

Telemetry Definition and Processing (TDAP): Standardizing Instrumentation and EU Conversion Descriptions

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ABSTRACT

Telemetry format descriptions and engineering unit conversion calibrations are generated in an assortment of formats and numbering systems on various media. Usually this information comes to the central telemetry receiving/processing system from multiple sources, fragmented and disjointed. As present day flight tests require more and more telemetry parameters to be instrumented and processed, standardization and automation for handling this ever increasing amount of information becomes more and more critical. In response to this need, the Telemetry Definition and Processing (TDAP) system has been developed by the Air Force Development Test Center (AFDTC) Eglin AFB, Florida.

TDAP standardizes the format of information required to convert PCM data and MIL-STD-1553 Bus data into engineering units. This includes both the format of the data files and the software necessary to display, output, and extract subsets of data. These standardized files are electronically available for TDAP users to review/update and are then used to automatically set up telemetry acquisition systems. This paper describes how TDAP is used to standardize the development and operational test community's telemetry data reduction process, both real-time and post-test.

KEY WORDS

Telemetry data conversion, Data Acquisition Stream (DAS), TDAP, Master Format File (MFF)

INTRODUCTION

The Telemetry Definition and Processing (TDAP) system is a concept to standardize the format of information required to convert raw telemetry data into engineering units. This includes both the format of the data files and the software necessary to create, edit, and extract sub-sets of data. This concept also includes procedures that will reduce the response time needed to support new projects requiring Pulse Code Modulation (PCM) and MIL-STD-1553 Bus data processing, enhance quality control, reduce data turnaround time and eliminate duplication of effort through the centralization of responsibility.

The TDAP software is structured for two groups of users referred to as “user” and “team.” The “user” group has display and output privileges, whereas the “team” has full privileges to create and edit files as well as display and output privileges. The “team” are those personnel who have been assigned the task of implementing and maintaining TDAP files and software. All data files are character-based ASCII files.

TDAP FILE STRUCTURE

The TDAP files consist of two general types, “standard” files and “auxiliary” files. The standard files are those for a particular Data Acquisition Stream (DAS) load and contain the PCM word locations with all the super-com occurrences. The standard TDAP files also include DAS loads for “Total Bus Monitor,” which are MIL-STD-1553 bus messages that do not contain PCM word number or super-com information (i.e., parameter names with supercom suffix, number of occurrences, or the delta interval).

The auxiliary files contain supplemental data such as non-linear calibrations, conditional word processing information, general comments, etc. The auxiliary files do not have the same format as the “standard” files but rather use a “free-form” text format. The auxiliary file data will follow the Telemetry Attributes Transfer Standards (TMATS) guidelines as to format [1].

STANDARD FILE CONTENT DEFINITION

The standard TDAP file is composed of the fields, or attributes, necessary to convert the raw telemetry parameters within a PCM or MIL-STD-1553 stream into engineering units (EUs). The file contains those attributes that are common to all users (i.e., parameter name, units, bits used, scaling, word type, and parameter description). Additional attributes are included for use that are dependent on the DAS system (i.e., PCM word number, sub-system, message ID, word number in message, minor frame number, word number in minor frame, and non-linear conversion flag). All attributes will not be applicable for a particular parameter; for instance, PCM word would not be applicable for Total Bus

Monitor data, neither would Message ID and Word Number in Message be applicable to non-Bus data. The attributes and format of the TDAP file are listed in Table 1 and are described in [2].

Word	Description	Format	Character
1	Parameter Name	String	1-10
2	Units	String	11-18
3	PCM Word Number	Integer	19-22
4	MSB	Integer	23-24
5	LSB	Integer	25-26
6	LSB Weight (Gain)	Double	27-41
7	Offset	Double	42-56
8	Word Type	Integer	57-58
9	Print Format	String	59-66
10	Sub-System	String	67-74
11	Parameter Description	String	75-114
12	Data Classification Code	String	115
13	Lower Limit	Double	116-123
14	Upper Limit	Double	124-131
15	Minor Frame Number	Integer	132-134
16	Minor Frame Word Number	Integer	135-138
17	Command/Select Word	String	139-142
18	Word Number in Message	Integer	143-144
19	Non-Linear Conversion Flag	Integer	145
20	Calibration Date (DDMMYY)	Date	146-151
21	Bus ID	String	152-153
22	Calibration Classification	String	154
23	Update Rate	String	155-158
24	Multiple Word Code (MWC)	Integer	159-160
25	Parameter 1	String	161-170
26	Parameter 2	String	171-180
27	Parameter 3	String	181-190
28	Parameter 4	String	191-200
29	Number of Occurrences (Super-Com)	Integer	201-203
30	Delta Interval (Super-Com)	Integer	204-207
31	Command Word 2	String	208-211
32	Spare	String	212-225

Table 1 - TDAP File Structure

There is no standard convention used for deciding on the bit break-out for discrete words or words containing multiple parameters—it is greatly dependent on the project requirements. There are, however, some general guidelines. Past experience indicates certain break-outs, discrete words, and multiple parameter words are converted into hexadecimal or octal using all bits. It is usually preferable to do discrete break-outs in follow-on software or when using a subset of the total data.

Each word of a double-precision parameter is included in the file. The most significant and least significant part is indicated in the parameter description field. For floating point

parameters, each part (mantissa and exponent) may be broken-out as a separate parameter. If the floating point word is in IEEE, DEC, IBM, or 1750A format, then each word (MSP and LSP) may be coded as such, if desired. The multiple word code (MWC) and parameter names 1 - 4 may be used in converting these data to engineering units if desirable (see Table 2).

Word Type	NLC	Multi-Word Code	Par 1	Par 2	Par 3	Par 4	Remarks
*	8	11					Special Processing code for 16-bit 1553 data split across two 10 or 12-bit PCM words.
*	8	21	P1	P2			$P1 + P2$
*	8	22	P1	P2			$P1 * 2^{**}P2$
Binary	8	23	P1	P2			Process as IEEE 32-bit Floating Point
Binary	8	24	P1	P2			Process as 1750A 32-bit Floating Point
Binary	8	25	P1	P2			Process as DEC 32-bit Floating Point
Binary	8	26	P1	P2			Process as IBM 32-bit Floating Point
*	8	31	P1	P2	P3		$P1 + P2 + P3$
*	8	32	P1	P2	P3		$(P1 + P2) * 2^{**}P3$
	8	33	P1	P2	P3		Not Defined
Binary	8	34	P1	P2	P3		Process as 1750A 48-bit Floating Point
*	8	41	P1	P2	P3	P4	$P1 + P2 + P3 + P4$
*	8	42	P1	P2	P3	P4	$(P1 + P2 + P3) * 2^{**}P4$
	8	43	P1	P2	P3	P4	Not Defined
	8	44	P1	P2	P3	P4	Not Defined

NOTE: * Word Type Binary or Word Type 2's Complement

Table 2 - Multiple Word Conversion Codes

Multiple format words are normally defined in the file for all formats; however, if the number of formats is greater than two or the word contains message data requiring table look-up, then the word is output in hexadecimal or octal (user's preference). The non-linear conversion (NLC) code may be used to identify the requirement for an auxiliary file that defines the data validity conditions and/or the multiple format conversion calibrations.

AUXILIARY FILE CONTENTS

An auxiliary file is used to provide general information about the DAS load and additional information about data conversion that cannot be included in the TDAP standard format (i.e., non-linear calibration tables, conditional word processing, etc.) The requirement for non-linear calibration information in the auxiliary file is triggered by NLC not equal to zero or eight (in the TDAP file). The auxiliary file data follows the Telemetry Attributes Transfer Standard (TMATS) as to format [1]. The actual code names used, however, are

established by the TDAP team. The attributes included in the auxiliary file are determined by the TDAP team based on user's requirements.

TDAP SOFTWARE

The TDAP Opening Menu is shown in Figure 1. The TDAP Loads command button consists of display and output functions. In this option, the user must select the group containing the file that will be displayed or printed. These are the valid groups: F-15 aircraft, F-16 aircraft, DAS loads, and Other. If F-15 or F-16 are selected, a tail number may also be entered. This allows access to all available F-15 or F-16 files. The user may also select a file pertaining to a single DAS number. After selecting the DAS option, the user simply enters the DAS number. Finally, the user has the ability to view files not associated with these aircraft. "Other" will include aircraft, munitions, or any item not pertaining to F-15s or F-16s.

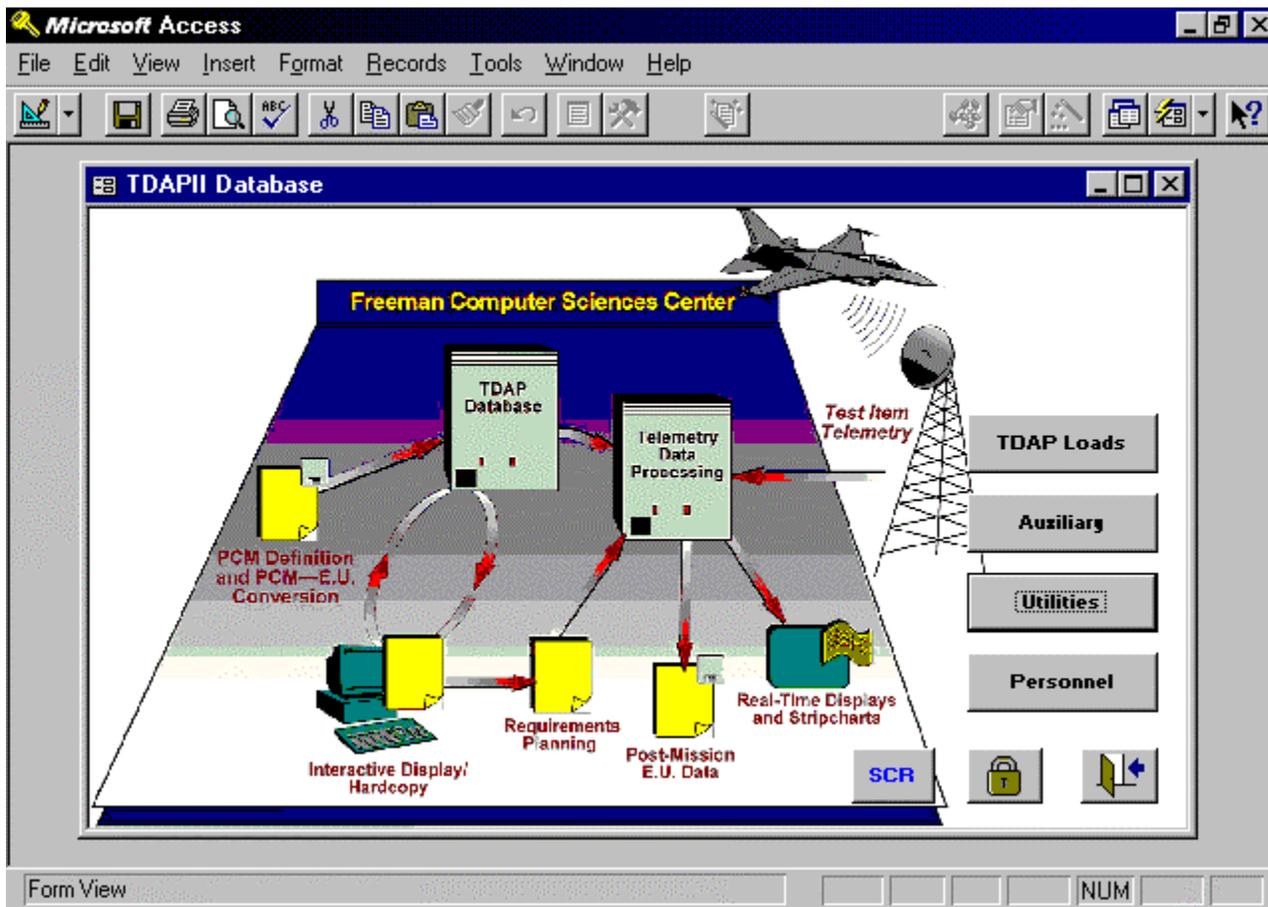


Figure 1 - TDAP Opening Menu

When prompted for a file to be output or displayed, the user is given a list of valid files along with a brief description of the project to which the file belongs. When the list is displayed, the user can select the desired file.

Several display formats are available in the TDAP Loads display function, each featuring different combinations of the attributes contained in the TDAP loads. The file is sorted with several key field options for each display format. The possible key fields differ for each format and consist of only a subset of the components displayed. The Single Parameter display option shows all attributes for just one parameter and does not require a sort. The Super-Com display option shows the parameter names, in alphabetical order, for the first occurrence in the main frame only. Display formats and their components are listed below in Table 3. The Super-Com and Multiple Word formats display only applicable records.

CALIBRATION	DESCRIPTION	PCM	PLOT
Parameter Name	Parameter Name	Parameter Name	Parameter Name
Units	Sub System	PCM Word Number	Units
MSB	Parameter Description	MSB	MSB
LSB	Command Word	LSB	LSB
Gain	Message Word Number	Word Type	Gain
Offset	Calibration Classificatn	Sub Frame Number	Print Format
Word Type		Sub Frame Word No.	Data Classification Code
Non-Linear Flag		Sub System	Lower Limit
Sub System		Command Word	Upper Limit
Command Word		Message Word Number	Sub System
Message Word Number		Bus ID	Message Word Number
Calibration Date		Update Rate	

MULTIPLE WORD	SINGLE PARAMETER	SUPER-COM	USER DEFINED
Parameter Name	Display all 32 TDAP attributes for one parameter	Parameter Name	User selects from 28 TDAP attributes to be displayed. The number of attributes to display is limited to their field length, with up to 76 characters allowed. The first attribute is set to Parameter Name.
Units		Units	
PCM Word Number		PCM Word Number	
Non-Linear Flag		Description	
Multiple Word Code		Sub Frame Number	
Parameter 1 Name		Sub Frame Word No.	
Parameter 2 Name		Command Word	
Parameter 3 Name		Message Word Number	
Parameter 4 Name		Number of Occurrences	
		Delta Interval	

Table 3 - Display Formats

The files displayed by the TDAP software are always sorted, and the key fields for sorting differ for each display and output format and consist of only a subset of the attributes displayed. The Single Parameter display differs from the other formats in that a sort is not needed and all attributes of the record are displayed. After a file is selected, the name of the parameter to be displayed is requested. Because a given Parameter Name may exist in a single file several times, the user may search for other occurrences of the same parameter name until all have been displayed or no more are desired.

The TDAP Loads output function gives the user the ability to print and/or save a file in several different formats. Output formats and their components are listed in Table 4. Super-Com and Multiple Word formats print and/or save only applicable records.

FORMAT-1 (With Calibration Info)	FORMAT-2 (Without Calibration Info)	FORMAT-3 (With Minor Frame & Command Words)	FORMAT-4 (Without Minor Frame Word & Limits)
Parameter Name	Parameter Name	Parameter Name	Parameter Name
Units	Units	Units	Units
PCM Word Number	PCM Word Number	PCM Word Number	PCM Word
MSB	Word Type	MSB	MSB
LSB	Sub-System	LSB	LSB
Gain	Parameter Description	Gain	Gain
Offset	Data Classification Code	Offset	Offset
Word Type	Command/Select Word	Word Type	Word Type
Print Format	Message Word Number	Minor Frame Number	Print Format
Sub-System	Update Rate	Minor Frame Word No.	Sub-System
Parameter Description	Bus ID	Command/Select Word	Parameter Description
Data Classification Code	Calibration Classification	Message Word Number	Calibration Classification
		Parameter Description	Command/Select Word
		Data Classification Code	Message Word Number
			Calibration Date

USER DEFINED	ENTIRE FILE	SUPER-COM INFO	MULTIPLE WORD
User selects from 28 TDAP attributes to be output. The number of attributes to be output is limited to their field length, with up to 130 characters allowed. The first attribute is set to Parameter Name.	The entire file (all 32 TDAP attributes) is output in wrap around mode, two lines per record	Parameter Name	Parameter Name
		Units	Units
		PCM Word Number	PCM Word
		Sub-System	MSB
		Parameter Description	LSB
		Minor Frame Number	Gain
		Minor Frame Word No.	Offset
		Command/Select Word	Word Type
		Message Word Number	Minor Frame Number
		Update Rate	Minor Frame Word No.
		Number of Occurrences	Non-Linear Conversion
		Delta Interval	Multiple Word Code
			Parameters 1 - 4

Table 4 - Output Formats

The Auxiliary command button allows the user the option of displaying or printing selected information from a TDAP auxiliary file. The user selects the TDAP file; the software checks for the applicable auxiliary file and displays it. The parameter name of any parameter coded with a NLC = 1 will be displayed after the general information. If there is an NLC table, it can be printed.

The Utilities command button provides options for viewing DAS information, for viewing Work Request status, and for creating a Master Format File (MFF) or a DataProbe Dictionary file from a TDAP file.

DAS information can be viewed from three different options: a DAS program list, a DAS program status list, and DAS descriptions. The DAS program list displays all of the DAS

load numbers that exist in the database. DAS Program Status displays all current DAS load numbers as well as the numbers assigned to non-DAS instrumentation and provides a status of the files and availability of the associated information. The DAS description displays all the pertinent PCM characteristics for the selected DAS load, such as wave form, bit rate, minor and major frame length, word length, number of minor frames, frame rates, sub-commutation, and frame synch pattern.

The MFF function allows the user to create an MFF from a selected TDAP file. A Master Format File is the description of telemetry formats and EU, or measurement, conversion calibrations in another specific formatted file other than TDAP, and used for specific weapons and/or test aircraft. The user will have to know the number of words per subframe, the first data word, the tag size (number of bits) to be used for digitizing the PCM stream, and the PCM word size. The subframe length and the PCM word size can be obtained from the DAS description in the Utility section. The first data word and the tag size can be obtained from the auxiliary file.

DataProbe dictionary files (.COD, .DIC, and .FDT) can be created from a selected TDAP file in the Utilities option. A tape type field identifying the mission and the digitized word size field are required inputs. When the user selects a TDAP file, the appropriate DAS number to use as input must be defined in the DAS description.

TDAP II

TDAP II is a software development project that is underway to convert both the TDAP ASCII files and TDAP software described above to a PC platform, while at the same time enhancing system functionality. Phase 1 of TDAP II will restructure the ASCII TDAP files into a relational database using Microsoft Access 95. Conversion of the current VAX/VMS-based TDAP software to PC software using Access and Microsoft Visual Basic is also being accomplished in this phase. Phase 2 of the project will consist of software enhancements to import data sources, improve interfaces, and process multiple formats of telemetry description data (including TMATS). Both the TDAP II database and software will be integrated on a PC network in order to create a more tightly coupled system.

CONCLUSION

TDAP provides software and procedures that will reduce the response time needed to support current and new projects requiring PCM and 1553 data processing. The standardization of telemetry information formats enhances quality control, reduces data turnaround time, and eliminates duplication of effort through the centralization of responsibility. PCM and 1553 data conversion information is maintained in computer files

that can be easily displayed and accessed using TDAP software. Data reduction software to convert raw PCM and/or 1553 data into EUs can easily interface with the TDAP ASCII files. TDAP II will migrate the TDAP files and software to a PC network with better availability.

REFERENCES

1. IRIG Standard 106.96, Telemetry Standards, Telemetry Group, Range Commander's Council
2. TDAP User's Guide, Department of the Air Force, Eglin Air Force Base, Florida