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(R) Helicopter Health and Usage Monitoring System Accelerometer Interface Specification

RATIONALE

This document defines interface requirements for accelerometers and associated interfacing electronics for use in a helicopter Health and Usage Monitoring System (HUMS). The purpose is to standardize the accelerometer-to-electronics interface with the intent of increasing interchangeability among HUMS sensors/systems and reducing the cost of HUMS accelerometers as the result of economy of scale. Additionally, the goal is to provide a set of high level requirements for HUMS accelerometers for system designers and integrators.

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1. SCOPE

Accelerometers are transducers, or sensors, that convert acceleration into an electrical signal that can be used for airframe, drive, and propulsion system vibration monitoring and analysis within vehicle health and usage monitoring systems.

This document defines interface requirements for accelerometers and associated interfacing electronics for use in a helicopter Health and Usage Monitoring System (HUMS). The purpose is to standardize the accelerometer-to-electronics interface with the intent of increasing interchangeability among HUMS sensors/systems and reducing the cost of HUMS accelerometers. Although this interface was specified with an internally amplified piezoelectric accelerometer in mind for Airframe and Drive Train accelerometers, this does not preclude the use of piezoelectric accelerometer with remote charge amplifier or any other sensor technology that meets the requirements given in this specification.

This SAE HUMS Accelerometer Interface Specification includes the minimal interface and performance requirements for commonality. Compliance with this Interface Specifications can be referenced in more comprehensive procurement and device specifications.

1.1 Classification

Accelerometers used in current HUMS fall into three distinct categories, they are:

- a. Airframe accelerometers (generally used for rotor track and balance performance),
- b. Drive train accelerometers, and
- c. Engine accelerometers.

This document is divided into three sections in recognition of this common industry classification.

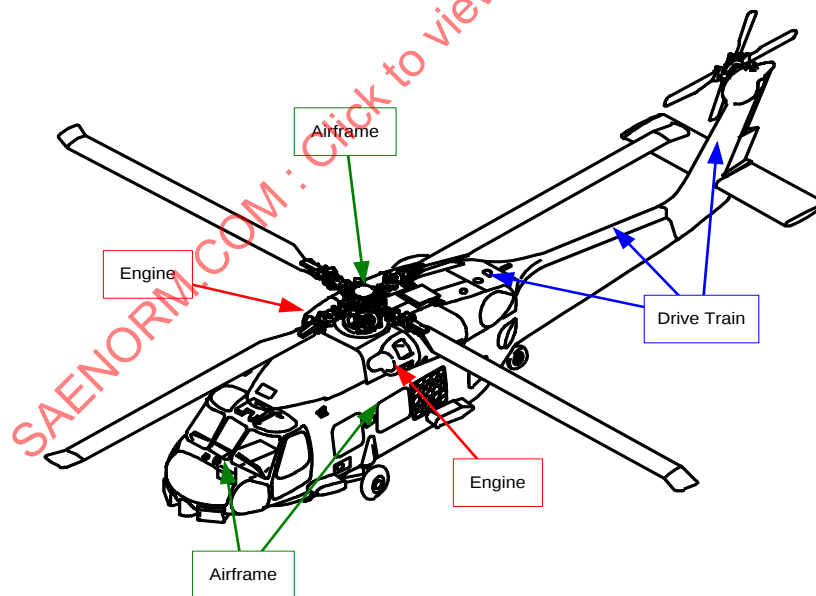


Figure 1 – Example of accelerometers location

1.2 Specification Terminology

The terms "shall" and "should" within this specification observe the following rules:

- a. The word "shall" expresses a mandatory requirement of the specification.
- b. The word "should" expresses a recommendation or advice on implementing the specification or actions expected of users of the system.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP1839

2.2 Definitions

ACCELERATION - The rate of change of velocity with time, usually along a specific axis and normally expressed in 'g' or gravitational units, ft/sec² or meters/sec².

ACCELEROMETER - A transducer which converts input accelerations into outputs (usually electrical) which are proportional to the input acceleration values.

BASE STRAIN SENSITIVITY - The sensitivity to strains applied to the base by bending, stretching or flexing in the absence of any rigid body motion of the transducer. Usually expressed in equivalent measurand units at 250 microstrain applied to the mounting surface.

BIAS VOLTAGE - A DC voltage which is seen at the output of the transducer with no acceleration applied and superimposed on acceleration signal. It is set by the transducer electronics (either internal or remote to transducer).

CHARGE AMPLIFIER - A capacitive feedback amplifier that converts the high impedance output from a charge mode sensor to a low impedance voltage signal.

CHARGE CONVERTER - Converts the high impedance output of a charge mode sensor to a low impedance voltage signal. This term is preferred to "charge amplifier".

CHARGE MODE ACCELEROMETER - A piezoelectric accelerometer that provides a high impedance charge output signal. As it lacks internal electronics, an external charge converter is required in the measurement chain to convert the charge signal into a voltage signal and to eliminate the cable capacitance effect.

"g" - Standard unit of acceleration equal to one earth's gravity at mean sea level - one "g" equals 32.17 ft/sec² (Imperial) or 9.807 m/s² (SI).

GROUND ISOLATION - Refers to a condition when the signal ground is electrically isolated from the test structure.

NATURAL FREQUENCY - The natural frequency of a spring-mass system is proportional to the square root of the ratio of the spring constant to the mass for each degree of freedom.

RESONANCE, MECHANICAL - The condition that occurs when the frequency of an exciting force equals a natural frequency of a spring-mass system. A frequency at which a structure readily vibrates, with no continuous excitation.

RT&B - Rotor Track and Balance

SENSITIVITY - The ratio of change in sensor output as a result of a unit change in acceleration

SENSOR - A measurement device that detects a change in a physical stimulus and turns it into an electrical signal which can be measured or recorded. Sensors are also referred to as transducer or pickup.

TEMPERATURE SENSITIVITY - The change in sensor output due to the change in temperature.

TRANSDUCER - See Sensor.

TRANSVERSE SENSITIVITY - Signal output as a result of acceleration perpendicular to the sensitive axis.

3. REQUIREMENTS AND RECOMMENDATIONS

The specific functional requirements for the three sensor categories are given in the following subparagraphs.

3.1 HUMS Airframe Accelerometers

3.1.1 Definition

Airframe (i.e., rotor balance) accelerometers measure airframe vibration, which usually results from rotor imbalance conditions. Rotor imbalance conditions cause rotor one per revolution disturbances in the airframe. These disturbances result in airframe vibrations in the frequency range from two Hz to tens of Hz, depending on the rotor rpm. The airframe measured acceleration is processed within rotor track and balance algorithms that, in some cases, utilize higher harmonic vibrations (2 per revolution up to 24 per revolution). Airframe accelerometers can be single or multi-axis depending on the requirements of rotor track and balance (RT&B) algorithms.

3.1.2 Characteristics

HUMS airframe accelerometers shall have a low-impedance voltage output (i.e., internal conditioning), directly proportional to the acceleration as described in 3.1.2.2.6.

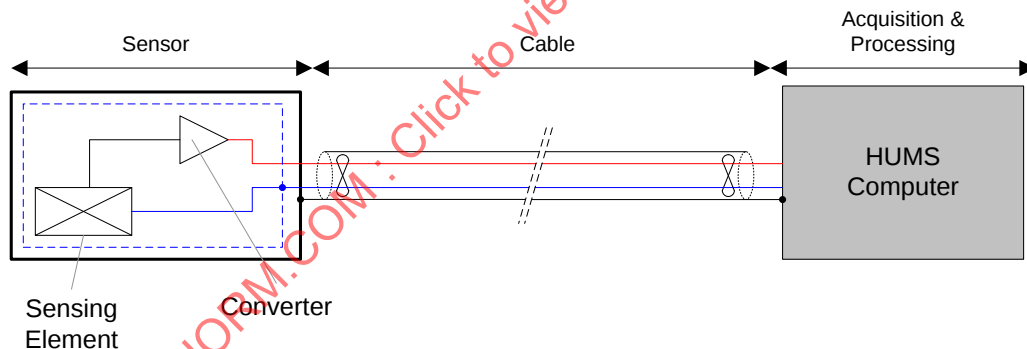


Figure 2 – Airframe accelerometer

Measurement of static (0 Hz) acceleration is not required for airframe vibration monitoring. Experience has shown that the measurement of airframe acceleration is easily corrupted by strain in the mounting base of the accelerometer that results in unwanted output signal. This vulnerability to strain on the accelerometer's mounting base requires the use of an accelerometer with low-base-strain sensitivity (given in 3.1.2.4.3).

The accelerometer signal return should be isolated, internally, from case ground to reject the frame voltage effect. For some RT&B applications, precise measurement of relative signal phase is required to determine which blade or combination of blades is causing an out-of-balance condition.

3.1.2.1 Performance

Performance requirements should be met using mounting hardware, cables and connectors as recommended in 3.1.2.3. Performance testing should be performed with cables tied down as specified in 4.1.

3.1.2.1.1 Sensitivity

The typical sensitivity to acceleration should be within 25...100 mV/g, $\pm 5\%$ when measured at its calibrating frequency of 100 Hz ± 5 Hz or 120 Hz ± 5 Hz.

3.1.2.1.2 Acceleration Range

The typical acceleration range should be $\pm 50 \dots 100$ g.

3.1.2.1.3 Dynamic Response

3.1.2.1.3.1 Amplitude Response

The amplitude response of the sensor should lie in the un-shaded region of the frequency response plot of Figure 3. The y-axis is given in units of percent deviation as defined in Equation 1.

$$\% \text{ Deviation} = \left(\frac{\text{Sensor Output} - \text{Sensor Output@100 or 120Hz}}{\text{Sensor Output@100 or 120Hz}} \right) \cdot 100\% \quad (\text{Eq. 1})$$

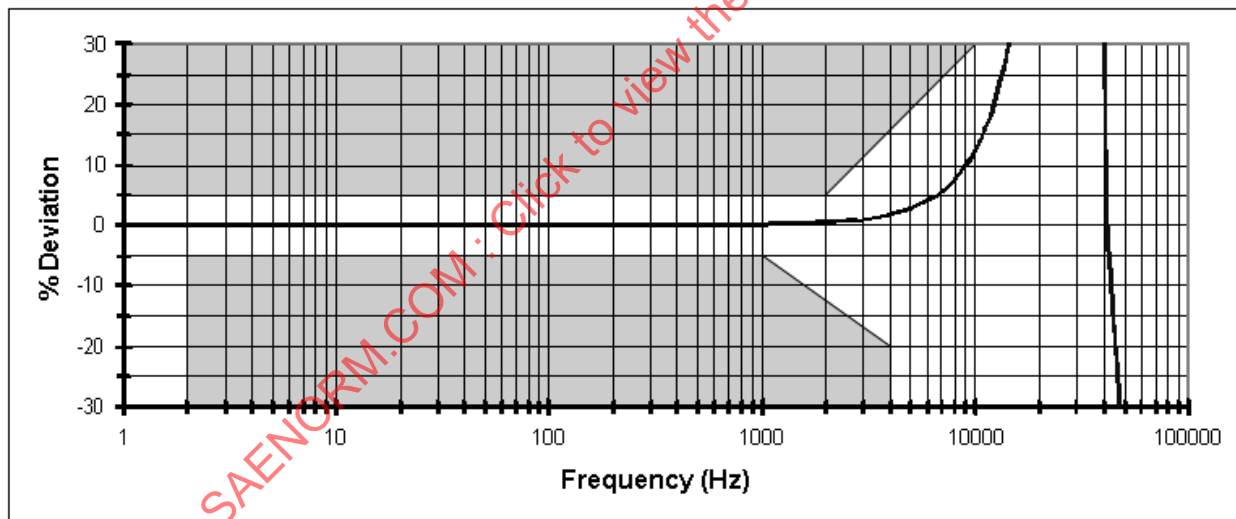


Figure 3 – Allowable airframe accelerometer amplitude response

3.1.2.1.3.2 Relative Phase Response

The phase response of the sensor should lie in the un-shaded region of the phase response plot of Figure 4. The y-axis (phase dispersion), in the figure below, is the phase of the sensor's output relative to a reference accelerometer and normalized to the value at 100 Hz ± 5 Hz or 120 Hz ± 5 Hz. The phase data is normalized by removing the relative phase (phase difference between the sensor under test and the reference accelerometer) at 100 Hz ± 5 Hz or 120 Hz ± 5 Hz from the rest of the test data. As a result, the curve in Figure 4 will always pass through the point of 0 degrees of phase dispersion at 100 Hz ± 5 Hz or 120 Hz ± 5 Hz.

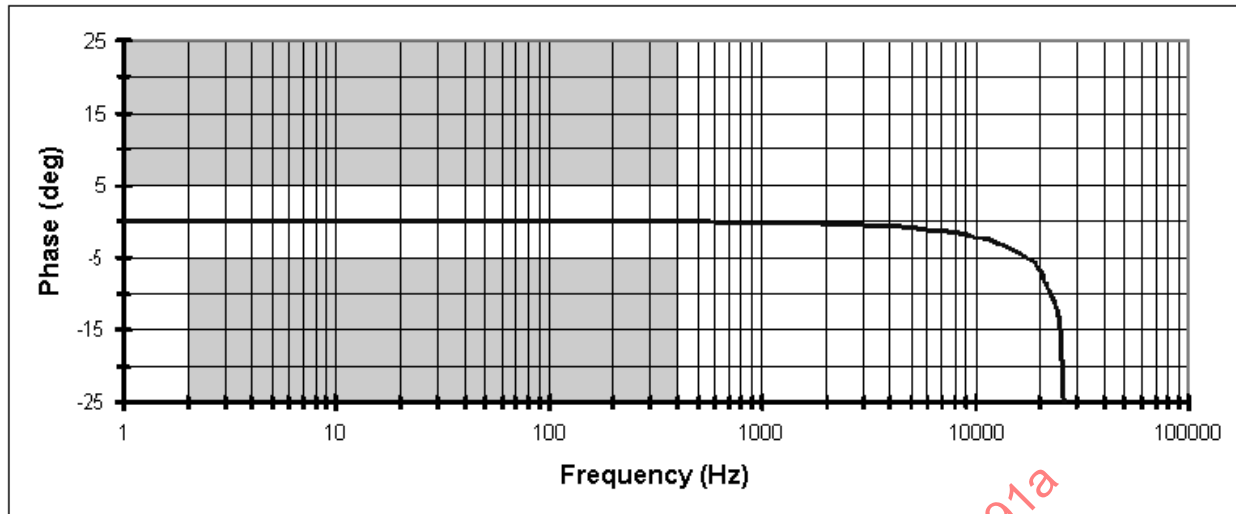


Figure 4 – Allowable airframe accelerometer relative phase response

3.1.2.1.3.3 Absolute Phase Lag

The phase difference between the mechanical excitation of the sensor and the sensor's electrical output shall be 0 degrees $\pm$ 5 degrees when excited with 2 Hz acceleration. This requirement is necessary only when precise phase measurement is needed by the processing algorithms.

3.1.2.1.3.4 Mounted Resonance Frequency

The mounted resonance frequency of the accelerometer should be high enough not to be excited by local forcing functions and compromise its acceleration measurements within the frequency range of interest. A resonance frequency greater than 20 kHz can be used as a reference.

3.1.2.1.4 Output Polarity

Positive acceleration into the base of the accelerometer shall produce a positive output voltage. Positive acceleration shall be in the direction pointing through the accelerometer's mounting base towards its mounting structural point. Neglecting the DC output bias, positive output voltage shall be defined as when the connector signal or power pin shall have a greater voltage than the signal common pin.

3.1.2.1.5 Transverse Sensitivity

The transverse sensitivity of the accelerometer shall be less than or equal to 5% of the sensitivity of the primary axis (given in 3.1.2.1.1).

3.1.2.1.6 Temperature Sensitivity

The sensitivity of the sensor to temperature should vary less than $\pm 8\%$, with respect to the sensitivity at room temperature $24^\circ\text{C} \pm 2^\circ\text{C}$ ($75^\circ\text{F} \pm 4^\circ\text{F}$), over the temperature range given in 3.1.2.4.1. If lower temperature sensitivity is required, this can be achieved by a specific sensor adaptation.

3.1.2.2 Electrical

The accelerometer is a two-wire device. The two-wire interface carries the electrical power to the accelerometer, as well as the converted acceleration signal to the interface electronics. The accelerometer accepts electrical power from a constant current regulated DC voltage source.

3.1.2.2.1 Supply Current

The accelerometer shall operate continuously with a DC supply current of 4 to 10 mA from the interface (HUMS computer). The selected DC supply current will directly define the accelerometer maximum measuring frequency for a maximum cable length between sensor and user electronic. (The cable capacitance and the maximum frequency define the level of the supply current.)

3.1.2.2.2 Maximum Supply Voltage

The maximum voltage supplied to the accelerometer shall not exceed 32 V DC, even under transient conditions.

3.1.2.2.3 DC Output Bias Voltage

At room temperature, the accelerometer output shall consist of a +7 to +13 V DC bias on which an AC signal, proportional to the acceleration, is superimposed.

3.1.2.2.4 Full Scale Output Voltage

The accelerometer output shall consist of a ± 5 volt (peak) AC signal that is directly proportional to the vibratory acceleration and is superimposed on a DC bias voltage.

3.1.2.2.5 Electrical Isolation

The accelerometer's output signal common shall be internally isolated ($>10\text{ M}\Omega$ at 50 V DC) from case ground. Alternatively, other accelerometer designs feature a case that is externally isolated from the airframe ground by a standard isolation pad.

3.1.2.2.6 Output Impedance

The output impedance shall be less than $200\ \Omega$ over the acceleration frequency measuring bandwidth specified in 3.1.2.1.3.

3.1.2.2.7 Case Resistance

In cases that sensors have case pin, or third pin, the electrical resistance between the connector's "case" pin and any point on the accelerometer body shall not exceed $2.5\text{ m}\Omega$ (without integral cable).

3.1.2.3 Physical Characteristic Recommendations

Two body styles are recommended for uni-axial HUMS airframe accelerometers. These styles will support sensor installation requirements for rotorcraft from multiple aircraft manufacturers. They are:

- a. The through-bolt mounted ("donut" style) accelerometer,



Figure 5 – Donut style accelerometer

- b. The tapped hole and stud mounted ("spark plug" style) accelerometer.



Figure 6 – Spark style accelerometer

Applications that use bi-axial and/or tri-axial accelerometers should be designed not to impose restrictions to rotation about the main axis.



Figure 7 – ARINC STD style accelerometer

For standardization purpose, uni-axial types may have the same ARINC body styles as for multi-axial accelerometer.

For each body style, the accelerometer case could have an integral cable (Figure 6) or a hermetically sealed connector (Figures 5 and 7).

3.1.2.3.1 Donut Style Accelerometer

The donut style accelerometer shall be mounted using a through bolt. Holes shall be provided in the through bolt that allows the through bolt to be lock wired to the airframe, unless another connector locking method is provided.

3.1.2.3.2 Spark Style Accelerometer

The "spark plug" style accelerometer should typically allow for a 1/4-28 stud mounting to a test article. The thread length shall be at least 0.22 inches (5.6 mm) and have a sufficient lead in chamfer on the end of the thread to prevent cross threading during installation. The female thread on the test article must be of sufficient depth to assure the mounting stud on the accelerometer does not bottom out. Holes shall be provided in the "spark plug" style accelerometer that allows the accelerometer to be secured in place with lock wire, unless another connector locking method is provided.

3.1.2.3.3 Accelerometer Case Sealing

The accelerometer case shall be hermetically sealed with a leak rate of less than 1×10^{-8} mbar liter/sec over the temperature range specified in 3.1.2.4.1.

3.1.2.3.4 Accelerometer with Integral Cable

The accelerometer can have a side exiting integral cable. This cable should consist of a twisted shielded pair of 22 gauge wires with low capacitance (<150 pF/m). In some instances 24 gauge wire can be used if approved for avionics by airworthiness authorities. The two wires should carry the output signal and the output signal common. Depending on the shielding concept, the cable shield should be connected either to the accelerometer case ground or to the HUMS computer. Typically, the integral cable length and the connector are determined by the installation requirements.

The accelerometer should have a strain relief where the cable exits the sensor body. The integral cable and strain relief should provide minimum pull strength of 40 pounds (178 N). The accelerometer case-to-cable interface shall be hermetically sealed with a leak rate of less than 1×10^{-8} mbar liter/sec over the temperature range specified in 3.1.2.4.1.

3.1.2.3.5 Accelerometer with Connector

The accelerometer case-to-connector interface shall be hermetically sealed with a leak rate of less than 1×10^{-8} mbar liter/sec over the temperature range specified in 3.2.2.4.1.

Three connector options are specified below.

Option #1

The receptacle on the accelerometer should mate to a D38999/26KA98SN or an EN2997 compatible mating plug. The connector pins to signal assignments are specified in Table 1.

Table 1 - Airframe accelerometer connector pin assignments option #1

Connector Pin	Function
A	signal, power
B	signal common
C	case

Holes shall be provided in the accelerometer that allow the mating electrical connector to be secured in place with lock wire, unless another connector locking method is provided.

Option #2

The receptacle on the accelerometer should mate to a MS3476W8-98S mating plug. The connector pins to signal assignments are specified in Table 2.

Table 2 - Airframe accelerometer connector pin assignments option #2

Connector Pin	Function
A	case
B	signal common
C	signal, power

Option #3

The receptacle on the accelerometer should mate to a PT06CE-8-4S/-4S (SR) mating plug. The connector pins to signal assignments are specified in Table 3.

Table 3 - Airframe accelerometer connector pin assignments option #3

Connector Pin	Function
A	Vibration "Y" axis
B	Vibration "X" axis
C	Vibration "Z" axis
D	signal, common

3.1.2.4 Environmental

3.1.2.4.1 Operating Temperature Range

The operating temperature range for the accelerometer shall be -67 to 250 °F (-55 to 121 °C).

3.1.2.4.2 Shock Limit

The minimum shock that the accelerometer can be exposed to before suffering permanent damage shall be greater than or equal to ± 5000 g peak.

3.1.2.4.3 Base Strain Sensitivity

The output of the accelerometer shall indicate no more than 0.05 equiv g pk/ μ strain as a result of strain on the accelerometers mounting base.

3.2 HUMS Drive Train Accelerometers

3.2.1 Definition

Drive train accelerometers are used to detect impending failures in gear boxes, drive shafts, and bearings. The upper end of the frequency range for these accelerometers, in kHz range, will be significantly higher than for airframe accelerometers. This extended range is required due to the higher rotational speeds of the drive train components being monitored, their higher harmonics, and the nature of the failure modes being detected.

3.2.2 Characteristics

HUMS drive train accelerometers have a low impedance voltage output (i.e., internal conditioning), directly proportional to the acceleration. Measurement of static (0 Hz) acceleration is not required for drive train vibration monitoring. The accelerometer signal return will be isolated, internally, from case ground. Three body styles are recommended for HUMS drive train accelerometers to accommodate the sensor installation requirements for rotorcraft from multiple aircraft manufacturers. The two first body styles are the same as for the airframe accelerometer; the third one features an ARINC standard fixation.



Figure 8 – Examples of ARINC style accelerometer

3.2.2.1 Performance

All performance requirements should be met using mounting hardware, cables and connectors as specified in 3.2.2.3. All performance testing should be performed with cables tied down, as specified in 4.1.

3.2.2.1.1 Sensitivity

The typical sensitivity to acceleration should be within 10...50 mV/g, $\pm 5\%$ when measured at its calibrating frequency of 100 Hz ± 5 Hz or 120 Hz ± 5 Hz.

3.2.2.1.2 Acceleration Range

The typical acceleration range should be ± 500 g.

3.2.2.1.3 Dynamic Response

3.2.2.1.3.1 Amplitude Response

The amplitude response of the sensor should lie in the un-shaded region of the frequency response plot of Figure 9. The y-axis is given in units of percent deviation as defined in Equation 2.

$$\% \text{ Deviation} = \left(\frac{\text{Sensor Output} - \text{Sensor Output@100 or 120Hz}}{\text{Sensor Output@100 or 120Hz}} \right) \cdot 100\% \quad (\text{Eq. 2})$$

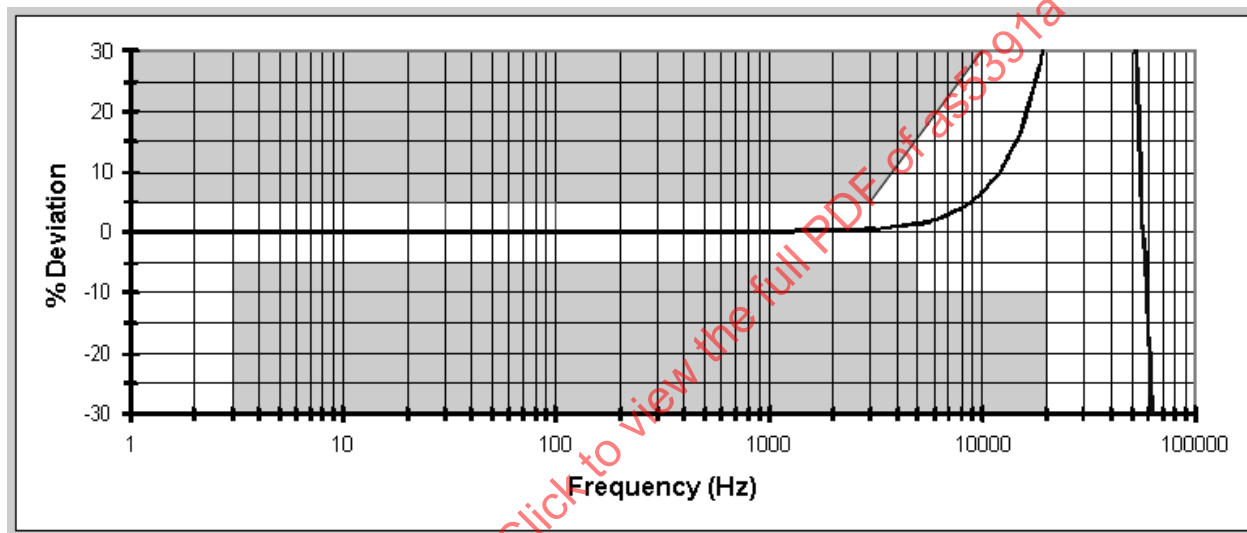


Figure 9 – Allowable drive train accelerometer amplitude response

3.2.2.1.3.2 Relative Phase Response

The phase response of the sensor should lie in the un-shaded region of the phase response plot of Figure 10. The y-axis (phase dispersion), in the figure below, is the phase of the sensor's output relative to a reference accelerometer and normalized to the value at $100 \text{ Hz} \pm 5 \text{ Hz}$ or $120 \text{ Hz} \pm 5 \text{ Hz}$. The phase data is normalized by removing the relative phase (phase difference between the sensor under test and the reference accelerometer) at $100 \text{ Hz} \pm 5 \text{ Hz}$ or $120 \text{ Hz} \pm 5 \text{ Hz}$ from the rest of the test data. As a result, the curve in Figure 10 will always pass through the point of 0° of phase dispersion at $100 \text{ Hz} \pm 5 \text{ Hz}$ or $120 \text{ Hz} \pm 5 \text{ Hz}$.

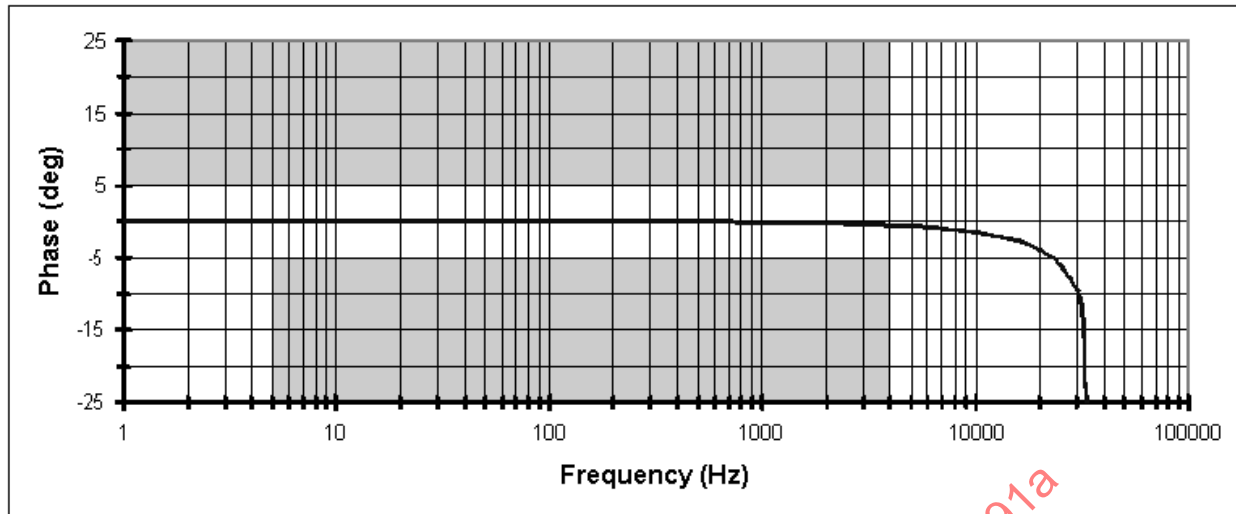


Figure 10 – Allowable drive train accelerometer relative phase response

3.2.2.1.3.3 Absolute Phase Lag

The phase difference between the mechanical excitation of the sensor and the sensor's electrical output shall be 0 degrees $\pm$ 5 degrees when excited with 5 Hz acceleration. This requirement is necessary only when precise phase measurement is needed by the processing algorithms.

3.2.2.1.3.4 Mounted Resonance Frequency

The accelerometer should be mounted so that its mounted dynamic response is not excited by local forcing functions and does not compromise its acceleration measurements within the frequency range of interest. The mounted resonance frequency of the accelerometer, without mating connector, should be greater than 40 kHz.

3.2.2.1.4 Output Polarity

Positive acceleration into the base of the accelerometer shall produce a positive output voltage. Positive acceleration shall be in the direction pointing through the accelerometer's mounting base towards its mounting structural point. Neglecting the DC output bias, positive output voltage shall be defined as when the connector signal or power pin shall have a greater voltage than the signal common pin.

3.2.2.1.5 Transverse Sensitivity

The transverse sensitivity of the accelerometer should be less than or equal to 5% of the sensitivity of the primary axis (given in 3.2.2.1.1).

3.2.2.1.6 Temperature Sensitivity

The sensitivity of the sensor to temperature should vary less than $\pm 8\%$, with respect to the sensitivity at room temperature $24^\circ\text{C} \pm 2^\circ\text{C}$ ($75^\circ\text{F} \pm 4^\circ\text{F}$), over the operating temperature defined in 3.2.2.4.1. If lower temperature sensitivity is required, this can be achieved by a specific sensor adaptation.

3.2.2.2 Electrical

The accelerometer is a two wire device. The two wire interface carries the electrical power to the accelerometer as well as the converted acceleration signal to the interface electronics. The accelerometer accepts electrical power from a constant current regulated DC voltage source.

3.2.2.2.1 Supply Current

The accelerometer shall operate continuously with a DC current supply of 4 to 10 mA from the interface (HUMS computer). The selected DC supply current will directly define the accelerometer maximum measuring frequency for a maximum cable length between sensor and user electronic. (This cable capacitance and the maximum frequency define the level of the supply current.)

3.2.2.2.2 Maximum Supply Voltage

The maximum voltage supplied to the accelerometer shall not exceed 32 V DC, even under transient conditions.

3.2.2.2.3 DC Output Bias Voltage

At room temperature, accelerometer output shall consist of a +7 to +13 V DC bias on which an AC signal, proportional to the acceleration, is superimposed.

3.2.2.2.4 Full Scale Output Voltage.

The accelerometer output shall consist of a ± 5 volt (peak) AC signal that is directly proportional to the vibratory acceleration and is superimposed on a DC bias voltage.

3.2.2.2.5 Electrical Isolation

The accelerometer's output signal common shall be internally isolated ($>10\text{ M}\Omega$ at 50 V DC) from case ground. Alternatively, other accelerometer designs feature a case that is externally isolated from the airframe ground by a standard isolation pad.

3.2.2.2.6 Output Impedance

The output impedance shall be less than $200\ \Omega$ over the acceleration frequency measuring bandwidth specified in 3.2.2.1.3.

3.2.2.2.7 Case Resistance

The electrical resistance between the connector's "case" pin and any point on the accelerometer body shall not exceed $2.5\text{ m}\Omega$ (without integral cable).

3.2.2.3 Physical Characteristic Recommendations

Three following body styles are recommended for HUMS drive train accelerometers to support sensor installation requirements for rotorcraft from multiple aircraft manufacturers.

- a. Through bolt mounted ("Donut" style).
- b. Tapped hole and stud mounted ("spark plug" style).
- c. ARINC style accelerometer body.

3.2.2.3.1 "Donut" Style Accelerometer

This accelerometer body is a center through bolt design. See 3.1.2.3.1

3.2.2.3.1.1 Weight

The weight of the accelerometer, excluding fasteners and integral cable, is typically less than 60 grams.

3.2.2.3.1.2 Size

The size of the accelerometer, excluding mounting hardware, is typically less than 1.2 inches (30.5 mm) wide, 1.2 inches (30.5 mm) deep, and 0.9 inches (22.9 mm) high.

3.2.2.3.1.3 Mounting

The donut accelerometer shall be mounted using a through bolt. Holes shall be provided in the through bolt that allows the through bolt to be lock wired to the airframe, unless another connector locking method is provided.

3.2.2.3.2 "Spark Plug" Style Accelerometer

This accelerometer is a "spark plug" style accelerometer with a tapped hole to accommodate a mounting stud or an integral mounting stud in the bottom for mounting and an electrical connector on the top.

3.2.2.3.2.1 Weight

The weight of the "spark plug" style accelerometer, excluding fasteners, is typically less than 60 grams.

3.2.2.3.2.2 Size

The dimensions of the accelerometer, excluding mounting hardware is typically less than 0.8 inches (20.3 mm) wide, 0.8 inches (20.3 mm) deep, and 1.65 inches (41.9 mm) high.

3.2.2.3.2.3 Mounting

The "spark plug" style accelerometer should allow for a 1/4-28 stud mounting to a test article. The thread length shall be at least 0.22 inches (5.6 mm) and have a sufficient lead in chamfer on the end of the thread to prevent cross threading during installation. The female thread on the test article must be of sufficient depth to assure the mounting stud on the accelerometer does not bottom out. Holes shall be provided in the "spark plug" style accelerometer that allows the accelerometer to be secured in place with lock wire, unless another connector locking method is provided.

3.2.2.3.3 ARINC Style Accelerometer

This accelerometer has a base plate with 3 holes for fixation, as shown in Figure 8.

3.2.2.3.3.1 Weight

The weight of the accelerometer, excluding fasteners and integral cable, is typically less than 100 grams.

3.2.2.3.3.2 Size

The size of the accelerometer, including base plate, is typically 1.496 inches (38 mm diameter and 1.3 inches (33.02 mm) high.

3.2.2.3.3.3 Mounting

According to ARINC 554, the accelerometer should have 3 mounting holes, diameter 0.180 inches (4.57 mm), located on a circle diameter 1.188 inches (30.175 mm). Holes shall be provided in the accelerometer that allows the accelerometer to be secured in place with lockwire, unless another connector locking method is provided.

3.2.2.3.4 Accelerometer Case Sealing

The accelerometer case shall be hermetically sealed with a leak rate of less than 1×10^{-8} mbar liter/sec over the temperature range specified in 3.1.2.4.1.

3.2.2.3.5 Accelerometer with Integral Cable

The accelerometer can have a side exiting integral cable. This cable should consist of a twisted shielded pair of 22 gauge wires with low capacitance (<150 pF/m). The two wires should carry the output signal and the output signal common. Depending on the shielding concept, the cable shield should be connected either to the accelerometer case ground or to the HUMS computer. Typically, the integral cable length and the connector are determined by the installation requirements.

The accelerometer should have a strain relief where the cable exits the sensor body. The integral cable and strain relief should provide minimum pull strength of 40 pounds (178 N). The accelerometer case-to-cable interface shall be hermetically sealed with a leak rate of less than 1×10^{-8} mbar liter/sec over the temperature range specified in 3.1.2.4.1.

3.2.2.3.5.1 Accelerometer with Connector

The accelerometer case-to-connector interface shall be hermetically sealed with a leak rate of less than 1×10^{-8} mbar liter/sec over the temperature range specified in 3.2.2.4.1.

Two connector options are specified below.

Option #1

The receptacle on the accelerometer should mate to a D38999/26KA98SN or an EN2997 compatible mating plug. The connector pins to signal assignments are specified in Table 4.

Table 4 - Drive train accelerometer connector pin assignments option #1

Connector Pin	Function
A	signal, power
B	signal common
C	case

Holes shall be provided in the accelerometer that allows the mating electrical connector to be secured in place with lockwire, unless another connector locking method is provided.

Option #2

The receptacle on the accelerometer should mate to a MS3476W8-98S mating plug. The connector pins to signal assignments are specified in Table 5.

Table 5 - Drive train accelerometer connector pin assignments option #2

Connector Pin	Function
A	case
B	signal common
C	signal, power

3.2.2.4 Environmental

3.2.2.4.1 Operating Temperature Range

The operating temperature range for the accelerometer shall be -67 to 250 °F (-55 to 121 °C).

3.2.2.4.2 Shock Limit

The minimum shock that the accelerometer can be exposed to before suffering permanent damage shall be greater than or equal to ± 5000 g peak.

3.2.2.4.3 Base Strain Sensitivity

The output of the accelerometer shall indicate no more than 0.05 equiv g pk/ μ strain as a result of strain on the accelerometers mounting base.

3.3 HUMS Engine Accelerometers

3.3.1 Definition

Accelerometers used to monitor engine vibrations can be split into two categories, Cold Section and Hot Section. The Drive Train accelerometers discussed in the previous section are appropriate for Cold Section environments on the engine (such as engine gearboxes), in which the temperature environment does not exceed 250 °F (121 °C). This limitation applies because of the internal conditioning electronics embedded in the sensor.

Hot Section environments, which exceed this temperature limitation, call for accelerometers that can withstand higher temperatures, forcing the conditioning electronics to be located outside the accelerometer. Measurement of acceleration in high temperature environments is accomplished using charge mode accelerometers with in-line/remote charge converters (Figure 11) or with remote charge converters directly integrated in the HUMS computer. More information is given in ARP1839.

In order to reduce the weight and the noise signal due to the sensor low noise cable, the remote charge converter shall be as near as possible to the sensing element.

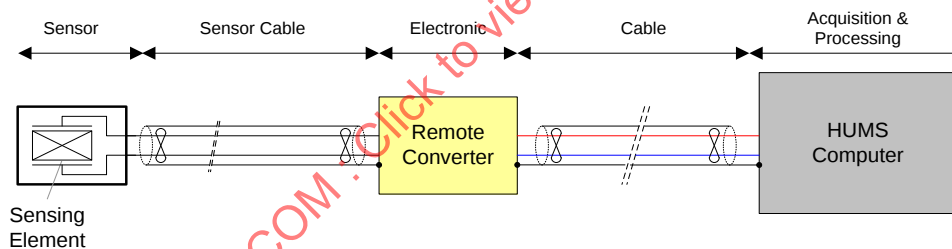


Figure 11 – Hot section engine accelerometer

Since the goal of this specification is the standardization of the accelerometer-to-HUMS computer interface, requirements given in this section of the document apply to Hot Section environments with the accelerometer/charge converter combination. There exists a large variation in temperature requirements for Hot Section accelerometers. The temperature requirement, along with other sensor characteristics not specified by this document, will be specified by the user prior to sensor procurement.

3.3.2 Characteristics

The sensor assembly may include a high impedance accelerometer with an external charge amplifier or a charge amplifier in the HUMS computer. The output of the sensor assembly is low impedance voltage, directly proportional to the acceleration. This specification will focus on the interface between the sensor assembly and the HUMS computer. Measurement of static (0 Hz) acceleration is not required for the engine accelerometer sensor assembly.

3.3.2.1 Performance