# Computer Column/Bibliography/ Editorial

**A review of Data Acquisition boards for the Apple Macintosh by Ed Haskell**

If your have a Macintosh (Mac) in your laboratory you probably use it for word processing, spreadsheet analysis, and graphics, but not for data acquisition. The Mac got off to a slow start in that area. It was released without a compiler, was difficult to program when compilers were made available, and, until the SE was released it didn't have any expansion slots to which high-speed data acquisition peripherals could be attached. Well, things have changed and now you can hook up your Mac to the equipment you use for data-acquisition or you can replace that equipment entirely with off the shelf or custom designed data acquisition and controller boards from a variety of Macintosh vendors. You can also choose the degree of programming you feel capable of, from high-level Icon-based programming using National Instruments' LabVIEW, to low-level programming at the board and chip level using the NuBus prototyping board from Diversified I/O. And you can acquire your data using anything from the Mac 512 to the Mac II.

**National Instruments NB series of Nubus boards for the Mac II**

National Instruments is well established in the data-acquisition and control systems, providing boards for most bus architectures including Digital Equipment's UNIBUS and Q-Bus, the VMEbus, MULTIBUS, STD Bus, S-100, IBM PC and PS/2, and Apollo 3000/AT. It also produces products for the serial port on the Mac 512 as well as cards for the Mac SE and the Mac II. National Instruments provides perhaps the most powerful and comprehensive set of D/A, A/D, digital I/O, GPIB and multifunction boards available for the Mac II. Enhanced by DMA (Direct Memory Access) and their Real-Time System Integration feature (RTSI, which provides high speed inter-board timing controls). These boards provide "complex system board measurements never before possible on a personal computer", according to the manufacturer. National Instruments Mac II boards include:

*NB-GPIB* The NB-GPIB is an IEEE-488 interface board which enables data transfers between the Mac II and any of the thousands of IEEE-488 compatible instruments. A Mac II equipped with the NB-GPIB can be connected to up to 13 engineering, scientific, or medical instruments and can function under the LabVIEW software construction system (more on LabVIEW later) as well as conventional languages such as C, BASIC, FORTRAN, Pascal and Assembly. The NB-GPIB can reach transfer speeds of up to 1M bytes/sec when used with the RTSI and DMA capability of the (optional) NB-DMA-8-G board.

*NB-MIO-16* The NB-MIO-16 is a multifunction analog, digital, and timing input/output board. It contains a 12-bit (4K intervals) A/D converter with up to 16 analog inputs and sample rates of up to 111K samples/sec, two 12-bit D/A converters; 8 lines of TTL-compatible digital I/O, and three 16-bit counter/timer channels for frequency counting, event counting, and pulse output applications.

*NB-AO-6* The NB-AO-6 consists of six identical D/A converter channels each of which has a 4-20mA current output and a voltage output. The NB-AO-6 when used with the NB-DMA-8-G board can simultaneously generate six different waveforms at sample rates up to 300 kHz. These waveforms can be synchronized with functions of the other NB series boards using the capabilities of the RTSI bus interface.

*NB-DIO-32F* The NB-DIO-32F is a high-speed 32-bit parallel digital I/O board. The 32 lines of digital I/O are divided into four bytes and each byte can be programmed as either an input or an output port. This board, with its variety of digital I/O handshaking options enables the Mac II to function as a system controller with high-speed digital I/O capabilities for a wide variety of laboratory applications.

*NB-DIO-24* The NB-DIO-24 is a lower priced 24-bit parallel digital I/O board which can operate in either unidirectional or bidirectional mode and can generate interrupt request outputs to peripheral devices. It is the only board of the NB series which cannot use the RTSI bus trigger lines for inter-board synchronization.

*NB-DMA-8-G* The NB-DMA-8-G is a multifunction interface board which provides DMA data transfer support for the other NB series boards by means of the RTSI bus. It also provides RTSI bus timing and interrupt support to integrate and synchronize the operations of other NB boards. The NB-DMA-8-G has a built-in IEEE-488 interface capable of transfer rates of up to 1 Mbytes/sec (compatible with the fastest IEEE-488 instruments).

**Programming the NB series boards**

LabDriver Software from National Instruments provides the driver routines for the NB board functions that can be called from the user's application programs. LabDriver is installed with a utility into the user's operating system and can then be accessed directly from any language that supports system toolbox device manager calls (most of them). Language interface libraries which provide even easier access to the routines are presently available for Lightspeed C, MPW C and MS BASIC. An important feature of the LabDriver Software is the ease with which DMA transfers are handled when the NB-DMA-8-G board is installed. The same routines which use interrupt-driven transfers when the NB-DMA-8-G is not installed automatically implement DMA transfers when it is connected, invisible to the software user. Aside from routines for directly controlling the A/D, D/A, digital I/O and timing functions of the NB boards, the LabDriver

Software provides high-level routines which allow the user to perform high-speed timing I/O functions such as pulse generation, frequency generation, event counting and timed process control when used with the NB-DMA-8-G board. Routines are also available for use with the RTSI bus trigger lines allowing boards to share clocks and signals between boards and to synchronize board operations.

**Boards for the Mac SE**

GPIB-SE The GPIB-SE is an IEEE-488 interface board for the Mac SE with optional MC-68881 floating point coprocessor and DMA controller. The GPIB-SE hardware consists of a plug-in circuit card and a 7 inch ribbon cable that connects the board to an IEEE-488 connector that mounts on the back of the Mac SE case. Transfer rates of between 2k to 200 kbytes/sec are achieved with the basic unit (without DMA) depending on software driver and instrumentation. With DMA, maximum *reads* from a GPIB device are 1 Mbytes/sec and *writes* to a GPIB device at 700 kbytes/sec. The GPIB-SE comes with the National Instruments NI-488 software package which contains a set of BPIB routines accessed from most programming languages through system calls. High-level interfaces are available for MPW C, MS BASIC and MS FORTRAN. LabVIEW software can also be used with the GPIB-SE.

**Serial Interfaces**

GPIB-422CV The GPIB-422CV (the 'Micro Box') is basically an IEEE-488 converter box which allows any Macintosh computer (including the 128k Mac) to control a single GPIB device. The GPIB-422CV communicates with the Mac at a maximum rate of 5 kbaud, but can transfer buffered data to the GPIB device at up to 900 kbytes/sec. The box can be powered from an external supply or by batteries. The standard unit comes with 64 kbytes of RAM buffer and can be expanded to 256 kbytes. This unit can act as a dedicated GPIB controller when left connected to the Mac, or it can be disconnected from the Mac after data downloading and act as a high speed buffer for driving CAD/CAM devices such as large plotters. The GPIB-422CV can be used with LabVIEW software, however no more than one device may be connected at a time.

*GPIB-MAC* The GPIB-Mac was the first IEEE-488 controller available for the Mac. This unit can also be used with the 128k Mac although to use it with the LabView software requires at least 1 Mbyte of memory. The GPIB-MAC comes with buffer sizes of from 2 kbytes to 32 kbytes. Data transfer rates are limited by the rate of data exchange on the Mac RS-422 serial port. The GPIB-MAC can control up to 13 IEEE-488 devices.

**LabVIEW Software**

LabVIEW is a unique programming environment developed by National Instruments (and now licensed to other board makers) which frees the programmer from the low level routines required for programming in C, Pascal, FORTRAN, Basic etc. LabView provides pre-designed graphics output modules for the data being collected as well as 'virtual' control panels for controlling equipment directly from the Macintosh screen. The functions needed from a number of GPIB instruments can be consolidated into a single 'virtual instrument' on the Mac screen, and a single Icon representing this new arrangement can be stored and used in conjunction with other functions or instruments in future applications. Programming with LabView is 'data flow oriented' and is accomplished by connecting the inputs and outputs of pre-designed and custom built icons corresponding to the functions of the instruments being controlled. Complex statistical, matrix, signal processing and database functions are also Icon based and can be used for analysis of data collected through the GPIB bus or input from other programs such as Microsoft Excel. Before external equipment is connected to the Mac a virtual instrument can be constructed and computer generated data can be used to test the program. This feature makes LabVIEW well suited for prototyping and educational uses. LabVIEW can also be used with the NB series of boards which provide non-GPIB functions.

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## Bibliography

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## Editorial

* Readers will have noticed an unfortunate typographical error in the item on electronic mail and Fax communications in the last issue of Ancient TL. The country prefix to Dave Huntley's Fax # was given as USA and not Canada, as it should have been. This was a genuine error, and I offer my unreserved apologies, and trust that diplomatic relations can now be restored.

* Some articles are travelling a circuitous route before they reach me for first submission. I should be grateful if authors would take note of the guidelines, particularly the requirements concerning the Reviewer's report which must accompany the final version of an accepted paper.

* New Date List entry forms are now available from Durham which enable simplified entry of data for multiple date entries. For those who use Macintosh computers, the data entries can also be made using Excel and Word skeleton worksheets /documents. The first compilation for archaeologists is due this year.

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