The Pentek Pipeline
A quarterly publication for engineering system design and applications.

Winter 2001 • Vol. 9, No. 4

Pentek, Inc.
One Park Way, Upper Saddle River, NJ 07458
Tel: (201) 818-5900 • Fax: (201) 818-5904
email: pipeline@pentek.com
http://www.pentek.com

DSPCon Develops a Machinery Analysis System for Pratt & Whitney

Pratt & Whitney is known for design and manufacture of engines for commercial and military aircraft, and space propulsion systems. It is a division of United Technologies, a company that includes Otis elevators and escalators, Carrier heating and air-conditioning systems, Sikorsky helicopters, and Hamilton Sundstrand aerospace systems. Today, Pratt & Whitney engines power about one half of the world's commercial aircraft. The aviation industry demands far more than power from an aircraft engine. It demands thrust at the lowest possible cost and the highest level of reliability.

To meet these demands and improve development and reliability of its engines, Pratt and Whitney selected DSPCon, Bridgewater, NJ to develop and deliver a VMEbus-based Digital Dynamic Data Monitoring and Analysis system (D3MAS). DSPCon specializes in the development, integration and marketing of DSP-based high technology systems that meet application-specific requirements.

DSPCon came to Pentek for much of the VMEbus data acquisition and DSP hardware, which included a multichannel A/D converter and a quad 'C6000 DSP processor board.

Figure 1. The Pratt & Whitney Rotating Machinery Analysis System. The VME cage is accessible from the rear of the rack. (Courtesy of Pratt & Whitney)

System Overview

The D3MAS system is designed to run on the Windows Platform. It's an integrated system for high-speed data acquisition, monitoring and analysis with DSP features designed to support the monitoring and testing of rotating machinery, such as aircraft jet engines. As shown in Figure 1, the system includes two workstations with large displays, the Control and Monitor computers, which provide the operator interface; it also includes ancillary test equipment for measuring other parameters of interest such as stress and pressure.

The Control PC controls data collection and provides full remote control of the system and an external tape drive. The Monitor PC monitors the data being collected in real time, acts as a conduit for distributing data to other processors for further data analysis, and provides for display of raw and processed data in a variety of plot formats.

A dedicated Ethernet connection provides the link between the Control PC and the Monitor PC. A high-speed MXI-2 bus connects the Monitor PC to the VMEbus chassis and downloads acquired data to this PC for further analysis.

The VME chassis houses the hardware that performs the data acquisition, recording, and real-time processing of the sampled data. The system software integrates the system through its hardware interfaces and communication links and provides the graphical interfaces for the system operator.

Signal Processing

As shown in Figure 2 next page, the D3MAS system includes a Pentek 4275B 32-channel 16-bit high-speed A/D converter. The 4275B is build with sigma-delta A/Ds that feature inherent low-pass filtering to avoid aliasing. Another major benefit of sigma-delta A/Ds is linear phase response, very useful for processing multisensor signals such as those found in online machine monitoring and sonar applications.

Presently, the system handles 24 channels of input data, but is designed to be expandable to additional input boards for future enhancements. Sampling frequency is externally programmable to 100 kHz maximum, and provisions have been included for synchronous sampling of all present and future channels.

The system provides two stages of digital signal processing: a DSPCon ➤

DSPCon Develops a Machinery Analysis System for Pratt & Whitney

[Continued from page 1]

9245 board handles the first stage and provides tachometer signal processing required by the Monitor PC and SGPOST processing, a Pratt & Whitney proprietary on-line analysis software. The intent of this processing is to provide high-accuracy but low-resolution data for rapid review without the need for off-line analysis. The 9245 is a single 60 MHz 'C40 processor board that also handles all data formatting and recording to high-speed SCSI disks in the VME cage. Two disks are employed, one for dedicated record sessions and the other for continuous data recording.

The second stage of DSP is implemented with a Pentek 4290 quad 200 MHz 'C6201 processor board equipped with a Model 6223 'C40 comm port adapter VIM module to allow communication with the DSPCon 9245 'C40 processor board. Model 4290 unpacks the data stream from the DSPCon 4295, performs real-time data reduction and analysis such as real-time FFTs, and transfers the data to the PCs for file storage and operator-selected displays.

The Monitor and Control PCs are 500 MHz Pentium III-class PCs. The Monitor PC is equipped with a MXI-2 interface to communicate with the VMEbus cage. The two PCs communicate with each other though a dedicated 10/100 Base-T Ethernet.

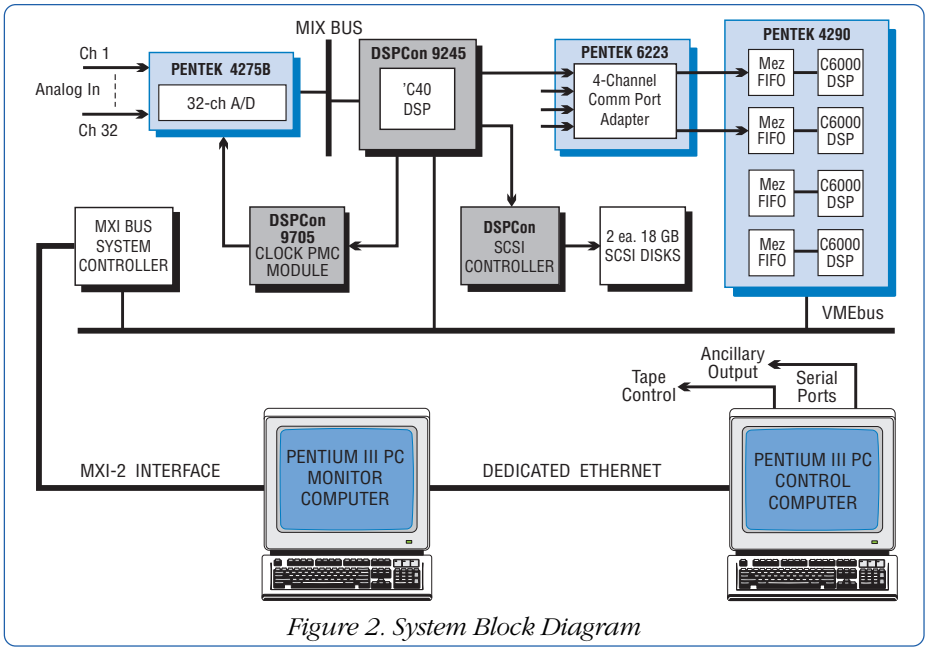


Figure 2. System Block Diagram

System Measurements

The system runs DSPCon's acclaimed Piranha™ Rotating Machinery Analyzer software, tailored to meet Pratt & Whitney's application requirements. This software provides a comprehensive tool set for the characterization of the signals commonly acquired during test of a rotating device such as a jet engine, turbine, or electrical motor. Time-history files which consist of tachometer and response signals are processed to provide time, spectral, filtered, and probability density views of the test data.

Shown in Figure 3 clockwise from lower left, some of the displays include:

- Tachometer Analysis, used to measure rotational speed (RPM) from up to three tachometer signals.
- Channel Analysis, measures magnitude response as a function of time or RPM and amplitude spectra at selected times or RPMs.
- Time Block Analysis, determines the time and spectral characterization of selected time blocks.
- Order Analysis, measures amplitude response using a band-pass filter that tracks a multiple (i.e. harmonic or order) of the fundamental frequency of a rotating machine.
- Peak-Hold Analysis (center) represents the peak values of selected spectra or time blocks in the channel time history.

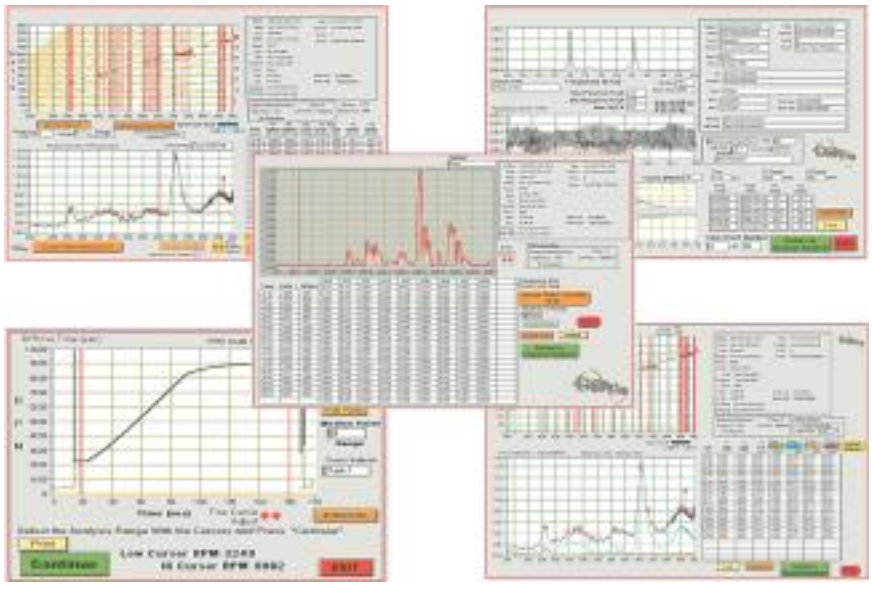


Figure 3. Typical System Displays (Courtesy of DSPCon)

Data Files

The time-history data is in the form of CATS files. Developed by the ➤

Quad AltiVec™ PowerPC G4 Processor for VMEbus

[From page 4]
between each processor and its associated VIM module.

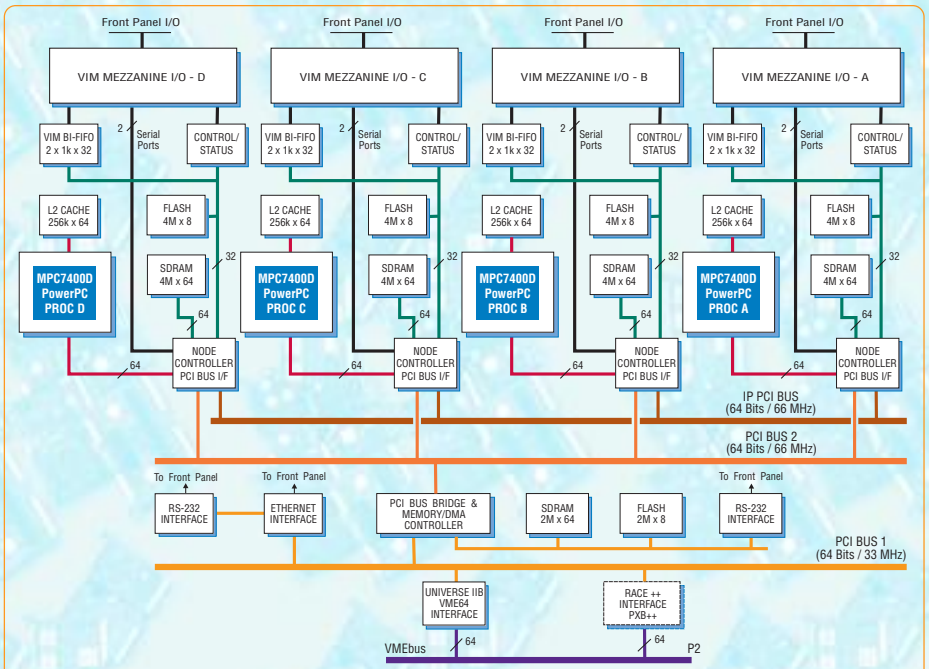
A path to the VME backplane P2 connector supports the optional RACE++ mezzanine interface.

Model 4294 may be equipped with one VIM-4 module or two VIM-2 modules of the same or different type.

The mezzanine board architecture allows a variety of application-specific front panel connectors. VIM module functions include digital receivers, A/D and D/A converters, RACEway and FPDP interfaces, and many more.

Pentek's SwiftNet® Host-to-target Networking and Communications software and Readyflow™ Board Support Libraries are available for this product.

For more information, visit our website at **http://www.pentek.com.** ❑



Model 4294 Block Diagram

Computer Aided Testing Systems (CATS) group of Lockheed Martin, this file format is self-documenting and optimized for the storage of large time histories, such as those associated with rotating machinery analysis. Some of the characteristics of a CATS file are:

- The file contains data from one channel.
- The file is made up of two principal sections, the *Header* and the *Data*.
- The *Header* is a keyword-based ASCII table that contains the "pedigree" of the data set. Several hundred keywords have been defined, but basic analysis requires a relatively small set.
- The *Data* is stored in a format described by the header. Time histories are normally stored in 16-bit binary form (raw A/D counts). Analysis results are normally stored in ASCII form to allow ready access by a number of programs.

The system has been delivered to Pratt and Whitney and has gone through approval tests and evaluation. Three more systems have been ordered. For more information, call DSPCon at (908) 722-5656 or visit **www.dspcon.com**. ❑

Online Seminar

To register go to to www.pentek.com/

An online seminar will be presented by Pentek on March 20, 2001 at 1:00 p.m. EST. The topic is *Choosing Your Processing Weapon to Best Fit Your Application.*

Don't spend your precious time wading through all the 'C6000 and PowerPC information trying to figure out which technology is best for your application. In all likelihood, you already know the basic differences between a DSP and a RISC processor — so we will provide you with the critical information you need to keep a step ahead of your competitors.

This technical seminar will highlight the specific applications where one technology ouperforms the other. It will also show you how different board-level designs can radically affect real-time performance in your application. Critical design factors will be discussed, including: On-board interprocessor communications, how to maximize external I/O bandwidth, latency issues for real-time applications, and time-saving software strategies.

The seminar is for engineers and engineering managers and will highlight the pros and cons of TI's high-performance TMS320C6203 and Motorola's G4 MPC7400 AltiVec PowerPC.

Learn about:

- Interprocessor and data I/O strategies for both the PowerPC and the 'C6000
- How application development tools for the PowerPC and the 'C6000 compare
- Operating system options including Linux, VxWorks, Solaris, and Windows
- How to leverage hardware and software investments when migrating between the PowerPC and the 'C6000
- Which typical digital signal processing functions are best allocated to each processor. ❑

Pentek, Inc.
One Park Way
Upper Saddle River, NJ 07458-2311

PRESORT
1ST CLASS MAIL
U.S. POSTAGE
PAID
Newark, NJ
PERMIT No. 625

In This Issue

Bookmark

DSP Central

http://www.pentek.com

- The latest datasheets
- The latest product brochures
- Technical overviews
- Seminar locations and more…

Product Focus

Model 4294

Quad AltiVec™ PowerPC G4 Processor for VMEbus

Brings High-performance DSP and VIM I/O to the PowerPC Platform

Model 4294 shown with two VIM modules installed

Pentek Model 4294 Quad PowerPC targets embedded applications requiring high-performance interfaces. Featuring four Motorola MPC7400's, the Model 4294 supports numerous high-speed interfaces including VIM, RACEway, VME64 and Ethernet.

Four identical processor nodes contain interface and memory resources ideally matching the I/O capabilities of the MPC7400 to high-performance system components.

MPC7400 AltiVec Processor

As the latest RISC processor in the PowerPC family, the Motorola MPC7400 utilizes the AltiVec engine to perform parallel processing of multiple data elements (SIMD) with 128-bit operations. The AltiVec processor executes both fixed- and floating-point instructions, augmenting its separate integer and floating-point units.

VIM Mezzanine

Each processor is equipped with its own VIM (Velocity Interface Mezzanine) connector, providing a private high-speed synchronous bidirectional FIFO (BI-FIFO). The BI-FIFO buffers 32-bit parallel data transfers between the VIM modules and the MPC7400. The VIM architecture allows simultaneous I/O data transfers to all four processors without contention for shared resources.

Control and status registers on the VIM modules can be read and written to as memory-mapped resources of the MPC7400.

Dual serial ports provide an additional data-streaming connection ➤

Pipeline