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Multiple controllers in a CAMAC crate

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BODY OF HD

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- **IEC 729 (1982) edition 1; IEC/TC 45,** not appended

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The English and French versions of this HD are provided by the text of the IEC publication and the German version is the official translation of the IEC text which is not yet available.

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by or before **1985-03-01**

to publish their new harmonized national standard

by or before **1986-03-01**

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Multiple controllers in a CAMAC crate

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MULTIPLE CONTROLLERS IN A CAMAC CRATE

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by IEC Technical Committee No. 45: Nuclear Instrumentation.

A first draft was discussed at the meeting held in Nice in 1978. As a result of this meeting, a draft, Document 45(Central Office)130, was submitted to the National Committees for approval under the Six Months' Rule in June 1979.

Amendments, Document 45(Central Office)144, were submitted to the National Committees for approval under the Two Months' Procedure in March 1981.

The National Committees of the following countries voted explicitly in favour of publication:

Australia	Germany
Austria	Italy
Belgium	Netherlands
Bulgaria	Poland
Canada	South Africa (Republic of)
China	Spain
Czechoslovakia	Sweden
Egypt	Union of Soviet Socialist Republics
Finland	United States of America
France	
German Democratic Republic	

Other IEC publications quoted in this standard:

Publications Nos. 516: A Modular Instrumentation System for Data Handling; CAMAC System.

552: CAMAC — Organization of Multi-crate Systems.
Specification of the Branch-highway and CAMAC Crate Controller Type A1.

640: CAMAC — Serial Highway Interface System.

MULTIPLE CONTROLLERS IN A CAMAC CRATE

1. Scope and object

1.1 *Scope*

This standard is applicable to CAMAC systems as defined in IEC Publication 516: A Modular Instrumentation System for Data Handling; CAMAC System. Its application shall not conflict or cause conflict with the mandatory requirements of IEC Publication 516.

1.2 *Object*

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 IEC Publication 516.

In order to allow more than one controller access to 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 (see IEC Publication 640), and the CAMAC Parallel Branch Highway Interface System (see IEC Publication 552). It may also be used in autonomous systems (systems with no external highways) or in systems with Type U Crate Controllers*.

Appendix A defines a Parallel Branch Highway Crate Controller, Type A2. This controller is similar to Crate Controller Type A1 (as defined in Appendix A of IEC Publication 552), except for the ACB connector and the priority arbitration protocol. When these two features are not required, Crate Controllers Type A1 and A2 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, IEC Publications 516, 552 and 640.

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

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* A Type U (Undefined) Crate Controller has an external interface that is not defined in the CAMAC specifications, such as a computer I/0 bus.

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

Mandatory clauses of the standard are written in bold type, as here, and usually include the word "shall".

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 shall satisfy all the mandatory requirements in this standard, excluding Appendix A. If constructed as a CAMAC plug-in unit, the equipment shall also satisfy the mandatory requirements of IEC Publication 516.

Appendix A defines the CAMAC Crate Controller Type A2 in such a way that Type A2 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 Appendix A regarding conformity with the specification of the CAMAC Crate Controller Type A2.

In order to be "compatible" with the ACB, equipment need not satisfy all the mandatory requirements, but shall 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 licence 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 IEC Publication 516 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 L2 (Appendix A of IEC Publication 640) and the Parallel Branch-Highway Crate Controller Type A2 (Appendix A).

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 ensures that at any time only one controller is permitted to have control of the crate. It also provides the means for assigning the control of the crate on the basis of a prearranged priority.

Access to the N and L lines is provided by the ACB via the CC (see Sub-clauses 4.2 and 4.3). 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 Figure 1, page 49.

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.

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 Figure 2, page 51.

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. 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 controller with the highest priority 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 Figure 3, page 53. 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 ensures that the Grant signal will propagate downstream to the highest priority controller which is requesting control of the crate.

When a controller requesting control receives Grant-In, it generates and maintains 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).

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 Branch-highway (IEC Publication 552). The R/G mode is unsuitable for a controller which cannot accommodate this delay. An example is the Serial Crate Controller Type L2 (IEC Publication 640). When a Serial Highway Crate Controller Type L2 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) uses 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 Sub-clause 4.1.5). Examples of the sequences of signals that occur with the ACL signal are shown in Figures 4a and 4b, page 55.

The necessary connections of the Request, Grant, Request Inhibit and ACL lines are illustrated in Figure 1, page 49.

The Serial Crate Controller Type L2, as described in Appendix A of IEC Publication 640, 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. The Serial Crate Controller Type L2 may thus be used as a CC compatible with this standard. However, some L2 controllers may not have a pull-up on the Request Inhibit line. In such instances, it will be necessary to add a pull-up on contact 17 of the SGL encoder connector of the L2 and connect it to the Request Inhibit line of the ACB connector.

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 Sub-clause 5.5.2 of IEC Publication 516), 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 shall be used in accordance with the mandatory requirements detailed in the following sections. Table I shows the titles, the standard designations, and the sources of the signals defined in this clause.

4.1 *Control Signals*

A controller, when used with one or more other controllers in a CAMAC crate, shall 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 shall 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 shall first generate a logic "1" signal on Request. 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 shall initiate the 1 → 0 transition of Request within 50 ns upon receiving either Request Inhibit = 1 or ACL = 1.

4.1.2 *Grant-In and Grant-Out Signals*

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

1) **It shall 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 shall 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 shall maintain a logic "0" on Grant-Out until it receives the next 0 → 1 transition of Grant-In signal and 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 shall 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 shall 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 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 shall be maintained until the Dataway operation is complete.

A controller generating ACL shall 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 L2, 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 four additional bytes have been received. The minimum elapsed time for the four additional bytes could be as short as 800 ns for a Serial Highway operating at its maximum data rate of $5 \cdot 10^6$ bytes per second in byte-serial mode.