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Multiple Controllers in a CAMAC* Crate

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Prepared and Adopted by

U.S. NIM Committee
(National Instrumentation Methods)
and ESONE Committee of European Laboratories
(European Standards on Nuclear Electronics)

March 1978

* Computer Automated Measurement and Control

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ABSTRACT and FOREWORD

This report makes provision for the use of auxiliary controllers in a CAMAC crate to extend the capabilities and fields of application of the CAMAC modular instrumentation and interface system of IEEE Standard 583-1975 (EUR 4100e). The ESONE document corresponding to this report document is EUR 6500e.

Auxiliary controllers, located in several crates on a CAMAC Command Highway (Parallel Branch or Serial) can provide the user with an extremely effective distributed processing capability. This capability is useful in both data-acquisition and automatic control systems where parallel processing is desirable. Auxiliary controllers can be of various degrees of sophistication and some may include processor elements for increased autonomy from central computers.

A further extension of the AC-based CAMAC system may include a special communication channel direct from an AC to another element in the system. High speed block transfer of data can be effected to and from the AC in such a case.

To permit use of the auxiliary controllers in CAMAC crates, this report defines the hardware and protocol so as to:

(1) Provide means for granting control of the Dataway to auxiliary controllers that request control and to provide a priority selection scheme to arbitrate in the case of simultaneous requests from multiple controllers.

(2) Provide means for the auxiliary controller to address (a) the dedicated module address lines and (b) the dedicated interrupt request LAM (Look-at-Me) lines, all of which terminate only at the crate controller station and at the module stations to which they are dedicated.

KEY Words

CAMAC
Computer Interfacing
Control Systems
Distributed Control
Instrumentation
Interfaces
Standards

ABBREVIATIONS USED

AC   Auxiliary Controller
ACB   Auxiliary Controller Bus
ACL   Auxiliary Controller Lockout
CC   Crate Controller
R/G   Request Grant

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CAMAC SPECIFICATIONS AND REPORTS

Title	IEEE, ANSI Std No.	IEC No.	DOE No.	EURATOM (EUR) No. or ESONE No.
Modular Instrumentation and Digital Interface System (CAMAC)	IEEE 583-1975* ANSI/IEEE 583-1975*	516	**	EUR 4100e
Serial Highway Interface System (CAMAC)	IEEE 595-1976* ANSI/IEEE 595-1976*	+	**	EUR 6100e
Parallel Highway Interface System (CAMAC)	IEEE 596-1976*	552	**	EUR 4600e
Block Transfers in CAMAC Systems	IEEE 683-1976	+	**	EUR 4100 suppl
CAMAC Instrumentation and Interface Standards***	SH06437*** (Library of Congress No. 76-39660)	-	-	-
Amplitude Analogue Signals within a 50Ω System	-	-	TID-26614	EUR 5100e
The Definition of IML A Language for use in CAMAC Systems	-	-	TID-26615	ESONE/IML/01
Multiple Controllers in a CAMAC Crate	+	-	DOE/EV-0007	EUR 6500e
CAMAC Tutorial Articles	-	-	TID-26618	-
Real-Time BASIC for CAMAC	-	-	TID-26619	ESONE/RTB/02
Recommendations for CAMAC Serial Highway Drivers and LAM Graders for the SCC-L2	-	-	DOE/EV-0006	ESONE/SD/02
Supplement to CAMAC Standards and Reports	+	-	DOE/EV-0009	-

*Includes supplementary information
**Superseded by corresponding IEEE Standard listed
***This is a hard cover book that contains IEEE Stds 583-1975, 595-1976, 596-1976 and 683-1976 plus introductory material
+In preparation

AVAILABILITY OF DOCUMENTS

IEEE — IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey 08854, U.S.A.

IEC — International Electrotechnical Commission, 1, rue de Varembe, CH-1211 Geneva 20, Switzerland

DOE & TID Reports — National Bureau of Standards, Washington, D.C. 20234, U.S.A., 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

CONTENTS

1. INTRODUCTION

This standard defines a method for incorporating more than one source of control into a CAMAC crate. The standard fully conforms to the mechanical and signal standards of the CAMAC system as described in. IEEE Std 583-1975 or EUR 4100e.

In order to allow more than one Controller to access the Dataway of a CAMAC Crate, an Auxiliary Controller Bus (ACB) and priority arbitration protocol are fully defined. This permits the use of Auxiliary Controllers (AC's) in normal stations in the crate. The ACB carries encoded address information from an AC to the Crate Controller (CC) in the control station of a CAMAC crate, and carries Look-at-Me signals from the CC to the AC's. The ACB, connected between controllers, may also be used to establish priority for control of the CAMAC Dataway.

This standard is fully compatible with the CAMAC Serial Highway Interface System (IEEE Std 595-1976 or EUR 6100e) and the CAMAC Parallel Highway Interface System (IEEE Std 596-1976 or EUR 4600e). It may also be used in autonomous systems (systems with no external highways) or in systems with Type U Crate Controllers (such as systems with a computer I/O bus as the highway).

Section A1 of the Appendix to this standard defines a Parallel Highway Crate Controller, Type A-2. This controller is similar to Crate Controller Type A-1 (as defined in Section A1 of the Appendix to IEEE Standard 596-1976 or EUR 4600e)., except for the ACB connector and the priority arbitration protocol. When these two features are not required, Crate Controllers Types A-1 and A-2 are totally interchangeable.

2. INTERPRETATION

This standard is a reference text describing and specifying multi-source control within a CAMAC crate. It should be read in conjunction with, and is supplementary to, IEEE Stds 583-1975, 595-1976, and 596-1976 or EUR 4100e, EUR 6100e, and EUR 4600e, respectively.

No part of this standard is intended to supersede or modify the above-mentioned standards.

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

> Mandatory clauses of the standard are enclosed in a box, as here, and usually include the word "must."

Definitions of recommended practices (those 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 specifications of this standard, 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 IEEE Std 583-1975 or EUR 4100e.

Section Al of this standard's Appendix defines the Parallel Crate Controller Type A-2 in such a way that Type A-2 Controllers produced by different manufacturers will be operationally interchangeable. The main text to this standard contains a less restrictive definition of Controllers that are not necessarily interchangeable. See Section Al of the Appendix regarding conformity with the specification of the CAMAC Crate Controller Type A-2.

> In order to be "compatible" with the ACB, equipment need not satisfy all the mandatory requirements, but must not interfere with the full operation of all the features of Controllers which "conform" to this standard.

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

No license or permission is needed in order to use this standard.

3. THE AUXILIARY CONTROLLER BUS AND ASSOCIATED FRONT PANEL SIGNALS

The standard CAMAC crate, described in IEEE Std 583-1975 or EUR 4100e requires the presence of a Controller to control and coordinate the activities of the crate. During a Dataway addressed command operation, the Controller establishes the necessary signals on the B, N, A, F, S1, and S2 lines to define the command operation to be performed and to define the timing of the operation. During addressed command operations involving data, the Controller transmits or receives data via the W or R lines, respectively. During unaddressed operations, the Controller establishes the necessary signals on the B, S1, S2 and C or Z lines. The Controller may establish the state of the I signal and may monitor the state of the L, X, and Q signals.

Each CAMAC crate has one control station, which is the only station providing access to the N and L lines. The control station and a normal station together provide access to all signal lines needed by a Controller to perform the operations described above. The Controller which occupies the control station

is designated the Crate Controller (CC) of the crate. Examples of CC's are the Serial Highway Crate Controller Type L-2 (Section A1 of the Appendix of IEEE Std 595-1976 or EUR 6100e) and the Parallel Highway Crate Controller Type A-2 (Section A1 of the Appendix of this document).

An additional source of control within a CAMAC crate can be provided by an Auxiliary Controller (AC), which occupies one or more normal stations. In order to accommodate AC's, two features are required: (1) access to the N and L lines at normal stations, and (2) priority arbitration for control of the Dataway. Access to the N lines is necessary to allow an AC to generate a complete addressed command operation. Access to the L lines is necessary if an AC is to respond to Look-at-Me signals from other modules and/or controllers. Priority arbitration protocol insures that at any time only one Controller is permitted to have control of the Crate. It also provides the means for assigning control of the Dataway on the basis of a prearranged priority.

Access to the N and L lines is provided by the ACB (see Sections 4.2 and 4.3) via the CC. A Controller which conforms to this standard requires a connector on its rear panel for connection to the ACB. All lines on the ACB are bussed to each Controller as in Fig 1.

When an AC performs an addressed command operation, it generates the 5 bit binary code for the station number associated with the command, and transmits it via the Encoded-N lines of the ACB. The CC receives this Station Number Code, decodes it, and places a logic "1" on the appropriate Dataway N line at the control station. The CC receives the 24 L signals at the control station and passes these signals to the ACB connector.
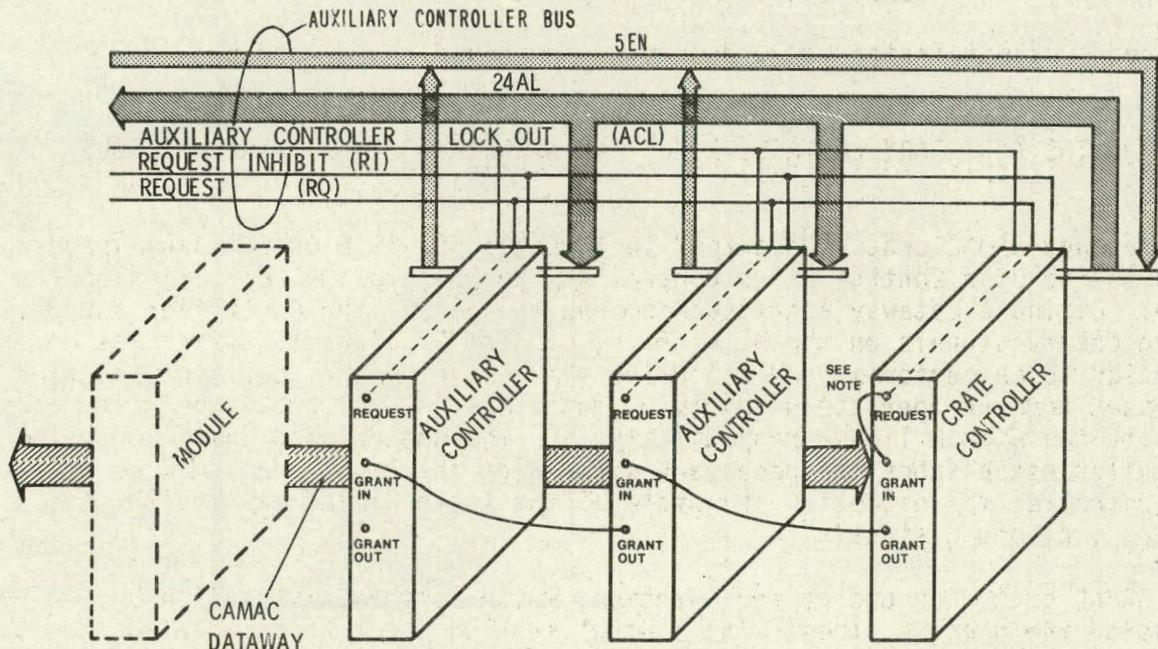
Fig. 1 Multiple Controllers in a CAMAC Crate

The minimum requirement for a CC which permits the use of AC's is that it links the Dataway L lines to the ACB and contains the N-decoder, the ACB connector, and pull-up current sources as in Fig 2.

The priority arbitration consists of two modes: Request/Grant (R/G) and Auxiliary Controller Lockout (ACL). The preferred arbitration mode is the R/G protocol.
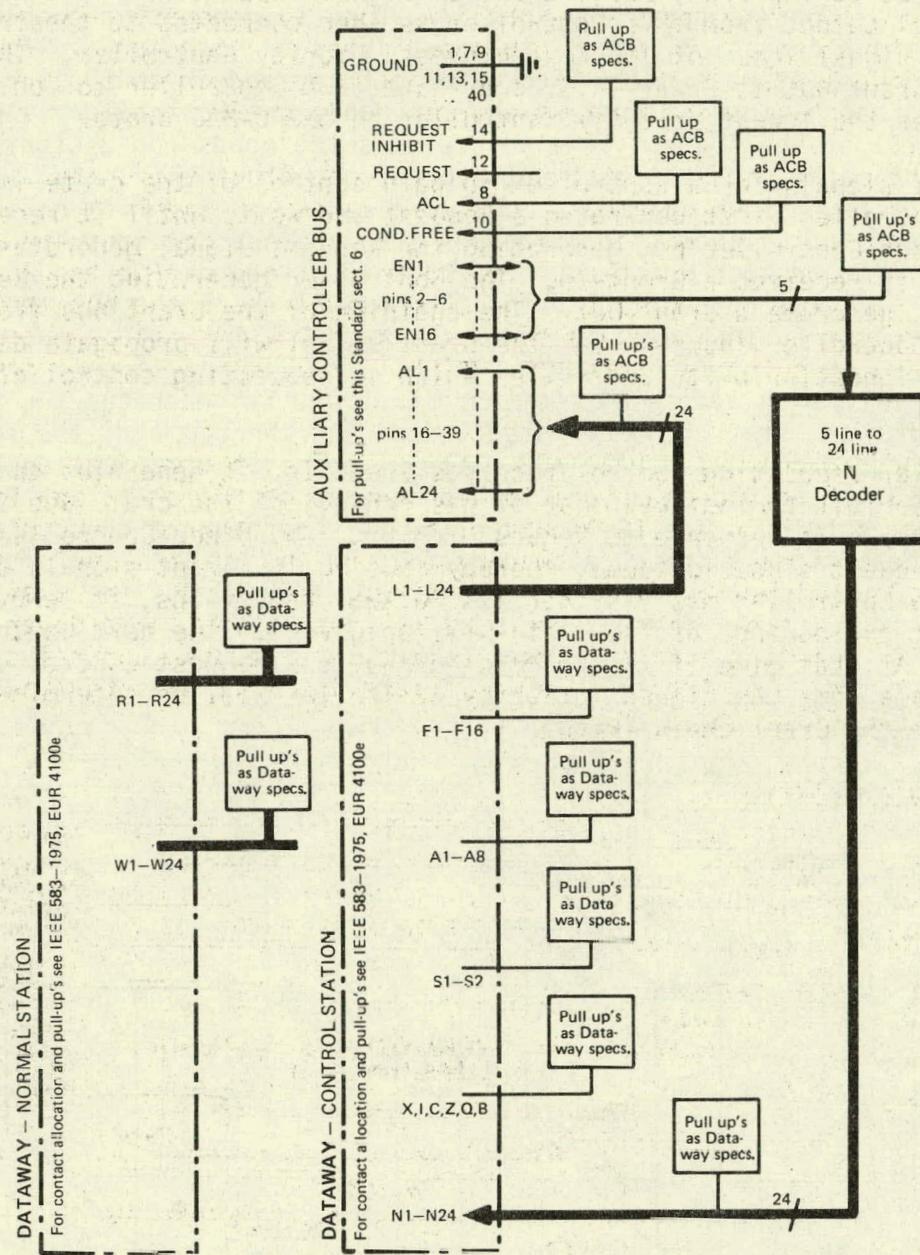
Fig. 2 Crate Controller, Minimum Configuration

Three signals are involved in this mode: (1) the REQUEST signal which is
bussed to each Controller on the ACB and is accessible at a front panel
connector on each controller; (2) the Grant signal which is daisy-chained,
i.e. the Grant-Out of one Controller is connected to the Grant-In of another
Controller by front panel connectors; and (3) the Request Inhibit signal
which is also bussed on the ACB.

The front panel Request signal output of the highest priority Controller
will be connected to its front panel Grant-In signal input. The front panel
Grant-Out signal output from this Controller is then connected to the front
panel Grant-In signal input of the next highest priority Controller. The
connection of Grant-Out to Grant-In is continued from Controller to Controller
until it reaches the lowest priority Controller in the CAMAC crate.

The sequence of signals for a Controller to gain control of the crate is shown
in Fig 3. A Controller first generates a Request and waits until it receives
a Grant-In. Each Controller not generating the Request signal generates a
Grant-Out when it receives a Grant-In. The Controller generating the Request
signal does not generate a Grant-Out. The chaining of the Grant bus from
Controller to Controller insures that the Grant signal will propagate down-
stream to the highest priority Controller which is requesting control of the
Dataway.

When a Controller requesting control receives Grant-In, it generates and main-
tains Request Inhibit to indicate that it has control of the crate and it removes
its Request signal. In response to Request Inhibit, any other Controllers also
remove their Request signal outputs, thereby causing the Grant signals to be
removed. When a Controller has finished its Dataway operations, it removes its
Request Inhibit and control of the crate will be given to the next Controller
requesting it. At that time if two or more Controllers request control of the
crate at the same time the highest priority Controller will be determined by
its position on the Grant chain (Figure 1).
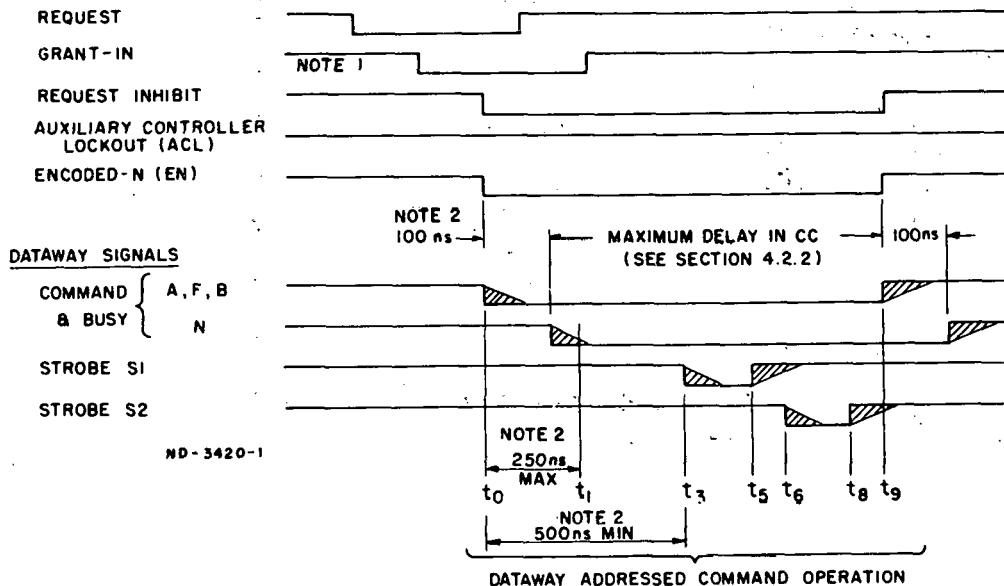
Fig. 3   Sequence of Signals for an AC to Gain Control of
Dataway for an Addressed Command Operation

Gain of control of the crate by a Controller is delayed if the Dataway is already in use. If a Controller is connected to an external highway, the interface to the highway is required to accommodate this delay. An example of a highway interface that can accommodate this delay is the CAMAC Parallel Highway (IEEE Std 596-1976 or EUR 4600e). The R/G mode is unsuitable for a Controller which can not accommodate this delay. An example is the Serial Crate Controller Type L-2 (IEEE Std 595-1976 or EUR 6100e). When a Serial Highway Crate Controller Type L-2 is addressed by the Serial Highway it will proceed with its Dataway operation independently of the R/G protocol.

The Auxiliary Controller Lockout (ACL) feature is provided to accommodate a Controller which cannot tolerate the delay associated with the R/G protocol. In a given crate, only one Controller (which may be either an AC or the CC) is allowed to use ACL to gain control of the crate. The ACL signal is bussed on the ACB to all other Controllers in the crate. Upon receiving this signal, a Controller which has control of the crate will either abort or complete its operation before the Controller generating ACL starts its Dataway operation (see Section 4.1.5). Examples of the sequences of signals that may occur with the ACL signal are shown in Figures 4(a) and 4(b).
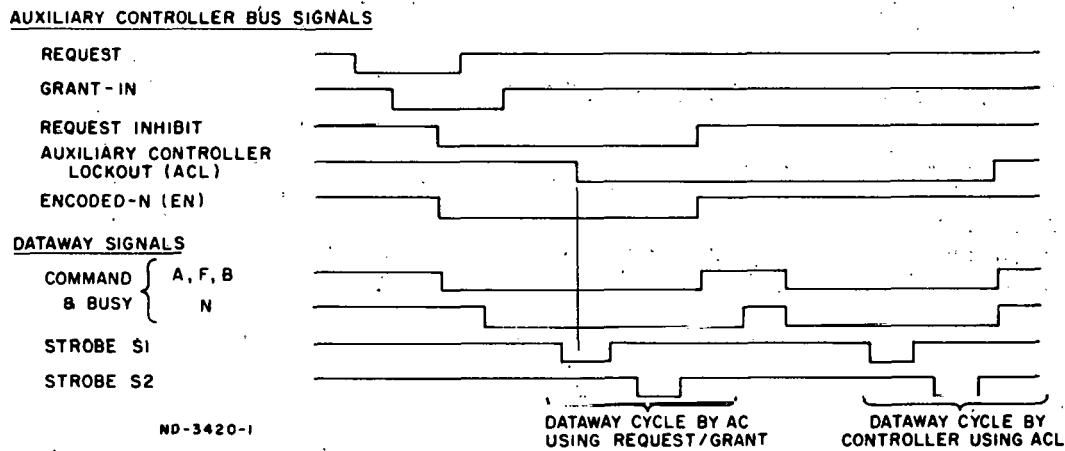

Fig. 4a   Example of a Sequence in which Auxiliary Controller Lockout
(ACL) Signal is Generated too Late to Cause Aborting of
Dataway Cycle Started by AC using Request Grant
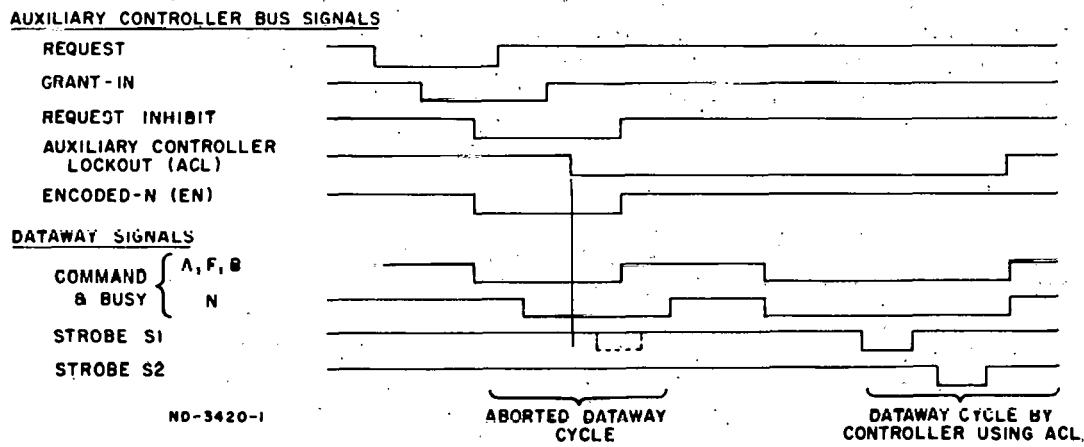
Fig. 4b   Example of Sequence in which a Dataway Cycle,
started by AC using Request/Grant, is Caused to
Abort by ACL Signal Generated by another Controller

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The necessary connections of the Request, Grant, Request Inhibit and ACL lines are illustrated in Fig 1.

The Serial Crate Controller Type L-2, as described in the Appendix to IEEE Std 595-1976 and EUR 6100e, does not have an ACB connector. However, its SGL-Encoder connector may be used to connect to the ACB since the signals on the ACB are a subset of those on the SGL-Encoder connector. With such an interface, the Serial Crate Controller Type L-2 may thus be used as a CC compatible with this standard.

The unaddressed operations, Dataway Initialize Z and Dataway Clear C, do not require use of the Encoded-N signals of the ACB. However, the Controller still uses one of the priority arbitration modes to gain control of the crate before issuing either of these commands. Care should be taken that a Dataway Z or C from one Controller does not adversely affect the operations of another Controller.

The Dataway Inhibit I is not associated with Dataway operations and may be generated at any time by either Controllers or other plug-in units. In contrast to requirements on other plug-in units (see Section 5.5.2 of IEEE Std 583-1975 or EUR 4100e), Controllers capable of generating and maintaining Dataway I do not respond to Z·S2 by generating and maintaining Dataway I.

4. USE OF THE LINES ON THE AUXILIARY CONTROLLER BUS AND ASSOCIATED SIGNALS

> Each line at the ACB connector and the associated front panel signal connectors 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 defined in this section.

4.1 CONTROL SIGNALS

> A Controller, when used in a CAMAC crate having one or more other Controllers, must not generate any Dataway signals, with the exception of the Dataway I and the L(s) of the station(s) it occupies, unless it has gained control of the crate or is addressed as a module. A Controller must gain control by generating Request in the R/G mode or ACL in the ACL mode. It should preferably gain control by the R/G mode unless there are strong technical reasons to the contrary.

4.1.1 Request

> In order to gain control of the crate when using the R/G protocol, a Controller must first generate a logic "1" signal on the Request signal line. It must not, however, initiate the 0→1 transition of the Request signal unless Request Inhibit and ACL are both logic "0". If it is generating a Request, it must initiate the 1→0 transition of Request within 50 ns upon receiving either Request Inhibit = 1 or ACL = 1.

TABLE 1

SIGNALS LINES AT THE AUXILIARY CONTROLLER BUS CONNECTOR AND ASSOCIATED FRONT PANEL CONNECTORS

Title	Location	Designation	Generated by	Signal lines	Use
Request	ACB and front panel	RQ	CC or AC	1	Indicates request for control
Grant-In	front panel	GI	CC or AC	1	Indicates request is granted
Grant-Out	front panel	GO	CC or AC	1	Issued by controller when GI is received but controller is not requesting
Request Inhibit	ACB	RI	CC or AC	1	Indicates controller has control in Request/Grant mode
Auxiliary Controller Lockout	ACB	ACL	one CC or AC	1	Indicates lockout control
Encoded-N	ACB	EN1,2,4,8,16	AC	5	Binary coded station number
Auxiliary Look-at-Me	ACB	AL1 - AL24	CC	24	24 Look-at-Me lines from modules
Conditional Free line	ACB		CC	1	Line recommended for Byte Clock in CAMAC Serial Highway systems
Ground	ACB	0V	CC or AC	7	System Ground

4.1.2. Grant-In and Grant-Out Signals

A Controller participating in the R/G mode must generate a Grant-Out signal as follows:

(1) It must generate a logic "0" on Grant-Out whenever it receives a logic "0" on Grant-In.

(2) If it is not generating the Request signal when it receives the 0→1 transition of Grant-In, it must retransmit on Grant-Out the signal it receives on Grant-In.

(3) If it is generating the Request signal when it receives the 0→1 transition of Grant-In it must maintain a logic "0" on Grant-Out until it receives the next 0→1 transition of the Grant-In signal and it must generate Request Inhibit to establish control of the crate.

If a Controller retransmits the Grant signal, it should do so with minimum delay.

4.1.3 Request Inhibit

A Controller gains control of the crate by initiating the 0→1 transition of Request Inhibit and it maintains control of the crate until it initiates the 1→0 transition of Request Inhibit. It must maintain control of the crate for a minimum of 350 ns unless it receives ACL = 1.

The generation of Request Inhibit by a Controller will establish its control of the crate. If the Controller generates Request Inhibit = 0 between command operations, then it releases its control after each operation, thereby allowing another Controller to gain (and possibly maintain) control. If, on the other hand, the Controller maintains Request Inhibit = 1 between command operations, then the Controller will maintain control of the crate, thus allowing, for example, the execution of a block transfer with minimum delay.

4.1.4 Generation of ACL Signal

At any one time, the generation of the ACL signal must be reserved to only one Controller in a CAMAC crate. The Controller generating the ACL signal should generate ACL only after it expects to initiate a Dataway operation (for example, on the recognition of the Crate Address in a CAMAC Command addressed to it) in order to allow maximum use of the Dataway by other Controllers. The ACL signal must be maintained until the Dataway operation is complete.

A Controller generating ACL must not initiate its Dataway operation until (1) a minimum of 200 ns has elapsed since generating ACL, and (2) it receives Request Inhibit in a logic "0" state.

The Serial Highway Crate Controller Type L-2, will proceed with its Dataway operation independently of the state of the Request Inhibit signal. After receiving the first byte of a command addressed to it, it will generate ACL in order to gain control of the crate. A Dataway operation may take place after 4 additional bytes have been received. The minimum elapsed time could be as short as 800 ns for a Serial Highway operating at its maximum data rate of 5×10^6 bytes per second in byte-serial mode.

4.1.5 Response to ACL Signal

A Controller must not initiate a Dataway operation while it is receiving the ACL signal in the logic "1" state. A Controller must complete its Dataway operation if it receives ACL at logic "1" after it has generated strobe S1. A Controller must release control of the crate in response to an ACL signal before the Controller generating ACL begins its Dataway operation.

A Controller releases control of the crate by either aborting or completing the Dataway operation. When used with the Serial Highway, a Controller may assume that the Serial Highway is operating at maximum speed, in which case 800 ns are allowed for completion. Alternatively, the byte clock information (see Section 2.3 of IEEE Std 595-1976 or EUR 6100e), may be used to extend its control. The latter could permit the Controller to complete several Dataway operations before releasing control.

4.2 Encoded-N Signals

4.2.1 Generation of Encoded-N Signals

In order to execute a Dataway command operation, an AC must generate the binary coded station number of the addressed station on the Encoded-N (EN1 - EN16) lines of the ACB. As with Dataway signals, an AC must not generate the EN signals unless it has gained control of the crate. In the timing of the Dataway command operation of an AC, the time between t_0 and t_1 (See Fig 9 of IEEE Std 583-1975 or EUR 4100e) must take into account delays caused by decoding of the EN signals in the CC.

4.2.2 Response to Encoded-N Signals

A CC must respond to the binary coded station numbers on the EN lines whenever it does not have control of the crate. In a CC, each of the Station Number codes N(1) through N(24) must be decoded to produce a signal on the corresponding Dataway line N1 through N24 with a delay of 100 ns maximum.

4.3 LOOK-AT-ME SIGNALS

The CC must retransmit the Look-At-Me (L1 - L24) signals from the control station of the Dataway to the Auxiliary Look-At-Me (AL1 - AL24) contacts of the ACB connector.

4.4 OTHER SIGNALS

The Conditional Free line is reserved for use as the Byte Clock signal in Serial Highway systems.

5. THE AUXILIARY CONTROLLER BUS CONNECTOR AND ASSOCIATED FRONT PANEL CONNECTORS

Each Controller must have a double row post header ACB connector with 40 0.64 mm by 0.64 mm pins on 2.54 mm centers, AMP No. 87272-1, AMP No. 4-825457-0, 3M No. 3495-1002, or an equivalent connector that is fully mateable with AMP No. 86896-2, and 3M No. 3417-3000. The connector body must be mounted at the rear of the Controller, above the Dataway connector. Contact 1 must be lower right (when facing the tips of the pins) and there must be an indication at the rear of the controller that this is so. Contact 1 must be located 130.4 mm to 133.4 mm above the Dataway plug horizontal datum. Note however that (1) no part of the connector shall extend beyond 188.6 mm above the Dataway plug horizontal datum, and (2) any portion of the connector below 126.6 mm from this datum must be contained within the 290 mm max horizontal dimension of the plug-in. (See Fig. 4 and Fig. 5 of IEEE Std 583-1975 or EUR 4100e.) The assignment of the signal lines of the ACB is given in Table 2.

TABLE 2 - CONTACT ASSIGNMENTS ON AUXILIARY CONTROLLER BUS CONNECTOR*

Contact	Usage	Contact	Usage
1	Ground (0V)	2	Encoded-N EN1
3	Encoded-N EN2	4	Encoded-N EN4
5	Encoded-N EN8	6	Encoded-N EN16
7	Ground (0V)	8	ACL
9	Ground (0V)	10	Conditionally Free
11	Ground (0V)	12	Request RQ
13	Ground (0V)	14	Request Inhibit RI
15	Ground (0V)	16	AL1
17	AL2	18	AL3
19	AL4	20	AL5
21	AL6	22	AL7
23	AL8	24	AL9
25	AL10	26	AL11
27	AL12	28	AL13
29	AL14	30	AL15
31	AL16	32	AL17
33	AL18	34	AL19
35	AL20	36	AL21
37	AL22	38	AL23
39	AL24	40	Ground (0V)

*Contact 2 is across from contact 1, contact 4 is across from contact 3, etc.

A Controller which uses the Request/Grant protocol to gain control of the crate must have, in addition, three coaxial connectors Type 50CM (see IEEE Std 583-1975 or Section 4.1 of EUR 5100e) on the front panel. The three connectors must be labeled and used as follows:

(1) There must be a connector for the Request signal output. This signal must be the same at all times as the Request signal on the ACB.

(2) There must be a connector for the Grant-In signal input.

(3) There must be a connector for the Grant-Out signal output.

6. SIGNAL STANDARDS

Signal outputs from Controllers onto all ACB lines must be delivered through intrinsic OR gates. Each line must be provided with an individual pull-up current source to restore the line to the "0" state in the absence of an applied "1" signal. The rise and fall times at signal outputs must not be less than 10 ns, in order that cross-coupling of signals is not excessive.

Signal outputs from Controllers onto all Dataway lines must conform fully with the mandatory requirements of IEEE Std 583-1975 or EUR 4100e.

6.1 SIGNAL STANDARDS ON THE ACB

All signals on the ACB must conform to the signal voltage standards shown in Table 5 of IEEE Std 583-1975 or EUR 4100e and the standards for pull-up current sources in Table 3 of this standard.

The standards for pull-up current sources on the ACB are derived from Table 6 of IEEE Std 583-1975 or EUR 4100e and correspond with those for compatible current sinking logic devices (e.g., standard TTL and DTL for units generating signals and low power Schottky TTL for units receiving signals). They also correspond with those of the SGL-Encoder connector of Serial Crate Controllers (see Section 14 of IEEE Std 595-1976 or EUR 6100e). These standards impose an upper limit on the number of AC's in a single CAMAC crate. This limit is 8 AC's and it is derived from the current sinking capability and load current on the AL lines. If an SGL-Encoder unit is attached to the SGL-Encoder connector it may impose a more severe restriction on the number of AC's. If some AC's do not receive the AL signals, then the limit on the number of AC's is imposed by the load current on the Dataway (see Section 6.3).

6.2 SIGNAL STANDARDS FOR THE ACB ASSOCIATED FRONT PANEL SIGNALS

> The Request, Grant-In, and Grant-Out front panel signals must conform to the signal voltage standards shown in Table 5 of IEEE Std 583-1975 or EUR 4100e and the standards for pull-up current sources in Table 3 of this standard.

TABLE 3

CURRENT SIGNAL STANDARDS AND PULL-UP CURRENT SOURCES FOR THE AUXILIARY CONTROLLER BUS CONNECTOR AND ASSOCIATED FRONT PANEL CONNECTORS

Signal Standards at Connector	Aux Cont Lockout, Request Inhibit	Aux LAM	Request Grant-In/Out	Encoded-N Cond Free
Line at "1" State at 0.5 Volt Minimum Current Sinking Capability (current drawn from line by unit generating the signal)	For CC 6.4 mA For AC 16.0 mA	3.2 mA	16.0 mA	16.0 mA
Line at "1" State at 0.5 Volt Maximum Load Current (current fed into line by unit receiving the signal)	0.4 mA per unit (6.4 mA max.)	0.4 mA per unit (3.2 mA max.)	12.8 mA	11.2 mA
Line at "0" State at 3.5 Volt (maximum current drawn from line by CC without Sinking Pull-Up)	100 μA	100 μA	100 μA	100 μA
Line at "0" State at 3.5 Volt (minimum current fed into line by CC with Sinking Pull-Up)	2.5 mA	2.5 mA	2.5 mA	2.5 mA
Location of Pull-Up for current, I_p, at 0.5 Volt: 6 mA $\leq I_p \leq$ 9.6 mA	CC	CC	Grant-In	CC

6.3 SIGNAL STANDARDS FOR AC DATAWAY CONNECTIONS

> All signals at the CAMAC Dataway-interface to an AC must conform to Table 6 of IEEE Std 583-1975 or EUR 4100e, with the exception of the signals Q, R, and X. The Q, R, and X signals must conform to standards contained in Table 4 of this standard.

The signal standards for the CAMAC Dataway interface impose a limit of 12 AC's in a single CAMAC crate. However, if other units fully compatible with IEEE Std 583-1975 or EUR 4100e receive Q, R, or X signals from the Dataway, then the limit on the number of AC's may be lower. Such a unit may present a current load on the Dataway as much as that of 4 AC's.

TABLE 4

SIGNAL STANDARDS FOR Q, R, AND X
AT THE AUXILIARY CONTROLLER DATAWAY CONNECTOR

Condition at Dataway Connection	Absolute Limit
Line in "1" state at +0.5 Volt (maximum current fed into line by AC receiving signal)	0.4 mA
Line in "0" state at +3.5 Volt (maximum current drawn from line by each AC)	100 μA

APPENDIX

A1. SPECIFICATION OF CAMAC CRATE CONTROLLER TYPE A-2

A1.1 CAMAC CRATE CONTROLLER TYPE A-2

> In order to conform with the specifications for CAMAC Controller
> Type A-2, a crate controller must have all the mandatory features
> defined in this Appendix. It must have no other features that would
> affect its interchangeability with any other Type A-2 Crate Control-
> lers, taking into account the effect of such interchange on both
> hardware and software. It must be fully interchangeable with one
> conforming to Fig A1-1, although it need not have identical
> structure, internal signals (shown without the prefix B in Fig
> A1-1) or logical expressions.

With respect to the communications protocol via the Branch highway, Crate Con-
troller Type A-2 (CCA-2) is interchangeable with Crate Controller Type A-1
(CCA-1) as defined in Section A1 of the Appendix of IEEE Std 596-1976 or
EUR 4600e. In practice the Branch Highway cycle times may differ because of
the priority arbitration logic used by the CCA-2.

In order to accommodate the use of Auxiliary Controllers, the CCA-2 differs
from the CCA-1 by having an Auxiliary Controller Bus connector, and its associated
features as described in DOE/EV-0007 or EUR 6500e (Sections 1-6 of this standard).
Differences between this Appendix and Section A1 of the Appendix of IEEE Std
596-1976 or EUR 4600e are indicated by a vertical bar in the left hand margin
of this appendix.

A1.2 Other Crate Controllers

It is recommended that other crate controllers should be interchangeable with
Crate Controller Type A-2 in respect to those features that they have in common,
although they need not have all the mandatory features of Crate Controller Type
A-2 and may have additional features.

A1.3 General Features

> The crate controller must conform fully with the mandatory require-
> ments of IEEE Std 583-1975 or EUR 4100e, and IEEE Std 596-1976 or EUR
> 4600e (Sections 1-7 of that standard). It is mandatory that all signal
> inputs at the Branch Highway ports of Crate Controller Type A-2 must
> satisfy the lower input current standard ($\pm$0.3 mA) shown in Table 8 of
> IEEE Std 596-1976 or EUR 4600e.
>
> Crate Controller Type A-2 must not occupy more than three stations.
> It should preferably be a double-width unit that engages with the
> Dataway at the control station and the adjacent normal station.

In addition to the two front panel connectors for the Branch
Highway ports (see Section Al.4), the crate controller must have
a rear-mounted connector for a link to an optional separate
LAM-Grader unit (see Section Al.9).

The crate controller must conform fully with the mandatory re-
quirements of DOE/EV-0007 or EUR 6500e (Sections 1-6 of this
standard). In addition to the rear-mounted LAM-Grader connector,
the crate controller must have a rear-mounted connector for a
link to the ACB.

A1.4 FRONT PANEL

The crate controller must have all the following front panel
features, and no others that would affect interchangeability (for
example, the addition of indicators for test purposes is permitted).

(1) There must be two connectors for Branch Highway ports, as
defined in Section 6 of IEEE Std 596-1976 or EUR 4600e, mounted
with the correct orientation and with all corresponding contacts
joined.

(2) There must be a means of indicating the selected crate address
(1-7). There may be limited access at or through the front panel to
the means of changing the crate address.

(3) There must be a means of selecting off-line status of the
crate controller (see Section Al.10).

(4) There must be a coaxial connector for the Inhibit signal input.
The type of connector is as specified in Section 4.2.5 of IEEE Std
583-1975 or Section 4.1 of EUR 5100e. The signal standards are as
specified in Section 7.2.1 of IEEE Std 583-1975 or EUR 4100e.

(5) There must be two push buttons, or equivalent manual controls,
for Initialize and Clear. These are only effective in the off-line
state, and the front panel layout or markings should indicate this.

(6) There must be three coaxial connectors for the Request and Grant
signals. These connectors must conform fully with the mandatory require-
ments of DOE/EV-0007 or EUR 6500e (Section 5 of this standard).

(7) There must be a means of indicating the state of the RG/ACL
control option (see Section Al.7). There may be a limited access at or
through the front panel to the means of changing this control option.

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> The Crate Controller Type A-2 must gain control of the crate in accordance with the mandatory requirements of Section 4.1 of this standard.

A1.5.1 Data Signals

> When the crate controller is on-line, addressed, and in control of the crate during a Read command operation with a station number other than N(30), it must retransmit the signals from the twenty-four Dataway Read lines through intrinsic OR outputs to the BRW lines. Crate Controller Type A-2 must have gates between the R and BRW lines so that this transfer of Read data occurs only when the crate controller is on-line, addressed, and in control of the crate, for example when $BCR_i \cdot (BTA + \overline{BTB}_i) = 1$.
>
> During Write operations with station number other than N(30) it must retransmit the signals from the twenty-four BRW lines to the Dataway Write lines. Crate Controller Type A-2 must have gates between the BRW and W lines so that this transfer of Write data occurs only when the crate controller is addressed, on-line, and in control of the crate.

The gates between the R and BRW lines and between the BRW and W lines may further limit the transfers to Read operations $BF16 \cdot BF8 = 1$ and Write operations $BF16 \cdot BF8 = 1$, respectively. However, the crate controller is permitted to generate signals on the Dataway Write lines during any operation for which it has control, but other units connected to the Dataway can only rely on the presence of such signals during Dataway Write operations.

A1.5.2 Command Signals.

The Branch Highway command signals BN, BA, and BF should be conditioned in the crate controller, for example, by integration or by staticizing at a time related to BTA $0 \rightarrow 1$ (the 0 to 1 transition of BTA), , in order to protect the Dataway command lines from the effects of crosstalk into Branch Highway command lines.

> The subaddress and function signals from the BA and BF lines must be retransmitted by the crate controller on the Dataway A and F lines during all command mode operations when the controller is on-line, addressed, and in control of the crate.
>
> In a double-width crate controller each of the Station Number codes N(1) through N(23) must be decoded in the crate controller to produce a signal on the corresponding Dataway line N1 to N23. The Station

Number code must be decoded from the BN lines of the Branch Highway port connector whenever the crate controller is in control of the crate in response to a Branch Highway operation. At all other times the Station Number codes must be decoded from the EN lines of the ACB connector.

Station Number codes N(26) through N(30) received from the Branch Highway port connector (but not necessarily the ACB connector) must be decoded to address internal features of the crate controller.

Command operations with N(26) must generate Dataway signals on all the lines N1 through N23. Command operations with N(24) generate Dataway signals on N1 through N23 as determined by the contents of 23 bit Station Number Register (SNR). This register is loaded from BRW1-BRW23 by the command N(30)·A(8)·F(16). The bit of the Station Number Register that is loaded from BRW1 controls the state of N1, etc. The register is not reset by the Dataway Initialize signal Z.

A triple-width controller may alternatively have a 22 bit Station Number Register, decode N(1) through N(22), and generate signals on Dataway lines N1 through N22.

A1.5.3 Common Control Signals

The Dataway Initialize signal Z must be generated in response to the command N(28)·A(8)·F(26) and to the Branch Initialize signal (see Section 4.5.1 of IEEE Std 596-1976 or EUR 4600e). It must also be generated in response to the manual Initialize control, but only when the crate controller is in the off-line state.

The Dataway Clear signal C must be generated in response to the command N(28)·A(9)·F(26). It must also be generated in response to the manual Clear control, but only when the crate controller is in the off-line state.

The Dataway Initialize Z and Clear C signals must not be generated until the crate controller is in control of the crate and must be generated with the timing specified for unaddressed operations in IEEE Std 583-1975 or EUR 4100e, Fig 10. They must be associated with a sequence including B and S2 signals, also with the time specified in IEEE Std 583-1975 or EUR 4100e, Fig 10. The sequence is permitted to include S1 but this is not mandatory, and other units connected to the Dataway must not rely on the generation of S1 with Z and C.

The Dataway Initialize Z signal must be generated in response to the Branch Initialize signal only when the crate controller is in control of the crate and the Branch Initialize signal is in the logic "1" state. (Note that Crate Controller Type A-2 could fail to generate Dataway Initialize Z in response to Branch Initialize while an auxiliary controller is performing continuous Dataway operations.)

The Dataway Inhibit signal I must be initiated when an on-line crate controller generates Dataway Initialize Z, and must reach a maintained "1"

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state not later than time t_3 (see IEEE Std 583-1975 or EUR 4100e, Fig 10). When some other unit generates Initialize (accompanied or not by Inhibit), an on-line crate controller must not generate Inhibit in response to Dataway Z gated by S2. The Inhibit signal must be generated in response to the command $N(30) \cdot A(9) \cdot F(26)$. In these cases the Inhibit signal must be maintained by the crate controller until reset by the command $N(30) \cdot A(9) \cdot F(24)$. It must also be generated while the front panel Inhibit signal is present.

The command $N(30) \cdot A(9) \cdot F(27)$ must produce a $Q = 1$ response if there is a "1" state signal on the Dataway Inhibit line.

A1.5.4 Patch Connections

Crate Controller Type A-2 must not use the patch pins of the Dataway stations that it occupies.

A1.5.5 Arbitration Methods used by the Crate Controller

Crate Controller Type A-2 must provide for both the Request/Grant and Auxiliary Controller Lockout methods of gaining control of the crate. Either the Auxiliary Controller Lockout method or the Request/Grant method will be used depending on the state of the RG/ACL option control. If the state of this control is "1" the Auxiliary Controller Lockout method must be used. If the state of the control is "0" the Request/Grant method must be used. When the crate controller is using the Request/Grant method, it must respond to an ACL signal on the ACB (see Section 4.1.5 of this standard).

A1.6 DEMAND HANDLING

A1.6.1 Branch Demand

The Branch Demand signal BD must be derived, subject to the following conditions, from the OR combination of an External Demand signal from contact 48 of the LAM-Grader connector and an Internal Demand signal which is the OR of the 24 GL signals received via the LAM-Grader connector.

The output of the Branch Demand signal to the BD line must be disabled by the command $N(30) \cdot A(10) \cdot F(24)$ or by the Dataway Initialize signal Z with S2 when generated by the crate controller. It must be enabled by the command $N(30) \cdot A(10) \cdot F(26)$. The command $N(30) \cdot A(10) \cdot F(27)$ must give a $BQ = 1$ response if the output of the BD is enabled. The command $N(30) \cdot A(11) \cdot F(27)$ must give a $BQ = 1$ response

if the OR of the Internal and External Demands is in the "1" state, even if the output of BD is disabled.

The Internal Demand signal must be inhibited by the "1" state of the Inhibit Internal D signal from contact 51 of the LAM-Grader connector.

A1.6.2 Graded-L

In response to a Graded-L Request signal $BG = 1$, accompanied by $BCR_i = 1$, the crate controller must gain control of the crate. It must generate the Graded-L operation signal on contact 1 of the LAM-Grader connector. It must accept the Graded-L signals GL1-GL24 from the LAM-Grader connector and transmit them to the BRW lines (GL1 to BRW1, etc).

The crate controller must also accept the Graded-L signals from the LAM-Grader connector and transmit them to the BRW lines in response to command mode operations with $N(30) \cdot A(0-7) \cdot F(0)$ (see Section A1.9.4).

In both cases the GL information must be transferred from the LAM-Grader to the BRW lines with minimum delay, and the signals must not appear on the Dataway Read lines.

A1.6.3 Pull Up for GL and L Lines

Pull-up current sources in accordance with IEEE Std 583-1975 or EUR 4100e, Table 6, must be provided on all GL lines of the LAM-Grader connector and all AL lines of the Auxiliary Controller Bus connector in the crate controller. The L lines of the LAM-Grader connector must be isolated from the Dataway L lines and must not be provided with pull-up current sources, thus allowing a simple LAM Grader to form wired-OR combinations of L signals without affecting the AL lines on the ACB.

A1.7 TIMING REQUIREMENTS

The initiation of any operation by the crate controller is determined by the Branch Highway signals BCR_i, BG, BZ, and BTA and the signals associated with ACB * Request, Grant, ACL, and Request Inhibit).

Before responding to any Branch Highway operation, the crate controller must first gain control of the crate. It must initiate the process of gaining control of the crate when it detects $BCR_i = 1$. It must maintain control of the crate, by generating Request Inhibit or ACL, until it detects $BCR_i = 0$.

If the Branch Driver generates $BCR_i = 0$ between command operations, the crate controller will release the crate after each operation allowing auxiliary controllers to gain control (and possibly maintain control) of the crate. If on the other hand, the Branch Driver maintains $BCR_i = 1$ between command operations, then the crate controller will maintain control, thus allowing, for example, the execution of a block transfer with minimum delay.

In command mode operations with Station Number codes other than N(30), the crate controller generates Dataway Strobe signals S1 and S2 with timing related to that of the Branch timing signals BTA and BTB as defined in Section A1.7.1.

Command operations with Station Number code N(30) do not generate S1, S2, or B signals on the Dataway lines (see Section A1.7.3).

In Graded-L operations there are no Dataway Strobe or B signals, and the timing must take into account the signal delays in any non-Dataway connections to a LAM-Grader unit. These timing requirements are defined in Sections A1.7.2 and A1.9.3.

The internal timing generator of the crate controller must be protected against spurious signals on the BTA and BCR lines.

One method of protection, shown in Fig A1-1, is to condition the incoming signals from the BTA line and the selected BCR line by integration with a time constant of 100+50 ns. Another method is to condition the internal signal TA which controls the timing generator. Transitions of the BTA and BCR signals are detected by the crate controller after a delay (shown in Fig 3 and 4 of IEEE Std 596-1976 or EUR 4600e) due to this protection.

A1.7.1 Command Mode Operations with Dataway S1, S2, and B.

.The following timing conditions must be satisfied when the crate controller responds to a command mode branch operation which requires a Dataway operation with signals S1, S2, and B. In this section the times t_0, t_3, t_5, etc, refer to the corresponding key points on Fig 9 of IEEE Std 583-1975 or EUR 4100e.

During Phase 1 of the operation, the Branch Driver generates the command signals BF, BA, and BN along with the signals BCR_i of the addressed crate controllers. The crate controller must initiate the process of gaining control of the crate with minimum delay when it detects the $0 \rightarrow 1$ transition of BCR_i (see Section 4 of this standard).

In Phase 2 of the operation, after actions by the Branch Driver and the crate controller during Phase 1, the crate controller detects BTA = 1, accompanied by BG = 0, $BCR_i = 1$, and the appropriate command signals. It must then initiate the required Dataway N and command signals, thus starting

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the Dataway operation at t_0, either when it detects BTA = 1 or at the appropriate time after it has gained control of the crate, if this occurs later (see Section 4 of this standard.)

At t_3, which is 400(+200/-0) ns after t_0, the crate controller must initiate the 0→1 transition of the Dataway Strobe S1, and the Branch timing signal transition BTB_i 1→0. At t_5, which is 200(+100/-0) ns after t_3, the 1→0 transition of the Strobe S1 must be initiated.

In Phase 4, the crate controller initiates the 0→1 transition of Strobe S2 at t_6, which is either when it detects BTA = 0 or when the interval t_5-t_6 is 100(+100/-0) ns, if this occurs later.

At t_8 which is 200(+100/-0) ns after t_6, the 1→0 transition of S2 must be initiated.

At t_9, which is 100(+100/-0) ns after t_8, the crate controller must initiate the 1→0 transitions of the Dataway signals N and B, and must isolate the Dataway Q and R lines from the Branch Highway BQ and BRW lines respectively. It must then initiate the Branch timing signal transition BTB_i 0→1. When the crate controller detects BCR_i = 0, it must initiate the 1→0 transition of the Request Inhibit signal or the Auxiliary Controller Lockout signal if the latter is in use.

A1.7.2 Graded-L Operations

The crate controller must satisfy the following timing conditions during Graded-L operations with BG = 1 and BCR_i = 1. In Phase 1 of the operation, the Branch Driver generates the command signal BG along with the signals BCR_i of the addressed crate controllers. The crate controller must initiate the process of gaining control of the crate with minimum delay when it detects the 0→1 transition of BCR_i. In Phase 2 it must initiate Branch timing signal transition BTB_i 1→0 within 400(+200/-0) ns after detecting BTA = 1 or 400(+200/-0) ns after gaining control of the crate, if this occurs later. At the same time it must be presenting to its BRW outputs the GL information received via the LAM-Grader connector (see Section A1.9.3). In Phase 4 it must remove the GL information from its BRW outputs with minimum delay after detecting BTA = 0, and initiate the signal transition BTB_i 0→1. The crate controller must maintain control of the crate until it detects BCR_i = 0 and it must then initiate the 1→0 transition of the Request Inhibit signal or the Auxiliary Controller Lockout signal if the latter is in use.

A1.7.3 Command Mode Operations Without Dataway S1, S2, or B

Command mode operations addressed to N(30) are concerned with internal features of the crate controller and with reading Graded-L information via the LAM-Grader connector. The crate controller must not generate signals on the Dataway S1, S2, B, or R lines.

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The timing of these operations must follow the requirements for command mode operations (see Section A1.7.1) with the exception that the S1, S2, and B signals are not generated on the Dataway lines, although there may be equivalent internal signals.

A1.8 COMMANDS IMPLEMENTED BY CRATE CONTROLLER TYPE A-2

Crate Controller Type A-2 must recognize and implement the commands summarized in Table A1-1, and must not use any other commands. When addressed with any of these commands it must generate BX = 1. The five Function codes F(0, 16, 24, 26, 27) must be fully decoded in the crate controller.

The crate controller must generate BQ = 1 in response to all commands that read from or write to its registers, or the LAM-Grader connector. In Crate Controller Type A-2 the two commands to which this applies are N(30)·A(0-7)·F(0) and N(30)·A(8)·F(16).

A1.9 LAM-GRADER CONNECTOR

The rear-mounted connector for a link to an optional separate LAM-Grader unit must be a fifty-two contact Cannon Double-Density fixed member with pins (Type 2DB52P), or equivalent type fully mateable with the free member with sockets, Cannon Type 2DB52S. It must be mounted at the rear of the crate controller above the Dataway connectors within the area for free access (see IEEE Std 583-1975 or EUR 4100e, Fig 3), with Contact 1 lowermost. The fifty-two contacts are assigned as shown in Table A1-2.

TABLE A1-1

BRANCH COMMANDS IMPLEMENTED BY CAMAC CRATE CONTROLLER TYPE A-2

Action	Command			Response
	N	A	F	
Generate Dataway Z	28	8	26	BQ=0
Generate Dataway C	28	9	26	BQ=0
Read GL	30	0-7	0	BQ=1
Load SNR	30	8	16	BQ=1
Remove Dataway I	30	9	24	BQ=0
Set Dataway I	30	9	26	BQ=0
Test Dataway I	30	9	27	BQ=1 if I=1
Disable BD output	30	10	24	BQ=0
Enable BD output	30	10	26	BQ=0
Test BD output enabled	30	10	27	BQ=1 if BD enabled
Test demands present	30	11	27	BQ=1 if demands present

The LAM Grader accepts L signals from the crate controller via the LAM-Grader connector. It generates Graded-L GL signals and, optionally, the External Demand signal. It may include gates, mask registers, etc, for processing the L signals, or may merely consist of passive interconnections between the contacts of the LAM-Grader connector. It may interact with the crate controller in the following ways:

(1) Branch Demand. Crate Controller Type A-2 derives the Branch Demand BD signal from the Graded-L signals (and, optionally, the External D signal) which it receives via the LAM-Grader connector.

(2) Graded-L Operations. The crate controller generates the Graded-L Operations signal on Contact 1 to indicate that it requires Graded-L signals.

> If the LAM Grader responds to this signal it must satisfy the
> timing requirements of Section A1.9.3.

(3) Command Mode Operations. In response to Branch commands with N(28) or N(30) the crate controller generates the Controller Addressed signal on Contact 50. This allows the LAM Grader to be treated as a detached part of the crate controller that can be addressed independently of its location in the crate. The presence of Dataway Busy B distinguishes operations with N(28) from those with N(30). The Controller Addressed signal with Dataway A(0-7), but without B, indicates that the crate controller requires Graded-L signals. In conjunction with a Dataway operation and B the Controller Addressed signal may be used, for example, to access registers in the LAM Grader.

> If the LAM Grader responds to the Controller Addressed signal it
> must satisfy the timing requirements of Section A1.9.4.
>
> The Graded-L Operation signal on Contact 1 must be in the logic "1"
> state when the crate controller is on-line, in control of the crate,
> and $(BTA + \overline{BTB_i}) \cdot BG \cdot BCR_i = 1$.
>
> The Controller Addressed signal on Contact 50 must be in the "1"
> state during command mode operations to N(28) or N(30) when the crate
> controller is on-line, in control of the crate, and
> $[N(28) + N(30)] \cdot (BTA + \overline{BTB_i}) \cdot \overline{BG} \, BCR_i = 1$.

Equivalent conditions for the generation of these two signals, Controller Addressed and Graded-L operation, are shown in Fig A1-1 in terms of the internal (nonmandatory) signals of a particular implementation of Crate Controller Type A-2.

> All mandatory timing requirements refer to signal conditions at
> the LAM-Grader connector on the crate controller. The interval be-
> tween the initiation of a signal by the crate controller and the
> receipt of an established response from the external unit thus
> includes delays due to both the external unit and its linking cable.

A1.9.1 Signal Standards

> All signals via the LAM-Grader connector must satisfy Section 7.1 of IEEE Std 583-1975 or EUR 4100e. The signal standard for N signals applies to the Graded-L operation signal on Contact 1, and also to the Controller Addressed signal on Contact 50. All other signals including External D on Contact 48 and Inhibit Internal D on Contact 51, follow the standard for L signals.

A1.9.2 Timing - Branch Demand

> The maximum overall delay between the time when an L signal at the control station of the crate controller reaches a maintained "1" or "0" state and the time when the BD signal at the Branch Highway port of the same crate controller reaches a corresponding maintained "1" or "0" state is defined in Section 4.4.1 of IEEE Std 596-1976 or EUR 4600e. When the crate controller is used in conjunction with an external LAM Grader the component of this delay due to the crate controller must not exceed 250 ns.

A1.9.3 Timing - Graded-L Operations

> The interval between the generation of the Graded-L operation signal, accompanied by L signals, and the establishment of corresponding Graded-L signals must not exceed 350 ns.

A1.9.4 Timing - Command Mode Operations

> The interval between the generation of the Controller Addressed signal (accompanied by L signals, and in conjunction with Dataway signals F(0), A(0-7), B = 0) and the establishment of corresponding Graded-L signals must not exceed 350 ns.
>
> The external unit must present identical GL information in response to the Graded-L operation signal and to the Controller Addressed signal with A(0), F(0), and B = 0. Subaddresses A(1-7) may be used to access different selections of GL information.
>
> If the external unit responds to command mode operations with N(28)·A(0-15), B = 1, and an F code, it must satisfy the normal timing reqirements of IEEE Std 583-1975 or EUR 4100e for a CAMAC module and is permitted to make data transfers via the Dataway R and W lines.

The off-line state is selected by means of the off-line manual control on the front panel of the crate controller. In this state the controller does not respond to command or Graded-L Request signals on the Branch Highway, and does not generate Branch timing or demand signals on the Highway.

The following minimum conditions must be observed in the off-line state:

(1) The front panel manual controls for Initialize and Clear must be effective. (They must be ineffective in the on-line state).

(2) The front panel Inhibit signal input must continue to be effective. Dataway Inhibit must only be generated in response to the front panel Inhibit input.

(3) The crate controller must not respond to BTA = 1. It must not generate Dataway B, N, S1 or S2 signals in response to BTA = 1 with BG = 0, or access the Graded-I information in response to BTA = 1 with BG = 1.

(4) The crate controller must not generate "1" state outputs to the BTB, BD, BRW, BQ, or BX lines. An off-line crate is thus prevented from interfering with Branch operations.

(5) The crate controller must not respond to BZ = 1.

(6) The crate controller must not take any action that would interfere with the control or use of the Dataway by Auxiliary Controllers.

The following additional condition is recommended in the off-line state:

(7) In the absence of power to the crate controller, all inputs and outputs via the Branch Highway ports should be free to assume either the "0" state or the "1" state, as required by other units connected to the Branch, and should not impose abnormal current loadings.

A1.11 DATAWAY INHIBIT I IN OFF-LINE STATE

It is mandatory in IEEE 583-1975 or EUR 4100e (Section 5.5.2) that units generating Initialize Z must also generate I. Units that can generate and maintain I must maintain I = 1 until specifically reset. See Section 5.5.2 of IEEE Std 583-1975 or EUR 4100e. Both these requirements are met by Crate Controller Type A-2 in the on-line state. However, Section A1.10(2) of this standard specifically prohibits the generation of I = 1 in the off-line state other than in response to the front panel Inhibit input. The off-line state has been defined in such a way that an Auxiliary Controller can control the Inhibit I signal while the crate controller is off line. Section A1.10(2) is primarily intended to prevent the generation of maintained I = 1 by Crate Controller Type A-2 when it is in the off-line state.

To be consistent with this aim:

(1) Crate Controller Type A-2 should generate I as defined in Sections A1.5.3 and A1.10 (and as shown in Fig A1-1).

(2) Any auxiliary means of generating I (other than Auxiliary Controllers) in an off-line crate should conform to Section 5.5.2 of IEEE Std 583-1975 or EUR 4100e by generating I = 1 in response to Z·S2. It should preferably maintain I = 1 and provide a means of resetting it.

A1.12 AUXILIARY CONTROLLER BUS CONNECTOR

> Crate Controller Type A-2 must have a rear mounted ACB connector of the type defined in Section 5 of this standard and with the contact assignment of signal lines given in Table A1-2 of this standard.

TABLE A1-2

CONTACT ASSIGNMENTS FOR LAM-GRADER CONNECTOR OF CRATE CONTROLLER TYPE A-2

Contact	Usage	Contact	Usage
1	Graded-L operation	2	L1
3	GL1	4	L2
5	GL2	6	L3
7	GL3	8	L4
9	GL4	10	L5
11	GL5	12	L6
13	GL6	14	L7
15	GL7	16	L8
17	GL8	18	L9
19	GL9	20	L10
21	GL10	22	L11
23	GL11	24	L12
25	GL12	26	L13
27	GL13	28	L14
29	GL14	30	L15
31	GL15	32	L16
33	GL16	34	L17
35	GL17	36	L18
37	GL18	38	L19
39	GL19	40	L20
41	GL20	42	L21
43	GL21	44	L22
45	GL22	46	L23
47	GL23	48	External D
49	GL24	50	Controller Addressed
51	Inhibit Internal D	52	Ground (0V)
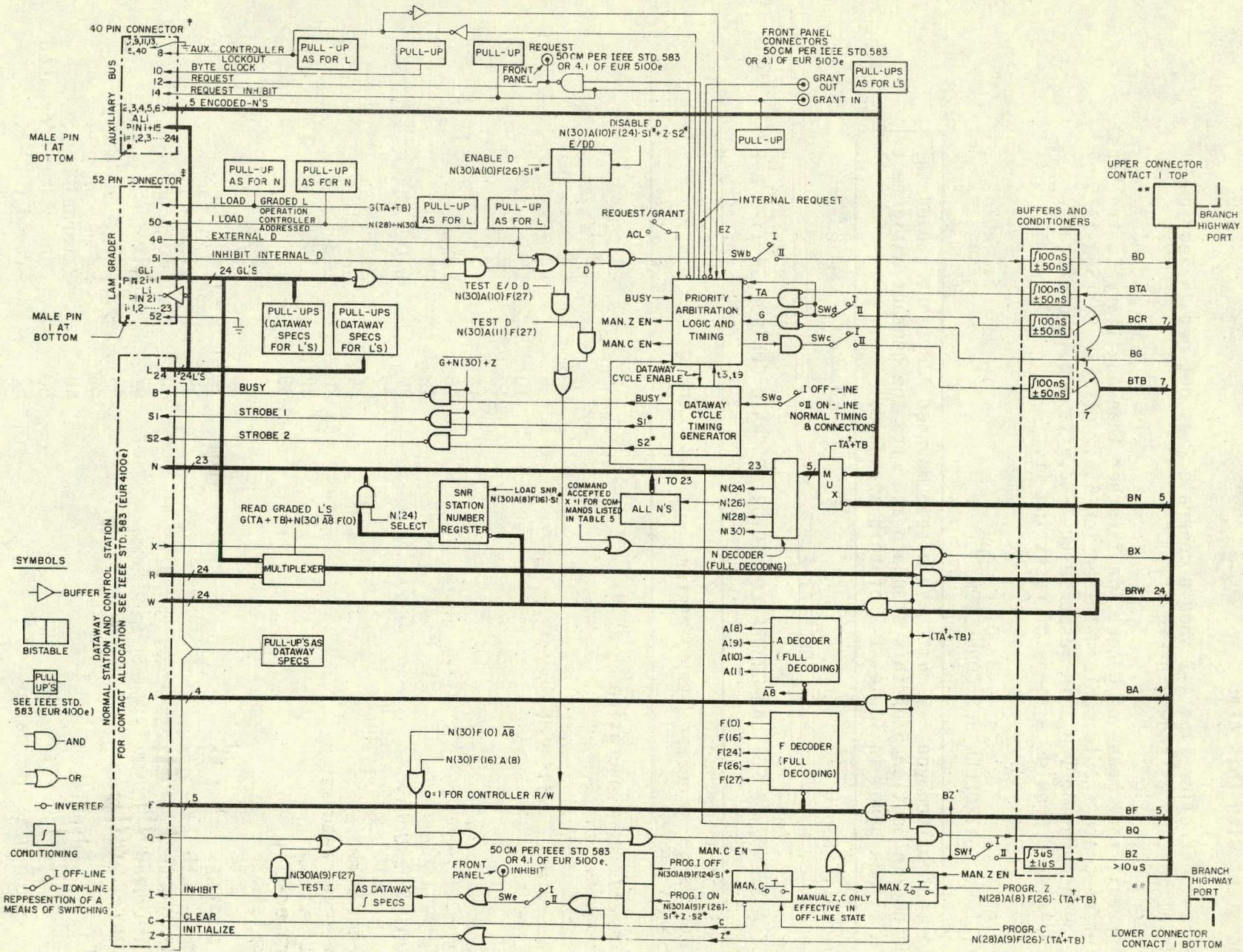
FIGURE AI-I

CAMAC CRATE CONTROLLER TYPE A-2
(DOUBLE WIDTH UNIT)

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