

# REAL-TIME TEST DATA PROCESSING SYSTEM

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## ABSTRACT

The U.S. Army Aviation Development Test Activity at Fort Rucker, Alabama needed a real-time test data collection and processing capability for helicopter flight testing. The system had to be capable of collecting and processing both FM and PCM data streams from analog tape and/or a telemetry receiver. The hardware and software was to be off the shelf whenever possible. The integration was to result in a stand alone telemetry collection and processing system.

The Test Data Processing System (TDPS) provides real-time preprocessing and display of Pulse Code Modulation (PCM) and Frequency Modulation (FM) aircraft test data. The FM front end equipment consists of FM demodulators, tunable filters, strip chart recorders, an array processor and a PCM encoder. PCM equipment includes a wide band demodulator, four tunable bit synchronizers and a preprocessor. The Integrated Telemetry Analysis System (ITAS), preprocessor which is Veda proprietary equipment offers functional redundancy with the HP 1000 real-time computer. This allows TDPS personnel to monitor selected real-time parameters in the event of HP 1000 system failure. All pertinent signals are routed through the system distribution panel to facilitate rapid changes in the system configuration.

The HP 1000 real-time computer system provides computer control for the front end equipment, storage capability for incoming test data, data reduction algorithms for real-time data analysis, and also provides control of peripheral devices. The HP 1000 interfaces with the host computer for post test transfer of data. The host computer is the HP 3000 which will be used for post test analysis of the data.

The TDPS is a collection of various vendors' hardware and software which have been functionally integrated by Veda, Inc. of Fort Walton Beach, Florida into a real-time telemetry processing system. The system was designed and constructed for the U.S. Army Aviation Development Test Activity at Fort Rucker, Alabama.

The distribution panel was custom fabricated. It was recessed into the 19 inch equipment rack and enclosed behind a plexiglas door. This approach eliminates accidental damage from bumping into the connectors, and also allows the operator to verify system connections at a glance. All associated connectors, shunts, adapters, and patch cords were provided with the panel.

### **Time Code Generator/Translator**

A time reference is used as a means of indexing records for rapidly and accurately locating points of interest. The time code generator/translator provides three basic functions to meet the need of the TDPS. The unit generates a time code in suitable form for recording on magnetic tapes or strip chart recorders. It is capable of automatically reading the recorded time when played back from a magnetic tape. The time code unit also generates time in suitable form for application to the ITAS preprocessor for time tagging data words.

### **PCM Subsystem**

The PCM subsystem functions as an integral part of the TDPS. Set up of the PCM system functional controls is accomplished by the real-time computer as part of the telemetry controller tasks. In addition, manual front panel setup capability is provided on the PCM subsystem components. All of the real-time computer software required for the setup and operation of the PCM subsystem was written as part of the integration effort.

### **Bit Synchronizers**

Four external PCM bit synchronizers are used to simultaneously process up to four channels of PCM DATA. The bit synchronizers accept a serial PCM data stream and generate a PCM data stream and clock at a selected phase. The output PCM data stream can be either NRZ-L data and

clock at TTL levels, or BIO-L bipolar data at 2-3 volts p-p. They can be both manually and computer controlled.

### **Telemetry Preprocessor**

The ITAS telemetry preprocessor is intended to relieve the real-time computer of the common repetitive tasks which must be performed on the data. ITAS is comprised of four IRIG Class II decommutators, an engineering unit conversion card, a digital to analog converter card, a data extraction (word selector) and time tagging card, an IEEE-488 interface card, and the standard peripheral interfaces including an engineering workstation interface.

ITAS is the heart of TDPS. It selects each parameter from the data stream, provides an associated identification and time tag, performs the appropriate engineering unit conversion, and outputs selected parameters to the DACs, engineering workstation and real-time computer. It also provides PCM data stream simulator to allow system setup and diagnostics prior to test data processing.

The ITAS architecture is based on a dual bus, data flow driven, multi-processor platform. It uses a PC/AT bus architecture for setup and control of all system modules. The unit is mounted in one of the 19" equipment racks and integrated into the TDPS system. The ITAS setup and control software is fully compatible with IBM PC/AT or similar computers. This allows users to have a personalized copy of the complete control software resident on a personal computer and create and modify system configurations remotely from the ITAS chassis. All software to operate the preprocessor and integrate it with the real-time computer is written in the C language. The operating system is Microsoft MS-DOS.

ITAS interfaces to the real-time computer through a standard GPIB IEEE-488 interface card. The IEEE-488 interface is used for remote setup and control from the real-time computer and for processing telemetry data from ITAS to the real-time computer. The TDPS specification required data to be transferred to the real-time computer at 1 megabit per second with no loss of data. The real-time computer interfaces to its hard disk drives through an IEEE-488 bus and had a maximum DMA data transfer rate of 2 megabits. Since the data through-put was limited by the storage device transfer rate there was no need to select a high speed

parallel I/O device for the telemetry interface. The IEEE-488 card selected for ITAS supports DMA data transfer and has successfully transferred data from ITAS to the real-time computer at a sustained rate of 1.8 megabits per second with no loss of data. ITAS can transfer raw data, processed data, a combination of raw and processed data, data with or without time tags from one PCM data stream or up to 4 merged PCM data streams well in excess of the data transfer rate that can be handled by the real-time computer.

### **FM Subsystem**

The FM subsystem functions as an integral part of the TDPS. The analog to PCM conversion accommodates Constant Bandwidth (CBW) and Proportional Bandwidth (PBW) data. Demodulators and input filters are provided for IRIG B CBW channels 3B through 21B and IRIG PBW channels 1 through 21 using a 240 KHz reference. All analog channels are sampled using a 5 samples per cycle or greater sampling criteria. The output PCM format is selectable from any of the following.

- (1) NRZ-L
- (2) BIO-L
- (3) 16 bit parallel

Automatic calibration of the FM demodulators is provided as an integral part of the TDPS.

### **Signal Conditioners**

Signal conditioners are provided for the 32 analog channels. Each signal conditioner performs filtering, amplification, and offset correction. They are modular in design and allow replacement on a plug in/out basis. They are each supplied with an output filter corresponding to the channel bandwidth of the unit.

### **FM Calibrator**

The FM frequency calibrator provides precise and convenient calibration of the FM demodulators. It can be used in manually or computer controlled telemetry systems. The frequency calibrator is designed to provide 5 point calibration of proportional bandwidth or constant bandwidth frequency modulation either on an individual channel basis or as one of several multiplexes.

## **Tunable Filters**

Anti-aliasing tunable filters are provided for all 32 analog channels. The filters can be either manually controlled or computer controlled from the operator's console. The software required for setup and control of the tunable filters is an integral part of the Telemetry Processing software on the Real Time computer.

## **PCM Multiplexer/Encoder**

The PCM multiplexer/encoder includes a 48 channel multiplexer (MUX) with analog-to-digital (A/D) converters, and a PCM encoder. The MUX and A/D units are included with the PCM encoding unit in the same chassis. The PCM multiplexer/encoder accepts up to 48 single ended analog inputs, multiplexes them into one serial stream, digitizes the serial stream (12 bits per words) and PCM encodes the digitized words into a serial PCM data stream of up to 2 Megabits per second. Parallel digital output for direct input to a computer is also available. It has both front panel controls for manual setup and a computer interface for computer control. The system is initialized at systems initialization time via the real-time computer.

## **Strip Chart Recorder**

The two strip chart recorders in both manual and remote controlled operation are capable of recording up to 24 channels on either 8" or 12" paper. The 24 DAC's from the ITAS are connected to the 24 channels of the strip chart recorders via the patch on exception distribution panel. Selecting parameters to send to the strip charts is part of the test configuration format used to configure ITAS during pre-test setup.

Each recorder meets the following minimum requirements:

Number of channels:	12
Chart Width:	Up to 1" per channel
Control:	Remote and Local
Chart Speeds:	13 speeds, from 0.5 mm/s to 5000 mm/s
Frequency Response:	5Khz

## **REAL TIME COMPUTER SYSTEM**

### **The Real-Time Computer**

The real-time computer system provides computer control for the front end equipment, storage capability for incoming test data, data reduction algorithms for real-time data analysis, and also provides control of peripheral devices. The real-time computer also interfaces with a host computer for post test transfer of data.

The real-time computer software provides for the set up and control of the TDPS hardware with IEEE-488 remote control capability, real-time archiving of the test data, post processing analysis including data plots, and transfer of the test data into a database.

### **Array Processor**

An array processor is interfaced to the real-time computer through a 16 bit parallel port. The array processor provides the capability to perform Fast Fourier Transforms FFTs on the test data. It's capable of processing several sizes of complex and real FFTs at very high floating point rates. The software to program the processing capability was furnished as a package with the system.

## **MISCELLANEOUS EQUIPMENT**

### **DC Power Supply**

The DC power supply is adjustable from 0 to 40 VDC with output current capacity of 0 to 10 Amperes. Separator coarse and fine adjustment knobs are provided on the front panel for voltage and current adjustment. Additional features include overvoltage crowbar protection; remove error sensing, and auto-series, auto-parrallel, and auto-tracking operation. The DC power supply is used to power aircraft radios and instruments requiring 24 VDC.

### **400 Hz Converter**

The 400 Hz converter provides 400 Hz voltage from 0 to 135 VAC at 1500 VA. Voltage adjustment is provided on the front panel by means of a variable control with an output meter. The 400 Hz converter is used to power 400 Hz aircraft radios and instruments.

## CONCLUSION

TDPS provides the U.S. Army Aviation Development Test Activity at Fort Rucker, Alabama with the capability to meet present and future real-time aircraft, data processing requirements. It also processes post test data from analog tape. TDPS allows the engineers to monitor quick look data on both CRT and strip charts while the data is being processed in real-time or from analog tape. TDPS processes both PCM and FM data providing the test engineers with the opportunity to choose the best data collectors for the task at hand. The real-time computer also allows post processing analysis and transfer of data to the host for report generation and analysis. The Integrated Telemetry Analysis System is the hub of the TDPs. It accomplishes all the data preprocessing at extremely high rates and distributes the data to the other functional elements. As a turn-key system TDPS rivals the largest telemetry processing systems in terms of speed, capacity and flexibility.

