A System Conforming to the New IRIG Standard for Processing MIL-STD-1553 Data

A SYSTEM CONFORMING TO THE NEW IRIG STANDARD FOR PROCESSING MIL-STD-1553 DATA

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ABSTRACT

The typical aircraft development program of the 1990's will use multiple airborne MIL-STD-1553 Data Busses to provide control of the avionics subsystems. These programs have created a need to process data from these busses in a standard format. This format is proposed for Chapter 8 of the IRIG-106 document. This paper describes EMR's MIL-STD-1553 PROCESSING SYSTEM to acquire and process data in accordance with this new standard.

This fully integrated and already available system consists of two basic elements:

- An All-Bus Instrumentation System(ABIS)
- A Ground Processing Station (GPS)

The ABIS monitors the MIL-STD-1553 airborne communications busses, and formats all data in a standard IRIG serial PCM stream suitable for on-board recording and/or real-time transmission on a radio link. Each ABIS will handle all data from one to eight busses.

The GPS provides both real-time display and post-flight processing of data captured by the ABIS.

INTRODUCTION

With the proliferation of MIL-STD-1553 data busses on each airframe, there is a need for a common way to acquire and analyze the communications on the busses. The IRIG Standards Committee has created a standard for an airborne and ground station system to

do this. The general objectives of the IRIG MIL-STD-1553 100% ACQUISITION STANDARD are featured below.

Each Airborne System must:

- Acquire all messages from up to 8 separate MIL-STD-1553 Data Busses.
- Monitor both Primary and Secondary sources.
- Allow for merging of time and other miscellaneous discrete information.
- Identify each word of a message with a tag identifying word type and bus number.
- Encode all information into a standard PCM code to allow utilization of existing IRIG airborne tape recorders.
- Provide recording of each MIL-STD-1553 bus on an IRIG Standard Instrumentation Recorder with bit rate selection and track spreading for efficient tape usage.
- Provide the ability to merge all MIL-STD-1553 busses together in a composite stream to be output to a serial link at user selectable rates.

The Ground Processing System must:

- Playback recorded MIL-STD-1553 tapes on any standard IRIG ground station recorder.
- Use existing IRIG PCM ground equipment such as Bit Synchronizers, Frame Synchronizers, Pre-processors, Host computers and Data Bases.
- Provide processing of selected data from the MIL-STD-1553 busses for analysis.

In order to meet these objectives, a complete MIL-STD-1553 PROCESSING SYSTEM was required. This system encompasses both the acquisition and processing of MIL-STD-1553 communications.

SYSTEM DESCRIPTION

The MIL-SID-1553 Processing system consists of an Airborne Acquisition System and a Ground Processing System (see Figure 1). This end to end system furnishes a complete set of hardware and software tools to capture and process 1553 data. The airborne portion consists of an EMR 5500 All Bus Instrumentation System (ABIS), an IRIG standard instrumentation recorder, and a telemetry link. The telemetry link could be a radio transmitter or rotary head recorder system.

Airborne Acquisition System

The EMR 5500 acquires data from up to eight MIL-STD 1553 busses, eight discrete inputs, one analog input and IRIG Parallel BCD1 time. The EMR 5500 can output the 1553 data simultaneously in two ways: *Split Stream Format and Composite Format.*

In the Split Stream Format, the EMR 5500 monitors each 1553 bus, decodes each word as it appears on the bus, merges time with a microsecond resolution per message, and outputs the data words as one, two, three or four serial data streams in a standard IRIG PCM format. Each 1553 input bus has it own set of serial PCM outputs for output to an IRIG standard Instrumentation Recorder.

In the Composite Format, the EMR 5500 merges the data from all the 1553 busses and outputs one composite IRIG serial PCM stream to a telemetry link.

Ground Processing System

The Ground Processing System consists of an IRIG Standard Instrumentation Recorder, Telemetry Link, Telemetry Front End (TFE), and Host Computer with Parameter Data Base.

The *IRIG Instrumentation Recorder* is used for playback of data recorded on the airborne recorder.

If the composite output feeds a *Telemetry Link* such as a radio, it could be used to monitor real time data during the flight. If the composite telemetry link is a high speed rotary head recorder, the ground station rotary head recorder would be used for playback. Both sources may feed the same telemetry front end
.
The *Telemetry Front End (TFE)* decommutates the serial data streams, selects and decodes the messages from the MIL-STD 1553 busses, and processes selected data words for output to the computer for disk or tape storage and quick look display. The TFE also processes selected data for output to stripchart recorders.

The *Host Computer* performs setup and control of the Telemetry Front End, formatting of data to disk or tape, quick look data displays, and post mission analysis of all stored data.

EMR 5500 ALL BUS INSTRUMENTATION SYSTEM

The EMR 5500 All Bus Instrumentation System (see Figure 2) resides in an airborne qualified chassis. The unit measures 5 inches high, 7.5 inches wide, and 10 inches deep.

The unit contains a modular, nine card slot backplane. Any EMR 5500 card may reside in any slot. The box is self configuring and allows cards to be added and removed as needed. For example, to monitor eight MIL-STD-1553 buses simultaneously, eight 1553 Receiver Cards and/or one Serial Output Card are inserted into the chassis.

The 1553 Receiver cards may be either transformer or direct coupled to a MIL-STD-1553 bus. The 1553 Receiver accepts all messages from a MIL-STD-1553 primary or secondary bus. Each bus message is tagged with a microsecond time word and the response time of the remote terminal to the bus controller is computed (optional). A Discrete Word is sampled each frame. Each word is tagged with a seven bit tag, consisting of a three bit bus identifier and a four bit Word Type. The 1553 Receiver Card is the source of the split PCM streams. The data may also be sent to the Serial OutputCard to be merged with data from other 1553 busses. The Serial Outputthen outputs the composite PCM stream.

In the split PCM stream output mode, the Receiver card produces one, two, three, or four RNRZ-L serial streams. There are four output rates available on the board. Other rates may be chosen by changing crystals. For each stream, a frame of 256 words of data is composed. Each contains a frame synchronization pattern. All data words are inserted across the output streams as they are received. Words are not positionally located within the frame. Fill words are inserted when no data is available.

In the composite output mode, the Command, Status, Data, Microsecond Time, Response Time, and Discrete words are converted to 24 bit parallel data words. The parallel data words are then sent to the Serial Output card over a sub-set of Fairchild Weston’s powerful Priority Command Data Bus (PCD) used in the EMR 8715. This version is called the PCD Jr. Bus. The PCD Jr. bus uses 24 bit data words and operates at 3 million words per second. Each Receiver Card may be disabled from merging to the PCD Jr. bus. Thus, the user can have split streams of an input bus with no data input to the composite stream.

The Serial Output card receives the data from the receiver cards, one analog input, and IRIG Parallel BCD 1 time. The Serial Output card digitizes the analog input using a 12 bit analog to digital converter. The digitized information is sampled and input to the merged data stream at eight times per frame. The IRIG Parallel BCD 1 time is converted to a binary count by the Serial Output card and Microsecond Time is generated and synchronized with the input time. This card produces the High Order IRIG Time(HOIT), Low Order IRIG Time (LOIT), and Microsecond Time words (uSEQ which are used on the Serial Outputand sent to the Receiver Cards.

The Serial Output card builds a frame of 256 words (including the Frame Sync Pattern). Each frame is time tagged with HOIT, LOIT and uSEC time. As the frame is built, time, data and the digitized analog words are inserted into the frame. The frame is output as a

continuous NRZ-L serial PCM stream. When there is no data available to be merged, the Serial Output card inserts Fill words in order to maintain a continuous output rate.

1553 GROUND PROCESSING STATION

The 1553 GPS (see Figure 3) processes either split stream 1553 data recorded on an IRIG standard instrumentation tape or composite 1553 data from the telemetry link. Each stream is processed first by bit synchronizers, which achieve synchronization of the data in the presence of noise and other perturbations. They reconstruct square-sided NRZ-L signals with zero degree clocks.

These NRZ signals and clocks are input to Frame Synchronizers. The frame synchronizers perform frame synchronization, recreating the original 24 bit created by the EMR 5500. The type of words include; command, status, data, error, time, response time, discrete, digitized voice, buffer overflow status, and fill words. The frame synchronizers route the 1553 words to a 1553 Decoder.

The 1553 Decoder is a FWSI DPU (see below) with processing algorithms developed for processing the IRIG format. The Decoder merges the split 1553 data streams, deletes fill words, decodes 1553 messages, and checks for errors. The composite 1553 data stream is handled in the same fashion as the split streams. In this case the 1553 Decoder separates the merged 1553 words as it receives them. Each stream is decoded, checked, and assigned indexing information used by the Data Mapping Module before being sent to the Data Mapping Module.

The Data Mapping Module performs data selection and system routing. Data words may be routed to multiple locations or routed multiple times with a unique command ID for each transfer. The Data Mapping Module assigns tags to data words and deletes any undesired or unprogrammed words.

The Distributed Processing Units (DPU’s) process each data word according to its own algorithm processing chain. The DPU’s perform such processing functions as data compression, word formatting, engineering units conversion, alarms checking, and DAC scaling. The DPU’s output the selected processed data to the computer resident Current Value Table (CVT) memory for use by the Quick Look Displays. Processed data is also sent to the computer DMA interface for archiving data on disk for analysis. Selected data may be output to a DAC/Discrete unit for driving strip charts and display panels.

The Host Computer provides setup and control of all Ground Station equipment. Setup information is stored in a central data base. This data base is accessed by the setup software, display software and analysis software. The user gives each parameter to be

processed and all parameters derived from other parameters, an alphanumeric parameter name. Once a parameter has been defined, it can be accessed using the parameter name. Multiple formats may be defined and stored on the host computer. This allows for multiple test formats to be stored.

Conclusions

The MIL-STD-1553 Processing System has been designed to conform completely with the new IRIG MIL-STD-1553 100% ACQUISITION STANDARD. Standard IRIG PCM equipment is used. Other data such as PCM streams and high speed parallel data, additional busses such as PAVETACK, SRAM, and ARINC 429 may be merged into the composite stream for later analysis. The system software minimizes end user tasks for setup, display and analysis, and maximizes concentration on the test missions. In short, a complete processing solution, with flight test data acquisition, real time data monitoring and post mission data analysis, exists today.

References:

1. RANGE COMMANDERS COUNCIL, IRIG STANDARD 106, CHAPTER 8 PROPOSED STANDARD FOR 100% DATA ACQUISITION OF MIL-STD-1553 BUS INFORMATION

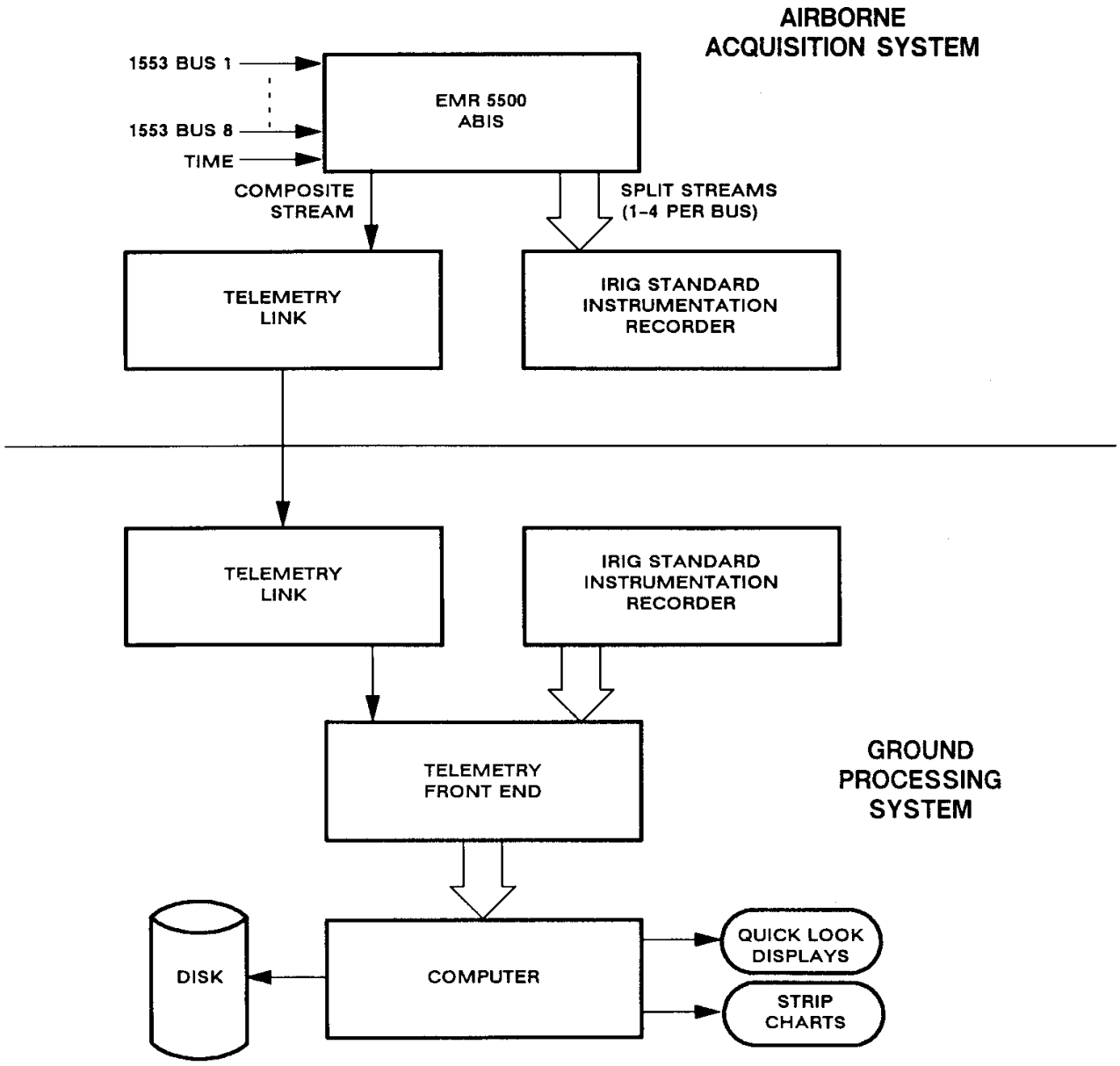

FIGURE 1 1553 PROCESSING SYSTEM

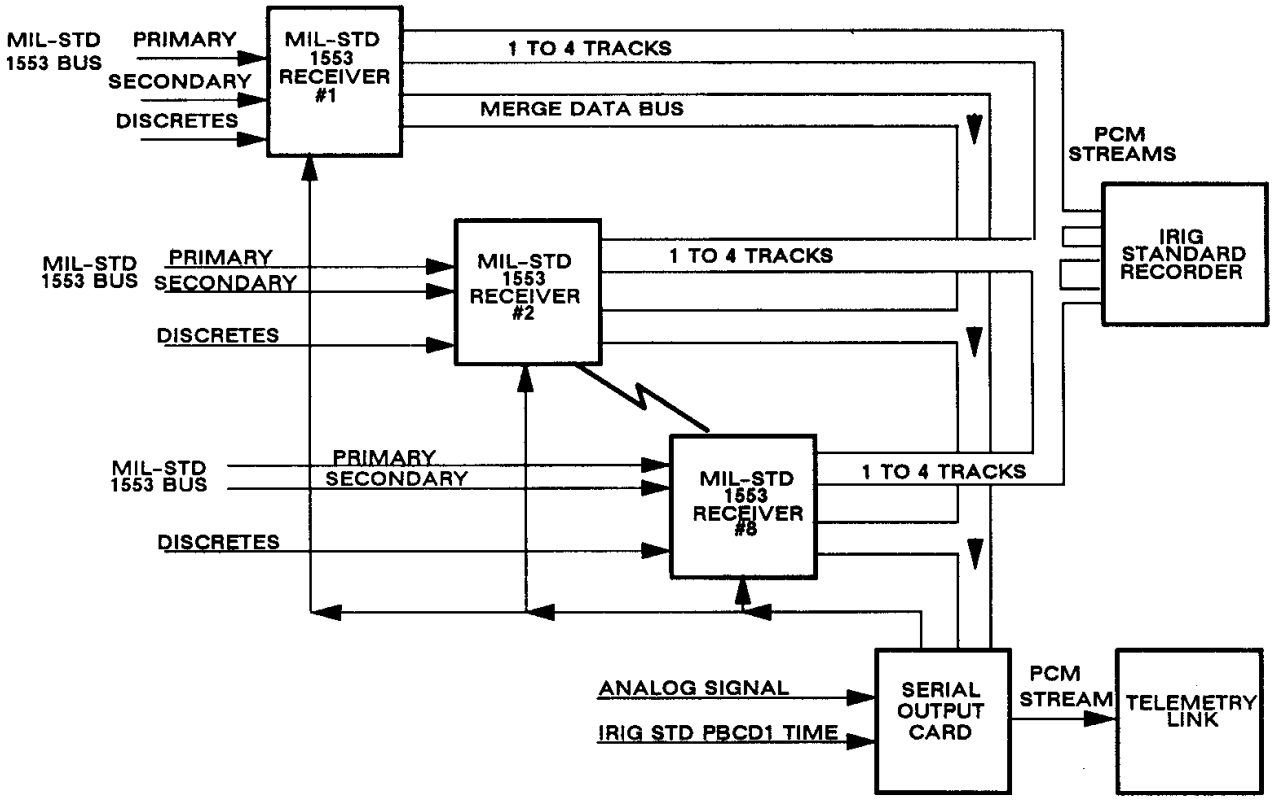

FIGURE 2 1553 AIRBORNE ACQUISITION SYSTEM DATA FLOW

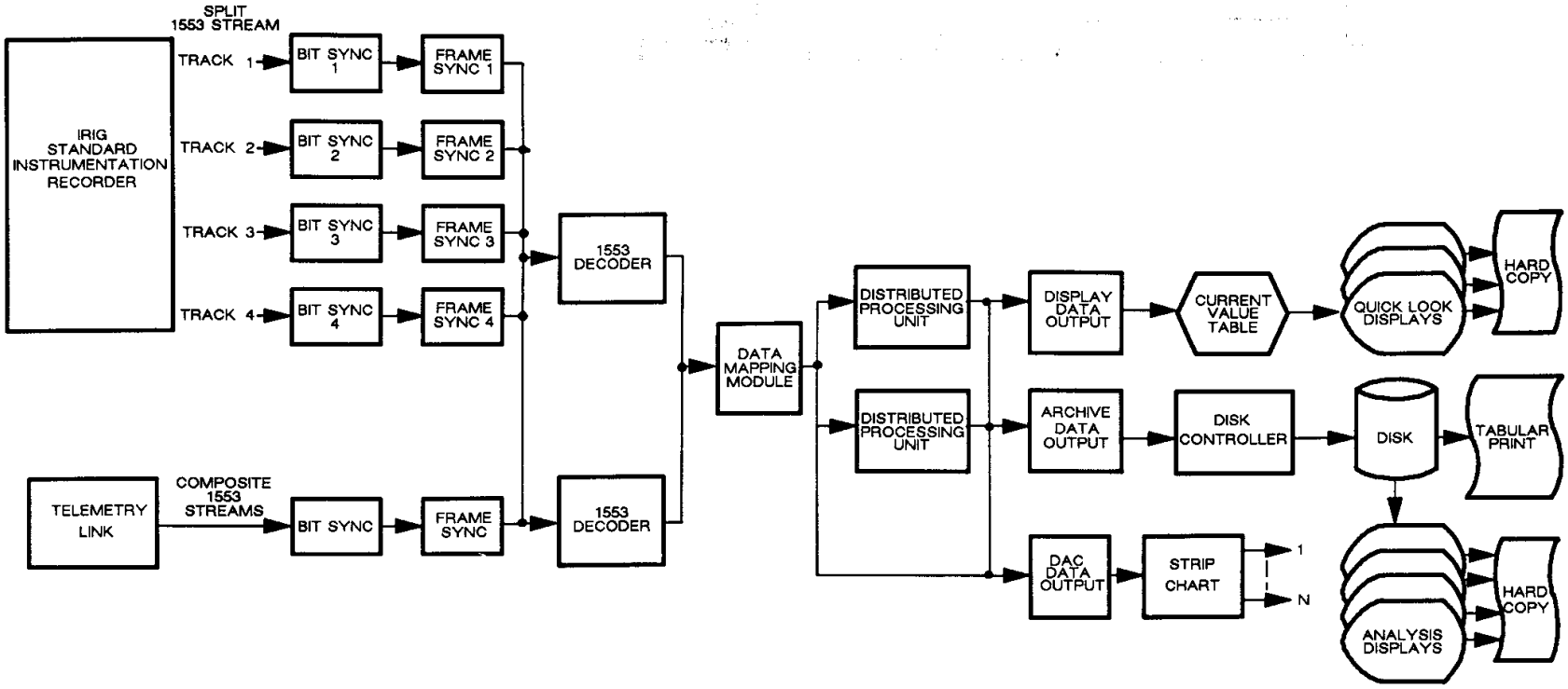

FIGURE 3 1553 GROUND PROCESSING STATION (GPS) DATA FLOW