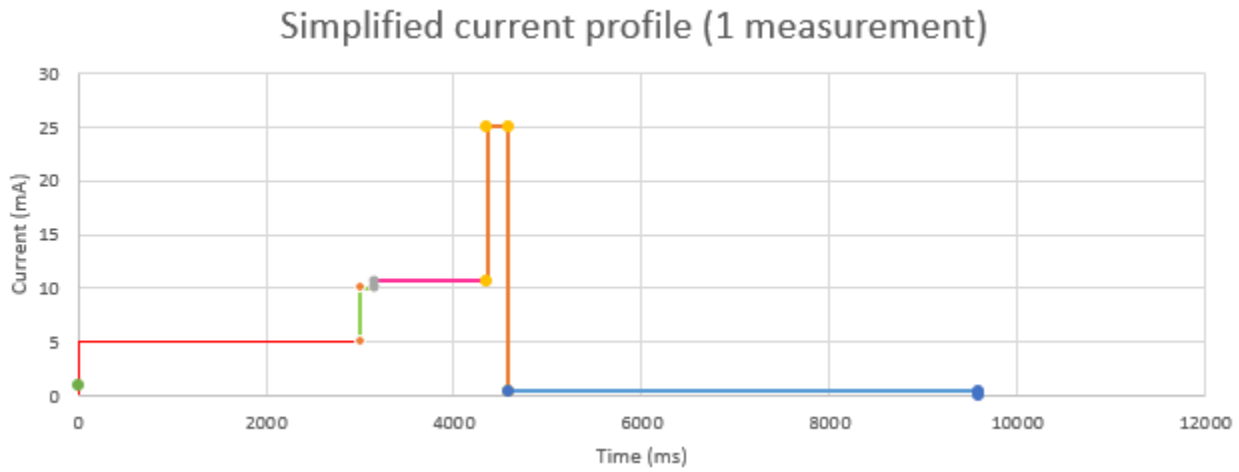
7.3 BATTERY REPLACEMENT

The 85X1N's battery must be replaced if depleted. Unscrew the plastic housing and remove it from the base. Carefully use a small tool (such as a flat screwdriver) to remove the battery. Note that it MUST be replaced by the same battery type as shown above. Substitute batteries may damage and/or bring uncontrolled behavior to the sensor. Double check the polarity and then insert the new battery inside the holder. Re-attach the plastic cover on the sensor. Refer to the Installation Manual (Doc# 20023687-24} for specific details regarding battery installation and replacement.

When complete, the battery life estimator in the firmware must be reset to a "full" battery status.

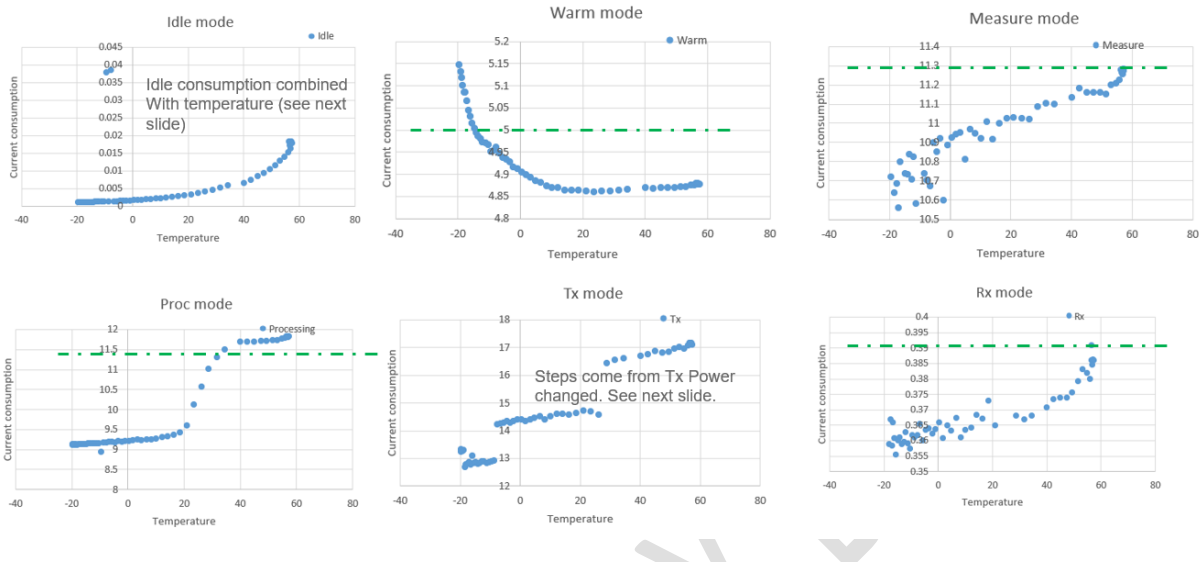
7.4 BATTERY ESTIMATION ALGORITHM



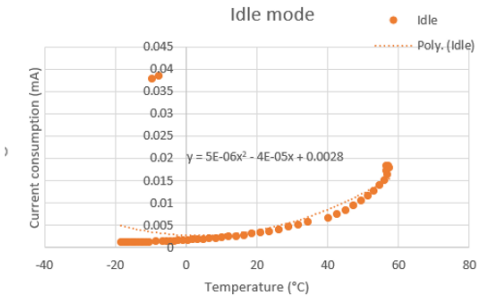


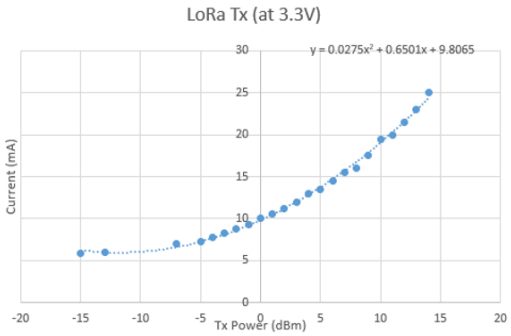
7.5 CURRENT CONSUMPTION PROFILES

Current consumption (mA) profiles over temperature (°C)

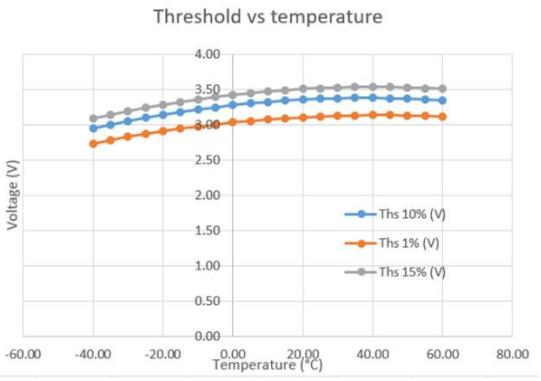


Current consumption profiles over temperature

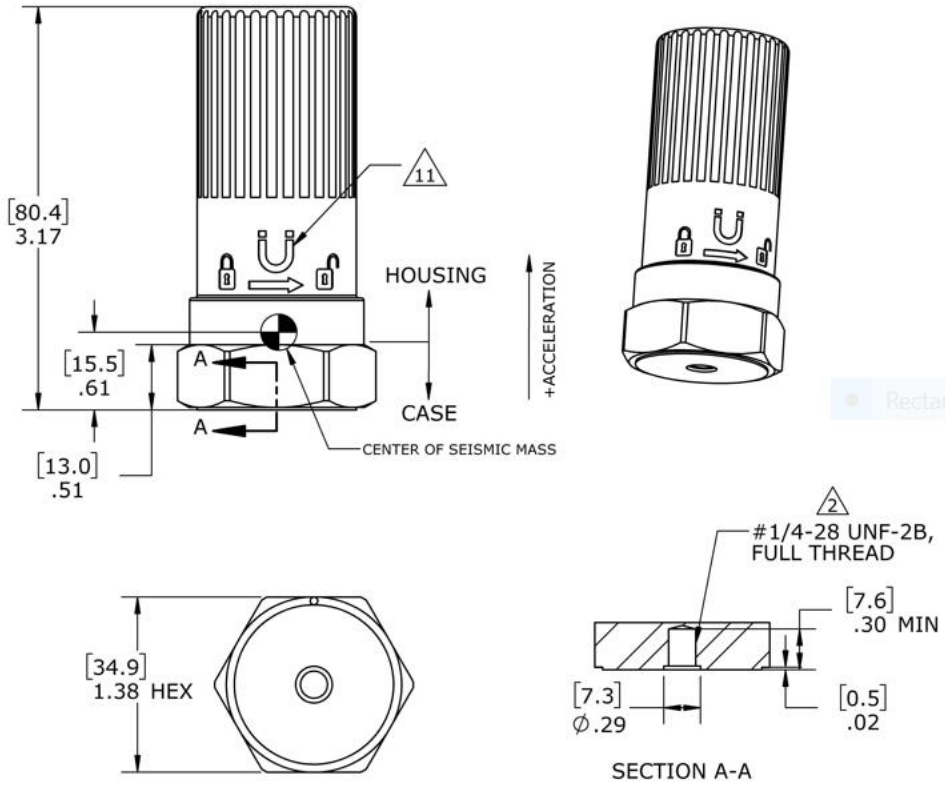




Cell voltage guards

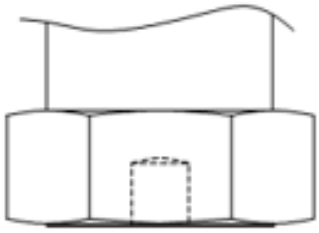


8 Dimensions

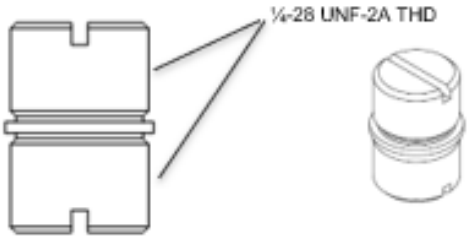


9 Mounting Considerations & Accessories

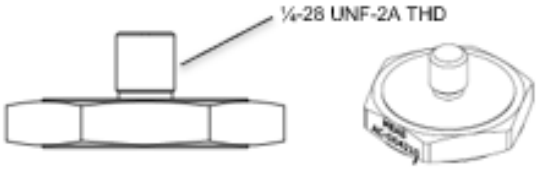
A solid mounting method is required to get optimum performance from the accelerometer. Any loose parts or unsecured mounting features will introduce noise and corrupt the signals of interest. Shown below are six different mounting options available for the 85X1N accelerometer.



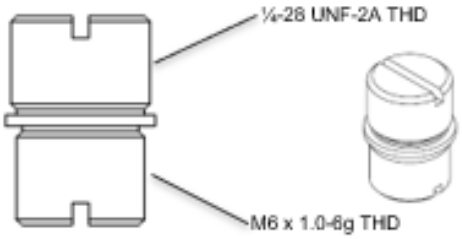
1/4-28 UNF Female THD
(Integrated part of the sensor)



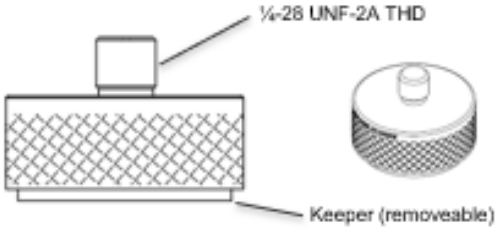
1/4-28:1/4-28 Male Stud
P/N AC-D03636



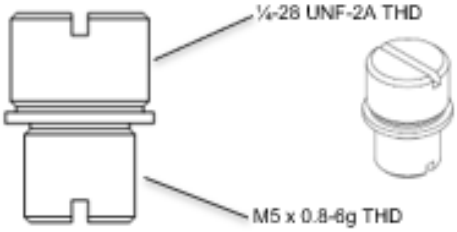
Adhesive Mounting Stud
P/N AC-D04210



1/4-28:M6 Male Stud
P/N AC-D03665



Magnetic Mounting Stud
P/N AC-A04209



1/4-28:M5 Male Stud
P/N AC-D03664

For the adhesive mounting stud, secure with a rigid adhesive such as epoxy or cyanoacrylate. Do not use pressure sensitive adhesives or foam tapes. For the magnetic mounting stud, remove the keeper prior to attachment. The magnetic mounting will have a 30 lb pull strength when attached to a ferrous surface.

Note – Some mounting accessories may be supplied with sample orders. For production deliveries, desired mounting accessories must be ordered as a separate item.

10 Intrinsic Safety

8511N and 8531N Wireless Sensors with characteristic (EX) in model name are certified for Intrinsic Safety to the following classification:

IS Class I, Div1, Groups A, B, C, and D;
Class I Zone 0, AEx ia IIC T4 Ga;
Ex ia IIC T4 Ga;
ll 1 G Ex ia IIC T4 Ga

Please see section 12 for details on how to order.

11 REGLUATORY STATEMENTS

FCC and IC

This Radio Equipment is Certified for FCC (US) and ISED (Canada).

This equipment does not support simultaneous transmissions.

Changes or modifications not expressly approved or authorized by TE Connectivity for compliance could void the user's authority to operate the equipment.

FCC Warning:

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.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does not cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

▪ Re-orient or relocate the receiving antenna

- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit that is different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Industry Canada (IC) Warning:

This device complies with ISED 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.

Le présent appareil est conforme aux CNR d'ISED Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IMPORTANT NOTE:

Radiation Exposure Statement:

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclarationd'exposition aux radiations:

Cetéquipementestconforme Canada limitesd'exposition aux radiations dans un environnement non contrôlé. Cetéquipementdoitêtreinstallé et utilisé à distance minimum de 20cm entre le radiateur et votre corps.

EU Conformity

The products below were tested by approved agencies and found compliant with EU regulatory standards.

Model Families: 8511N & 8531N

Product Description: Wireless Vibration Sensor

Manufacture/Brand: TE Connectivity Ltd

Manufacturer:

Measurement Specialties (China) LTD

No 26 LangShan Road

518057 Shenzhen-Nanshan District, China

European Contact:

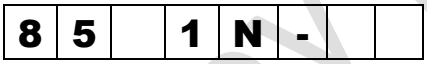
TE Connectivity Sensors France

4 Rue Gaye Marie

31027 Toulouse – France

12 Ordering Information

Model Number:



Sensor Axis	
1	Uniaxial
3	Triaxial

Certification	
NX	None
EX	Explosive Atmospheres: ATEX/IECEx/US/CANADA IS CL I, DIV 1, GRP A, B, C, D, T4; CL 1. ZN 0, AEx ia IICT4 Ga; II 1 G, Exia IIC T4 Ga;

Mounting Accessories	
Part Number	**Description**
AC-D04210	Adhesive Mounting Stud
AC-A04209	Magnetic Mounting Stud
AC-D03636	¼ x 28 by ¼ x 28 Double-ended Male Stud
AC-D03665	¼ x 28 by M6 Double-ended Male Stud
AD-D03664	¼ x 28 by M5 Double-ended Male Stud

Sales and technical support

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Tel: +86 0400-820-6015 customercare.shzn@te.com