



Innovative Integration of Electronics

Electronics Support Sensors and Measurement Systems

Analog and Digital Systems Group

The Analog and Digital Systems (ADS) Group uses modern electronic methods to bridge the gap between research scientists and solutions to nationally and internationally significant problems. This group specializes in the design of analog, digital, and mixed-signal electronics including complete supporting software from the device driver level to the user interface. Capabilities include printed circuit board design and layout, programmable logic devices, embedded microprocessors, low-power systems, and complete measurement system design and integration. The ADS Group thrives on providing innovative electronic solutions to challenging real-world problems.

Key Capabilities

- Analog circuits: Custom signal conditioning, low-noise high gain amplifiers, power modules, high-voltage bias supplies for detectors, circumvention circuits, etc.
- Digital circuits: Custom high-speed logic designs, bus interfaces, “interfacing” logic, etc.
- Programmable devices: PALs, PLDs, FPGAs, UARTs and DSP cores for FPGAs, microprocessors, VHDL, etc.
- Low-power systems: Battery-operated handheld “smart” instruments
- Software: Sample and control software to collect and process data from sensors and measurement systems

Block II Chemical and Biological Mass Spectrometer (CBMS)

The Block II Chemical Biological Mass Spectrometer (CBMS) is the first integrated system capable of detecting and identifying both chemical and biological warfare agents. It was developed for the U. S. Army Soldier and Biological Chemical Command for missions such as reconnaissance, point detection and stand-alone deployment. About the size of a two-drawer file cabinet, the instrument analyzes samples from the air and from the ground. The development team was led by ORNL and included the coordination of five divisions and several outside agencies. CBMS won the 2000 R&D 100 Award and is currently in pre-production by an industrial partner. Other potential applications include counter-terrorism, civil defense, and health care.



The Block II Chemical and Biological Mass Spectrometer won an R&D100 Award in 2000.

The ADS Group led the electronics development for the CBMS. This radiation-hardened system was designed to withstand rugged battlefield vehicle conditions such as vibration and shock. Key electronics components include:

- Embedded Computer System – ADS modified first Pentium to pass radiation tests.
- Three Custom CompactPCI Circuit Boards – Data acquisition and control, arbitrary waveform generation, and RF excitation generation and control.
- Low-Noise Analog Detection Electronics – delivers a new level of system sensitivity.
- Soldier Display Subsystem – compact embedded computer enclosure with removable media.
- QNX Operating System – ADS developed device drivers and real time control and sequencing software.

Small Handheld “Smart” Instruments

In addition to larger systems (such as the Block II CBMS), ORNL has extensive experience in the development of small handheld “smart” instruments. In many cases, the necessary signal processing can be accomplished in the handheld instrument. In other situations, preliminary analysis is conducted in the instrument with more detailed analysis conducted on a more powerful processing platform. These handheld “smart” instruments offer the following features:

- Low power for extended battery life
- Non-volatile on-board memory
- Flexible operating modes
- Interface to upload data to more powerful processing platforms



The Hotspotter (under development) is an inexpensive portable device capable of differentiating medical isotopes in the field.

Miniaturization of Measurement Systems

The Nuclear Material Identification System (NMIS) was pioneered by ORNL and the Oak Ridge Y-12 Plant to sense the presence of fissile materials inside closed containers.

Applications include nuclear materials control and accountability, process plant monitoring and control, nuclear criticality safety applications, nuclear warhead dismantlement, and nuclear arms control treaty verification. The system utilizes active and/or passive neutron and gamma interrogation to determine the characteristics of containers or devices containing fissile material. It also has the ability to perform active and passive gamma spectrometry. The ADS Group recently developed data acquisition electronics for the NMIS system. Some highlights of this system include:

- 5 analog input channels
- Sustained 1.0 GHz sampling
- Real-time data compression and formatting
- Powered by PCI bus to improve portability
- Field-upgradeable firmware for flexibility



In less than ten years, NMIS has been miniaturized from being moved by semi-tractors (see top photos) to being hand carried (see bottom photos).

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