



AEROSPACE STANDARD

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Superseding AS5393

Health and Usage Monitoring System,
Blade Tracker Interface Specification

RATIONALE

The HM-1 Committee has agreed to stabilize this document due to a lack of industry standardization for the blade tracker interface. However, the document contains useful technical information and therefore should not be cancelled.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE HM-1 Integrated Vehicle Health Management Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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1. SCOPE:

Blade trackers measure: (a) rotor blade height and (b) lead-lag for use in a Rotor Track and Balance (RT&B) function in a Health and Usage Monitoring System (HUMS). HUMS is a generic term for a system used to measure, monitor, process, and store information relating to the functioning and usage of an aircraft's on-board primary systems, including the engine(s).

1.1 Classifications:

This specification establishes the interface requirements for blade trackers for use in a helicopter Health and Usage Monitoring System. The main purpose of this document is to standardize the electrical and data interfaces between the blade tracker and the aircraft. We expect that a successful standardization effort will reduce the cost of HUMS blade trackers, reduce HUMS sensor inventories and increase interchangeability among HUMS sensors and systems. This blade tracker utilizes the SAE AS5394 - HUMS Advanced Multipoint Interface Specification. Sensor characteristics have been specified where they are fixed or limited by the sensing application. The blade tracker may have up to four electrical interfaces with the aircraft: electrical power, rotational system indexing sensor (SAE AS5392), accelerometer (SAE AS5391) (optional), and HUMS processor as illustrated in Figure 1.

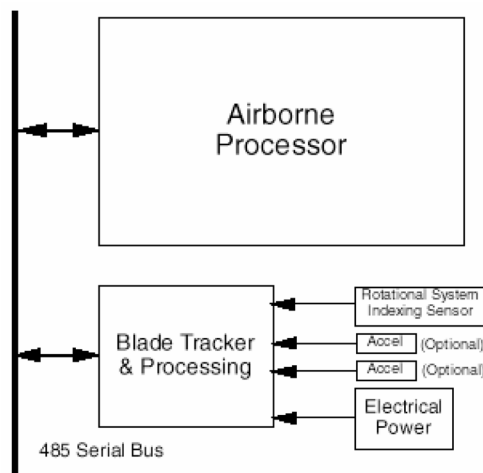


FIGURE 1 - Blade Tracker Electrical Interfaces

1.2 Specification Terminology:

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

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

2. 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 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS5391	Health and Usage Monitoring System Accelerometer Interface Specification
AS5392	Health and Usage Monitoring System Rotational System Indexing Sensor Interface Specification
AS5394	Health and Usage Monitoring System Advanced Multipoint Interface Specification

3. DEFINITIONS:

ACCELERATION - The time rate of change of velocity – usually expressed in ft/s/s, m/s/s, or G's in gravity units (g).

ACCELEROMETER - A sensor with an output that varies directly proportionally to the acceleration aspect of motion.

“g” - Standard unit of acceleration equal to one earth” gravity at mean sea level – one “g” equals 32.17 ft/s² or 9.807 m/s².

SENSOR - A measurement device that transforms one form of energy into another. Also referred to as transducer or pick up

4. POWER/BLADE TRACKER INTERFACE:

The blade tracker shall use 28 V DC power, 30 watts, maximum. The blade tracker shall be designed to work under the power quality specification used for the particular aircraft for which it is installed.

5. INDEXING SENSOR/BLADE TRACKER INTERFACE:

In order to match blade track and lag to a specific blade, the blade tracker needs input from an indexing sensor. The blade tracker shall accept an indexing sensor signal from a “self powered indexing sensor” as specified in the “SAE AS5392 - HUMS Rotational System Indexing Sensor Interface Specification.”

6. HUMS PROCESSOR/BLADE TRACKER INTERFACE:

This interface shall meet the requirements of the "SAE AS5394 - HUMS Advanced Multipoint Interface Specification." The HUMS processor and blade tracker will have a Master/Sub Master relationship as defined in the aforementioned specification, so as to allow the blade tracker to possibly control other digital sensors in the future. All the blade tracker commands shall be sent in the standard message format as specified in the multipoint interface specification. Only the data part of the message will be specified in this document. The remainder of the message shall conform to the standard message format specified in the "SAE AS5394 - HUMS Advanced Multipoint Interface Specification." The blade tracker shall always respond to the "Send Rotor Track Data" command. All other commands, defined in the table below, are optional:

TABLE 1 - Blade Tracker Command Set

Command	Command Description
16	Send Rotor Track Data
17	Send Rotor Balance Data
18	Send Average Rotor Track Data
19	Send Average Rotor Balance Data
20	Send Average Rotor Track With Statistics
21	Send Average Rotor Balance With Statistics
22	Send All Track Data
23	Send All Balance Data
24	Set Auto Lighting Mode
25	Force active Mode
26	Force passive Mode
27	Clean Lens
28	Number of Blades
29	Number of Revolution s to Acquire
30	Reference Angle
31	Rotor Diameter
32	Mean Blade Chord
33	Blade Radius
34	Tracker "r" Position
35	Tracker "θ" Position
36	Tracker "z" Position
37	Tracker Pointing Angle
38	Number of Harmonics
39	Minimum Rotor Speed
40	Maximum Rotor Speed
41	Minimum Coning Angle
42	Maximum Coning Angle

6.1 Send Rotor Track Data:

The "Send Rotor Track Data" command is used to communicate per revolution blade track data.

6.1.1 Command Message: The command message will have the following data blocks:

Data Block #	Signal	Type	Units
1	Number of Revolutions	Integer	Revolutions

FIGURE 2

6.1.1.1 Number of Revolutions: This will contain the number of revolutions over which the command shall be performed. Valid values for the "Number of Revolutions" block are 0 to 255. If "Number of Revolutions" equals "0", the default number of revolutions specified in the "Number of Revolutions To Acquire" command will be used.

6.1.2 Response: The blade tracker shall respond to the "Send Rotor Track Data" command with the following data blocks:

Data Block #	Signal	Type	Units
1	Initiating Command	Integer	N/A
2	Revolution Being Returned	Integer	Revolutions
3	Total Revolutions	Integer	Revolutions
4	Number of Blades	Integer	Blades
5	Average Absolute Track	Float	Millimeters
6	Relative Track Blade 1	Float	Millimeters
•	•	•	•
•	•	•	•
N+5	Relative Track Blade N	Float	Millimeters
N+6	Average Absolute Lag	Float	Millimeters
N+7	Relative Lag Blade 1	Float	Millimeters
•	•	•	•
•	•	•	•
2N+6	Relative Lag Blade N	Float	Millimeters

N = number of rotor blades

FIGURE 3

- 6.1.2.1 **Initiating Command:** This is an echo of the command number sent to the blade tracker and will be used by the interface electronics to insure that the return message is properly interpreted.
- 6.1.2.2 **Revolution Being Returned:** This is the revolution number during which the data in this message was collected. This signal can have any value between 1 and the value of the "Total Revolutions" block. Zero is not a valid value for the "Revolution Being Returned" block in response to the "Send Rotor Track Data" command. The "Revolution Being Returned" block is equal to the "Total Revolutions" block when the final message is being sent.
- 6.1.2.3 **Total Revolutions:** This block reports the total number of revolutions for which data will be collected. Valid values for the "Total Revolutions" block are 1 to 255.
- 6.1.2.4 **Number of Blades:** The number of blades on the particular rotor shaft is included in this message so that the structure of the return message can be properly interpreted. Valid values for the "Number of Blades" block are 1 to 255.
- 6.1.2.5 **Average Absolute Track:** The average absolute track is defined in 9.1.1.
- 6.1.2.6 **Relative Track:** Relative track is defined in 9.1.1.
- 6.1.2.7 **Average Absolute Lag:** Average absolute lag is defined in 9.1.2. Average absolute lag is given in millimeters and referenced to the blade tip.
- 6.1.2.8 **Relative Lag:** Relative lag is defined in 9.1.2.

6.2 Send Rotor Balance Data:

The Send Rotor Balance Data command is used to communicate per revolution balance data.

- 6.2.1 **Command Message:** The command message will have the following data blocks:

Data Block #	Signal	Type	Units
1	Number of Revolutions	Integer	Revolutions

FIGURE 4

- 6.2.1.1 **Number of Revolutions:** This will contain the number of revolutions over which the command shall be performed. Valid values for the "Number of Revolutions" block is 0 to 255. If "Number of Revolutions" equals "0", the default number of revolutions specified in the "Number of Revolutions To Acquire" command will be used.

6.2.2 Response: The blade tracker shall respond to the "Send Rotor Balance Data" with the following data blocks:

Data Block #	Signal	Type	Units
1	Initiating Command	Integer	N/A
2	Revolution Being Returned	Integer	Revolutions
3	Total Revolutions	Integer	Revolutions
4	Accelerometers	Integer	Accelerometers
5	Accelerometer ID/Address	Integer	N/A
6	Accel Amplitude 1 per Rev	Float	g's
•	•	•	•
•	•	•	•
n+5	Accel Amplitude n per Rev	Float	g's
n+6	Accel Phase 1 per Rev	Float	Degrees
•	•	•	•
•	•	•	•
2n+5	Accel Phase n per Rev	Float	Degrees

n = number of harmonics be collected

FIGURE 5

- 6.2.2.1 Initiating Command: This is an echo of the command number sent to the blade tracker and will be used by the interface electronics to insure that the return message is properly interpreted.
- 6.2.2.2 Revolution Being Returned: This is the revolution number during which the data in this message was collected. This signal can have any value between 1 and the value of the "Total Revolutions" Block. Zero is not a valid value for the "Revolution Being Returned" Block in response to the "Send Rotor Track Data" command. The "Revolution Being Returned" Block is equal to the "Total Revolutions" Block when the final message is being sent.
- 6.2.2.3 Total Revolutions: This block reports the total number of revolutions for which data will be collected. Valid values for the "Total Revolutions" block are 1 to 255.
- 6.2.2.4 Accelerometers: The number of Accelerometers being monitored.
- 6.2.2.5 Accelerometer ID/Address: The accelerometer identification number or address (in the case of digital accelerometers) for the accelerometer being monitored.