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Summary

A NIM Committee working group has recently completed a specification that defines a standard digital bus for use with NIM modules. The standard bus is based on the General Purpose Instrumentation Bus of IEEE Standard 488. It incorporates a subset of the codes and conventions for the GPIB given in IEEE Standard 728. The standard bus definition also includes specifications for additional features and provisions that are special to the NIM application. The most prominent of these is the set of mnemonics defined for information transfer.

Introduction

In 1964 the National Instrument Methods committee (nee Nuclear Instrumentation Modules committee) first published the "Standard Nuclear Instrument Modules" specification [1]. It was one of the first standards intended to ease the process of assembling arrays of functional modular equipment into instrumentation systems. The NIM module, as it became known, is a simple concept in today's technological ecology. The NIM standard described the module in terms of: mechanical aspects such as shape, dimensions, and tolerances; power supply voltages; signal standards (mainly in terms of front panel input and output signals); and a 42-pin rear-panel connector for access to backplane wiring.

It must be remembered that this standard was conceived and completed before the technological revolution (still in progress) that introduced and proliferated the use and usefulness of small computers in nuclear instrumentation. In fact, the integrated circuit was just in its infancy--remember RTL and DTL? Thus, in addition to power distribution, the original rear-panel connector and backplane wiring specification included specific assignments for only a few specific pins and wires. The rest were considered "Spare" or "Reserved". Although these assignments could possibly be redefined, the rear connector and bin wiring are not adaptable to busing digital signals.

Since its original effort, the NIM committee has fostered the development of the CAMAC and FASTBUS standards, both of which are spinoffs of various stages of the technological revolution. These latter standards therefore incorporate increasingly sophisticated capabilities for exploiting, in nuclear instrumentation, the results of this revolution.

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Surprisingly, the NIM module continues to see heavy use, even in new designs. There have existed significant segments of instrumentation--amplifiers, discriminators, etc.--that have not demanded an interface with a computer. The superior shielding qualities of the module have also made it attractive for applications where noise suppression is an important factor. Inevitably, however, cases have arisen in which some degree of communication with a computer becomes desirable. It might be desirable to adjust the gain of an amplifier or to adjust the threshold of a discriminator by computer control, just to mention two examples. Thus, the need for a relatively simple way of adapting NIM modules to the new technology becomes obvious.

In 1982, the NIM committee established a working group to study the need and feasibility of defining a digital bus for NIM modules. Since the most practical choice for such a bus was the General Purpose Instrumentation Bus (GPIB) defined by IEEE Standard 488, the working group immediately became known as the NIM/GPIB Working Group, and focused its attention on adapting the GPIB for use with NIM. The resulting standard is titled: Standard NIM Digital Bus (NIM/GPIB) [2].

Raw Materials

The Working Group started with a rich store of raw materials. First, of course, was the NIM specification itself [1]. It was immediately resolved that no changes to existing specifications for the NIM module be changed--i.e., only features that did not conflict with the existing specification could be added.

The second item was the GPIB specification, IEEE Standard 488-1978 [3]. This standard was adopted completely, with one exception--the preferred GPIB connector orientation.

Designers and users of GPIB equipment had long recognized that, while IEEE 488 successfully defined a vehicle for digital data transmission, it nevertheless did not adequately answer questions regarding the formats and protocols by which instruments and computers exchange information by means of the GPIB. Fortunately for the working group, a second standard related to IEEE 488 made a timely appearance. This was IEEE Standard 728-1982, "Codes and Format Conventions for Use with ANSI/IEEE Std 488-1972" [4]. This document, which represented the third item of raw material, defines preferred methods (note the plural) for encoding and formatting data, commands and responses that are exchanged between instruments and controllers on the GPIB. In most cases where more than one method was defined for a given procedure, the Working Group selected the one or two methods that appeared most useful for NIM purposes.

The fourth type of material consisted of additional definitions which were felt to be necessary to complete the standard. Chief among these was the list of mnemonics that were selected as representing the most common types of parameters--i.e., controlled or measured variables--built into NIM hardware.

Elements of the Standard

Following is a short description of the principal elements of the NIM/GPIB standard.

Mechanical Features

The only mechanical features necessary to be defined for this purpose have to do with GPIB cables and connectors. GPIB connectors are to be mounted on the rear panels of NIM modules. It was deemed impractical to specify an exact location, since the rear panels are used for many other types of connectors, as well.

A vertical orientation of the connector is required by the NIM/GPIB standard. This is in disagreement with the preferred orientation given in IEEE Standard 488. However, on NIM modules, particularly single-width modules, this is the only practical orientation.

Codes and Formats

As described in the NIM/GPIB standard, the specification of a set of codes and formats for transmission of information has two important goals:

- a) To minimize the effort required to generate programs (software) for the controllers used with NIM systems interconnected by the GPIB; and
- b) To enhance the interchangeability of NIM/GPIB modules that fulfill similar functions.

As mentioned above, a set of codes and format conventions for the GPIB is given in IEEE Standard 728. The task of the Working Group was to choose a subset of these that provided all the desirable capabilities for transmission of information in NIM applications. It was felt that a narrowing of choices was necessary to achieve the two goals stated above.

Examples of areas in which conventions were chosen include: message separators (characters used to delimit messages or parts of messages); header fields (leading fields in messages); and program message formats (the sequence and separation of fields of a message).

The ways in which numeric data is to be encoded is also specified. Unless transmitted by means of a block transfer, numeric data is to be in decimal form, transmitted, of course, as ASCII characters. It may be formatted as signed or unsigned integer values, as signed or unsigned explicit point values (e.g., 123.45), or in floating point notation (e.g., 1.2345E02).

Block data may be transmitted either in

ASCII-coded decimal or in a binary code. A checksum method of error detection is specified.

NIM/GPIB modules are required to have the ability to respond to a serial poll on the GPIB. In response to a serial poll, the polled instrument responds with at least one byte of information describing various facets of its status. For NIM/GPIB use, specific definitions of the individual bits in the status byte are defined in the standard. This permits a single software routine to decipher status bytes returned by a variety of modules.

Operational Aspects

Several topics related to procedures and protocols are also addressed by the NIM/GPIB standard. The most significant of these is the subject of mnemonic codes. This subject was attacked by performing an extensive survey of existing NIM module designs to catalog the types of functions that they perform, particularly those functions that might be subject to monitoring or control via the GPIB. The result was the generation of three tables of mnemonics, verbs, nouns and modifiers. Examples taken from these three tables are given in Table I. The complete tables defined in the standard contain 19 verbs, 89 nouns and 51 modifiers.

In the Table, the "minimum mnemonic" is capitalized. The "minimum mnemonic" consists of up to four letters. It must be included in its entirety in any transmission. Additional characters, shown in brackets ([]), may optionally be included to make the command more readable.

Table I
Examples of Mnemonic Codes

Verbs

DISA[ble]	(inhibit, turn-off, lock)
ENAB[ble]	(turn-on, arm, activate)
SET	(adjust, change)
READ	
WRIT[e]	

Nouns

CHAN[nel]	
GAIN	
LLDI[sriminator]	(lower-level discriminator)
SHAP[ing-time-constant]	
VOLT[age]	

Modifiers

ABSOLute]
DC
LIVE
THRE[shold]

A command and associated data (if any) transmitted by a controller to a NIM module is to be transmitted in the following syntax:

VERB[NOUN[MODIFIER]][DATA][,DATA]...[,DATA].

In this syntax, optional fields are enclosed by square brackets. The minimum command, therefore, consists only of a verb. The com-

mand to enable the only process contained in a module could be conveyed by "ENAB", which is the four-character minimum mnemonic for "enable". Modules are required not to be confused by commands having more than the minimum mnemonic, and must also consider upper- and lower-case characters as having the same value. Thus, the command to enable could be transmitted as: "ENAB", "Enab", "enab", "Enable", etc. The intent here was to give the user an option. He may choose to write programs in which commands are sent via the GPIB in a minimum of characters, perhaps to gain speed. Or, he may opt to employ more characters than the minimum in order to make his program more readable.

Continuing the example above, one could enable a specific function within a more complex module by additional mnemonic fields--e.g.:

ENAB_COUNTER_LIVE.

Data may be appended to specify a value as in:

SET_HV_DC 400.

This command might be sent to set a high-voltage supply to 400 volts.

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References

1. "Standard Nuclear Instrument Modules", TID-20893(Rev. 4), July 1974. U.S. Department of Energy, Physical and Technological Research Division, Office of Health and Environmental Research, Washington, D.C. 20545.
2. "Standard NIM Digital Bus (NIM/GPIB)", DOE/ER-0173, August 1983. U.S. Department of Energy, Physical and Technological Research Division, Office of Health and Environmental Research, Washington, D.C. 20545.
3. "IEEE Standard Digital Interface for Programmable Instrumentation", ANSI/IEEE Std 488-1978, The Institute of Electrical and Electronics Engineers, 345 East 47 Street, New York, NY 10017.
4. "Code and Format Conventions for Use with ANSI/IEEE Std 488-1978", The Institute of Electrical and Electronics Engineers, 345 East 47 Street, New York, NY 10017.

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