Solid-Propellant Missile Testing

using the DaqBook®

Aerospace

Application Note #33

Used in a variety of applications, satellites house an array of expensive and highly sensitive equipment. Missiles and other high-altitude vehicles are used to launch these satellites into the Earth's orbit. In some instances, harsh flight conditions put damaging stress on vital satellite instrumentation. Using a portable PC-based data acquisition system, engineers are able to monitor the effects of ambient factors during missile-test launches into orbit.

Application Summary

To study the earth's ozone layer, NASA launches sophisticated mini-satellites, like the Total Ozone Mapping Spectrometers (TOMS), into low-Earth orbit. Engineers send TOMS into orbit aboard Pegasus missile/winged vehicles, which are air-launched from a Lockheed L-1011 carrier aircraft. During TOMS development, engineers were concerned that flight conditions might destroy sensitive satellite equipment, such as optical sensors that degrade when subjected to environmental stress.

To evaluate how the TOMS satellite would be affected during launch, engineers needed to measure several variables in the carrier missile's fairing environment during flight. Variables included acoustic vibration, temperature, contamination, air velocity, humidity, heat transfer rate, and calorimeter voltage.

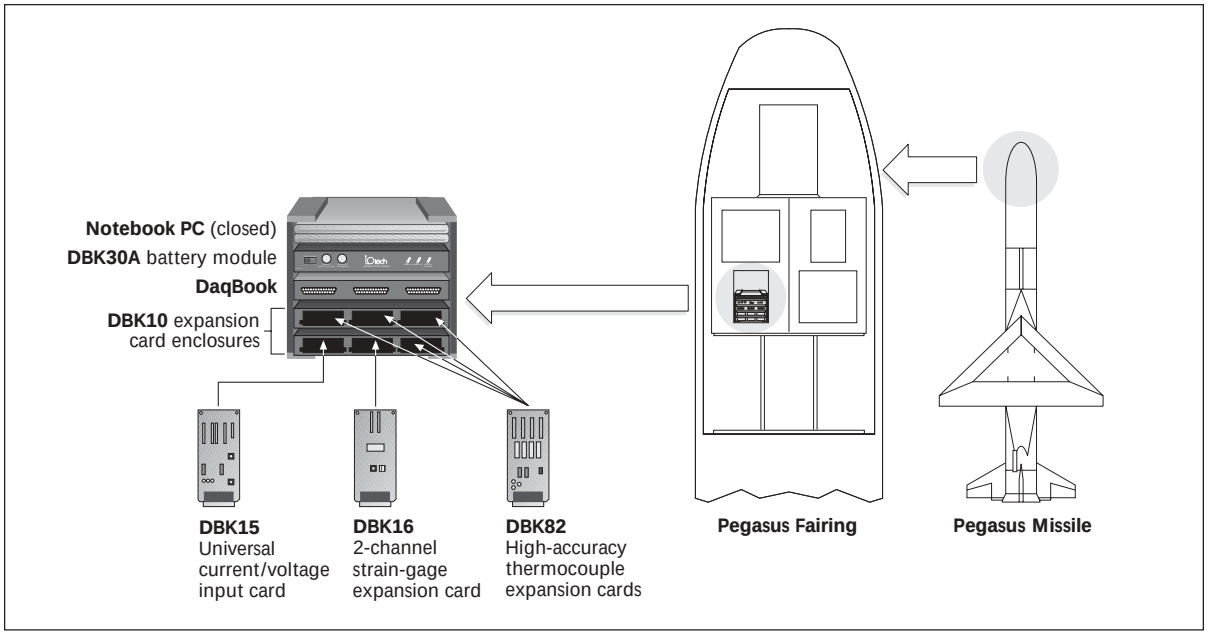
Potential Solution

The test engineers quickly realized that traditional test-and-measurement instruments would be much too bulky and too difficult to transport for the project. Instead, they needed a compact, reliable, stand-alone test system that would easily fit in the Pegasus fairing and collect data from multiple channels. In addition to being portable, the system had to be rugged as it would be subjected to high-altitude flight dynamics and extreme temperature conditions of -40˚C to 50˚C.

IOtech's Solution

Consulting with IOtech, the engineering team designed a light-weight, simulated payload that featured a self-contained data acquisition system. The payload system, easily mounted within the vehicle's fairing, was equipped to measure 69 channels of flight-environmental data from various sources.

The system featured IOtech's DaqBook®, a portable PC-based data acquisition system. Housed in DBK10 expansion-card enclosures, the system featured three IOtech DBK expansion/signal conditioning cards. IOtech's DBK15 universal current/voltage card collected air velocity and pressure measurements. A DBK16 strain-gage card gathered data from two calorimeters, and four DBK82 high-accuracy



Housed in the nose of the Pegasus, the DaqBook data acquisition system collects data from numerous transducers (not shown) mounted in the missile's fairing, educating test engineers about in-flight environmental conditions

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thermocouple cards collected data from numerous sensors. A DBK30A battery module supplied power to all of the system's components. Mixed-analog signals were supplied by calorimeters, pressure transducers, humidity sensors, and air velocity sensors.

The system's 256-channel capacity easily handled the test's 69-channel requirement. The DaqBook's 16-bit A/D resolution easily provided the required accuracy for the project.

Software was used to control and view data as it was being collected, and LabVIEW® was used to analyze and present analog data after it was acquired. The software ran on an IOtech-recommended notebook PC that was seamlessly compatible with the system.

Key to the project's success was the system's mobility and durability. The DaqBook and expansion modules matched the notebook PC's form factor (8.5" x 11.5" x 1.375") and were mounted on top of each other with brackets, creating a compact system that easily fit inside the payload assembly box. The total system weighed a total of 27.9 lbs., easily meeting the project's weight limitations. The DaqBook system easily withstood the harsh flight environments, thanks in part to its rugged metal enclosures that protected and isolated the system's circuitry.

Conclusion

The DaqBook system's multichannel data acquisition capability, light weight, and ease of use made it possible for engineers to assess the conditions aboard the satellite launch missile. With the results, the engineers were able to assure that sensitive equipment would not be damaged during flight. The DaqBook system's extensive I/O and signal conditioning capabilities and low cost per channel make it a perfect solution for applications that require high performance and portability.

DaqBook/2000 Series

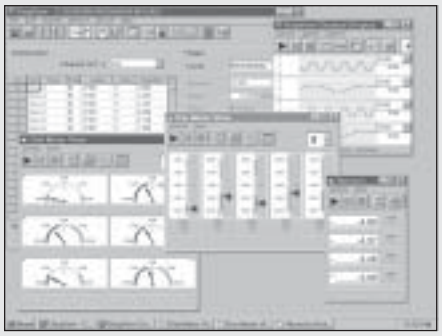
The DaqBook/2000® series of portable data acquisition devices are available with either a built-in Ethernet interface (model /2000E), or a parallel-port interface (model /2000A or /2000X). The Ethernet-based DaqBook/2000E can attach directly to the Ethernet port of a PC, or to an installed Ethernet network. The DaqBook/2000E also contains three parallel expansion ports, which can attach to an additional three parallel DaqBooks, thereby quadrupling the channel capacity of a single Ethernet link to the PC.

Features

- Analog input, frequency input, timer output, digital I/O, and analog output; all in one compact and portable enclosure
- Available with either an Ethernet PC connection, or a parallel port which can link directly to a PC parallel port, or with an interface to PCI bus, PC-Card slot, or ISA slot
- 16-bit, 200-kHz A/D converter
- Synchronous analog, digital, and frequency measurements
- 8 differential or 16 single-ended analog inputs (software selectable per channel)
- Expandable up to 256 analog input channels, while maintaining 200-kHz (5 µs per channel) scan rate
- Expandable up to 1024 analog inputs with DaqBook/2000E plus three slave parallel DaqBooks
- 512 location channel/gain FIFO, capable of scanning all channels, including expansion channels and digital/counter channels, at 5 µs per channel
- Trigger modes include analog, digital, & software, with <5 µs latency
- Virtually infinite pre-trigger buffer
- Optional four channel, 16-bit, 100-kHz analog output card installs internally
- 40 digital I/O lines scanned synchronously or asynchronously with analog inputs
- Digital I/O is expandable up to 272 lines, including isolation and relay closure options
- Four cascadable counter/pulse input channels scanned synchronously or asynchronously with analog inputs
- Two timer/pulse output channels
- Digital calibration — no potentiometers
- Multi-unit scan synchronization
- Vehicle network interface option

Signal Conditioning Options

- Signal conditioning and expansion options for thermocouples, strain gages, accelerometers, isolation, RTDs, etc.—over 40 DBK I/O expansion options in all



Software

- DaqView™ software with eZ-PostView™
- Included drivers for Visual Basic®, Delphi™ and C++ for Windows®; DASYLab®, TestPoint®, and LabVIEW®

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