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IEEE Standard Parallel Highway Interface System (CAMAC¹)

Sponsor

**Instrumentation and Detectors Committee
of the
IEEE Nuclear and Plasma Sciences Society**

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¹Computer Automated Measurement and Control

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Foreword

[This Foreword is not a part of ANSI/IEEE Std 596-1982 , IEEE Standard Parallel Highway Interface System (CAMAC).]

The interface system on which this standard is based was developed by the ESONE Committee of European Laboratories** with the collaboration of the NIM Committee of the US Department of Energy.* This standard is supplementary to ANSI/IEEE Std 583-1982, Modular Instrumentation and Digital Interface System (CAMAC), and is based on ERDA² Reports TID-25876, March 1972 (corresponding to ESONE Report EUR 4600e) and TID-25877. The mandatory features in this standard are identical to those in the preceding reports and in Publication 552 of the International Electrotechnical Commission (IEC). A serial highway interface system, also intended for use with ANSI/IEEE Std 583-1982, as defined in ANSI/IEEE Std 595-1982 , Serial Highway Interface System.

This standard was reviewed and balloted by the Nuclear Instruments and Detectors Committee of the IEEE Nuclear and Plasma Sciences Society. Because of the broad applicability of this standard, coordination was established with numerous IEEE Societies, Groups, and Committees, including the Communications Society, Computer Society, Industry Applications Society, Industrial Electronics and Control Instrumentation Group, Instrumentation and Measurement Group, and the Power Generation and Nuclear Power Engineering Committees of the Power Engineering Society.

The revision of this standard was in conjunction with the 1981 review (1982 issue) of the entire family of IEEE CAMAC standards undertaken to incorporate existing addenda and corrections into the standards.

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CAMAC and NIM Standards and Reports

Title	IEEE, ANSI Std No	IEC No	DOE No	EURATOM (EUR) or ESONE No
CAMAC Instrumentation and Interface Standards*	SH08482* (Library of Congress No 8185060)	—	—	—
Modular Instrumentation and Digital Interface System (CAMAC)	ANSI/IEEE Std 583-1982	516	TID-25875 [†] and TID-25877 [†]	EUR 4100e
Serial Highway Interface System (CAMAC)	ANSI/IEEE Std 595-1982	640	TID-26488 [†]	EUR 6100e
Parallel Highway Interface System (CAMAC)	ANSI/IEEE Std 596-1982	552	TID-25876 [†] and TID-25877 [†]	EUR 4600e
Multiple Controllers in a CAMAC Crate	ANSI/IEEE Std 675-1982	729	DOE/EV-0007	EUR 6500e
Block Transfers in CAMAC Systems	ANSI/IEEE Std 683-1976 (Reaff 1981)	677	TID-26616 [†]	EUR 4100 suppl
Amplitude Analog Signals within a 50 Ω System	—	—	TID-26614	EUR 5100e
The Definition of IML A Language for Use in CAMAC Systems	—	—	TID-26615	ESONE/IML/01
CAMAC Tutorial Articles	—	—	TID-26618	—
Real-Time BASIC for CAMAC	ANSI/IEEE Std 726-1982	‡	TID-26619 [†]	ESONE/RTB/03
Subroutines for CAMAC	ANSI/IEEE Std 758-1979 (Reaff 1981)	713	DOE/EV-0016 [†]	ESONE/SR/01
Recommendations for CAMAC Serial Highway Drivers and LAM Graders for the SCC-L2	—	—	DOE/EV-0006	ESONE/SD/02
Definitions of CAMAC Terms	Included in SH08482	678	DOE/ER-0104	ESONE/GEN/01
Standard Nuclear Instrument Modules NIM	—	547**	TID-20893 (Rev 4)	—

*This is a hard cover book that contains ANSI/IEEE Std 583-1982, ANSI/IEEE Std 595-1982, ANSI/IEEE Std 596-1982, ANSI/IEEE Std 675-1982, ANSI/IEEE Std 683-1976 (Reaff 1981), ANSI/IEEE Std 726-1982 and IEEE Std 758-1979 (Reaff 1981), plus introductory material and a glossary of CAMAC terms.

[†]Superseded by corresponding IEEE Standard listed.

[‡]In preparation.

**Covers only mechanical features and connector pin assignments.

NOTE — Availability of Documents

ANSI	Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.
IEEE	IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey 08854, USA.
IEC	International Electrotechnical Commission, 1, rue de Varembe, CH-1211 Geneva 20, Switzerland.
DOE and TID Reports	National Bureau of Standards, Washington, D.C. 20234, USA, Attn: L. Costrell.
EURATOM	Office of Official Publications of the European Communities, P.O. Box 1003, Luxembourg.
ESONE	Commission of the European Communities, CGR-BCMN, B-2440 GEEL, Belgium, Attn: ESONE Secretariat, H. Meyer.

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An American National Standard

IEEE Standard Parallel Highway Interface System (CAMAC)

1. Introduction

The Dataway defined in ANSI/IEEE Std 583-1982, Modular Instrumentation and Digital Interface System, is the basis for all CAMAC* systems. It provides the means of interconnection between modules and a crate controller within one crate. This standard defines the CAMAC Parallel Highway Interface System for interconnecting up to seven CAMAC crates (or other devices) and a system controller. The Parallel Highway, so called because the data bits are transmitted along the Highway in parallel, is capable of handling higher data rates than nonparallel highways. However, in some applications, for example, where there are long distances between crates or where simplicity of interconnections is particularly important, the Serial Highway of ANSI/IEEE Std 595-1982, Serial Highway Interface System (CAMAC), may be more suitable.

This standard defines the signals, timing, and logical organization of the connections from crate controllers and Parallel Highway Drivers to the Parallel Highway through a standard connector. The internal structures of crate controllers and Parallel Highway Drivers, and the physical construction of the Parallel Highway System are defined only where they affect compatibility between parts of the system.

An appendix defines in more detail those features of the crate controller that affect hardware and software compatibility. The appendix can be used as a formal specification of a standard crate controller, Crate Controller Type A-1 (CCA-1), or as a general recommendation to promote uniformity between crate controllers.

Since a number of Parallel Highways can be used to assemble a large system (as discussed in Section 3.), a CAMAC Parallel Highway, together with its connected equipment and its Driver, is designated a CAMAC Branch. The CAMAC Parallel Highway Driver is thus commonly referred to as the CAMAC Branch Driver. Associated terms are Branch Demand, Branch Address, Branch Initialize, Branch operation, etc. The use of these designations is continued in this standard. Where the meaning is clear, shortened terms, usually with the prefix CAMAC omitted, are also used.

2. Interpretation

This standard is a reference text describing and defining the CAMAC Parallel Highway Interface System (CAMAC Parallel Highway System). It should be read in conjunction with, and is supplementary to, ANSI/IEEE Std 583-1982. No part of this standard is intended to supersede or modify ANSI/IEEE Std 583-1982.

In this standard there are mandatory requirements, recommendations, and examples of permitted practice.

Mandatory clauses of the specification are enclosed in a box, as here, and usually include the word *must*.

Definitions of recommended or preferred practice (to be followed unless there are sound reasons to the contrary) include the word *should*.

Examples of permitted practice generally include the word *may*, and leave freedom of choice to the designer or user.

In order to *conform* with the specification of the CAMAC Parallel Highway System, an equipment or system must satisfy all the mandatory requirements in this standard, excluding the appendix. If constructed as a CAMAC plug-in unit the equipment must also satisfy the mandatory requirements of ANSI/IEEE Std 583-1982.

Section A.1 of this standard's appendix defines Parallel Crate Controller Type A-1 in such a way that operationally interchangeable units can be produced by different manufacturers. See Section A.1.1 of the Appendix regarding conforming with the specification of the CAMAC Crate Controller Type A-1.

The single letter designations *A*, *B*, *C*, *D*, and *E* (prefixed in some cases by "CC") are reserved for future use in connection with this standard and are not to be used until assigned.

In order to be *compatible* with the CAMAC Parallel Highway System, equipment need not satisfy all the mandatory requirements but must not interfere with the full operation of all the features of the Parallel Highway System and crate controllers (including Type A-1) as defined in this standard.

No part of this document is intended to exclude the use of equipment that is compatible in the above sense, even if it does not conform fully to the specification or is not constructed as CAMAC plug-in units.

3. The Branch

A multicrate CAMAC system consists of one or more *Branches*, each having a *Branch Highway* which is the means of interconnection between a *Branch Driver* and *crate controllers*. During each *Branch operation* the Branch Driver can communicate with a maximum of seven crate controllers. All Branch Drivers and crate controllers have standard *Branch Highway ports*¹ by which they are connected to the Highway. Each port consists of a 132-contact connector (for 65 signals and their individual return lines, plus cable shield) with defined contact allocations and signal conventions. Each crate controller has two identical internally linked ports in order to allow the Branch to have the chain configuration shown in Fig 1. Other configurations are possible, such as that shown in Fig 2, where the Branch Driver is not at the end of the Branch and some crates are connected by only one port.

¹In the sense, that a *port* is 'an entrance or exit of a network, etc.'

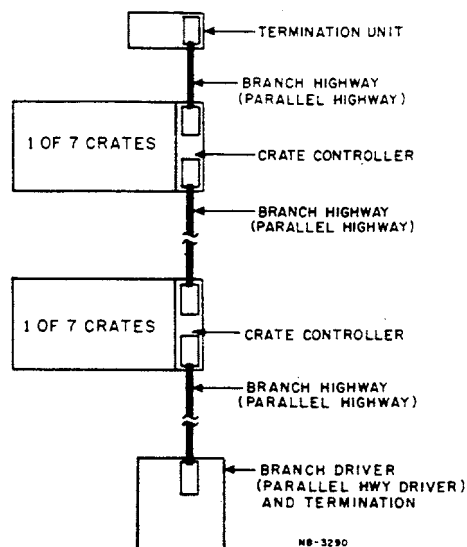


Figure 1— CAMAC Branch: Chain Configuration

In addition to their normal *on-line* state, crate controllers have an *off-line* state which allows them to remain physically connected to the Branch while ignoring (and not impeding) all Branch operations. If required, the Branch Driver can recognize which crate addresses are associated with on-line crate controllers.

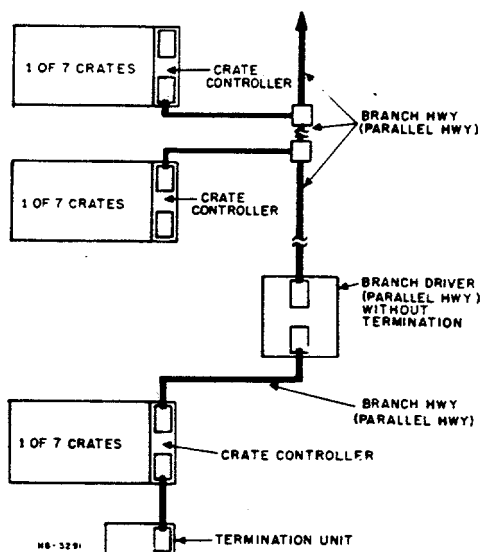


Figure 2— CAMAC Branch: Example of an Alternative Configuration

The basic mode of operation of the Branch is the *command mode*. The Branch Driver, which is typically associated with a system controller or computer, issues a command during each Branch operation. This command includes crate address information to select one or more crate controllers. Each addressed crate controller accepts the command from the Branch Highway and generates the corresponding Dataway command (station number, subaddress, and function). During *read* operations data signals are generated by a module on the Dataway Read lines, transferred to the data lines of the Branch Highway by the crate controller, and accepted by the Branch Driver. During *write* operations the Branch Driver generates data signals on the Branch Highway, and these are transferred to the Dataway Write lines by the crate

controller, and accepted by a module. During other command operations there is no transfer of read or write data via the Branch Highway.

The Branch has two *demand handling* features which allow the Branch Driver to respond to Look-at-Me (LAM) signals from modules. For single-level demand handling, which merely indicates the presence of demands without identifying them, the crate controllers combine the LAM signals to form a common *Branch Demand* signal. For multilevel demand handling, which allows the Branch Driver to identify twenty-four different demands, there is the *Graded-L mode* of Branch operation. The Branch Driver issues a Graded-L Request (typically as the result of receiving the Branch Demand signal) and each on-line crate controller responds by selecting or rearranging its LAM signals to form a 24 bit Graded-L word. The Graded-L words from all crates are combined on the Branch Highway and presented to the Branch Driver.

At a Branch Highway port the *Data* lines are used in the command mode for information transfers in either direction between crate controllers and the Branch Driver. These lines are also used to convey the pattern of demands in the Graded-L mode.

Transfers in either mode through a Branch Highway port are controlled by interlocking *timing signals*, which automatically adjust the timing of each Branch operation to suit the actual transmission delays and controller performance that are encountered.

Initialize is the only *common control* signal that is transmitted through the Branch Highway port to the Dataway.

Highway Length Limitations (Supplementary Information). The standard Branch Highway uses a single-ended (unbalanced) mode of signal transmission. This mode gives reliable transmission in systems where the total length of the Highway is not excessive. The Branch Highway length can be extended considerably by the use of single-ended to balanced converters. This subject is discussed in Section A.2 of the appendix.

4. Use of Lines at a Branch Highway Port

Each line at a Branch Highway port must be used in accordance with the mandatory requirements detailed in the following sections. Table 1 shows the titles, the standard designations, and the sources of the signals. Lines at a port are distinguished from corresponding lines in the Dataway by the prefix *B*, for example, the function code is carried by *F* lines in the Dataway and *BF* lines at a Branch Highway port.

4.1 Command

The command signals are used to control operations in the command mode, at which time the signal on the *BG* line (see Section 4.4.2) must be in the **0** state. They are transmitted by the Branch Driver on the *BCR*, *BN*, *BA*, and *BF* lines at the Branch Highway port (see following text).

4.1.1 Crate Address *BCR1–BCR7*

The seven crate controllers that can be addressed during any Branch operation must each be associated with a different *BCR* line (although all Branch Highway ports have provision for all seven *BCR* lines).

Each crate controller must therefore include means, such as a switch or patch connection, for selecting the appropriate *BCR* line (referred to as *BCR_i*). The assignment of *BCR* lines to crates is not necessarily related to the physical arrangement of crates within the Branch. The Branch Driver is permitted to generate signals simultaneously on more than one *BCR* line in order to select several crates for the same operation.

Table 1— Signal Lines at Branch Highway Ports

	Title	Designation	Generated by	Signal Lines	Use
Command	Crate Address	<i>BCR1–BCR7</i>	Branch Driver	7	each line addresses one crate in the branch
	Station Number	<i>BN1</i> , 2, 4, 8, 16.	Branch Driver	5	binary coded station number
	Subaddress	<i>BA1</i> , 2, 4, 8.	Branch Driver	4	as on Dataway <i>A</i> lines
	Function	<i>BF1</i> , 2, 4, 8, 16.	Branch Driver	5	as on Dataway <i>F</i> lines
Data	Read/Write	<i>BRW1–BRW24</i>	Branch Driver <i>W</i> or Crate Controller <i>R</i> , <i>GL</i>	24	for Read data, Write data, and Graded- <i>L</i>
Status	Response	<i>BQ</i>	Crate Controller	1	as on Dataway <i>Q</i> line
	Command Accepted	<i>BX</i>	Crate Controller	1	as on Dataway <i>X</i> line
Timing	Timing A	<i>BTA</i>	Branch Driver	1	indicates presence of command, etc
	Timing B	<i>BTB1–BTB7</i>	Crate Controller	7	each line indicates presence of data, etc, from one crate controller
Demand Handling	Branch Demand	<i>BD</i>	Crate Controller	1	indicates presence of demand
	Graded- <i>L</i> Request	<i>BG</i>	Branch Driver	1	requests Graded- <i>L</i> operation

Table 1— Signal Lines at Branch Highway Ports (Continued)

	Title	Designation	Generated by	Signal Lines	Use
Common Control	Initialize	<i>BZ</i>	Branch Driver	1	as on Dataway <i>Z</i> line
Reserved		<i>BV6</i> and <i>BV7</i>		2	for future requirements
Free		<i>BV1–BV5</i>		5	for non-standard user requirements

NOTE — An individual return line is provided for each signal line. Two lines are provided for a connection to the shield, if any, of the Branch Highway cable.

Table 2— Station Number Codes Used in Crate Controllers

<i>N</i> Code	<i>Use</i>	<i>B</i>, <i>S1</i>, and <i>S2</i>	<i>Remarks</i>
<i>N</i> (0)	reserved		
<i>N</i> (1) – (23)	address the corresponding normal station	yes	normal stations occupied by the controller need not be addressed
<i>N</i> (24)	address preselected normal stations	yes	
<i>N</i> (26)	address all normal stations	yes	
<i>N</i> (28)	address crate controller only	yes	
<i>N</i> (30)	address crate controller only	no	no Dataway operation
<i>N</i> (25, 27, 29, 31)	reserved		

It is recommended that the crate controller should include a means of protection against spurious signals on the selected *BCR* line. For example, the incoming *BCR* signal or an internal signal derived from it may be conditioned by integration.

It will be seen later, in Section 4.3, that each crate controller is associated with not only one of the *BCR* lines but also the corresponding one of seven *BTB* lines.

The Branch is not in a valid operating condition if more than one on-line crate controller is connected to the same *BCR* line. A means of reducing the risk of this occurring is suggested in Section 5.4.

4.1.2 Station Number *BN1*, 2, 4, 8, 16

Signals on these five lines indicate the binary coded station number to be used within the selected crate or crates, and are decoded in the crate controller. In a crate controller the 32 codes are allocated as shown in Table 2.

At least one normal station is occupied by the crate controller, and there are station number codes to address the remaining 23 normal stations individually. In addition there are codes to multiaddress all normal stations or those stations indicated by the contents of a *Station Number Register* (SNR). Two further station number codes address the controller and its extensions irrespective of their location in the crate.