NOTICE

U.S. Department of Transportation
Federal Aviation Administration

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SUBJ: POLICY AND GUIDANCE FOR THE CERTIFICATION AND CONTINUED AIRWORTHINESS OF DIGITAL FLIGHT DATA RECORDERS SYSTEMS

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1. **PURPOSE.** This notice provides guidance material relevant to digital flight data recorder systems (DFDRS). The DFDRS are used for both inspection/maintenance and accident/incident investigations. To facilitate the use of these systems for the purpose outlined above, DFDRS shall contain a standard data format that is documented at the time of certification and maintained by the operator as a permanent part of the aircraft record. This notice provides a standard data definition for all DFDRS.

2. **DISTRIBUTION.** This notice is distributed to Washington headquarters branch level of the Aircraft Certification Service and Flight Standards Service, to branch level of the regional aircraft certification directorates and regional Flight Standards Division; to all aircraft certification field offices and to the Brussels Aircraft Certification Division.

3. **RELATED FAR SECTIONS.** Title 14 CFR part 43, FAR § 91.609, FAR § 121.343, FAR § 125.225, FAR § 135.152, FAR § 25.1459(c), FAR § 23.1459(c), and FAR § 27.1459(c).

4. **RELATED PUBLICATIONS.**

a. Aeronautical Radio Incorporated (ARINC) Characteristic 573, "Aircraft Integrated Data Systems."

b. ARINC, Characteristic 717, "Flight Data Acquisition and Recording System."

c. ARINC, Characteristic 747, "Flight Data Recorder."

d. ARINC, Characteristic 429, "Digital Information Transfer System."

5. **BACKGROUND.** A DFDRS records values for parameters related to the operation of an aircraft (for example, ALTITUDE, AIRSPEED, and HEADING). These values are recorded in a serial binary digital data stream that must be converted either to engineering units or to discrete states. The arrangement of the recorded values in the data stream (the configuration) often varies from one DFDRS to another; consequently, accurate conversion of the recorded values to their corresponding engineering units or discrete states can be accomplished only when the configuration of the data stream has been thoroughly documented.

Distribution: A-W(IR)-3, A-X(CD)-4, A-FFS-1,2,7(LTD); A-FAC-O(MAX)

Initiated By: AIR-100

a. The number of DFDRS currently installed in aircraft and the lack of a DFDRS standard data definition has resulted in numerous configurations. It is inefficient and impractical for any one agency to maintain current files for all these configurations. For example, in the event of an accident/incident, the National Transportation Safety Board (NTSB) must rely on the documented data formats maintained by the operator to extract the recorded data. Unfortunately, many operators do not maintain the necessary documentation in sufficient detail to provide timely NTSB support.

b. This notice defines the required documentation with sufficient specificity to enable timely data recovery and analysis in the event of an accident/incident by providing standardization across all DFDRS.

6. **DEFINITIONS** This section provides standardized definitions for every element of the DFDRS needed to recover and evaluate the recorded values for a given make and model aircraft.

a. **Parameter Name:** The name of the function being recorded. The parameter name shall not exceed 24 characters. Mnemonic codes may be used in lieu of parameter name.

b. **Mnemonic code:** Recommended abbreviation of parameter name. It shall be used in formats when the parameter name may be too large. It shall not exceed eight characters. Appendix 1, Mnemonic codes, contains a partial list of acceptable mnemonic codes.

c. **Subframe Number:** As defined in ARINC Characteristic 573/717, Section 5.3.1.1, Frame Structure, applicable subframes shall be noted as follows: 1, 3 for subframes 1 and 3, or “All” when all four are used. Use N/A if other than ARINC.

d. **Superframe Cycle:** A subdivision of a given subframe/word slot address, typically 16 additional addresses. A counter provides the cycle number reference. The cycle number counter must be documented as a parameter.

e. **Word Slot:** Defines the location of a 12-bit data word within a 32, 64, or 128 word per second serial data stream (subframe), with one of four unique 12-bit Barker Code, in the first word slot. Other data stream formats will require additional documentation.

f. **Digital Information Transfer System (DITS) Label:** As defined in ARINC Characteristic 429, Section 2.1.3, the octal value (0-377) that identifies type of data (e.g., DME, Static Air, etc.).

g. **Transport Delays:** Acquisition channel delays which are defined as the time between the input sampling and the output for recording.

h. **DITS Bit (Number):** As defined in ARINC Characteristic 429 Section 2.3.1.4, the standard DITS format is a 32-bit Binary Coded Decimal (BCD) word, with bits (9-29) assigned as the data bits. The remaining bits contain labeling, parity, source/destination codes, and sign/status information. Documentation shall indicate all DITS data bits (11-29), and the bits assigned to the DFDRS (1-12).

i. **DITS Coding:** Type of data: Binary, BCD, Discrete, etc.

j. **DFDRS Bits:** Defines specific bits within a DFDRS word that are dedicated to a given parameter (An example would be 3-12 indicating bits 3 through 12).

k. **Range:** The full range of parameter (minimum and maximum) expressed in engineering units (E.U.). Discrete parameters shall be entered as N/A.

l. **Signal Type:** As defined in ARINC 573/717 Sections 4.2 through 4.4.

m. **Sign Convention:** Aircraft attitude - (+ANU, +RWD). Flight Control Surfaces - (+TEU). Acceleration values as referenced in ARINC 573/717, Section 7.1. Glide Slope/Localizer Deviation - (fly-up/down and fly-left/right, respectively). Other signed parameters must be clearly defined in footnotes.

n. **Parameter Accuracy:** As defined in ARINC 573/717, Section 4.1.1., parameter accuracy shall include sensor and Flight Data Acquisition Unit(FDAU) tolerances.

o. **Parameter Resolution:** As defined in ARINC 573/717, Section 4.1.2.

p. **Signal Source:** Aircraft subsystem, dedicated transducer, or signal conditioners installed primarily as the flight data acquisition and recording system signal source.

q. **Coefficient of Determination (also called Correlation Coefficient):** It shall lie between 0 and 1 and indicate how closely the equation fits the measured data: the closer to 1 the better the fit.

7. **ENGINEERING UNIT/DISCRETE CONVERSION**

a. Engineering Unit (E.U.) Conversion.

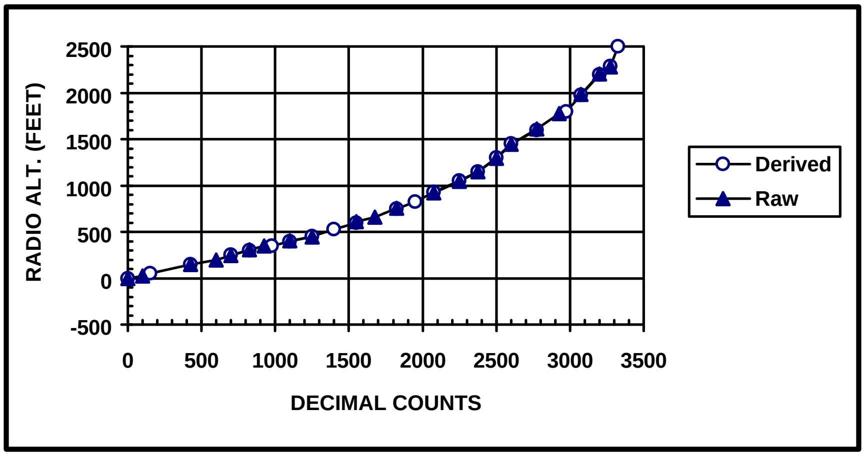
(1) Linear parameters: $E.U. = A_0 + A_1 * CNTS_{10}$ where A_0 and A_1 = Coefficients listed as part of the documentation.

(2) Polynomial Equation: $E.U. = A_0 + A_1 * CNTS_{10} + A_2 * CNTS_{10}^2 + A_3 \ldots$ where A_0, A_1, A_2 .....= Coefficients listed as part of the documentation.

(3) Unique Equation: When unique equations are needed, explicit documentation must be provided at the time of certification, and presented as an attachment to the documentation package.

b. Engineering Unit Conversion Validation: A coefficient of determination of 0.9 or more is the minimum acceptable level of correlation between the raw and derived values. In addition, a plot of engineering units versus decimal counts shall be provided to further validate the ability of the derived coefficients or unique equation to fit the raw values. The plot shall cover the full operating range of the parameter (See example in figure 1).

FIGURE 1. AN EXAMPLE PLOT OF THE RADIO ALTIMETER IN FEET VERSUS DECIMAL COUNTS



c. Tabular Data Listings: When the data set cannot be defined by any of the previously mentioned methods, it may be necessary to present the data in a tabular format. The table shall display the Engineering Unit and corresponding decimal counts. The tabular data set must have a sufficient number of data points that accurately define the parameter's full range of operation. A plot of the E.U. versus decimal counts shall also be provided to validate that a sufficient number of data points have been provided (See example in figure 2). See table 1 for an example.

TABLE 1. AN EXAMPLE TABULAR DATA LISTING OF ENGINEERING UNITS AND DECIMAL COUNTS

ENGINEERING UNITS (E.U.)	DECIMAL COUNTS ($CNTS_{10}$)
0.0	0
-10.0	61
-16.0	100
-23.0	154
23.0	874
16.0	924
10.0	963
0.0	1023

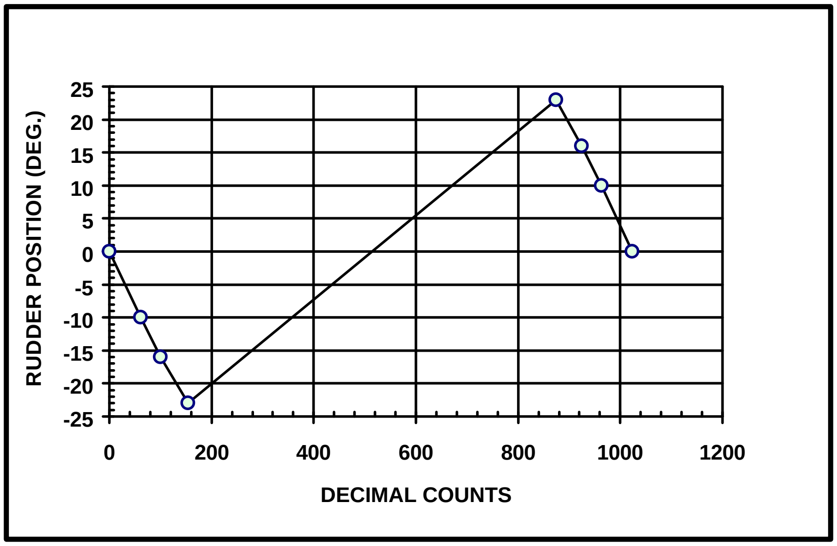


Figure 2. Plot of the engineering units versus decimal counts for the data contained in Table 1

d. Discrete Decipher Logic: The documentation of discrete parameters must denote the status represented by each state "0" or "1" (e.g., "1" = on, "0" = off). However, when discrete values are encoded as a group, a given discrete state can have multiple statuses. Therefore, the documentation of grouped discretes require an expanded format. The following example matrix of grouped discrete codes versus discrete states is recommended (See example in table 2):

DISCRETE STATUS	**DISCRETE CODES** **7 6 5 4 3 2 1**
A/P MODE THROTTLE "OFF"	1 1 0 0 0 0 0
A/P MODE THROTTLE "RETARD"	1 1 0 0 0 0 1
A/P MODE THROTTLE "CLAMP"	1 1 0 0 0 1 0
A/P MODE THROTTLE "SPD/MCH,ALPHA"	1 1 0 0 0 1 1
A/P MODE THROTTLE "SPD/MCH,FLAP"	1 1 0 0 1 0 0
A/P MODE THROTTLE "SPD/MCH,SLAT"	1 1 0 0 1 0 1
A/P MODE THROTTLE "SPEED"	1 1 0 0 1 1 0
A/P MODE THROTTLE "EPR LIMIT"	1 1 0 0 1 1 1
A/P MODE THROTTLE "SPD/EPR LIMIT"	1 1 0 1 0 0 0

Table 2. Example matrix of grouped discrete codes versus discrete states

The word slot, subframe, and bit location for the specific discrete codes will be identified in the documentation package. The discrete status matrix shall be provided as an attachment to the documentation package.

8. AIRCRAFT SPECIFIC DOCUMENTATION. The documentation criteria defined in this section represents the minimum information needed by a playback facility to insure a complete and accurate data recovery for a given aircraft. A sample documentation package is provided in appendix 2. It is not intended that the full documentation package be maintained for each aircraft of a given make and model. However, at least one full documentation package of the level defined in this section and sections 4 and 5 shall be maintained by the operator. As a minimum, the following information shall be included in the aircraft specific documentation package:

a. Lexicon and Mnemonic Codes

b. Aircraft Identification

(1) Make and Model

(2) Registration Number

c. Flight Recorder System Identification

(1) Flight Recorder Make and Model/Part Number

(2) Flight Data Acquisition Unit Make and Model/Part Number

(3) DFDRS Documentation Reference

d. Information to be listed per Parameter

(1) Parameter Name

(2) Parameter Mnemonic Code

(3) Source

(4) Parameter word location

(5) Subframe

(6) Superframe Cycle

(7) Assigned Bits (1 through 12)

(8) Range (in engineering units when applicable)

(9) Sign Convention

(10) Engineering Unit Conversion (as defined in section 7b of this notice)

(11) Discrete Parameters (status as defined in section 7d of this notice)

The E.U. and Discrete parameter documentation, as defined in Section 5, must be included as an attachment to the package when necessary.

9. FLIGHT DATA RECORDER DOCUMENTATION STANDARD ELECTRONIC DATABASE. This section defines a standardized electronic database for the documentation of flight data recorder system characteristics.

a. The electronic database will be an ASCII file with variable length elements. The header information will be listed first with each element separated by a carriage return. The header element will be separated from the subsequent parameter elements by a semicolon and a carriage return which will terminate the header file.

b. Each parameter record will contain 18 elements and a 264 character comment field. The elements will be separated by a carriage return. An N/A entry will be given for those elements that are not applicable for a given parameter.

c. The comment portion will be used to list the tabular data or any reference documents needed in the engineering unit conversion or discrete deciphering. When listing a tabular data set, decimal counts will be given first followed by the corresponding engineering unit, each separated by a comma.

d. The configuration file will contain the following information in the order presented:

(1) Aircraft Make and Model

(2) Aircraft Registration Number

(3) DFDR Make and Model/Part Number

(4) FDAU Make and Model/Part Number

(5) Parameter Name

(6) Mnemonic Code

(7) Word Location

(8) Subframe

(9) Superframe Cycle Number

(10) Bits

(11) Units

(12) Range

(13) Sign Convention

(14) Type Sensor

(15) Signal Source

(16) Resolution

(17) A_0

(18) A_1

(19) A_2

(20) A_3

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APPENDIX 1. MNEMONIC CODES

CODE	PARAMETER
AOA	Angle of Attack
CAS	Computed Airspeed
ANU	Aircraft Nose Up
TEU	Trailing Edge Up
SPD	Speed
A/P	Autopilot
EPR	Engine Pressure Ratio
THRTL	Throttle
MCH	Mach

APPENDIX 2

FLIGHT DATA RECORDER PARAMETER AND DATA CONVERSION DOCUMENTATION

		FLIGHT DATA RECORDER PARAMETER AND DATA CONVERSION DOCUMENTATION									
AIRCRAFT		FLIGHT DATA RECORDER					FLIGHT DATA ACQUISITION UNIT				
MAKE AND MODEL :		MAKE AND MODEL :					MAKE AND MODEL :				
REGISTRATION :		PART NUMBER :					PART NUMBER :				
PARAMETER NAME	**WORD SLOTS**	**S/F**	**BITS**	**SFCY#**	**UNITS**	**RANGE**	**SIGN**	**A0**	**A1**	**A2**	**A3**
ALTITUDE FINE	5	ALL	1-12	N/A	FEET	0-4096	+ > MSL	SEE ATTACHS, 2 & 3			
ALTITUDE COURSE	23	1	1-7	N/A	FEET	-1000 50,000	+ > MSL	SEE ATTACHS, 2 & 3			
AIRSPEED	19	ALL	1-12	N/A	KNOTS	0-450	N/A	0.0	0.25	0.0	0.0
HEADING	3	ALL	3-12	N/A	DEG.	0-360	N/A	SEE ATTACH, 5			
VERTICAL ACCELERATION	2,10,19,26,34,42,50,58	ALL	1-12	N/A	"G"	-3 TO 6	+ UP	-4.3968	0.00229	0.0	0.0
A/P MODE CODE 1	11	ALL	2	N/A	N/A	N/A	N/A	SEE ATTACH DISCRETE MATRIX			
A/P MODE CODE 2	13	ALL	2	N/A	N/A	N/A	N/A				
A/P MODE CODE 3	59	ALL	1	N/A	N/A	N/A	N/A				
A/P MODE CODE 4	27	ALL	1	N/A	N/A	N/A	N/A				
A/P MODE CODE 5	27	ALL	2	N/A	N/A	N/A	N/A				
A/P MODE CODE 6	28	ALL	1	N/A	N/A	N/A	N/A				
SUPER FRAME COUNTER	61	3	9-12	N/A	CNTS10	N/A	N/A	0.0	1.0	0.0	0.0
N1 IMBAL. ENG.1	61	4	1-8	N/A	"G"	N/A	N/A	0.0	0.00229	0.0	0.0
N1 IMBAL. ENG.2	61	4	1-8	8	"G"	N/A	N/A	0.0	0.00229	0.0	0.0
RADIO ALT. COARSE	44	ALL	1-12	9	FEET	-20 TO 2,500	+AGL	-38.411	0.54951	-0.00022	8.96E-08
A/P IN USE	59	ALL	2	N/A	N/A	N/A	N/A	1=A/P#1 0=A/P#2			

1 ENGINEERING UNIT CONVERSION EQUATION (POLYNOMIAL):
$E.U. = A_0 + A_1{*}CNTS_{10} + A_2{*}CNTS_{10}^2 + A_3{*}CNTS_{10}^3$