CAMAC bulletin

A publication
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ESONE Committee

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WHAT IS CAMAC?

CAMAC is the designation of rules for the design and use of modular electronic data-handling equipment. The rules offer a standard scheme for interfacing computers to data transducers and actuators in on-line systems. The aim is to encourage common practice and compatibility between products (both hardware and software) from different sources.
CAMAC was originally defined by the ESONE Committee, a multi-national inter-laboratory organisation of data-processing experts from nuclear institutes. However, CAMAC is concerned with data-handling problems that are not specific to nuclear research and is being applied already in many other fields. Working groups of the ESONE Committee are considering further hardware and software aspects of systems for measurement and control, and maintain close liaison with similar working groups of the US AEC-NIM Committee and also with the International Electrotechnical Commission.
CAMAC is a non-proprietary specification which can be adopted and used free of charge by any organisation and without any form of permission, registration or licence action.
The CAMAC Bulletin, a publication of the ESONE Committee, disseminates information on CAMAC activities, commercially available equipment, applications, extensions and explanations of the rules.

PRINCIPAL CONTENTS OF PREVIOUS CAMAC BULLETIN ISSUES

CONTRIBUTIONS TO FUTURE ISSUES*

of the Bulletin should be sent to the following members of the Editorial Working Group:

Application Notes, Development Activities, Laboratory Reviews and Software:	Mr. W. Attwenger, SGAE, 1082 Wien VIII, Lenaugasse 10, Austria.
New Products and Manufacturer News:	Dr. H. Meyer, CBNM Euratom, Steenweg naar Retie, Geel, Belgium.
Product Guide:	Mr. O.Ph. Nicolaysen, N.P. Division, CERN, 1211, Geneva, 23, Switzerland.
Bibliography and any ESONE News Items, etc.:	Dr. W. Becker, JRC Euratom, 21020 Ispra (Varese), Italy.

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On the cover:

The front-entrance gardens at the Atomic Energy Research Establishment, Harwell, Berkshire, England, where the ESONE Annual Meeting was held in May, 1965.

CAMAC

bulletin

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

COMITÉ D'ÉTUDES 45

COMMISSARIAT A L'ÉNERGIE ATOMIQUE
INSPECTION GÉNÉRALE

Mieux que personne, les lecteurs de Camac connaissent et apprécient les avantages de la Normalisation. L'un des plus importants sur le plan économique est sans doute l'unification de certaines caractéristiques des produits afin d'assurer leur interchangeabilité, mais c'est aussi l'une des tâches les plus difficiles à réaliser surtout quand on veut le faire à l'échelle internationale.

Aussi, lorsque le Comité Esone a entrepris, il y a plus de 10 ans, à l'occasion du démarrage de l'électronique nucléaire à transistors, la normalisation des dimensions mécaniques des châssis, on pouvait craindre qu'il ne puisse arriver à un accord dans un domaine aussi évolutif.

Le mérite du Comité Esone est non seulement d'y être parvenu malgré les difficultés de toutes sortes mais encore d'avoir aussitôt compris l'intérêt qu'il y avait à élargir le cadre des utilisateurs du nouveau Standard en demandant à la Commission Electrotechnique Internationale de normaliser certaines des dimensions mécaniques, ce qui fit l'objet de la Publication 297 parue en 1969.

Fort de ce premier succès, le Comité Esone n'a pas hésité, voici quelques années, à se lancer dans la définition d'un nouveau système tenant compte de l'utilisation croissante des circuits intégrés et permettant le traitement numérique des résultats par un calculateur. Ainsi fut établi le document EUR 4100 en mars 1969, definissant le CAMAC.

Dès sa naissance, ce système semble rencontrer un total succès, d'autant plus qu'ayant sagement prévu l'adaptation des tiroirs NIM, il a été reconnu officiellement par le Comité NIM comme complément indispensable pour la transmission des données.

C'est pourquoi la CEI, par la voix de son Bureau Central, a estimé que le moment était venu de donner une audience internationale à ce système. Le choix du moment où l'on fait la normalisation est toujours très important. Il ne faut pas normaliser trop tôt pour que la technique ait acquis une maturité suffisante et il ne faut pas normaliser trop tard pour ne pas se trouver en face d'une trop grande diversité de matériel.

Dans le cas du CAMAC, l'autodiscipline des organismes qui sont membres du Comité Esone facilitera l'adoption des recommandations internationales qui en seront extraites. L'appartenance de la majorité de ces organismes aux milieux nucléaires a conduit la CEI à désigner son Comité d'Etudes n° 45 "Instrumentation Nucléaire" pour assurer la liaison avec Esone.

Cela ne veut pas dire que cette normalisation devra se cantonner dans le domaine nucléaire. Au contraire l'ACET (Advisory Committee on Electronics and Telecommunications) qui groupe tous les Comités de la CEI s'intéressant à l'électronique a déjà admis le principe de son extension aux autres domaines.

Le premier travail à faire sera d'examiner quelles sont les parties du document EUR 4100 qui sont maintenant suffisamment éprouvées pour pouvoir être normalisées sans difficultés. Déjà les dimensions des tiroirs CAMAC ont été reprises dans un document qui va être soumis au vote des pays membres de la CEI. Mais il y a certainement d'autres éléments à normaliser et ce sera le rôle de M. BISBY, qui a été désigné par le CE 45 pour assurer la liaison avec Esone, de proposer à la prochaine réunion plénière les points qui pourraient faire l'objet d'une normalisation CEI.

Le passage à la CEI entraînera pour le CAMAC des avantages et des servitudes.

Les servitudes sont dues aux procédures forcément lentes mais nécessaires de la CEI. Il en résultera une moins grande souplesse pour apporter au système des modifications éventuelles. Néanmoins, cela ne doit pas être un obstacle aux améliorations indispensables car les Normes ne sont pas intangibles et les procédures pourront être allégées grâce aux excellentes relations qui existent entre le Comité Esone et le CE 45.

Parmi les avantages, on peut penser que les observations qui seront formulées par les Comités Nationaux de la CEI permettront encore d'améliorer le texte du document EUR 4100 malgré tout le soin qui a déjà été apporté à sa rédaction.

Mais surtout, ce système déjà bien répandu en Europe et aux Etats-Unis dans les milieux nucléaires, va pouvoir être étendu au monde entier et pouvoir faire la preuve de son intérêt dans d'autres domaines d'activité pour lesquels ses performances le rendent apte à apporter d'immenses services.

SUMMARY

Better than anyone, the designers of CAMAC recognise and understand the advantages of standardisation. Without doubt one of the most important economic considerations is to ensure interchangeability of products, but it is also one of the most difficult to attain especially on an international scale. Choice of the point in time when standardisation should be attempted is very important. It should not be too soon, before the technology or technique involved has acquired sufficient maturity, but on the other hand not so late that one is faced with excessive material diversity.

Since its birth CAMAC has met with unqualified success and the Central Office of the IEC believe that the moment has arrived for CAMAC to be given a wider international presentation by introducing it into the programme of the IEC, whose Advisory Committee on Electronics and Telecommunications (ACET) has admitted that it could be extended into other than nuclear areas.

Certainly, CAMAC is already widely known in European and North American nuclear circles and should be extended into the rest of the world and demonstrate its value in other areas of activity for which it is qualified to bring enormous benefits.

A. Rys

BIOGRAPHICAL NOTE

Born 1918. Graduate Engineer of l'Ecole Polytechnique de Paris. Joined Commissariat à l'Energie Atomique in 1960. Head of Standardisation Group of CEA. President of Technical Committee No. 45 of the International Electrotechnical Commission since 1968 and Representative of France on TG 85 of International Standards.

A DECADE WITH ESONE

by
W. Becker
CCR Euratom, Ispra, Italy

SUMMARY The secretary of the ESONE Committee reviews a decade of increasing activity and membership, during which the Committee has formulated two modular systems; the ESONE specification for nuclear instrumentation and CAMAC for data handling.

ORIGINS OF ESONE

Once upon a time in the early days of what has been called Nuclear Electronics the inventor happily created instruments according to his own beloved formula. Then he was expelled from paradise and forced to develop more and bigger apparatus. Fortunately, before he despaired he discovered that the logical answer was to share development effort by matching different instrument units to a common standard so that they could fit together.

By 1959 the NUTRA standard for transistorised equipment had been developed by collaboration between Euratom—Ispra and the French laboratories at Saclay and Grenoble. This predecessor of the ESONE standard owed much to the initiative of Prof. Giannelli. German standardisation work had proceeded independently, and in Spring 1961 the 'Deutsche Studiengruppe für Nukleare Elektronik' appeared on the scene, at Heidelberg, in discussions with the NUTRA people.

Shortly after this, in July 1961, there was a conference at Ispra where engineers were present from CEA-Saclay, CEA-Grenoble, CNEN-Casaccia, CNEN-Frascati, HMI-Berlin, DESY-Hamburg, MPI-Heidelberg, CERN-Geneva, EURATOM-Ispra, and EURATOM-BCMN-Geel. The ESONE Committee was founded, with Prof. Giannelli as its first chairman, and the first working text of the ESONE standard was defined.

EXPANSION AND COMPETITION

In the United Kingdom there had been independent development of a standard, then mainly for electron tube equipment. This was well established by 1962, when CERN people took the initiative of suggesting contacts between AERE-Harwell and ESONE. Before long the membership of ESONE had extended to organisations outside the European Community, such as Austria, Switzerland, Yugoslavia and the United Kingdom. In the meantime a conference of representatives from the Common Market countries agreed that the ESONE Committee should remain a purely technical organisation, consisting of people whose work in their home institutions depended on the standards set up by the Committee. This turned out to be an effective stimulant.

Things went well. Industry was producing ESONE equipment, especially in France, Germany and Italy. However, many larger firms hesitated to do so, and the system did not really spread to non-nuclear applications. Into this situation there came the announcement by the USAEC NIM Committee of the Nuclear Instrument Module system, which followed a similar philosophy to the ESONE standard. However, the NIM standard got much bigger support from industry, and this affected the growth of production in the ESONE standard. Three modular concepts were competing: Harwell 2000 (1957), ESONE (1961 and 1964) and USAEC NIM (1964).

After successful meetings of the ESONE Committee in March 1963 at Geel, November 1963 in Paris, June 1964 in Berlin and May 1965 at Harwell there was a setback in May 1966 at Grenoble. CERN, represented on the ESONE Committee for the first time since 1961, announced their decision to use the NIM, rather than ESONE, standard for their new instrumentation.

CAMAC EMERGES

Harwell, in particular, urged the ESONE Committee that this was an appropriate time to start studying a completely new modular system for on-line connection of transducers and actuators to computers. This was a logical and far-reaching conclusion, taking into account that small computers were becoming available in the mid-60's for on-line systems and that the packing density of components could be increased considerably by small-scale integration. A meeting in Munich, in the fall of 1966, was the turning point, after which ESONE directed its efforts almost exclusively to the new system.

Between the General Assembly in Vienna, May 1967, and the extra ESONE Conference in Karlsruhe, November, 1967, where module size, connector position and other questions were resolved, there had been a rather dramatic decision. A meeting at CERN in August 1967 abandoned the proposed 20mm module-width and chose a NIM-compatible dimension (half the width of a NIM module). This turned out later to be a decision of great importance since it opened the way to trans-Atlantic co-operation.

Agreement on the new system, finally called CAMAC, was reached during the General Assembly in Rome, May 1968. The specification was published as EURATOM Report EUR 4100e (1969) with the title 'CAMAC—A modular instrumentation system for data handling'. The response to the publication of this standard was extremely encouraging.

A most welcome event was the establishment of working contacts with the NIM Committee in

November 1967. Since then there has been continuously growing collaboration. In one direction this led to the endorsement by the NIM Committee of two CAMAC specifications; EUR 4100 in February 1970 and EUR 4600 (organisation of multi-crate systems) in November, 1971. In the other direction the NIM Committee influenced the choice of the 24-bit word length, the full decoding of sub-address and function codes, the polarity of analogue signals, and a better definition of the timing cycle. The Chairman of the USAEC NIM Committee, Mr. L. Costrell, participated in the ESONE General Assemblies in 1970 and 1971.

INCREASING ACTIVITY

The 1969 version of EUR 4100 was published in four languages, English, French, German and Italian. This involved much work, since to a certain extent translation also means interpretation. During 1969 work started on the specification of the Branch Highway for multi-crate systems. The increasing amount of work required very vigorous efforts by the various working groups. At the General Assembly in Petten, September/October 1969, the new chairman proposed that there should be some sort of central ESONE research group. Subsequently a Software Working Group was formed, reflecting the increasing importance of this work for CAMAC.

A further important aspect has been the strengthening of contacts with industry. In connection with the General Assembly at CERN, October 1970, the industry exhibited an impressive range of CAMAC products. Diversification of CAMAC applications to non-nuclear fields began to be promising. It was at this CERN Assembly that another valuable idea was brought to life; an Information Working Group was formed to create a periodical, 'CAMAC Bulletin', and this has continued to be a major activity.

ORGANISATION

During the Rome Assembly, in 1968, the organisation of the ESONE Committee was reviewed, in order to deal with expanding activities and membership. An Executive Group of seven members was formed, and the ESONE Secretariat at Ispra was reinforced. The interactions between various parts of the ESONE and NIM Committees are summarised in the block diagram on the back cover of this Bulletin.

It is with great regret that this report on a decade mentions that two of the original ESONE members, Prof. Baldinger from Switzerland and Mr. Ghigo from Italy, have died during this period.

WORK AND PLAY

Intense activity has been needed to achieve the present results. There have been interminable meetings going on into the early hours of the morning, with sandwich meals and difficulties in getting out of buildings at strange hours. In contrast, there have been some excellent meals in various capitals of Europe. Members recall the snow-engulfed restaurant in Grenoble, Heuriger in Vienna, Paddy's Clam-Bar 42nd Street New York, Blockhaus Nikolskoe in West Berlin, the reception at the old City Hall in Geneva, and many more events accompanying the working meetings. One member jokingly interpreted CAMAC as standing for 'Committee to Arrange Meetings at Any City'.

CONCLUSION

It should not be forgotten that a very positive outcome of all these efforts has been the personal contacts between many researchers and engineers, offering them great technical stimulation and saving a considerable amount of parallel work. Therefore, this look at a decade with ESONE gives justifiable satisfaction, and confidence in future progress.

ESONE ANNOUNCEMENTS

CORRIGENDUM TO EUR 4600e

Owing to an unavoidable error in collation some few copies in the initial distribution of EUR 4600e were sent out without the corrigendum sheet. As far as possible, known recipients of these copies have now been sent the corrigendum sheet under separate cover. The sheet is repeated below to ensure that everyone is aware of its existence and anyone who would like a sheet to complete their copy should please contact the ESONE Secretary (Dr. W. Becker).

EUR 4600e

Please read page 32, line 20

is on-line and $(BTA+\overline{BTB_i}).BG.BCR_i = 1$.

instead of

is on-line and $(BTA+BTB_i).BG.BCR_i = 1$.

Please read page 32, line 22

. . . . the crate controller is on-line and $[N(28)+N(30)](BTA+\overline{BTB_i}).\overline{BG}.BCR_i = 1$.

instead of

. . . . the crate controller is on-line and $[N(28)+N(30)](BTA+BTB_i).BG.BCR_i = 1$.

AVAILABILITY OF EUR 4100 (1972), EUR 4600 AND EUR 5100

Report EUR 4600e to which AEC TID 25876 corresponds, 'CAMAC, Organisation of Multi-Crate Systems, Specification of the Branch Highway and CAMAC Crate Controller Type A' is available as already announced in Bulletin No. 4. Reports EUR 5100e 'CAMAC, Specification of Amplitude Analogue Signals' and EUR 4100e (1972) 'CAMAC, a Modular Instrumentation System for Data Handling', a revised version of the EUR 4100e (March 1969) and to which AEC TID 25875 corresponds, are also available from September 1972. The price for one copy of EUR 4100e is BF 85.–, for EUR 4600e BF 60.– and for EUR 5100e BF 25.–, (or any other equivalent currency).

Orders can be submitted to the following address:

Office for Official Publications
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INTRODUCTION TO CAMAC

USE OF THE Q RESPONSE FOR CONTROLLING BLOCK TRANSFERS

by

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Received 25th May 1972

SUMMARY The Response (Q) line in the CAMAC Dataway may be used to control block transfers. This paper describes the three types of block transfers named in EUR 4100e (1972) and makes recommendations concerning their implementation.

THREE MODES OF BLOCK TRANSFER

The revised CAMAC Specification EUR 4100e (1972) defines three ways in which the Response signal (Q) can be used to control the transfer of blocks of data. CAMAC is often used to multiplex many data inputs or outputs to a controller (usually coupled to a computer). The ***Address Scan*** mode (previously defined in EUR 4100e (1969)) is used for data transfers to or from an array of registers that do not necessarily occupy consecutive CAMAC addresses. CAMAC is also used as the link between a controller (usually coupled to a computer) and a selected register associated with one device that requires to transfer a block of data. Examples of such devices are a buffer store, oscilloscope, proportional/spark chamber read-out system, or electromechanical input/output equipment. The ***Repeat*** mode is used if the block of data has a known number of data words, but the device is not always able to keep pace with the CAMAC system. The ***Stop*** mode is used if the device is able to keep pace with the CAMAC system, but the end of the data block is determined by the device and is not known in advance.

The three modes of transferring blocks of data are described in more detail in this paper.

ADDRESS SCAN MODE

When data transfers are to be made to (or from) many registers two methods are available to the system designer. Either the CAMAC address of each register can be extracted from an address list in a store, or it can be calculated by the CAMAC controller on a cycle-by-cycle basis depending on the Q response of the previous cycle. This latter method is known as the address scan mode, and depends on the modules following the rules given in Section 5.4.3.1 or EUR 4100e (1972).

When a module intended for use in the address scan mode is addressed with a read or write command to a Group 1 or Group 2 register the action taken by the CAMAC controller depends on the Q response.

Response Q = 1

This indicates that a register exists at the address; that a data transfer must be made to (or from) the storage medium of the CAMAC controller; and that unless the current sub-address is A(15) there may be another register at the next sub-address of the same station.

The address of the CAMAC register accessed during the next cycle is derived as follows. (As an example it is assumed here that the address scan covers the first 22 stations of the CAMAC crate. If not, the appropriate maximum value of N is used):

- If the sub-address A is less than 15, then increment A.
- If A = 15 and the Station Number N is less than 22, then increment N and set A = 0.
- If A = 15 and N = 22, then increment the Crate Address C, set N = 1 and A = 0.

All registers intended to be accessed in the address scan mode are located at consecutive sub-addresses in a module, beginning at A(0), and respond to read and write operations by generating Q = 1.

Response Q = 0

This indicates that there is no register for use in address scan mode at this sub-address as well as all the higher sub-addresses at the same station, and that no transfer of data is required to (or from) the storage medium of the controller.

The address of the CAMAC register accessed during the next cycle is derived as follows:

- If the Station Number N is less than 22, then increment N and set A = 0.
- If N = 22, then increment the Crate Number C and set N = 1, A = 0.

At each station within the range of the address scan the first sub-address at which there is no register to be accessed in this mode must respond with Q = 0. However, it is in principle possible for this sub-address to be used for any other feature, provided the response to read and write operations is always Q = 0. At any further remaining sub-addresses the response may be either Q = 1 or Q = 0.

Terminating the Address Scan Transfers

The sequence of operations with addresses derived in this way is continued until a specified terminal CAMAC address is reached and/or a specified number of cycles with Q = 1 have taken place. The properties of these two methods of terminating the block transfer are discussed below.

In the majority of applications the number of CAMAC registers to be accessed is known beforehand, and consequently the address scan can be terminated either by reaching a specified word count or by reaching a specified CAMAC address, since one is implicit in the other.

This is not always so. For example, in order to save space in the storage medium it is possible to design more sophisticated modules in which the address scan may encounter a variable number of registers, so that the total number of transfers in the block is also variable. Another example occurs under fault conditions, when the word count may be reached before the final address, or the final address may be reached (or even skipped altogether) before the word count is reached.

Therefore it is good practice that controllers designed for the address scan mode should terminate the transfer if either the specified word count is reached, or if the specified final CAMAC address is reached or exceeded.

Comparison between Address Scan and Address List Methods

In the address scan mode the CAMAC addresses are calculated, taking into account the Q responses. The alternative is to extract the addresses from a stored list. The main features affecting the choice between these two methods are discussed below.

If the address list mode is used there must be storage locations for all the CAMAC addresses. On large systems it is no small task to load these addresses. The actual address of each register must be known, and this may not be obvious for multi-width modules.

If the address scan mode is used there is no need to know the precise addresses of all registers. It is necessary to know the range of Station Numbers in each crate, the total or maximum number of registers (in order to determine the required data storage area), and the conditions for terminating the block transfer.

Address scan mode is restricted to accessing all the registers in ascending order of addresses. Address list mode is more flexible, since it allows all the registers, or any selection of them, to be accessed in arbitrary order.

Address scan requires modules whose use of sub-addresses and Q suits this mode, whereas address list mode can use any module.

In address list mode the number of CAMAC operations is equal to the number of registers. Address scan mode requires an extra operation for each vacant station or station with less than 16 registers. Thus address scan mode is slower if the registers are not densely packed.

Any irregularity in the address scan mode (for example, a missing module, a faulty Q response, or a corrupted command) upsets the correlation between all the following CAMAC registers and the corresponding locations in the storage medium. If the address scan is terminated by counting the number of transfers, irregularities may also lead to the system attempting to access registers outside the required range. In the address list mode irregularities are unlikely to have such serious effects.

REPEAT MODE

Repeat mode is used for transferring a block of data between a register in a CAMAC module (typically associated with an external device which is the source or receiver of data) and the controller (typically coupled to a computer) under conditions such that the controller may attempt to make transfers before the module and external device are ready to participate in the transfer.

If the module has been designed for use in the Repeat mode of block data transfer as defined in Section 5.4.3.2 of EUR 4100e (1972) it responds to each data transfer operation with a Q signal indicating whether valid data was transferred. Thus $Q = 1$ signifies a valid data transfer, and the module then either requests the next read-word from the device or offers the write-word to the device (from time S1 onwards). The response $Q = 0$ signifies a non-valid transfer because the module is still waiting for the external device either to present read-data or to finish accepting write data from a previous valid transfer. In this case the controller repeats the same transfer operation, many times if necessary, until a $Q = 1$ response is obtained.

In order to comply with the CAMAC specification each module that is addressed with a read or write command must establish the Q signal ($Q = 0$ or $Q = 1$ as appropriate) before Strobe S1 and maintain it until Strobe S2. This presents special problems in Repeat mode, because the controller can (in principle) maintain the same command and the Busy signal thoughout the block of data transfers. It is possible to meet these requirements by staticising the readiness condition in the module at S2 (in order to deal with a continuous sequence of transfers) and also at the leading edge of N (in order to deal with the first transfer of the sequence and with slower discontinuous sequences).

The block of repeat mode transfers may be terminated either by the controller counting a specified number of valid transfers or by the module generating a LAM signal. The latter method is appropriate when the number of words to be transferred is not known in advance by the controller. It is good practice to set a limit on the number of successive transfers with $Q = 0$ and halt the transfers if this limit is exceeded, in order to prevent system lock-up under fault conditions.

Alternatives to Repeat Mode

If the device is very much slower than CAMAC then the LAM mode of operation, in which the Look-at-Me signal signifies 'job done', is an efficient alternative to Repeat mode, since it frees the controller for other tasks while the device is busy. If the device is not much slower than CAMAC another alternative is for the controller to enter a wait loop program in which the readiness of the module (and therefore the device) is tested repetitively by Test Status operations with the command F(27) at an appropriate sub-address. The response $Q = 1$ informs the controller that the module and device are ready to perform a data transfer operation. The response $Q = 0$ indicates that they are still busy as a result of the previous data transfer, and the controller repeats the test.

The principles of the Repeat mode, the LAM mode, and the testing of readiness status are not unique to CAMAC, and are often used for transfers between computers and peripherals.

STOP MODE

If the relative speeds are such that the external device will always be ready for the next CAMAC transfer operation, then the Q response associated with the data transfer may be used by the module to indicate the end of the data block. This use of the Q response is called the Stop Mode of block transfer, and is defined in Section 5.4.3.3 of EUR 4100e (1972).

The response Q = 1 signifies a valid data transfer. The controller must perform at least one more transfer.

The response Q = 0 signifies a non-valid transfer following the last valid transfer of the block. The controller should terminate the sequence of transfers. Thus to effect N valid transfers requires N+1 transfers.

The CERN NP Electronics II Group intend to increase the power of the Stop mode to cope with modules that are not always ready for the next transfer operation. This involves the module generating a Hold signal when it is addressed but not yet ready to take part in a valid data transfer. The controller responds to the Hold signal by 'freezing' the timing cycle of the Dataway operation before S1 and the corresponding BTB are generated. When the module is ready it removes the Hold signal, and the controller continues the timing cycle. (For further details see CERN-NP CAMAC Note 38-00, and the paper by Iselin, Löfstedt and Ponting on page 7 of CAMAC Bulletin No. 3).

The Hold feature requires additional circuits in the crate controller compared with the Crate Controller Type A defined in EUR 4600e, but many manufacturers are now offering crate controllers that can be adapted to work either as a Crate Controller Type A or as a crate controller with Hold feature.

NEWS

IEC-ESONE LIAISON

On a recommendation from the International Electrotechnical Commission's (IEC) Advisory Committee on Electronics and Telecommunications (ACET), the CAMAC standard will be introduced onto the IEC programme via Technical Commission No. 45 (TC. 45). With the approval of the ESONE Committee, Mr. Harry Bisby has accepted an invitation from Monsieur A. Rys the President of TC. 45 to provide the liaison between the ESONE Committee and the IEC on the CAMAC topic.

At the last meeting of TC.45 (London 18/29 September, 1972) the procedures for including CAMAC on the work programme have been discussed and a schedule defined.

As a preliminary to this meeting, Mr. Bisby and Mr. Louis Costrell (Chairman NIM Committee) had informal discussions in Washington on 6th June and the topic was further discussed at the ESONE Executive Group meeting in Brussels 5/7 July.

Part of the liaison activity is to establish contact with all those areas of the IEC which might be interested in CAMAC. So far three areas, other than TC.45 have been identified in Technical Commissions 48, 57 and 66. Would anyone knowing additional areas, please be kind enough to write to Mr. H. Bisby at Harwell.

ESONE ANNOUNCEMENTS

LARGE-SCALE DRAWINGS

The reduced-scale drawings included in the CAMAC specifications are likely to be adequate for most users, and for those whose construction of CAMAC units is based on commercially available module-kits. However, large-scale copies of some of the drawings will be useful to those who design and manufacture CAMAC crates and plug-in units. The following large-scale drawings will shortly be available from:

— Dr. W. Becker
Secretary, ESONE Committee
JRC Euratom, I-21020 Ispra (Va), Italy

— Mr. L. Costrell,
Chairman, NIM Committee
Radiation Physics Building
National Bureau of Standards
Washington DC 20234, USA

ESONE Drawing Numbers	*NIM Drawing Numbers*	*Title*	*Derived from*
CA-600	NA-600	Drawing list	—
CD-601	ND-601	Unventilated Crate - Front View	Fig. 1, EUR 4100e
CD-602	ND-602	Plan View of Lower Guides in Crate	Fig. 2, EUR 4100e
CD-603	ND-603	Crate - Side View, Section	Fig. 3, EUR 4100e
CD-604	ND-604	Plug-in Unit - Side and Rear Views	Fig. 4, EUR 4100e
CD-605	ND-605	Dataway Connector	Fig. 5, EUR 4100e
CD-606	ND-606	Ventilated Crate - Front View	Fig. 6, EUR 4100e
CD-607	ND-607	Adaptor for NIM Units	Fig. 7, EUR 4100e
CD-608	ND-608	Typical Printed Wiring Card	Fig. 8, EUR 4100e
CD-609	ND-609	CAMAC Crate Controller Type A	Fig. 7, EUR 4600e
CD-549	ND-549	NIM-CAMAC Coaxial Connectors Type 50 CM	—

Each large-scale drawing will be kept up to date with corrections and modifications as necessary, without waiting for a revision of the CAMAC Specification from which it is derived. Users should therefore be careful that they have the latest issue of each drawing.

NEWS

CAMAC IN BERLIN HOSPITAL

A Berlin Hospital (Rudolf-Virchow-Krankenhaus) is to computerise its Department of Nuclear Medicine and Radio-Therapy by a real-time configuration using CAMAC as an interface.

The Department contains 2 gamma-cameras, 3 scintillation-scanners, 2 automatic well-type counting systems, various Na.I (T1) detector systems for diagnostic purposes and 2 betatrons (35 MeV, 45 MeV) for radio-therapy.

All the data collection and the control of these clinical instruments will be handled by computer via CAMAC!

Some of the reasons why CAMAC was chosen are:

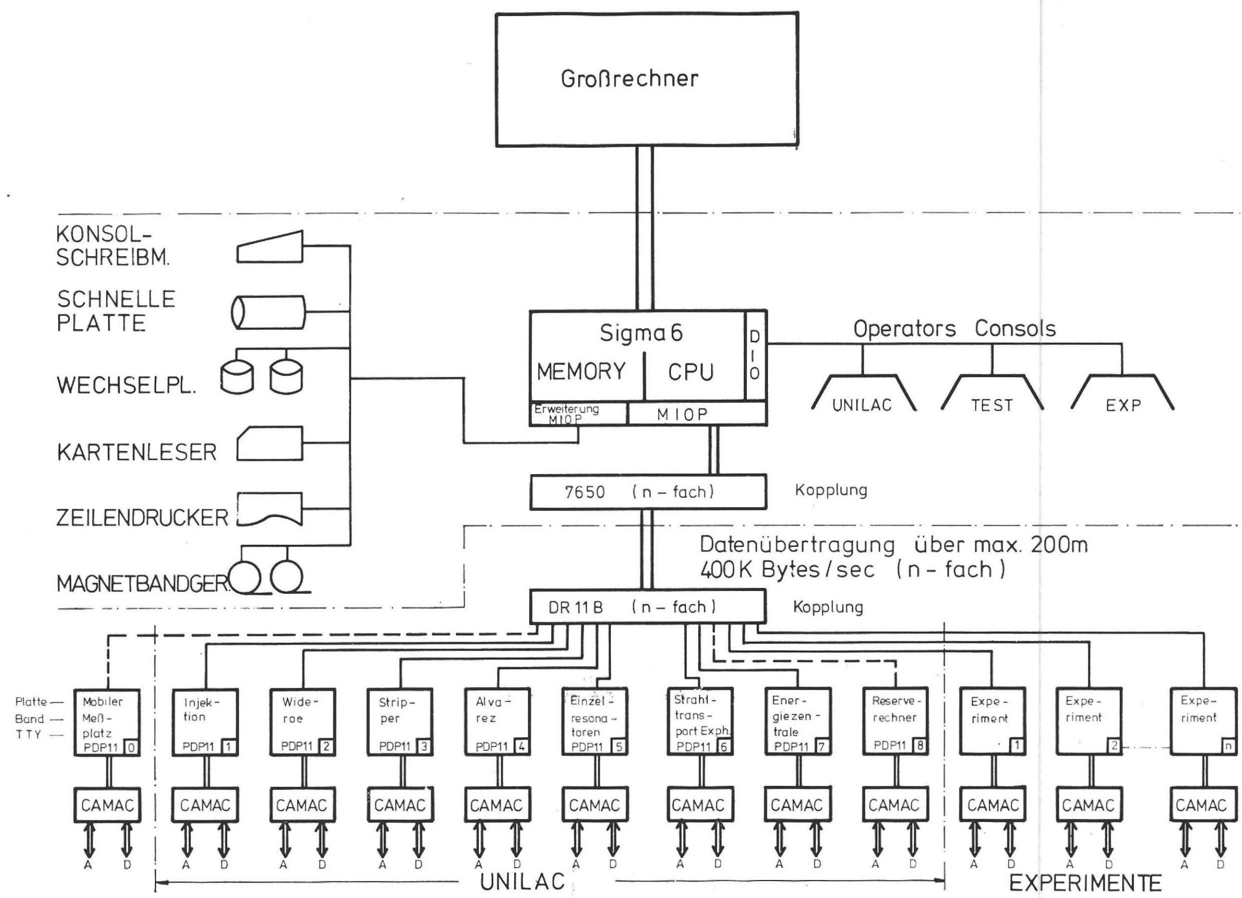
— many of the CAMAC-modules developed for nuclear physics can be used in nuclear medicine
— CAMAC may be connected to various types of computers
— the modularity of CAMAC allows easy application of this pilot-configuration to other hospitals having different clinical instruments

CAMAC AT THE GESELLSCHAFT FÜR SCHWERIONENFORSCHUNG, DARMSTADT (GSI)

Under the name 'UNILAC' the Gesellschaft für Schwerionenforschung is launching a project for the construction of a linear accelerator for heavy ions due to be in operation by the end of 1974. Data for the operation and checking of the accelerator will be acquired by CAMAC instrumentation. A computer satellite system will be set up with Sigma 6 (RXDS) as central processor and about 10 PDP-11 (DEC) computers as satellites.

Each satellite computer will be able to drive up to two CAMAC branches. At present in an experimental set-up, problems of adapting existing measurement equipment to CAMAC and the transmission of analogue and digital signals to the CAMAC system are being studied.

The decision in favour of using CAMAC has been greatly influenced by the saving of long-term developments and the achieved independence from one manufacturer only.



Struture of Dataprocessing and Control System at GSI

APPLICATION NOTES

1

ACQUISITION DE MESURE EN CAMAC (CAMAC DATA LOGGING)

by

J. Rion

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Received 19th June 1972

SUMMARY A set of modules has been developed to permit analogue data logging stations to be implemented in CAMAC. The principal characteristics of these modules are summarised.

INTRODUCTION

Bien que le système CAMAC ait été initialement défini en vue de l'acquisition des données nucléaires, il est rapidement apparu souhaitable d'étendre son application à l'acquisition de données analogiques classiques. C'est ainsi qu'en France, le CEA a étudié et réalisé en collaboration avec la Société Schlumberger, une centrale d'acquisition à vitesse limitée (40 voies par sec) dont la description est fournie ci-dessous; au cours de l'élaboration de ce matériel, on a recherché systématiquement la diminution des prix; à cet égard un résultat très satisfaisant a été obtenu en limitant les performances au strict nécessaire, en réduisant l'encombrement des modules, et en adaptant exactement les caractéristiques en fonctionnement avec calculateur en ligne.

DESCRIPTION GÉNÉRALE

La figure (fig. 1) représente la structure de la centrale. Le système comporte six types de tiroirs.

Les tiroirs JMX, JCTF et JEF correspondent aux principales fonctions et réalisent le multiplexage, la conversion tension fréquence et la mesure de fréquence.

Les tiroirs JET, JAX et JAF 20 assurent respectivement l'alimentation en tension programmable pour l'étalonnage automatique de la chaîne de mesure, la sélection et l'affichage manuel du numéro de voie, et la visualisation du contenu brut de l'échelle JEF.

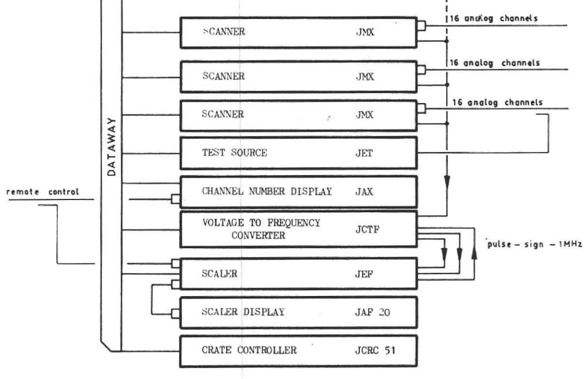

Fig. 1 CAMAC Data-logger

Dans le cas où l'utilisateur désire une visualisation plus élaborée, il peut utiliser le tiroir JAF 15 qui implique un dialogue avec le calculateur.

CARACTÉRISTIQUES TECHNIQUES PRINCIPALES

La capacité de la centrale est extensible jusqu'à 256 voies par module de 16. La vitesse de scrutation atteint 40 voies par seconde pour un temps de comptage de 20 millisecondes, et une résolution de 4000 points. Les sensibilités sont comprises entre 10 mV et 10 V, et dans des rapports 4.

La précision globale est de $\pm 10^{-3}$ de la pleine échelle. Une protection efficace de l'appareil contre les parasites est obtenue grâce à une commutation trois fils, à un taux élevé de rejection de tension de mode commun, et à un isolement galvanique de 250 V entre capteur et calculateur. Une protection supplémentaire est assurée contre les interférences industrielles par l'intégration pendant une ou plusieurs périodes du secteur.

Le système a été conçu pour une utilisation rationnelle avec un calculateur. C'est ainsi que le contenu de l'échelle de comptage est en code binaire complément à 2, que les étendues de mesure sont dans des rapports 4 et que les pleines échelles s'expriment par des puissances entières de 2.

Le choix de la voie de l'étendue de mesure, du temps de comptage et de la tension d'étalonnage s'effectue en une seule instruction CAMAC, adressée au tiroir fréquencemètre JEF.

Enfin l'ensemble est très compact puisqu'il est possible de réaliser une centrale de 256 voies dans un seul châssis d'alimentation.

LE MULTIPLEXEUR (JMX)

Ce module 1/25 assure la commutation par relais sous ampoule de 16 voies analogiques trois fils. Les entrées analogiques en bifilaires blindées sont branchées sur la face avant, par un connecteur spécial verrouillable. Les sorties analogiques, également en face avant, utilisent des prises bifilaires isolées LEMO.

La commutation est à deux niveaux. La sélection d'une voie codée sur 8 bits peut être faite soit par calculateur — aléatoirement (F(17) ou F(19)) ou séquentiellement (F(25)) — soit manuellement à l'aide du module JAX.

Seize modules sont associés pour réaliser une centrale de 256 voies. Enfin, il existe deux versions distinctes : l'une économique, équipée de relais standards pour niveaux supérieurs à 100 mV, l'autre pour des niveaux inférieurs, équipée de relais spéciaux, à faible couple thermoélectrique.

CONVERTISSEUR TENSION FRÉQUENCE: (JCTF)

Ce module 2/25 se compose essentiellement d'un amplificateur différentiel à gain programmable suivi d'un convertisseur tension fréquence d'une conception originale, ces deux éléments étant gardés et isolés électriquement du châssis.

Huit sensibilités peuvent être choisies par programme (trois bits) entre 10 mV et 10 V dont deux valeurs spéciales peuvent être déterminées par l'utilisateur, la valeur choisie étant affichée par 8 voyants en face avant.

Les réglages du zéro et de la pente de conversion, les sorties impulsion et signe, l'entrée d'une horloge 1 MHz (normalement fournie par JEF) sont également disponibles en face avant.

ÉCHELLE COMPTANTE/DÉCOMPTANTE-FRÉQUENCEMÈTRE (JEF)

Elément terminal de la centrale, il peut aussi être utilisé séparément comme fréquencemètre ou comme compteur (à présélection) pour tous les éléments émetteurs d'impulsion : débitmètre à moulinets, tachymètre, convertisseur courant-fréquence, détecteur nucléaire.

Le module d'une largeur de 1/25 comporte essentiellement une échelle comptante-décomptante (entrées impulsion et signe) de 16 bits en code complément à deux.

On peut choisir par programme une capacité de $\pm 2^{14}$ ou $\pm 2^{12}$ (correspondant à la pleine échelle sur 20 ms pour la seconde.)

En fréquencemètre, les temps de comptage sont de 20 ms, 80 ms ou 1280 ms sélectionnés par programme.

En compteur, le comptage peut être commandé soit de l'extérieur (prises marche arrêt, inhibition) soit par calculateur (F(26) et (F(24)).

SOURCE DE TENSION D'ÉTALONNAGE (JET)

Ce module (1/25) délivre, sur l'une quelconque des voies de la centrale, des tensions étalonnées permettant de régler et de vérifier la centrale.

Ces tensions sont soit zero, soit la pleine échelle en positif, soit la pleine échelle en négatif. Elles sont liées automatiquement à la sensibilité choisie pour le convertisseur JCTF.

PROGRAMMATION

Le fonctionnement sur interruption est en général utilisé. L'ensemble des paramètres de la mesure, regroupés dans un registre dit de consigne, et le déclenchement de celle-ci (en fréquencemètre seulement) s'effectue par une seule instruction F(17) adressée au tiroir JEF.

A réception de l'appel L, F(0) ou F(2) assure la lecture du registre de comptage. Il existe enfin d'autres instructions concernant des fonctions secondaires telles que contrôle électronique, utilisation du débordement, etc.

COMMANDE MANUELLE (JAX) ET VISUALISATION D'ÉCHELLE (JAF)

Pour les mises au point et réglages « OFF LINE » de la centrale, il est indispensable de disposer d'un minimum de commandes manuelles, et de visualisation. Il est donc possible d'adjoindre deux modules de service aux trois types de modules précédents.

Le module JAX (1/25) porte l'inverseur MANUEL-PROGRAMME qui valide en position « manuel » les poussoirs de sélection situés sur les différents tiroirs. Dans cette position, il est alors possible de sélectionner par poussoir :

1. une voie et un groupe visualisés sur JAX;
2. une sensibilité du convertisseur visualisée sur JCTF;
3. une tension test visualisée sur le tiroir JET;
4. un mode de mesure visualisé sur JEF.

L'initialisation de l'ensemble est faite au préalable à l'aide du poussoir Z du contrôleur de châssis.

Le déclenchement d'une mesure est assuré par la prise MARCHE de JEF et la mise à zéro de l'échelle par le poussoir C du contrôleur de châssis

Le contenu de l'échelle est affiché de façon très directe par le tiroir JAF.

Ces modules permettent donc de vérifier aisément la centrale, et de régler le zéro et la pente de conversion du convertisseur.

READER'S COMMENTS*

Charles E. Cohn of the Argonne National Laboratory, USA has written to suggest that the value of the Bulletin would be enhanced by inclusion of a list of unit designs developed by various laboratories. Something similar to the Product Guide would be desirable with a short functional description of the unit and a name to contact for further information.

The ***Editorial Working Group*** discussed this proposal at its last meeting and appreciated that this information could be useful for CAMAC manufacturers and also reduce duplication of design effort in laboratories. However, because the present Product Guide occupies 1/3 of the Bulletin space and a total space limitation must be applied, another solution may be to have a central depository for such information from laboratories and prepare a list of the contents, copies of which could be available on request. An invitation to laboratories to send information will possibly be included in Bulletin No. 6 or as soon as the details of a scheme have been worked out. An ESONE Announcement on CAMAC-related software from suppliers and users appears on page 23 of this issue.

* The Editorial Working Group invites readers' comments and proposals and intends to publish these in the Bulletin, together with responses if the topic is of general interest.

2 A CAMAC-BASED DATA-PROCESSING SYSTEM: LABCOM

by

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Received 5th June 1972

SUMMARY A laboratory-oriented computer system (LABCOM) is operating in a laboratory with a number of different working areas. The system accepts and displays data at CAMAC terminals remote from the computer.It operates in a time-sharing mode which allows several data acquisition and processing tasks to be handled simultaneously.

INTRODUCTION

The application of instruments coupled directly to computers for the measurement of the physical and chemical properties of materials is expanding rapidly. Development has proceeded along two main lines; (a) small dedicated computers which can be integrated into a unit with one instrument and (b) larger computers handling the input from several instruments in a time-sharing mode of operation. The LABCOM data-processing system[1] gathers and processes the data from several instruments using a small computer in a time-sharing mode of operation. This concept of time-sharing means that the system can carry out a number of unrelated operations in a way which appears to be simultaneous to the user or users.

The LABCOM system has been designed for the R & D laboratory or process control environment; user interaction with the system is flexible to cope with a wide range of skills and experience. The computer will frequently be far from the instrument collecting data and a multicrate CAMAC system is used to provide several remote terminals. Each terminal can accept data from more than one instrument, and the system is designed to cope with a number of instruments operating simultaneously in any configuration up to the maximum interrupt rate. Operator interaction is made through a teletype with graphical data displayed on an oscilloscope or X-Y plotter at each terminal.

INTERACTION WITH THE USER

Each user begins by declaring the mode of use, i.e. the instrument name, followed by a personal identifier. Further interaction follows one of several courses depending on requirements:

(a) At the simplest level the user answers a short series of prompted commands to give a title and initiate an experimental run.

(b) The user may insert new conditions for the run and process the data by answering prompted commands.

(c) Experienced users familiar with computer operation can process the data in a high level language such as Basic or Focal.

The end of a run is signalled by the instrument and the user is prompted to ask for a further run or a data processing calculation; the results of a calculation are displayed or printed. The data set can then be stored on magnetic tape where it is available for later processing and display, or as a reference for example, as part of a library of infra-red spectra.

The system uses a PDP-8/I or similar 12-bit computer with at least 8k of core, a 32k disk and two magnetic tape transports which are used for reference data and long term storage. Simultaneous acquisition of data together with programming in a high-level language will require 12k of core.

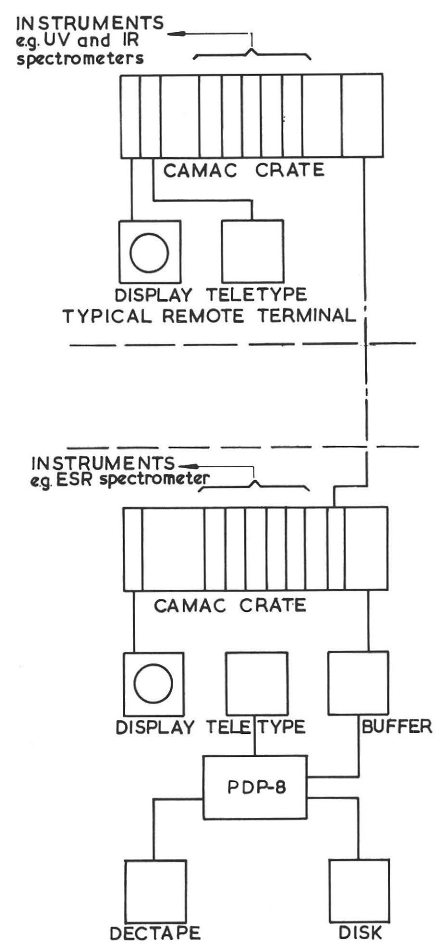

Fig. 1 Configuration of a LABCOM system

The computer is coupled to the different instruments using a CAMAC system (Fig. 1) which allows remote terminals to be placed several hundred metres from the computer in order to serve a number of instruments dispersed throughout a building. Each instrument has its own interface modules plugged into a nearby crate but can share a teletype and display unit with neighbouring instruments. The system allows great flexibility in the facilities that can be provided for each interface, and in the number of interfaces and remote crates that are installed.

SOFTWARE

A supervisory program is used to control the time-sharing between the external devices through a hierarchy of interrupts. The real-time supervisor handles interrupts, maintains a priority-ordered list of programs awaiting attention, organises linkages between programs, and transfers programs to and from the disk. When a device calls for attention the supervisor allocates time depending on the priority rating. This permits a highly efficient utilisation of the fast core since low priority programs which are not currently in use may be transferred back to the disk when a high priority interrupt occurs.

The program handling the data input from the various instruments is retained permanently in core and as a consequence these interrupts can be handled by the supervisor in 400 μsec and processed in a further 600 μsec on average. The absolute maximum interrupt rate would therefore be 1000 a second if the computer could perform this job in isolation. In practise it is not possible to drive a real-time system to this limit, e.g. in LABCOM the visual displays also require some time.

The main programs are structured so that it is relatively easy to introduce a new instrument to the system. Separate data processing programs for each instrument enable alterations or extensions to be made easily and minimise interference with the rest of the system. Other programs running under the control of the real-time supervisor are relocatable to any free area of core within a given field, and may be used by any instrument and from any teletype.

Table 1. Present and proposed applications of LABCOM

Instrument	Use with LABCOM
Infra-red spectrometers	Archiving spectra for later retrieval with extension to computer matching of spectra. Alteration of scales or conversion of transmission to optical density and measurement of band shape. Calibration of spectra and subtraction of background spectra from support materials. Control and processing of kinetic runs.
Raman spectrometer	Data normalisation and background corrections.
Electron spin resonance	Double integration of 1st derivative spectra. The operator can choose the base line and integration limits. Spectra subtraction. Spectral enhancement by cumulative scanning.
Recording spectrophotometer	Spectrum analysis into optical absorption bands. Treatment of diffuse reflectance data using Kubelka-Munk relation. Measurement of colour.
Gas Chromatography	Calculation of peak areas etc.
Surface Area Measurements	Control of surface area apparatus and absorption/desorption isotherm; calculation of surface areas and pore size distribution.

APPLICATIONS

The LABCOM system is suitable for a wide range of applications of which some are shown in Table I. The time-sharing feature of LABCOM allows many of these instruments to feed data into the computer concurrently. The system at present handles three instruments operating simultaneously and is expected to handle more. The graphical display permits the operator to check quickly that data are recorded properly and allows almost immediate inspection of the processed results.

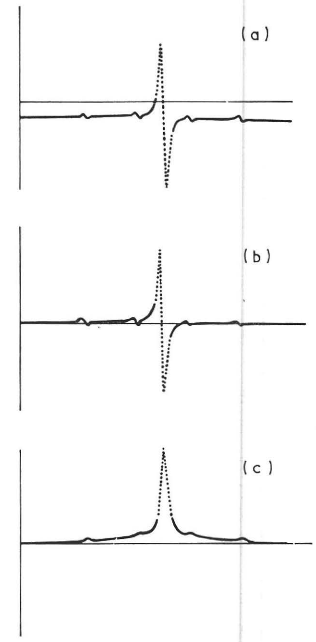

Fig. 2 Data processing options for ESR Spectrum.
a) *Derivative spectrum as collected*
b) *After base-line correction*
c) *After first integration*

For example the electron spin resonance (esr) spectrum is collected as a first derivative, and the double integral is required to obtain the electron spin concentration. After the data has been collected and displayed (Fig. 2a) the user can ask for data processing options to adjust the base line onto the zero axis (Fig. 2b), to integrate the spectrum between chosen limits and display the integrated spectrum (Fig. 2c), to readjust the base line and to compute and print the second integral.

CONCLUSION

The CAMAC hardware has provided a convenient and flexible means of interfacing a number of different instruments to a small computer. The use of the laboratory instruments has been extended considerably, since simple data processing is immediately available. Removal of the need for simple but time consuming calculations has resulted in significantly increased efficiency in the use of manpower.

REFERENCE

1. LABCOM, a laboratory orientated data processing system. AERE R 7020.

3

THE HELIOS SEARCH COIL MAGNETOMETER AND ITS TEST EQUIPMENT USING CAMAC

by

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Received 3rd July 1972

SUMMARY The test equipment for the HELIOS search coil magnetometer experiment uses CAMAC, and is described as an example of computerised functional testing of a space experiment.

INTRODUCTION

The test equipment described here was developed as an economical and efficient means of executing the many functional tests necessary during the development, construction and qualification of the search coil magnetometer experiment which will fly in the HELIOS spacecraft in 1974 and 1975. It was decided to use a system controlled by a small computer (Mulby C of Krantz Elektronik GmbH) and, since the main contractor of the experiment (Dornier AG) has experience in the CAMAC module field, the CAMAC system was adopted for as much hardware as possible.

THE HELIOS SPACE PROJECT

HELIOS is the name for a joint space project of the German Federal Republic and the USA. The aim is to investigate the properties of interplanetary space in the direction of and close to the sun by developing, launching and operating two automated spacecrafts HELIOS A and HELIOS B[1]. Germany has the responsibilities for the HELIOS spacecraft including eight scientific experiments, and for the operation and control of the spacecraft with German and US ground facilities; the USA provides three scientific experiments, and support in tracking, data acquisition and data analysis.

THE SEARCH COIL MAGNETOMETER EXPERIMENT

There are three magnetometer experiments on HELIOS. The search coil magnetometer[2], with which this paper is concerned, measures AC magnetic fields from 4.7 to 2200 Hz with a resolution of 0.2 mγ to 1.5 mγ by measuring the time-derivative of the magnetic field strength (dH/dt) with a measuring range of 10^4 Hz. The other two magnetometers measure DC fields.

The search coil experiment consists of two units. The sensor box, mounted at the end of a boom, is essentially a triaxial arrangement of three coils with high-μ cores, each with a low-noise preamplifier. The electronics box, in the central compartment of the spacecraft, houses all the analogue and digital electronics needed to generate outputs to the digital data handling and telemetry subsystems of the spacecraft. It also includes auxiliary electronics such as the DC/DC converter, and in-flight test generator.

Two different methods of analysis are applied to the X, Y and Z signals from the sensor box. The waveform channel (WFC) converts the analogue signals into digital data which is buffered before being output to the telemetry system. It also produces data indicating the angular position of the spacecraft in the spin plane. The spectrum analyser (SPA) carries out an analysis using 8 filters of equal logarithmic width for the Z signal and another 8 filters for either the X or Y signal. The digitised data from the 16 chonnels of the analyser is processed by a mean-value campputer (MVC) which squares and accumulates the data, and also identifies the maximum value in each channel during each interval of time.

TESTS AND TEST PHILOSOPHY

The success of any space project depends strongly on the reliability of the total system as well as its individual parts. The reliability must be proved before launch, therefore an extensive quality assurance program must be carried out. This requires large test programs during all phases of the project, in addition to the use of high-reliability components, reliability analysis of all electronic circuits, and an appropriate derating philosophy. This means that with all models (the lab model, the electrical integrations model, the prototype and the flight units) many electrical and functional checks must be made between and during the acceptance and qualification tests. For example, for the qualification test the prototype will be submitted to 1.5 times the load that is expected during launch and the mission. Between all the single environmental tests such as temperature, humidity, sine and random vibration, acoustic noise and shock, acceleration, thermal vacuum, solar simulation and electromagnetic compatibility, the proper functioning of the experiment has to be verified or failures have to be noted, recorded and analysed. For this purpose a special experiment test equipment (ETE) has been developed, which makes use of the CAMAC system. Several functional tests in connection with the experiment can be distinguished.

Inflight Test (IFT)

An inflight test generator which produces a sequence of different test signals is included in the experiment and can be actuated on telecommand. Together with the house-keeping data, which include command verification, experiment and mean-value computer status and information on the current in the various supply voltage lines, an overall judgement on the health and status of the experiment can be given until lift-off and during the entire mission. No extra test equipment is necessary other than the normal equipment to operate the spacecraft.

Integrated System Test (IST)

The IST allows testing of the experiment at box level by stimulation with signals of an external generator at test inputs of the electronics box. As with IFT, only the data outputs need be evaluated. This can be done by the ETE, which contains a stimulus generator and a spacecraft simulator, or by the HELIOS test set which is used to check the complete HELIOS spacecraft and all its subsystems including the experiments.

Detailed Performance Test (DPT)

The DPT enables a test of functional units down to at least card level. Test signals are fed into various internal test-points of the experiment and measurements are made at different points. The DPT can be carried out only by the ETE, and requires the use of a special experiment test connector.

FUNCTIONS OF THE EXPERIMENT TEST EQUIPMENT (ETE)

The ETE has to fulfil the following purposes[2,3]:

- to provide the experiment with all signals necessary to operate it fully;
- to receive, evaluate and display all data from the normal outputs and the special test outputs;
- to provide the necessary test records and to document the correct execution of the tests;
- to detect and locate failures as far as possible from the data available, and to check the proper functioning of the experiment by comparing actual and nominal values;
- to generate test signals used at various points controlled by the HELIOS test set (HTS).

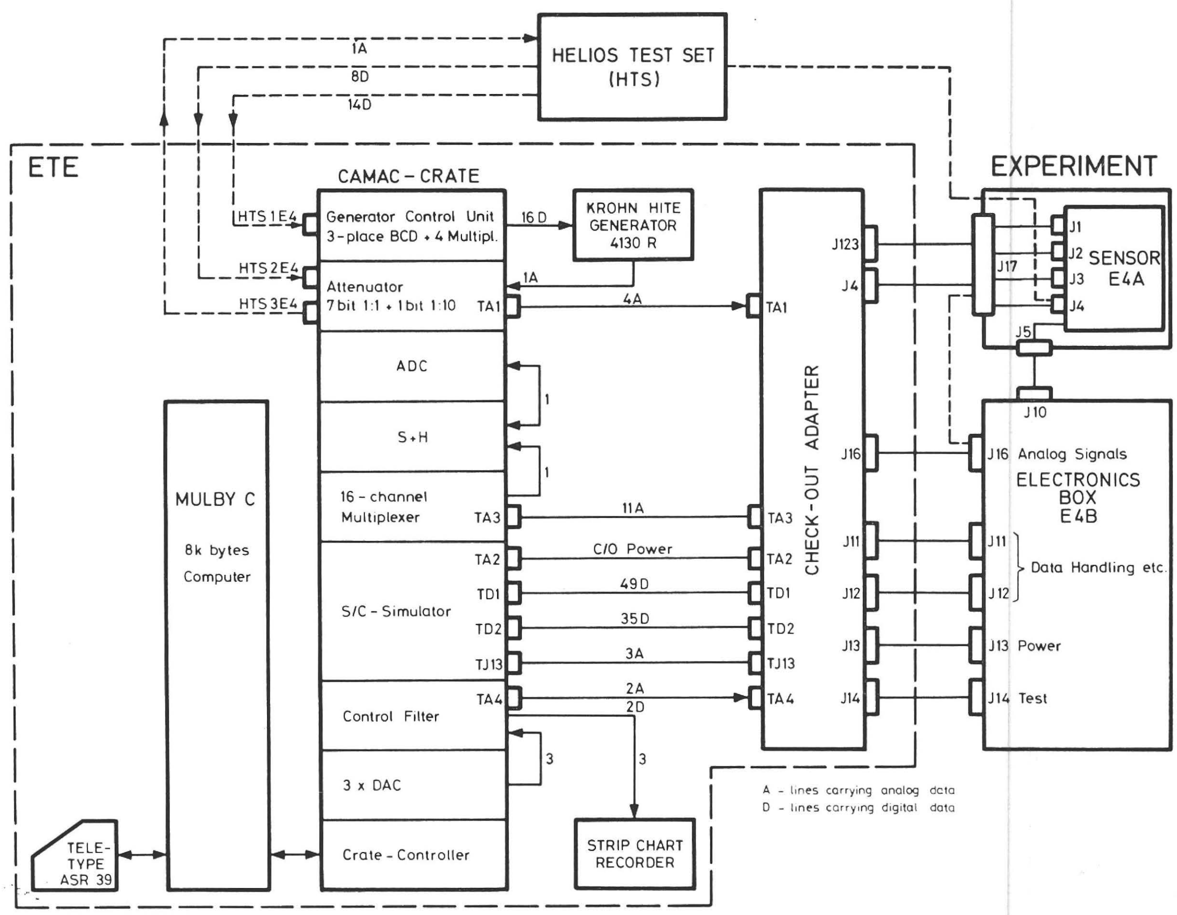


Fig. 1 Schematic of experiment test equipment (ETE) with the magnetometer experiment.

DESCRIPTION OF THE EQUIPMENT

The ETE occupies a 19-inch rack and consists of the following parts (see Fig. 1):

- Teletype ASR 39
- Computer Mulby C (8 k bytes, 16 interrupts, 0.9 µsec cycle time)
- Test signal generator Krohn Hite 4130. (sinusoidal and rectangular signals, 1 Hz to 1 MHz remote controlled).
- One CAMAC crate with the following plug-in units:
  - Generator control (DO 200-2405, width 1/25, controls frequency of Krohn-Hite 4130 signal generator.)
  - Attenuator (DO 200-2406, width 2/25, 7-bit binary 1:128, 1 bit 1:10.)
  - Analogue to digital converter (DO 200-1024, width 2/25, 12 bit, ±10 V, conversion time 25 µsec).
  - Sample and Hold (DO 200-1041, width 2/25, hold-failure: 50 µV/msec, acquisition time: 5 µs.)

- 16 Channel multiplexer
  (DO 200-1035, width 2/25, 3-pole relays.)
- Spacecraft-simulators 1 & 2 (width 2 x 5/25)
  - provide data handling signals, commands, registers for receiving all experiment data
  - generate digital test signals
  - control and supply the check-out adaptor
- Triple digital to analogue converter
  (DO 200-1501 and DO 200-1502, width 2/25 each, 12-bits, ± 10 V settling time 2 μsec)
  - generates analogue test voltages
  - drives three channels of a strip chart recorder (*X*, *Y* and *Z* channels of the WFC)
  - CAMAC crate controller for Mulby C (DO 280-2901, width 2/25.)

— Strip chart recorder Visigraph PR-101
  - 4 channels with 4 galvanometers
  - photo-sensitive paper

— Check-out adaptor, located close to the experiment
  - buffers analogue and digital data in both directions (Exp.-ETE)

TEST PROGRAMS

With the system described, the following test programs can be carried out.

— Test of the preamplifiers
Objective: Amplification as a function of input amplitude and frequency.
Test signal: Sinewave 80 μV ... 100 mV, 2 ... 4400 Hz.

— Test of WFC analogue electronics
Objective: Amplification as a function of amplitude and frequency.
Parameters: Amplification factors of bandpass-gain change amplifier (BP-GCA) corner frequencies of commandable low-pass filter (LP)
Test signal: Sinewave 4 mV ... 5 V, 2 ... 170 Hz.

— Test of total WFC
Objective: Analogue-to-digital conversion of the non-linear ADC, timing of digital circuitry, generation of sector information.
Parameters: Amplitude and frequency of input sinewave, formats and bit rate.
Display: Teletype or strip-chart recorder via DAC.

— Test of SPA analogue electronics
Objective: Amplification factors and frequency response of filters and amplifiers, switching of MPX.
Parameters: 4 ampl. factors of BP-GCA, position of multiplexer, amplitude and frequency of input sinewave appropriate to each filter characteristic.

— Test of SPA - sample and hold and ADC
Objective: Analogue to digital conversion of 8-bit ADC's
Parameters: DC-voltages with 10-bit resolution fed into test points, external control of MVC.

— Test of squaring and accumulation of MVC
Objective: Squaring and accumulation process of the MVC.
Parameters: DC voltages into SPA via test inputs, formats and bit rates.

— Test of reduction of MVC
Objective: Reduction and fixed point-floating point conversion process of the accumulated data.
Method: Unreduced data is read out of the MVC via test points, converted to reduced data by the Mulby C computer and compared with the MVC data received at the normal output.

— Test of total SPA
Objective: Function of SPA under all expected conditions.
Parameters: Format, bit-rate, gain of BP-GCA, amplitude and frequency of input voltage.

— Housekeeping test
Objective: Generation of command verification, experiment and MVC status, power consumption in different experiment operating modes.

— In-flight test
Objective: Overall test by evaluating the data generated by the signal sequence of the in-flight test generator.
Parameters: All operational modes of the experiment possible by telecommands.

REFERENCES

1. Project Plan for HELIOS A and HELIOS B. Ges. für Weltraumforschung mbH (February 1972).
2. HELIOS experiment 4 description. Institut f. Nachrichtentechnik, T.U. Braunschweig (May 1972).
3. Bedienung des Testgerätes für HELIOS Experiment 4. Dornier A.G. Friedrichshafen (May 1972).

NEWS

ANNOUNCEMENTS BY CAMAC MANUFACTURERS

NUCLEAR ENTERPRISES have received an order from a Belgian University for a cyclotron control and monitor system in CAMAC.

Using the series 600 Multiplexers, a total of 80 analogue inputs from voltmeters, vacuum indicators, beam current monitors and nuclear resonance monitors are fed to a combined PDP-8 and PDP-11 Computer System; CAMAC being interfaced to the PDP-8.

150 BCD outputs for positioning beam transporters and control of beam current etc. are also provided.

NUCLEAR SPECIALTIES INC. is now manufacturing new CAMAC crates and module hardware. This new series 100 offers several features not available in the past. These features are the result of a continuing engineering policy of improving products to meet the changing desires and needs of customers. The new series 100 CAMAC crates are fully wired and are compatible also with the recommendations of the USAEC NIM-CAMAC working groups for typical equipment performance.

NEWS

CAMAC AT MIAMI BEACH

The following titles are for papers to be presented at the 1972 Nuclear Science Symposium in Miami Beach, Florida during Sessions 6, 10 and 12 on 7th and 8th December.

CAMAC, a Review and Status Report. L. Costrell, National Bureau of Standards.

CAMAC Specifications. F.A. Kirsten, Lawrence Berkeley Laboratory.

A CAMAC System for Remote Data Acquisition. R.C. Furst, J.D. Wiedwald, Lawrence Livermore Laboratory.

A Versatile Modular Readout System for CAMAC Scalers. D. Horelick, Stanford Linear Accelerator Center.

Standard Software for CAMAC. S. Dhawan, Yale University, F. Thomas, Los Alamos Scientific Laboratory.

An Extended FOCAL Language for CAMAC Programming. C.P. Hohberger, Brookhaven National Laboratory.

A Long Distance CAMAC Branch via Data-Link and Microprogrammed Branch Driver. L.R. Biswell, D.R. Machen, R.E. Rajala, R.F. Thomas, Los Alamos Scientific Laboratory.

A CAMAC Branch Driver for the Varian 620 Series Computers. L.B. Mortara, Kitt Peak National Observatory.

A Variable Wordsize CAMAC Tape Controller. A.E. Oakes, W. Andrea, R.J. Rudden, Lawrence Berkeley Laboratory.

RICE-A Multi-Processer Real-time Acquisition and Analysis System Incorporating CAMAC. H.V. Jones, J.A. Buchanan, D.B. Mann, K. McGrath, Rice University.

Design of the Precision Gamma Scanner. F.H. Just, J.W. Rizzie, H.E. Adkins, Argonne National Laboratory.

CAMAC Magneto Strictive Readout System using Schottky Memories. B. Bertolucci, Stanford Linear Accelerator Center.

Digitizing Electronics for the EMI Multiwire Proportional Chambers. E. Binnall, F.A. Kirsten, K. Lee, C. Nunally, Lawrence Berkeley Laboratory.

Sessions 10 and 12 will contain panel discussions on CAMAC Fundamentals, Specifications, Status and on CAMAC Systems and Software respectively.

V.I.P.'s VISIT TO HAHN-MEITNER INSTITUT, BERLIN

Professor Karl Zander reports that Dr. Gustav Heinemann, President of the Federal German Republic, was fully informed about CAMAC during a presentation of a nuclear experiment at his Institut on 30th June. The President expressed his great satisfaction that the scientists involved in the CAMAC operation had been so successful in international co-operation.

On the same day, the Institut had great pleasure also in welcoming a small delegation which was en route to Moscow for discussions within the programme of scientific co-operation between USSR and USA. The delegation was headed by Dr. Edward E. David, Scientific Advisor to President Nixon and included:

Dr. James B. Fisk, President, Bell Telephone Laboratory.
Dr. Eugene Fubini, President, Fubini Consultants Ltd., and former Vice-President of IBM.
Dr. John Granger, Deputy Director, Bureau of International Scientific and Technological Affairs, State Department.
Dr. Norman P. Neureiter, Technical Assistant for International Science.
Mr. John Lannan, Special Assistant to Director for Logistics and Press Affairs.

The technological, economic and political aspects of CAMAC were thoroughly explained to the delegation which showed an extraordinary interest in CAMAC and were very impressed with its worldwide distribution. Dr. David declared his wish to be kept fully informed on further developments.

Both Dr. Heinemann and Dr. David were especially impressed to learn that the CAMAC system has spread not only throughout western countries but also in eastern countries.

ANNOUNCEMENTS BY CAMAC MANUFACTURERS

JOERGER ENTERPRISES is a new company manufacturing CAMAC units and accessories. Although a new company, the personnel have a broad experience in CAMAC and were responsible for the development of the first CAMAC unit manufactured in the United States. This experience has been used to develop a new series of CAMAC units meeting the specifications of both EUR 4100 and 4600, inclusive of all recent revisions. The most up-to-date units are offered with regards to both electrical specifications and mechanical packaging. For instance, all functions and sub-addresses are fully decoded, the X-response is fully implemented and standard connectors are used. Units already available are an 'A-1' Crate Controller (model CCA-1), a Manual Crate Controller (model MCC); a Dataway Display (model DD) for use with the MCC controller and for monitoring purposes; a Manual Branch Driver (model MBD) used in conjunction with a Branch Terminator—with or without a separate Visual Display (models BT and VBT resp.) applicable also to monitor the 66 Branch lines and to check systems; an Analog Relay Multiplexer (model AM), Dual 24-bit Input- and Output Registers (models IR and OR resp.); a Module Extender (model ME) and scalers.

The following CAMAC accessories are offered: Branch Highway cables and connectors; module kits; signal connectors and cables.

LABORATORY REVIEWS

CAMAC ACTIVITIES IN THE NETHERLANDS

Compiled by
P.C. van den Berg
Reactor Centrum Nederland, Petten (N-H) the Netherlands
Received 16th June 1972

SUMMARY The article describes the CAMAC activities of six institutions in the Netherlands.

INTRODUCTION

CAMAC was introduced in the Netherlands right from the beginning. The Reactor Centrum Nederland (RCN) has been a member of the ESONE Committee from the early sixties. One of the first operating CAMAC systems in the world was set up at RCN (Petten). Later other institutions became interested in CAMAC; some are trying the system out on a small scale, others are building more involved systems. Also some interest is arising outside the nuclear field. The following article describes the activities of six institutions in the nuclear field. Two other institutions have definite plans to use CAMAC in the near future.

CYCLOTRON LABORATORY UNIVERSITY OF TECHNOLOGY EINDHOVEN

For the automatic control of the 130 cm isochronous cyclotron more than 60 beam properties have to be measured continously and without intercepting the beam:

— The intensity and the phase of the internal beam with respect to the HF accelerating voltage at 8 different radii;
— The horizontal position and the intensity of the beam immediately after extraction;
— The horizontal and vertical position, the beam width and height, and in some cases the intensity, at 15 locations in the external beam transport system.

All this data will be transmitted to a single-crate CAMAC system, interfaced to a 16k DEC PDP-9 computer.

In the near future this system will be used also for the control of the cyclotron. A number of cyclotron parameters, the beam transport system included, will be set automatically to a fixed or optimal value depending on the measured values of the above mentioned data.

FOM-INSTITUUT VOOR ATOOM-EN MOLECUULFYSICA, AMSTERDAM

Since January 1972 an atomic collision experiment has been controlled by CAMAC and a PDP-15 computer. Because of the distance between the experiment and the computer a branch highway cable of 55m length is used.

The configuration on the experimental side is: CAMAC crate (Borer) in which are a digital synchronous detector (FOM), a relay driver (NE), an ADC (NE), a DAC (NE), a DAC 12-bit (FOM), a Status register (FOM), crate controller A (Elliott) and a branch highway receiver (FOM). On the computer side there is: a light-coupled branch highway transmitter (FOM) and a CAMAC interface CA 15 (DEC) to the computer.

The following short description explains the functions of the modules in the crate. The synchronous detector accumulates the signal and the background pulses from a channeltron in the experiment for a preset time TM. After TM seconds the LAM-flag causes a program interrupt. As required by the program the target angle is incremented under control of a DAC and the measurement is repeated. The other DAC controls a mechanical velocity selector in the atomic beam. The ADC monitors the target beam. The status register controls the vacuum, chopper and other flags of the experiment.

In May 1972 a second experiment was added to the system. To check the system FOM have developed a test module which is mounted in the crate and used in combination with a special CAMAC test program.

FOM-INSTITUTE FOR PLASMA PHYSICS "RIJNHUIZEN" JUTPHAAS

CAMAC was adopted at Rijnhuizen in 1971 with the intention of coupling at least three different plasma physical experiments to one PDP-15 computer.

In view of the very fast rate (>1 MHz) at which data will be generated a local store is necessary. As the amount of data per shot is relatively low, this store can be small (<1000 words). For some signals it is intended to use Biomation Transient recorders type 610B. This recorder has a 256 word memory, a frequency response from DC-2,5 MHz and a 6-bit output. A special module has been built to couple these recorders to the CAMAC system. Four recorders can be coupled through this module to the dataway.

Another problem in plasma physics, apart from the fast data rate, is the high interference level due to the discharge of large capacitor banks. This makes it necessary to place the local CAMAC crate in a screened cage. An optical coupling between the screened cages and the computer (glass fibre through the wall of the cage) has been considered in order to prevent unwanted earth currents. This optical link in the branch highway is still an object of study. A puncher-controller module has been designed so that the CAMAC crate can be used off-line in order not to be dependent on the outcome of this development.

INSTITUTE FOR NUCLEAR PHYSICS RESEARCH (IKO), AMSTERDAM

The first CAMAC crate at IKO was purchased in 1971, to obtain practical experience with the CAMAC system. This crate was completed with a Borer Type A crate controller and some modules.

A new experimental setup (pulse radiolysis) in the IKO Radiochemical Department was chosen to be run with CAMAC, but this would have involved developing CAMAC-compatible special modules. In due course it appeared that buying special electronics for this pulse radiolysis experiment was much more efficient. Thus the CAMAC equipment became available for experiments in the IKO Digital Electronics Department which was studying a control system for a 250–500 MeV high duty-cycle linear electron accelerator (LINAC). Even at a preliminary stage it was clear that a system with addressable stations was preferred on grounds of cable costs and simplicity. A detailed survey indicated a 'CAMAC-like' system with special address-, function- and data lines but it was obvious that the available CAMAC equipment should be used. The activities planned for 1972 are divided in the following way:

- Connection of a PDP-8L to the EL-X8 (medium-sized) computer at IKO.
- Development of a PDP-8L CAMAC branch driver.
- Development of a long-distance (~500 m) branch highway (serial or parallel, with photocouplers if necessary).
- Connection of apparatus, such as prototype modulator, control processor and control panel, to the crate by means of special CAMAC modules.

The results of this experiment will show if the CAMAC system is to be considered (hardware, software, costs) for further LINAC control applications.

INTERUNIVERSITAIR REACTOR INSTITUUT (I.R.I.) DELFT

Several experiments are being interfaced by CAMAC to a PDP-9 real-time monitor system, consisting of 24k memory, DEC-tapes, magnetic tape equipment and multi-teletype control.

A multi-crate system is used via the standard branch highway of EUR 4600. In view of the long distances involved, highways of the balanced-line type are used in combination with converters and Type A crate controllers.

The experiments involve control and/or data handling of directional angular correlation equipment, a double focussing ($\pi\sqrt{2}$) spectrometer, a local oscillator for epithermal neutron absorption, time-of-flight neutron cross-section measurements, various reactor physics experiments with a pulsed neutron source, non-destructive neutron activation analysis using Ge(Li) semiconductor detectors and computer-coupled sample changers, experiments in nuclear medicine (for example, with a scanner coupled to a PDP-9), general γ-ray spectroscopy, and various experiments in the field of chemistry which require data-handling by a computer.

Use will be made of special-purpose interfaces for Laben ADC's and time-of-flight units (12-bit), display drivers for memory scopes, input registers, interrupt registers, scalers, timers, etc.

REACTOR CENTRUM NEDERLAND (R.C.N.) PETTEN

The first application of CAMAC in Petten was for the reactor kinetic experiments at the fast-thermal critical facility (STEK). A single crate is interfaced to a Honeywell DDP-516 computer.

The experiments involve measurements with reactor noise, a pulsed neutron source, a reactor oscillator, a time-of-flight spectrometer, and a proton recoil spectrometer. Several CAMAC modules have been made e.g. time-analyser, input gate, output gate, clock, ADC interface, time-of-flight module, range selector. Also an oscilloscope display, a magnetic tape recorder and a plotter are interfaced via CAMAC. The system has been in operation since September 1969.

Secondly, CAMAC is used for a magnetic tape recording system. Some ten experiments, mainly multi-channel analysers, wire scanners and scalers are, or will be, connected to a single magnetic tape recorder. Data relevant to the experiment (contained in switch registers), date and clock time are recorded together with the measured data. Two I/O Teletypes are connected to the system, keeping a log of the data recorded on the tape and permitting instructions, necessary for computation, to be written on the magnetic tape. The system has been in operation for one year; six experiments are now connected.

A third CAMAC system is now being installed. It is a time-sharing system for seven neutron physics experiments[1]. The system consists of a Honeywell H.316, 16k computer with fixed-head disk, paper-tape punch/reader, Calcomp plotter and eight Teletypes. There are three CAMAC crates, one for controlling a storage oscilloscope display and magnetic tape recorders, one for the interfaces to six existing experiments, and one for the instrumentation of the single crystal spectrometer.

A standard branch highway is used with a branch transmitter/receiver to bridge the distance of 70 m between first and second crate.

REFERENCE

1. CAMAC Bulletin No. 3. A computer control system for neutron physics experiments by P.C. van den Berg and H.M. Rietveld.

DEVELOPMENT ACTIVITIES

1

DIGITAL MODULES FOR PHYSICS EXPERIMENTS AND MEASUREMENTS IN THE CAMAC SYSTEM

by

V.A. Arefiev, M.P. Belyakova, A.G. Grachev, I.F. Kolpakov, A.P. Kryachko, N.M. Nikityuk, G.M. Susova, E.V. Tchernych, and L.A. Urmanova

Laboratory of High Energies, Joint Institute for Nuclear Research, Dubna, USSR

Received April 1972

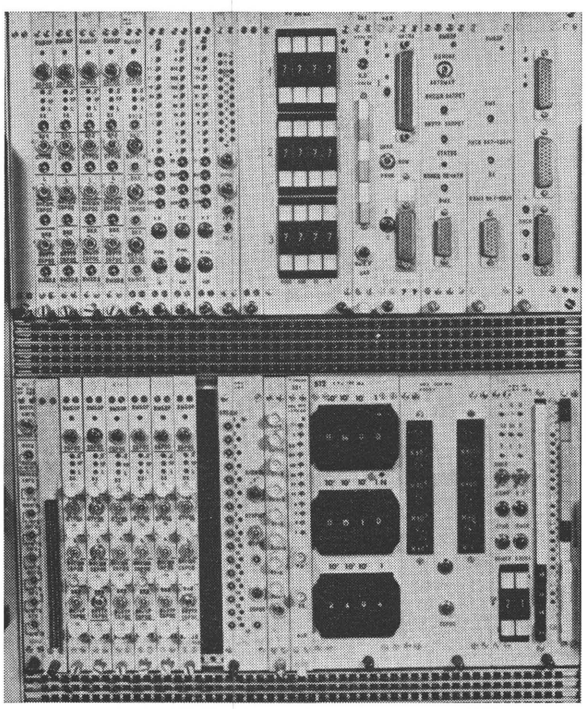
SUMMARY The Laboratory of High Energies has developed CAMAC units for measurement and control applications associated with physics experiments. The 16 types of units described include controllers for TPA 1001 and HP 2116B computers.

INTRODUCTION

In the Laboratory of High Energies of JINR a system of CAMAC modules has been developed for physics measurements and control. Up to now about twenty different modules have been designed for on-line use with small computers HP2116B and TPA1001. The logic and mechanics of the modules correspond to the ESONE Committee's requirements in EUR 4100e (1969) and EUR 4600e (1972).

The modules can be sub-divided into the following classes according to applications: controllers, convertors, scalers and interfaces. The CERN system of CAMAC module functional principles was used when developing many of the modules[1].

The brief characteristics and functional abilities of some of the modules are considered below.



CONTROLLERS

Because the crates are used on-line with computers that have radial interfacing, a type 'A' controller was not developed.

Type 611 controller interfaces a CAMAC crate to a programmed channel of the TPA1001 computer. It includes registers for address, function, data, Q and L. A 24-bit register is used for data. Input-output commands or a programmed function decoder can be used.

Manual selection of module number, function and single-cycle mode are provided for adjusting and testing the controller. The register content is displayed on the front panel. A minimum of 5 cycles of the computer, i.e., 50 μsec, are required for reading a 24-bit number from any module in the crate. Width: four units.

Type 612 controller interfaces a CAMAC crate to a direct memory access (DMA) channel of the TPA1001 computer. The data transfer time of the computer is 10 μsec. The controller contains a 24-bit I/0 register and a 12-bit counter, in which is set the number of words transferred in the file. The other circuits of the controller are a flag trigger and an address register. Width: two units.

Type 613 controller for a multiplexer channel of the HP2116B computer, is coupled to the computer by means of 3 standard interfacing cards. Relative priority is determined by the external addressing. Width: two units.

Type 621 manual controller is used for addressing modules in the crate and controlling the type of data transfer. By means of switches on the front panel it is possible to set a module address, sub-address, function and so on. Two modes of operation are provided: cyclic and one shot. On the front panel are displayed the content of the 24-bit register, the operating mode and the channel generation. It is possible to generate two cycles sequentially with 2 different functions, for example, read and write. Module addresses are set in decimal code. Function and sub-address codes are set in binary code. Width: four units.

SCALERS

Binary scaler, type 411 has 24-bits with a maximum speed of 80 MHz. The status 'Clear', 'Overflow' and '1' in the first bit are displayed on the front panel. Width: one unit.

Binary dual scaler, type 412 contains two 16-bit scalers with a maximum speed of 25 MHz. The counters can be connected in series.

Quartz stabilised pulse generator, type 402 has two modes of operation. As a clock pulse generator it uses an internal 1 MHz quartz oscillator, and a 6-decade divider provides output pulses with frequencies from 1 Hz to 1 MHz at decade increments. As a frequency divider it accepts a maximum input frequency of 20 MHz. Width: one unit.

CONVERTERS

Analogue-to-digital converter, type 331 converts analogue signals into 10-bit parallel binary code which is displayed on the front panel. An input is provided for stabilisation of ADC parameters. The conversion time is 100 µsec. Linear input gates are provided for constant voltage measurements. Width: one unit.

Digital-to-analogue converter (DAC), type 341 converts an 8-bit binary code into an analogue output voltage signal. The DAC can be used for controlling parameters of analogue modules (to change frequency, pulse length, etc.) and for output to displays and plotters. The module has an input register. The conversion time does not exceed 10 µsec. Width: one unit.

Digital-to-analogue converter, type 342 differs from the previous module by having switches on the front-panel, which can be used to set a 6-bit binary code into the register.

Pulse integrator, type 351 is used for converting the measured pulse area to an amplitude. The integration time constant is 5 µsec. Width: one unit.

Pattern unit, type 332 is used as a temporary memory for nanosecond pulses from the counter array of an experiment. The input pulses are strobed by a gate signal. The module can be used as a multichannel coincidence unit or for displaying a pattern of events from an experiment. All inputs are NIM-compatible. The minimum length of the input signal is 8 nsec. The register content is displayed on the front panel. The module can be tested from the controller by an F(25) command or by setting '1' into all bits of the register with a push-button on the front panel. The contents of the register can be read by an F(0) operation. The register can be cleared manually from the front panel by an external NIM signal or by F(9), C, Z operations. Width: two units.

INTERFACING MODULES

These modules are used for interconnections to external devices, and also allow interaction with an operator.

Digital voltmeter interface, type 521 is used for coupling a digital voltmeter to the CAMAC system. It is connected to the DVM by means of a front panel connector. Width: two units.

Decimal display, type 513 is used for displaying BCD-coded data in decimal form. The module consists of one 32-bit register and eight decoders for controlling digital tubes. Width: four units.

Constant setting-up module, type 511 is used for setting up constants relating to the experiment, so that they can be transferred to a computer or to another module. The module contains thumb-wheel switches for setting up three 4-digit decimal words. These words are converted by the module into 16-bit BCD words. Width: four units.

Constant setting-up module, type 512 is similar to type 511, but the constants are set up as BCD words.

All the modules described above are used in the Laboratory of High Energies for interfacing to the TPA1001 computer, which is applied to measurements of accelerator parameters and to physics experiments in a preparatory stage.

REFERENCE

1. F. Iselin *et al.* Introduction to CAMAC, CERN-NP, CAMAC Note 25-00, January 1971.

PREPARATION OF CONTRIBUTIONS

Authors are requested to follow these instructions when submitting contributions for the Bulletin. Failure to do so may result in contributions being returned to the author for re-submission in a modified form, and may delay publication.

1. *English is the preferred language. Contributions in other languages are equally welcome but only the summary will be translated.*
2. *Authors should state their name, business affiliation and postal address on a separate sheet if not included in the contribution.*
3. *The style, layout, use of bibliographic references and so on should follow as closely as possible the appropriate contents of this Bulletin.*
4. *For contributions to the New Products Section, each product description should be on a separate sheet and* ***any one description must not exceed 250 words or 1/3 Bulletin-page, including illustrations.***
5. *For contributed articles, 1 200-1 600 words are preferred.* ***They must not exceed 2 000 words or 3 Bulletin-pages, including illustrations.*** *They should be accompanied by a summary (abstract) suitable for translation into other languages and preferably not exceeding 50 words.*
6. *Manuscripts should be typed on alternate lines on only one side of the page.*
7. *Drawings and photographs should only be included if they are essential to the text. Original ink (not pencil) drawings and semi-mat prints of photographs, at least twice the final size, should be submitted. The author's name and the figure number should be written, lightly, in pencil on the back of each illustration. A list of all figure numbers and captions should be included on a separate sheet, even if these are given in the text or on the illustrations themselves.*
8. *Articles which are shortened, or adapted from, original papers should identify the original in the references.*
9. ***Authors must submit contributions before the closing dates*** *announced elsewhere in this Bulletin.*
10. *Reprints can be ordered at any time, but authors who are likely to require reprints in bulk should request these when submitting a contribution.*

2

A MICROPROGRAMMED BRANCH DRIVER FOR A PDP-11 COMPUTER

by

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Received 14th March 1972

SUMMARY A microprogrammed branch driver has been developed for data acquisition systems in experimental areas of the Los Alamos Meson Physics Facility (LAMPF). The unit couples a CAMAC branch to a PDP-11 computer, through multiple direct-memory-access (DMA) channels.

INTRODUCTION

In August 1970 a group met at Los Alamos to develop a system design for the on-line data-acquisition facilities at LAMPF. The results of this study are documented in the report, 'LAMPF Data-Acquisition System'.[1]

It was recommended that, in order to accommodate the wide variety of users at LAMPF, all interfacing between the experimental equipment and the dedicated computer be implemented in the CAMAC standard. The Digital Equipment Corp. (DEC) PDP-11 was selected as the standard computer for the LAMPF data-acquisition system.

The basic requirement for the branch driver is to interface the PDP-11 computer[2, 3], to the CAMAC branch highway. It is also desired to free the PDP-11 for as much real-time data analysis as possible. Many of the experiments will have high event rates and very high data rates. The minimum system requirements are: two DMA channels for experimental data, one DMA channel to display accumulated data, and one DMA channel for communication with LAMPF terminal computers.

From the requirement it was decided that what was needed was a multiple DMA channel branch driver that could be easily modified or programmed. With the advent of micro-programmable processors it was concluded that this would give the flexibility required and exploit the maximum capabilities of the PDP-11 computer and the CAMAC system. This was the approach taken in the design of the micro-programmed branch driver (MBD) discussed in this report, which is one of two designs resulting from co-operation between Los Alamos Scientific Laboratory (LASL) and Bonner Research Laboratories, Rice University[4]. This work was performed under the auspices of the U.S. Atomic Energy Commission.

GENERAL SPECIFICATIONS AND OPERATION OF THE MBD

A functional diagram of the MBD is shown in Fig. 1. The unit can be divided into three major areas: the PDP-11 computer interface, the CAMAC branch driver, and the micro-programmed processor.

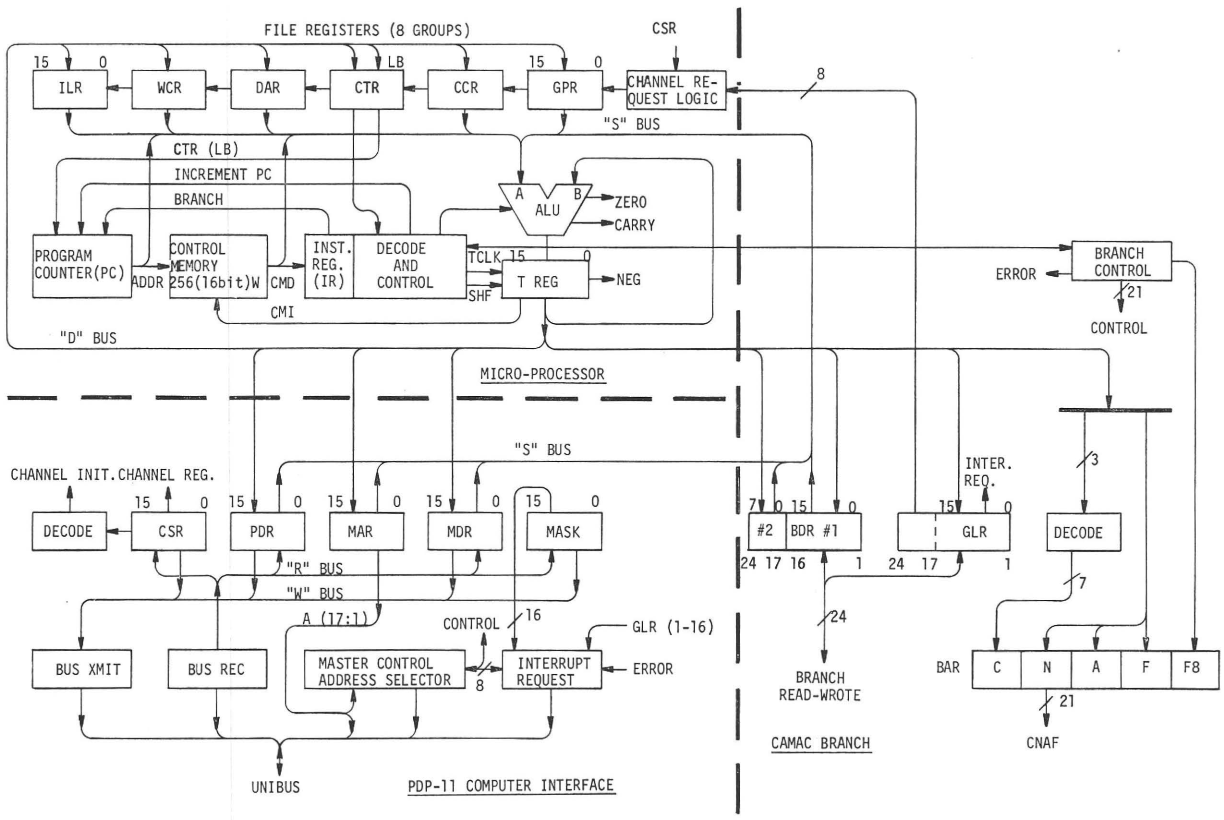

Fig. 1 Microprogrammed Branch Driver

Branch Driver

The branch driver is a very conventional design. It contains three basic registers; the command register (CNAF), the 24-bit branch data register (BDR) and the 24-bit graded-L register (GLR). In order to get around the problem of the command requiring 17 bits, three different command types are defined: read, write, and control/test. Bit F8 is omitted from the command word and is supplied by the processor, depending on the type of command in which it appears. The processor is in complete control of the branch driver. It controls reading and loading the registers, starting the branch operation, and testing the 'Q' and 'X' lines. A branch time-out error will generate an interrupt. The computer initialise command (INIT) generates a 'BZ' command to the branch. A branch demand (BD) will result in a graded-L (GL) operation if the processor is in the stop mode, but if in the run mode, the processor will not allow a GL operation until it completes the current job and generates an exit command. The results of a GL operation are that the GL's from the branch are stored in the GLR. Bits 17-24 of GLR result in DMA channel requests 0-7. Bit 24 corresponds to channel 7 and is highest priority. Bits 16-1 of GLR are masked by the MASK register in the computer interface and appear as 16 unique interrupt vectors to the PDP-11 computer. Bit 16 is the highest priority L request. The MASK register can be loaded only from the PDP-11. Two transfers are required to read or load the BDR since the BDR is 24 bits in length and the processor and PDP-11 are 16-bit machines. Bits 24-17 are the low byte of the second transfer.

Computer Interface

The computer interface part of the MBD is very similar to the standard DEC interface. The interface has five registers. The memory address register (MAR) and the memory data register (MDR) are the DMA channel registers and are controlled from the processor. The processor is bus master during all DMA transfers. A bus request is made when the processor executes a data-channel read or write. The bus is released at the end of each transfer unless the unit has been commanded into the 2-cycle mode for increment and add-to-memory function; then it is released at completion of the second transfer. A UNIBUS transfer time-out error sets an error interrupt to the computer and an error flag in the CSR register.

The other registers of the interface are the control and status register (CSR), the program data register (PDR), and the MASK register. The instruction register (IR) can be loaded from the PDP-11 in the single-cycle mode. These registers may be given any device addresses allowed by DEC and are used to initialise the processor; that is, to load the control memory of the processor from the computer and read it to verify correct loading. They are also used in the single-cycle (manual) mode for controlling and testing the processor. The CSR register is used by the PDP-11 to make a channel request when the processor is in the run mode by setting the desired channel number into the channel-select field and run-mode bit.

The registers are buffered and appear to the computer UNIBUS as a single unit load. The DMA channel looks like one channel to the UNIBUS and the interrupts appear as one hardware interrupt, but generate 25 unique vectors starting at location 400 in the PDP-11. The error interrupt is the highest priority, the eight end-of-channel operations are the next level, and the 16 GL's are the lowest level. All 24 interrupts appear as one level to the PDP-11 and can be assigned to any one of the BR levels. In the first models of the MBD they are assigned to the BR5 level.

Microprocessor

The micro-programmed processor is a fully-fledged processor and is the control device that gives the MBD the speed and flexibility required. The processor's prime function is to command the branch and to transfer data between the branch and the computer. The microprocessor design has developed to the point where a transfer between registers via buses and a processor is faster, and requires less hardware than with gates alone.

The heart of the processor is the arithmetic and logic unit (ALU) which connects the Source bus and the Destination bus and allows transfers between any of the registers connected to the buses in one micro instruction of the ALU. One of the functions of the processor is to create (multiplex) and control eight DMA channels. The information pertinent to the DMA operation is stored in 48 file registers, all of which are connected to the S and D buses. The registers are organised in eight groups of six registers; each group contains information for one of the eight DMA channels. The branch and computer interface registers are connected to the S and D buses, this gives the processor control of the communication between the CAMAC branch and the computer I/O.

Operation of MBD

The control memory (CM) contains the microprograms that define the transfer sequences. The read-write memory has 256 16-bit words and an access time of approximately 70 nsec.

Micro instructions are executed in four clock periods, which are initially set at 400 nsec. The basic clock is 10 MHz, but can be adjusted over a range of 1-25 MHz. The instruction set is divided into normal and not-normal instructions. Each of the normal instructions can select one of 16 control functions, a source register, and a destination register. The normal instructions are move, increment, decrement, add, subtract, inclusive OR, exclusive OR, and AND. The not-normal set consists of branch-if-true, branch-if-false, jump via a low byte in CTR, store, load, jump, shift-T-register, and load CTR LB from IR LB. The branch instructions can select one of 16 conditions for test.

The low byte of the control register (CTR) is connected directly to the PC register and contains the address of the service program in control memory. Bits of the high order byte can be tested by the control program to determine which alternative procedure to execute. The instruction location register (ILR) contains the address of the next word in the PDP-11 core memory instruction list.

The data address register (DAR) contains the pointer to the next word in the data list. The word count register (WCR) contains the number of words to be transferred to the data list. The CAMAC command register (CCR) contains the CAMAC function and CAMAC device address, minus the F8 bit. This bit is supplied by the processor, depending on the type of control command that loads the CCR command into the branch address register (BAR). The general-purpose register (GPR) is a free register and can be used as the programmer desires. For an example, it may be used to create loops, as an index register, or as a counter.

The channel request logic is the area that ties the three major areas together and is the starting point for all run-mode operations.

After initialising the processor, which will be discussed later, operation begins by making a channel request. Each of the eight channels has two sources of requests: the PDP-11 computer and a GL in CAMAC. The computer request is higher priority than CAMAC. If the source of the request was CAMAC, then the instruction in control memory location zero is executed. Location zero will contain a JVC instruction, which is a jump via low byte in CTR register. This allows each channel a link to its own micro-program. If the source was the PDP-11 then execution will start at location one of central memory. Starting at location one will be a file register initialise routine using channel transfers. When a transfer is completed an end-of-block interrupt for that channel is sent to the PDP-11 by a control command. The PDP-11 recognises the interrupt and issues a channel request that will re-initialise the channel, if that is desired.

Once the processor is executing a program it cannot be interrupted, and will relinquish control to the channel request logic by executing one of three exit control commands. The operation of the processor is such that any exit causes a temporary stop. If there is no request, the unit remains in stop mode until a request is made from either the computer or CAMAC. If there is a request from CAMAC (BD) then a BG operation is automatically started and the channel select logic waits for completion of the GL cycle before priority is arbitrated.

MBD MANUAL CONTROL CONSOLE

The control console, a separate unit, was designed for two purposes; to facilitate checkout and testing, and to operate the MBD as a stand-alone branch driver.

The operation of the console is that of a PDP-11 simulator and connects to the MBD through the UNIBUS connector. The console cannot be connected to the MBD at the same time as the PDP-11. The units have 16 switches for entering data or address into their respective registers in the unit. The register can be loaded either from the console switches or from the UNIBUS, depending on the type of transfer executed. Lights on the console display the contents of the data and address registers. The units will be used primarily for program I/O transfers (DATO and DATI).

INITIALISING MBD

The first step in initialising the MBD is to load the control memory with the programs required to control the channels and the CAMAC system during the run mode of operation. The control memory is loaded and checked using the single-cycle mode of the MBD.

After loading and verifying the loading of control memory, the system is put in the run mode and the file registers are loaded from a list in the PDP-11 memory.

MBD HARDWARE AND FABRICATION

The system was designed and fabricated using the computer automated system hardware (CASH) developed by Standard Logic, Inc. The CASH hardware is designed for use with computer-aided design (CAD) technology and is supported by a complete line of systems software, computerised documentation, and semi-automatic wiring.

The model of the MED with eight DMA channels and 256 words of memory has 500 integrated circuits and requires a separate 5V d.c. 25 amp power supply. The MBD memory may be expanded to 2k words in 256-word increments.

The manual console uses the CASH hardware and is housed in a DC-01 vertical panel. The unit has three CASH cards and a 5V d.c. 5 amp power supply. One cable connects the unit to the MBD. The front-panel has the control switches and the address and data lights.

ACKNOWLEDGEMENTS

The authors are indebted to Richard F. Thomas, Jnr., Los Alamos Scientific Laboratory, by whom the MBD systems design and operation was greatly influenced, and to James A. Buchanan and Hugh V. Jones, Rice University, for the initial development of the MBD.

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ESONE ANNOUNCEMENTS

SOFTWARE PRODUCTS

The Information Working Group would like to expand the content of the Bulletin to include a list of CAMAC-related programs and routines which might be made available from both suppliers and users of CAMAC. Anyone with such products should send a brief description with references and address to Mr. O. Nicolaysen at CERN so that items can be listed or published in another suitable way in the following issues of this Bulletin.

NEWS

ESONE/CAMAC LIBRARY

The creation of an ESONE/CAMAC Library by the ESONE Committee Secretariat was announced in Bulletin No.4, p. 11. Unfortunately, the number of publications lodged with the Secretariat is only a small percentage of the total listed in the CAMAC Bibliography. The Secretariat therefore appeals to all authors, who have not already sent a copy of their papers to the Secretary, to be so kind as to do so now to the address given below. This co-operation will enable the Secretariat to provide an effective library service to all who are interested in obtaining information.

ESONE Secretariat,
EURATOM, JRC,
21020 ISPRA (Varese) Italy.

CAMAC AT MESUCORA

On the occasion of the Mesucora Exhibition, April 1973 in Paris, CAMAC equipment and documentation will be displayed.

ESONE GENERAL ASSEMBLY AND CAMAC EXHIBITION

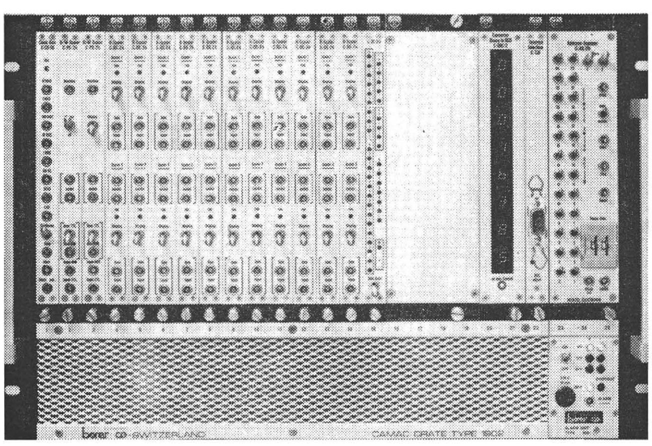
The 1972 General Assembly of the ESONE Committee was held from 3rd to 5th October in KFA Jülich, Germany. In association with this there was an exhibition of CAMAC products by 34 manufacturers from Europe and the USA. The exhibition and many sessions of the General Assembly were open, for the first time, to everybody interested in CAMAC. The increasing use of CAMAC by industry and in other areas outside the ESONE member laboratories was demonstrated by the presence of many new participants, by papers, and by discussions in the exhibitions.

The ESONE Committee reported important progress, including the publication of the revised specification EUR 4100e (1972) and a proposal for a CAMAC programming language.

A more detailed report on the highlights of the General Assembly will appear in the next issue of CAMAC Bulletin.

ANNOUNCEMENTS BY CAMAC MANUFACTURERS

WENZEL ELEKTRONIK has delivered a CAMAC system for counting experiments to G.F.K. Karlsruhe, Germany. The system is equipped with a newly developed Address Scanner (model C-AS-20) for computerless control. In this unit, two 24-bit registers can be set manually to control two presettable scalers (model C-PS-24) for 'preset count' and 'preset time' mode (together with a clock generator) respectively.



During readout of a series of scalers (dual 24-bit counting registers, model C-DS-24) the address scanner controls the transfer of scaler contents, via the dataway, to a binary-to-BCD converter (model C-BBC-2) and a teletype interface (model C-TIF) to a teletype for printout of results. The scanner allows repetitive readout with presettable pause periods between.

With the exception of the powered crate (from Borer & Co.), all equipment is manufactured by Wenzel Elektronik.

For computer controlled experiments only the address scanner need be replaced by a crate system-controller or by a Crate Controller Type 'A' for branch systems.

NUCLEAR ENTERPRISES have recently been awarded a contract for the supply of 65 8-Channel Analogue to Digital Converters to the Daresbury Nuclear Physics Laboratory. The unit known as 9040 will be used with fast photomultiplier tubes in high energy physics experiments and delivery of the first units will be in the summer of this year.

STANDARD ENGINEERING CORP. is a new company which has recently purchased the Rodcor Industries facility and continues to design and manufacture CAMAC products as unit hardware, blower units and powered crates to CAMAC specifications and most recent USAEC NIM-CAMAC recommendations.

SOFTWARE

TRIUMF CONTROL SYSTEM SOFTWARE

by

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Received 12th June 1972

SUMMARY The control system for the TRIUMF cyclotron makes extensive use of CAMAC. The structure of the software for this control system is described. A similar structure has been used successfully for operating the full-scale « Center Region Model » cyclotron.

INTRODUCTION

The TRIUMF project is centered around a 500 MeV negative ion isochronous cyclotron currently under construction in Vancouver by four Western Canadian universities—the University of Alberta, the University of British Columbia, the University of Victoria, and Simon Fraser University. It is designed to produce a high intensity ($\sim$100 μA) proton beam for meson production. An independent proton beam of lower intensity will simultaneously be available. The first (low intensity) beam extraction is scheduled for the late fall of 1973.

CONTROL SYSTEM PHILOSOPHY

The cyclotron control system specifications call for the monitoring of over 1000 analogue parameters, searching for out-of-limits readings, displaying measurements on request, and logging parameters on magnetic tape. Similar monitoring functions are required for over 1000 digital status points. In addition the control system must be capable of setting some 300 analogue points from a central console as well as performing on/off type functions (direct digital control) on most cyclotron devices.

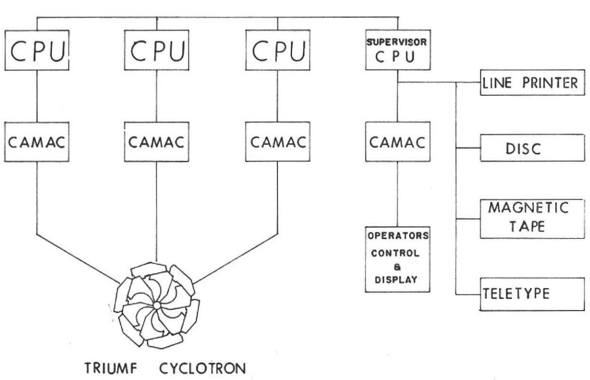

Fig. 1 Block diagram of TRIUMF control system hardware

These operations will be carried out by a number of small computers and TRIUMF has adopted the CAMAC standard as the means of communication between cyclotron devices and the computers. Three minicomputers[1] will each be interfaced to a Branch Highway devoted to a specific area of cyclotron control (e.g., ion source and injection system; cyclotron magnets, resonators and services; beam lines). Each of these computers communicates using standard hardware[2] with a central (similar) computer, which is interfaced to the main control console through another CAMAC Branch Highway. It is expected that the TRIUMF control system will involve a total of 20 to 30 crates on 6 to 8 branches.

High speed is not generally a necessity in a control application. A more important consideration is the ability to monitor each control operation as it is executed. With this in mind and in order that the hardware be both simple and reliable, TRIUMF has elected to run its CAMAC based control system completely under program control.

THE SUPERVISOR PROGRAM

Systems which run in a real-time interrupt driven environment usually make use of an executive or supervisory program for scheduling the various jobs as they are requested. Economy of both time and core requires that this executive be compact and efficient, while retaining a fairly powerful and versatile repertory of commands. The TRIUMF supervisory program, Nova Asynchronous Tasking Supervisor (NATS)[3], occupies 374_{10} words of memory and can supervise the execution of a virtually unlimited number of tasks operating asynchronously.

The word *task*, as used here, means a sequence of instructions which may be thought of as constituting one job. Any number of tasks may be defined to the supervisor, and these tasks may have coding (e.g., subroutines) in common. Tasks may schedule the execution of other tasks. Also a task may be placed in an inactive state by the supervisor while it is waiting for results from other tasks or for an interrupt. No limitations other than those of space requirements are placed on the number of tasks running concurrently at various levels of priority, but each task *must* run to completion before it can be activated again by the supervisor. This is in contradistinction to re-entrant subroutines, for example, which may be used concurrently by two or more tasks.

In one approach adopted, all CAMAC operations are treated as a single task in the sense described above. This 'CAMAC task' may be called through any one of a number of re-entrant subroutines which by making suitable requests through the supervisor select different CAMAC operations. Thus whenever a CAMAC operation, or sequence of CAMAC operations, is required, a request for the CAMAC task is placed in the task queue along with parameters describing the particular operation desired. In this way, the supervisor assures that CAMAC operations are executed in orderly sequence according to a user defined priority scheme. In the following paragraphs, the structure of this 'CAMAC task' is described.

THE CAMAC TASK

The hierarchical structure of the CAMAC task is illustrated in Fig. 2. This figure also shows the, terminology used in describing the various components of the task.

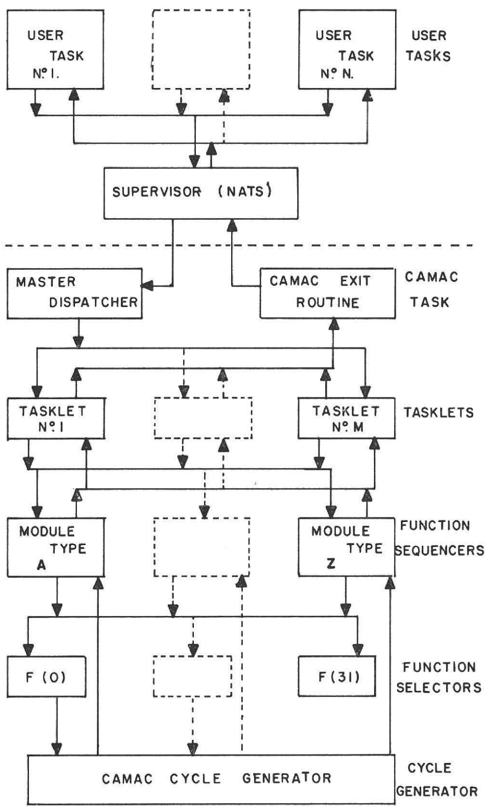

Fig. 2 Structure of the CAMAC Task

THE MASTER DISPATCHER AND CAMAC EXIT ROUTINE

When control is given by the supervisor to the highest priority queue entry for the CAMAC task, the task is entered at the Master Dispatcher level with up to three parameters passed from the calling task. One of these parameters is always the number of a 'tasklet' to be executed. Each entry into the CAMAC task involves the execution of *one* and *only one* tasklet.

All tasklets end with a call to the CAMAC exit routine. This routine uses the supervisor to return data and error information to the calling task, and terminates the CAMAC task.

TASKLETS

Each well defined sequence of operations on one or more CAMAC modules is defined as being a tasklet in the CAMAC task. For example, operations such as reading a series of registers and storing the results, or setting a block of DACs to predefined values (run-up) would be considered as tasklets. In order that all CAMAC operations may be treated in the same manner, one tasklet is available which executes any single CAMAC operation (cycle) defined by the passed parameters. Normally, CAMAC task tasklets simply call one or more 'Function Sequencers' as subroutines.

FUNCTION SEQUENCERS

The key to CAMAC task modularity is the Function Sequencer. Each Function Sequencer corresponds to a particular CAMAC module. It is a subroutine which performs a sequence of CAMAC operations specific to a piece of hardware. Here the hardware-software relationship is most evident. The addition of a new CAMAC module to the system will normally require little more than the addition of a corresponding Function Sequencer to the CAMAC task.

For example, a double width module containing four TRIUMF-designed 10-bit digital to analogue converters (DACs) is one of the basic building blocks of the TRIUMF control system. To this CAMAC module there corresponds a function sequencer in the CAMAC task. The program module first sends data to a selected DAC (F(17)), and then reads the contents of the DAC register (F(1)) back into the computer for comparison with the original data. If a difference is detected, the whole process is tried up to two more times before an error is signalled. The response time of the DAC is such that transmission errors on the first or second try have little effect on its output provided the third try is successful.

Similar Function Sequencers exist for TRIUMF-designed 4 and 8 bit parallel input-output registers used for direct digital control (DDC), for a TRIUMF designed CAMAC interface to a commercially available multiplex analogue to digital converter system, as well as for other commercially available CAMAC modules used in the control system.

FUNCTION SELECTORS

Function Selectors are, in practice, merely different entry points to the CAMAC Cycle Generator, a description of which follows. They load the required CAMAC function code into a computer working register before proceeding to the execution of the Cycle Generator.

THE CAMAC CYCLE GENERATOR

At the bottom of the CAMAC task hierarchy, at the very heart of the CAMAC task, is the 'CAMAC Cycle Generator'. Each entry into the CAMAC task results in the execution of at least one CAMAC cycle, and each CAMAC cycle is initiated by the CAMAC Cycle Generator which reflects in software the various stages of the cycle.

Figure 3 is a simplified flow chart of the CAMAC Cycle Generator, and it is in this diagram that the full implications of programmed CAMAC 1/0 and complete software monitoring of each CAMAC operation are most evident.

Table I gives CAMAC Cycle Generator execution times for a Supernova computer using the TRIUMF Branch Highway Driver. The times are calculated from entry to the function selectors, which, we recall, may be considered as cycle generator entry points.

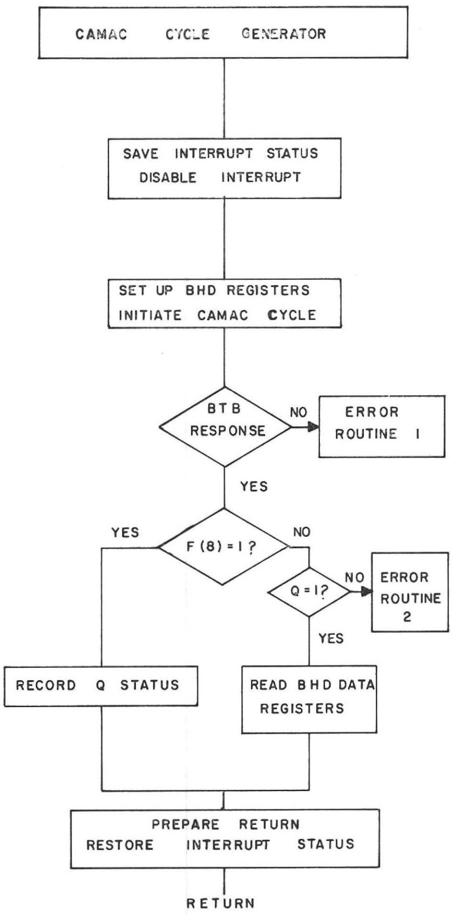

Fig. 3 CAMAC Cycle Generator Flow Chart

This table shows that although the CAMAC dataway cycle is complete in approximately 1 μsec, supporting software requires 35-46 μsecs. This does

Table I

	Interrupts were on μsec	Interrupts were off μsec
Read Operations [F(8) = 0; F(16) = 0]	35.9	42.5
Write Operations [F(8) = 0; F(16 – 1]	39.2	45.8
Other Operations [F(8) = 1; Q = 0]	35.4	42.0
Other Operations [F(8) = 1; Q = 1]	34.6	41.2

not yet appear to be a serious handicap in the TRIUMF controls application, and is a direct consequence of the philosophy that has been adopted.

INTERRUPT HANDLING

Our basic approach has been that cyclotron monitoring should be based on a software scan initiated by the computer clock. Interrupts (LAMS) originating from cyclotron devices should be kept to a minimum. On the other hand, all console activities must be interrupt (LAM) driven. Events requiring a rapid response for machine or personnel protection will initiate hard-wired sequences.

The software responds to a CAMAC interrupt by first identifying the branch from a device code associated with the interrupt, then addressing a 'Graded Look-at-Me' (GLAM) operation to that branch, then identifying the interrupting module by an examination of the GLAM word returned, and finally executing the appropriate subroutine. Execution of this subroutine clears the interrupt.

It is possible to perform the first three of these operations in CAMAC system hardware before interrupting the computer, but the approach described here is consistent with the philosophy outlined above. As a consequence, an average of approximately 100 μsecs in required from the time of the raising of a branch demand until it is cleared.

CONCLUSION

The CAMAC task as described in the preceding sections has been incorporated in the control system for TRIUMF's 'Center Region Cyclotron' where it has been used in an expanding role during the past 12 months. Only monitoring functions were attempted at first. More recently a CAMAC-interfaced control console has been added. Our experience with the CAMAC software described above has been entirely satisfactory. In particular, its structure has facilitated the addition of new types of CAMAC operations as they became necessary. The handling of CAMAC interrupts (LAMS), which now arrive in a steady stream from the operating console, is adequate. No perceptable delays are observed by the operators and the CPU is busy less than 20% of the time.

Nevertheless, the creation of a CAMAC task to handle all CAMAC activities is not the only solution and we are currently preparing a new CAMAC software package which retains much of the current structure and modularity but in which CAMAC ceases to be a task under executive supervision. Dispatcher and tasklets disappear, and are replaced by a series of re-entrant subroutines which directly call the Function Sequencers described above. In the next few months we expect to be able to assess this approach, which has the advantage of significantly reducing both core requirements and the executive overhead required for CAMAC operations.

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2

PDP-8 OPERATING SYSTEM FOR NON-TIME-CRITICAL CAMAC EXPERIMENTS

by

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Zentrallabor für Elektronik der KFA Jülich GmbH, Germany

Received 3rd July 1972

SUMMARY An operating system for non-time-critical applications has been developed for the PDP-8 computer. The system is based on the FOCAL (8k) interpretive language. It provides control of CAMAC, flexible programming, simple data handling, and program chaining.

INTRODUCTION

Complex on-line experiments require background storage and interactive display. The particular system with which this paper is concerned consists of a PDP-8/I (8k) computer, dual DEC-tape, a single CAMAC crate with a crate-system-controller[1], and a home-made display with light-pen connected directly to the computer. A previous paper[2] demonstrated the advantages of an interpretive language for simple and flexible CAMAC programming. An expansion of this overlay technique created an operating system which is capable of controlling CAMAC, transferring data between memory and tape, chaining FOCAL programs, and allowing a light-pen control of the display.

DISPLAY WITH LIGHT-PEN

The system refreshes the display by writing the contents of sequential locations in a fixed part of the core-memory using incremental address scan mode. The light-pen is used to mark the address of a displayed value using direct memory access (DMA) for arithmetic modification of the dataword (setting the most significant bit), instead of interrupting. This avoids a special light-pen handling sub-routine. A special set of displayed addresses can be used to activate tasks such as integrating or printing-out the contents of the addresses marked by the light-pen.

INTERRUPT HANDLING

To meet the real-time demands, interrupt handling has been implemented in FOCAL by setting software switches when an interrupt occurs during execution of a command. After finishing the line, the software switches are tested and a line linked to an appropriate interrupt source is executed next.

PROGRAM SYSTEM

The DEC-tape used as background memory is controlled by the PDP-8/I DOS system. The library statement is used for FOCAL[3] program chaining and task activating by exchanging page 0 and locations 3200 to 4600 of field 0, and 0 to 5600 of field 1 (Fig. 1). The statement is followed by a parameter set specifying the number of tape, read or write, block-number and starting line of the FOCAL program.

Locations 5600 to the upper limit of field 1 are used as a display refreshing buffer and common area. An additional function statement can be used

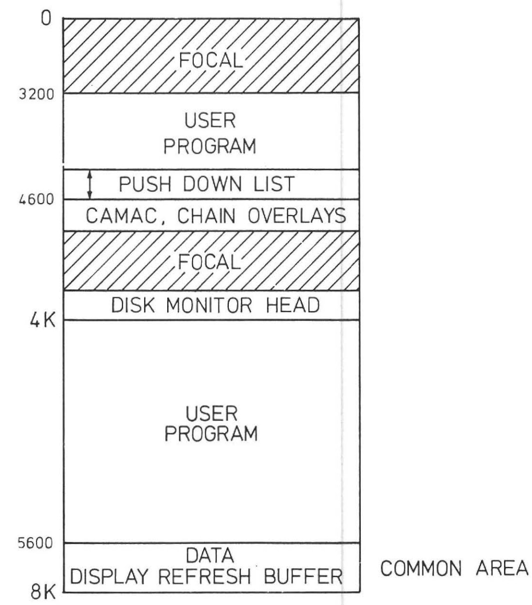

Fig. 1 Core layout for the PDP-8/I

to exchange this area, transfer its contents to tape, or access single values.

The system is used to control a four-circle neutron diffractometer. The combination of FOCAL and DOS extends the calculating power of the system. The most important programs are:

- General test of the CAMAC system in conjunction with the positioning system (electronics-mechanics interaction).
- Calculation of the mechanical shaft positions determined by the specific scattering planes of the crystal.
- Automatic adjustment of the sample crystal and measurement of its orientation parameters by a closed loop optimising program.
- Refinement of the lattice and orientation parameter by a least squares fitting method.
- Automatic data acquisition over long periods with self-calibrating and testing procedures.
- Data reduction under light-pen control.

Most of the calculation programs are matrix algorithms.

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CAMACRO — AN AID TO CAMAC INTERFACE PROGRAMMING

by

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Received 12th June 1972

SUMMARY A translator incorporating macro commands to simplify the programming of peripherals interfaced through the CAMAC system is in regular use at the Daresbury Laboratory, where it was developed.

INTRODUCTION

The CAMAC system is analogous in computer hardware to the high level language in computer software. It allows the computer user to configure his system by choosing suitable modules from a proven range and connect these together in a closely-defined, systematic way to build a working system. All this is made possible without more than a cursory understanding of either computer or CAMAC hardware operating principles. As with the use of a high-level language, however, there are penalties. The extended addressing and control features possible within the CAMAC specification cannot usually be met by the computer's input/output arrangements alone, so that it is usually more difficult to control devices through CAMAC, than directly from the computer's own input/output system. The 24-bit CAMAC data path is also generally wider than those of the modern, small, process-control computer that is normally used for CAMAC applications; this results in added complexity of the programs needed.

To meet CAMAC addressing requirements, the computer must be capable of transmitting a binary pattern comprising a total of 21 bits for each CAMAC operation. These are made up as follows:

(A) 7 crate addressing bits (C bits);

(B) 5 module addressing bits (N bits);

(C) 4 module sub-addressing bits (A bits);

(D) 5 function bits (F bits).

However, in the majority of applications, it is possible to adopt procedures which enable less than 21 bits to be transmitted concurrently, for example 16 bits at a time.

To transmit 16 bits of control information from a small digital computer such as a Honeywell 316 or 516, it is necessary for a data transfer from the computer to be used as a control transfer to the CAMAC system. Thus every command to a module in the CAMAC system from the computer must contain one data transfer additional to what would normally be required were that module connected directly to the computer input/output bus. For example, to start the Honeywell interfaced paper-tape reader, only one control instruction is necessary:

```
OCP '001
```

To perform the same operation on a CAMAC-interfaced tape reader requires the following sequence of instructions:

```
LDA Control Code    Load appropriate C,N,A,F,
                    bits into A register
OTA '240            Transmit to CAMAC
JMP *-1
```

It is clear from this example that, to program in such an environment, it is necessary to know not only how a given peripheral device operates but also how to control the computer to CAMAC interface and how to form the appropriate control codes that are required.

The specification of a 24-bit data-path in the CAMAC system presents a problem not normally encountered in programming a 316 or 516 computer. Although the processor itself is capable of double-length operation, by manipulating the A and B registers together, there is no method of direct output or input transfer in this form. Thus, to output to a 16-bit device on the input/output bus, it is customary to execute the following code:

```
OTA   Control Code
JMP   *-1
```

However, to perform a similar operation for a 24-bit CAMAC device, it is necessary to have a code sequence of the form:

```
OTA   '140  }  Output high order bits
JMP   *-1   }

IAB         }  Move low order bits to A
OTA   '340  }  register and output to
JMP   *-1   }  CAMAC

LDA   CNTL     Control Code

OTA   '240  }  Control Code Transfer
JMP   *-1   }
```

From this example also, it can be seen that the programmer must understand the caracteristics of the computer-CAMAC interface in addition to those of the peripheral device and computer.

Much of the extra programming burden would be eliminated, and the need to fully understand the working of system components avoided to a great extent if the programmer were able to code CAMAC operations by reference to say the function code as operand followed by a CAMAC module address. For example, instead of the 24-bit transfer, written above in assembler language, we could write a Macro call in the following manner:

```
F16   1,4,0
```

where

F16 is a Macro name corresponding to the CAMAC function code

1 is the Crate address
4 is the Station address
0 is the Module sub-address
} Macro parameters

For such a statement, the translation process to assembler language is dependent upon the CAMAC function definition, which is defined by the CAMAC specification, the computer language in use, and the CAMAC controller. At any particular installation, all these features are well defined, so that it would be reasonable for such an installation to have an assembler with inbuilt rules for translation. It is essential, however, to have a simple method of incorporating these rules into the assembler so that the flexibility of the package is maintained.

At most laboratories using CAMAC, the small computers that are used do not have any mass storage media, and they use paper-tape for input and output. This is the situation at Daresbury Laboratory, where it was considered best to implement the translator as part of the assembler, rather than as a separate preprocessor. One consequence of this decision is that the translation and assembly processes involve the same operations as a traditional assembly, and do not involve additional passes.

THE BUILDER

Before an assembler can translate code including Macro commands, it is necessary to add two features. The first is a simple extension to the algorithm, which decides the type of command that is being translated. The second is a table look-up which gives an indication of the way in which the command is to be expanded in the case of a Macro. In general, the first of these features will not need to be changed once it is functioning correctly. However, the table may well be expanded or altered in the light of experience, for example when it is necessary to add a new Macro to the system.

The translation system is intended to be used with small computers, so that the table should be designed to be as compact as possible. Because of this, the problem of generating a new Macro table, for example in octal, is considerable. To simplify this process, it is possible to use an automatic procedure for table generation termed a BUILDER. The BUILDER reads a series of Macro definitions and generates a tape—which is the table, referred to above—to be used to generate a new assembler.

THE ASSEMBLER AND TRANSLATOR

At Daresbury Laboratory, CAMACRO has been made available to users of Honeywell 316 and 516 computers by modification of the Honeywell DAP 16 assembler. A general CAMACRO preprocessor is also under development which will take an assembler source tape and replace all CAMACRO calls so that the resulting tape can be compiled by the manufacturer's standard assemblers or by their assemblers which run on an IBM 360.

The modified assembler for the '516' can also be used in the normal way by anyone who does not need to use CAMACRO calls and has no knowledge of CAMACRO.

AN EXAMPLE OF THE USE OF CAMACRO

As an example, it is useful to consider a specific problem frequently encountered in CAMAC systems, namely to read a block of data into an array AREA from the paper-tape reader. The following source statements can be used:

```
LOOP $F27   $RDR, 0   TEST FOR READER READY
     JMP    LOOP      LOOP UNTIL READY
     $F02   $RDR, 0   READ DATA INTO A REGISTER
     STA    AREA, 1   STORE DATA INTO ARRAY AREA
     IRS    0         INCREMENT INDEX REGISTER
     JMP    LOOP      IF INDEX NOT ZERO REPEAT
     —                CONTINUE IF INDEX = 0
```

The resulting output from the CAMACRO assembler is:

```
0004                   LOOP $F27   $RDR,0    TEST FOR READER READY
0004 00000  0 02 00045      LDA    ='05033   LOAD C,N,A,F
0004 00001  74 0240         OTA    '240      OUTPUT TO
0004 00002  0 01 00001      JMP    *-1       CAMAC
0004 00003  34 1340         SKS    '1340     WAIT UNTIL
0004 00004  0 01 00003      JMP    *-1       READY
0004 00005  34 1040         SKS    '1040     TEST Q
0005 00006  0 01 00000      JMP    LOOP      LOOP UNTIL READY
0006                        $F02   $RDR,0    READ DATA INTO A REGISTER
0006 00007  0 02 00044      LDA    ='05002   LOAD C,N,A,F
0006 00010  74 0240         OTA    '240      OUTPUT TO
0006 00011  0 01 00010      JMP    *-1       CAMAC
0006 00012  54 1640         INA    '1640     INPUT LOW
0006 00013  0 01 00012      JMP    *-1
0007 00014  1 04 00017      STA    AREA,1    STORE DATA INTO ARRAY AREA
0008 00015  0 12 00000      IRS    0         INCREMENT INDEX REGISTER
0009 00016  0 01 00000      JMP    LOOP      IF INDEX NOT ZERO REPEAT
0010                      * -                CONTINUE IF INDEX = 0
```

An alternative method that could be used in this particular example is to check Q for a valid read operation. In this case and without using the string definitions the source program could be written:

```
LOOP $F02   0, 5, 0, Q   READ DATA IF READY
     JMP    LOOP         LOOP UNTIL READY
     STA    AREA, 1      STORE DATA INTO ARRAY AREA
     IRS    0            INCREMENT INDEX REGISTER
     JMP    LOOP         IF INDEX NOT ZERO REPEAT
     —                   CONTINUE IF INDEX = 0
```

The resulting output now is:

```
0003                   LOOP $F02   0,5,0,Q   READ DATA IF READY
0003 00000  0 02 00015      LDA    ='05002   LOAD C,N,A,F
0003 00001  74 0240         OTA    '240      OUTPUT TO
0003 00002  0 01 00001      JMP    *-1       CAMAC
0003 00003  54 1640         INA    '1640     INPUT·LOW
0003 00004  0 01 00003      JMP    *-1
0003 00005  34 1340         SKS    '1340     WAIT UNTIL
0003 00006  0 01 00005      JMP    *-1       READY
0003 00007  34 1040         SKS    '1040     TEST Q
0004 00010  0 01 00000      JMP    LOOP      LOOP UNTIL READY
0005 00011  1 04 00014      STA    AREA,1    STORE DATA INTO ARRAY AREA
0006 00012  0 12 00000      IRS    0         INCREMENT INDEX REGISTER
0007 00013  0 01 00000      JMP    LOOP      IF INDEX NOT ZERO REPEAT
0008                                         CONTINUE IF INDEX = 0
```

CONCLUSIONS

The adoption and use of CAMACRO has considerably simplified the writing of input/output software for CAMAC systems and has relieved the programmer of the need to understand in detail the working of the system components. A particular advantage is the flexibility provided by the Macro and string definition facilities by which modifications arising from changes in hardware specification or module relocation can be easily implemented. This work is being further developed towards improved hardware independence and the use of a wider range of computer languages.

ACTIVITIES OF THE CAMAC WORKING GROUPS

The ESONE Committee in Europe and the USAEC NIM Committee in America have both authorised different working groups to investigate specific aspects of CAMAC. The European and American working parties are performing their activities in close collaboration.

ESONE-CAMAC WORKING GROUPS

Dataway Working Group

Chairman: H. Klessmann, HMI Berlin

At its meeting in June, 1972 the ESONE Dataway Working Group investigated the NIM proposals for a CAMAC Supplement. This makes recommendations concerning the implementation and interpretation of CAMAC specifications and includes descriptions of preferred practices and current applications. The Working Group agreed that the Supplement should not constitute any modification or extension to the CAMAC specifications. This response was presented to the NIM Dataway and Mechanics Working Group meetings (July 1972, Boulder, Colorado) and, by very close co-operation, agreement on many items of the Supplement was reached so that approval by both the NIM and the ESONE Committee seems possible.

The ESONE Dataway Working Group has further analysed several schemes for a Serial Branch System and is continuing this work by more detailed investigation of a basic scheme which shows many attractive features. In this configuration the Serial Branch is connected in an unidirectional loop so that each Crate Controller need only have two ports, and the Branch Controller can check that commands have been transmitted correctly through the whole system. The information is organised into bytes and may be transferred either bit-serial in a fully asynchronous mode or in a synchronous mode or byte-serial. For simple systems, possibly with low data transmission rates, the structure will allow the use of a simple teletype (Transmit/Receive) port as a Branch Driver. The byte structure considered allows read and write data in fully transparent 8-bit bytes while control bytes contain an identifier for unique identification of the various control or command information.

The mechanism for demand handling, error detection and recovery, byte synchronisation and transmission via standard communication are currently being investigated in co-operation with the NIM Dataway Working Group whose many contributions to the general structure of a Serial Branch System are most helpful and are highly appreciated.

Software Working Group

Chairman: I. N. Hooton, AERE Harwell

The group has now reached a point in its definition of a CAMAC Language in which comments and criticisms from all interested organisations and individuals are required before a final specification can be generated. A 'Proposal for a CAMAC Language' has therefore been published and is available from the distributor of this Bulletin. All communications to the secretary or to other members of the Working Group—see address list, published together with the paper—will be considered in preparing the final document.

A draft proposal is being prepared for an intermediate language (IML) which constitutes a possible object language for a CAMAC Language translator. Simple means of making this language applicable as an assembly language are also being considered. Collaboration with the NIM-CAMAC Software Working Group continues to be of great value.

Analogue Signals Working Group

Chairman: Dr. K. Tradowsky, G.F.K. Karlsruhe

The Working Group has concentrated its activities on the elaboration of an extension of the specification to high frequency signals, in close co-operation with the NIM Analogue Signals Working Group.

This topic has been discussed at two meetings during 1972, at Karlsruhe (February 21-22) and at Harwell (June 28-July 1), and a final proposal was available for presentation at the ESONE General Assembly in October.

Much effort has also been put into the problem of combining the present contents of EUR 5100e (1972) and the extension to high frequency signals as an integrated proposal for a revised version of EUR 5100e. This proposal was prepared at the ESONE General Assembly in October to obtain the ESONE Committee's approval.

Information Working Group

Chairman: Dr. H. Meyer, CBNM, J.R.C. Euratom, Geel, Belgium

The Working Group has appreciated the growing interest of authors in publishing their work in the Bulletin, as judged by the increasing number of papers received. Because the Group wishes to continue to publish as many articles from as wide a spectrum of applications as possible, within the unavoidable page-limitations of the Bulletin, authors will be asked in future to follow more strictly the rules of paper preparation, particularly that appertaining to the maximum number of words allowed.

Several extensions of Bulletin content are under consideration and should improve its value. An example is a proposed section 'Readers' Comments' which could allow some sort of dialogue between CAMAC Users/Suppliers etc. Or again, another section may detail recommendations and give preferred practices in the application of the CAMAC specifications.

The latest information from the distribution centre at Luxembourg indicates a total distribution of 3870 copies for Bulletin No. 4. The response to the annual subscription fees has been reasonable but could be greater. Clearly, the greater the response, the more certain will be the continued support for, and publication of, the Bulletin by the Commission of the European Communities whose assistance so far has been both considerable and tolerant.

NIM-CAMAC WORKING GROUPS

Reporter: Louis Costrell, Chairman NIM Committee

The following NIM-CAMAC Working Groups met at the U.S. National Bureau of Standards in Boulder, Colorado on July 10-14, 1972:

Analogue Signals Working Group
Dataway Working Group
Mechanics and Power Supplies Working Group
Software Working Group

The Groups reviewed in detail a draft of the forthcoming supplement to the CAMAC Specifications that is to be issued as U.S. AEC Report TID-25877. The Supplement will make recommendations concerning the implementation and interpretation of the specifications and will include descriptions of preferred practices and current applications. It is expected that the Supplement will be available in December.

The Chairman of the ESONE Dataway Working Group (H. Klessmann of the Hahn-Meitner Institute, Berlin) and the Chairman of the ESONE Software Working Group (I.N. Hooton, Atomic Energy Research Establishment, Harwell) participated in the Working Group Meetings.

The Analogue Working Group gave further consideration to the standards proposed for fast analogue signals. The proposals are to be reviewed again by the ESONE Analogue Signals Working Group prior to the ESONE General Assembly in October.

The Mechanics and Power Supplies Working Group studied proposals for preferred auxiliary connectors and power supply/crate interface connectors as well as a standard drawing for the CAMAC coaxial connector. The coaxial connector drawing is expected to be issued in August. Numerous additional items for inclusion in the Supplement were also reviewed.

The Dataway Working Group, though primarily involved with the details of the Supplement, was also concerned with serial branch highways. This subject is now receiving attention from both the ESONE and NIM Dataway Working Groups.

The Software Working Group again studied papers dealing with CAMAC software, giving primary consideration to the ESONE Software Working Group's 'Proposal for a CAMAC Language' which was critically reviewed in detail.

NEWS

ANNOUNCEMENTS BY CAMAC MANUFACTURERS

WALLAC INSTRUMENTS LTD. is a new company offering CAMAC equipment that meets the revised specifications EUR 4100e (1972). The present range of units comprises input registers (readers) and output registers. The '150' range of Input Readers, having a store capacity of up to 256 bits, allow some significant economies by making increased use of the basic crate station.

The Readers are designed for general purpose data acquisition with CAMAC systems. The range of Readers is as follows:

Type
151 - four 16-bit words on subaddresses (0-3)
152 - four 24-bit words on subaddresses (0-3)
153 - eight 16-bit words on subaddresses (0-7)
154 - eight 24-bit words on subaddresses (0-7)
155 - sixteen 8-bit words on subaddresses (0-15)
156 - sixteen 16-bit words on subaddresses (0-15)

In basic form the data inputs are wiring points on the internal printed circuit card, hence the user can enter the system in a manner most suitable to this application (i.e. multipin connectors, tape wire, flexible printed wire). Input connectors can be supplied wired and tested to user's instructions. These connectors may modify the basic dimensions (single-width).

The Readers are recommended for these applications:

1. General purpose data reader for D.V.M.'s, shaft encoders, data-loggers, switch data, etc.
2. Read-only memory—in conjunction with a pre-wired programme.
3. Programme/parameter generator—in conjunction with a plugboard or switch registers.
4. Pattern generator—a single input word can be wired to provide up to n patterns, the pattern required being selected by dataway command (n being the number of word registers available).
5. Temporary store—in conjunction with output register modules (S.R.A. '170' range).

NUCLEAR ENTERPRISES, after the acquisition of the CAMAC interests of EKCO Instruments Ltd., have combined the Research and Development teams of the two companies in the new laboratory at Beenham,

This is already having a marked effect on the development programme of new instruments and has also increased the systems capability, resulting in hastening the supply of CAMAC systems to an ever widening range of users.

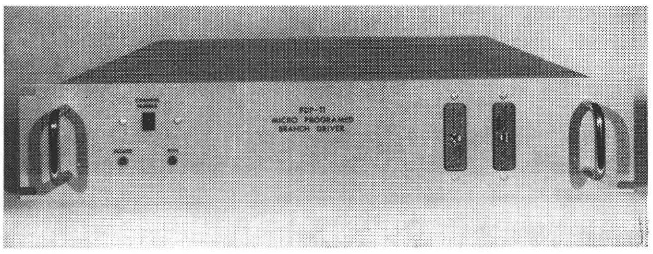
Amongst the latest orders for systems received are a data-logging system for an industrial company in the consumer goods industry, a general data-acquisition system for a physics department of a British university, a data-logger in the Electricity Supply Service, a cyclotron control and monitor system for a Belgian university and a 150-Channel monitor alarm system for British Nuclear Fuels in Cumberland.

SYSTEM UNITS, TEST EQUIPMENT

MBD-11 Microprogrammed Branch Driver for a PDP-11 Computer

The MBD-11 is a multiple, direct memory access (DMA) channel Branch Driver. The unit is an 8-channel multiplexer controlled by information stored in 48 file registers. The 16 bit microprocessor has 256 words of read-write memory with an access time of 70 nsec. The MBD has 16 instructions that are each executed in four clock periods or 400 nsec. An instruction can select one of 16 control functions, a source register, and a destination register. The unit has 25 interrupts: 1 error, 8 channel service, and 16 'L' requests from the branch.

The MBD was fabricated using the Standard Logic Inc., computer automated hardware system (CASH). The MBD has a panel height of $3\frac{1}{2}$ in., 500 integrated circuits, and requires a separate 5 Vdc, 25 A power supply.



Ref. TMA Electronics

Type A-1 Crate Controller, Model CCA-1

This unit is the most up-to-date controller available. In addition to meeting all the 1972 specifications of EUR 4600 for a Type A Controller, it will also meet the requirements to qualify it as a Type A-1. The X response is fully implemented in this unit. Some additional features have been designed into this unit to allow optional modes of operation. Because they are not 'standard' features, they are normally not wired into the unit. However, by the simple addition of jumpers these modes may be utilized.

The two additional modes are a 'Fast Read' mode (*S*2 is eliminated during a dataway cycle) and a 'Hold' mode (the '1' state of an additional 'Hold' line—bussed Patch Pin *P*2—inhibits the generation of *S*1 and the remaining dataway cycle. When the module is ready, the 'Hold' line can be released to continue the dataway cycle).

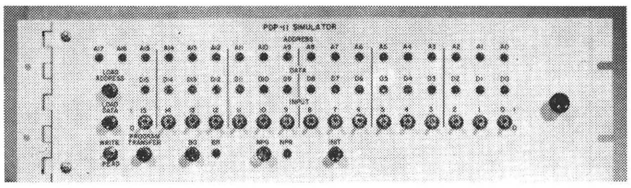
To provide some protection against over-voltage signals on the dataway due to ringing, clamps have been provided on all the high current dataway drivers. These will clamp the logic 'O' level to approximately 4 volts rather than the commonly used Vcc line, and thus give an added level of protection to the TTL inputs that use the dataway.

Visual indicators show the presence of an Inhibit signal or a Demand signal and a BCR indicator shows when the crate has been addressed. The crate address is indicated on a LED display.

Ref. Joerger Enterprises

PDP-11 Simulator

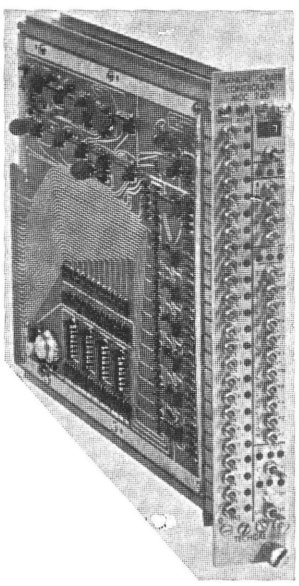
The PDP-11 Simulator is a manual controller and test device for the MBD-11 Branch Driver. The unit will perform program transfers singly, or at a 100 KHz rate, and also test DMA operation and identify interrupts. The simulator can be used to test any PDP-11 computer interface. The unit was fabricated using the Standard Logic Inc., computer automated hardware system (CASH) and requires 120 Vac, 60 Hz power.



Ref. TMA Electronics

Manual Crate Controller, MCC-240

The Manual Crate Controller, MCC-240, is designed to provide manual control of a CAMAC Dataway.



It may be used as either a CAMAC systems' teaching aid, or as a test unit for examining individual modules and setting up a working CAMAC crate. It incorporates, all features necessary to control or monitor the Dataway, including an indicator lamp for the recently designated Dataway X line (Command Accepted). Another feature is electronic crate station number (N) selection with a digital LED station number indicator. Most importantly, the MCC-240 is a double width unit, and therefore can be substituted directly in the physical location of a Type A-1 Crate Controller, thus allowing all other modules in a full crate to remain in place during tests, or more generally, allowing maximum use of crate space.

On the Dataway all pull-ups and signal standards are identical to those specified for crate controllers Type A-1 and all timed dataway signals are generated in proper sequence in 'continuous' mode or stepwise in 'step' mode.

Ref. Techcal Electronic Services

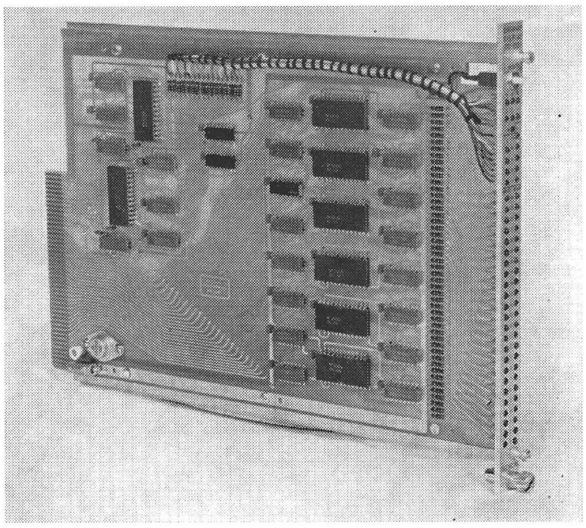
Dataway Display

The Dataway Display Unit (DD-001) is a single-width CAMAC unit for use in test, fault finding, and educational situations. The unit has 64 miniature LED indicators on the front panel to give the latest dataway operation. This module may be used in any station in the CAMAC crate.

Latest dataway signals are latched in memory and displayed via the front panel. All displays are cleared with a front panel push button. The DD-001 does not generate any signals onto the dataway.

Signals on the following lines are displayed:

R1-R24
W1-W24
F16, F8, F4, F2, F1
A8, A4, A2, A1
N
B, I, Z, C, Q, X



Ref. Techcal Electronic Services

I/O REGISTERS, DISPLAYS

100MHz Scalers

Two new developments at Nuclear Enterprises add 100MHz scalers to the present range of equipment:
Scaler 003 — This well proved unit has been updated to give under optional input (3 nsec) a guaranteed count capability of 100MHz.

The scalers are controlled and their contents are read by dataway command. Front-panel switches permit the unit to be arranged as two 32-bit scalers, each with an overflow. All scalers and overflows can be reset by front panel control.
Scaler 9015 — This is a new unit designed as a general-purpose, fast scaler. It embodies four 16-bit binary 'ripple-through' scalers each with an overflow bit and capable of counting input events at rates of typically 100MHz. Events are accepted through front panel connectors under the control of individual inhibit inputs also accepted through the front panel. A front panel push-button enables all scalers and overflows to be reset. Overflow (Carry) outputs are available at the rear of the unit.

Ref. Nuclear Enterprises

Quad 100MHz Scaler

Model S.1 will meet all the requirements of the SLAC-Berkeley specifications for 100MHz scalers and, in addition, will offer some features which should prove useful. Basically the unit has four 24 bit scalers with counting speed in excess of 100MHz. The inputs are D.C. coupled, transient protected, and the input signals are reshaped for reliable operation. In addition to 'Carry' output signals, an overflow flip-flop is provided for each channel. These have the ability to be triggered from either bit 15 or bit 23 and to be read out as bit 16 or 24 onto the dataway as the overflow bit. The 'Carry' and 'Overflow' signals are also available as output signals. The 'Carry' can be either CAMAC levels or fast NIM levels. A better method of extracting these signals is by a rear mounted connector or connectors, rather than the patch pins and for this purpose units can be supplied with rear panels.

In addition to Functions F0, F9, and F25, Function F2 (read and clear) has been incorporated as a useful command. In accordance with the new specification a '1' will be generated on the X line in response to $N\cdot(F0+F2+F9+F25)\cdot(A0+A1+\cdot+A2+A3)$. The Q response will be normally for $N\cdot(F0+F2)\cdot(A0+A1+A2+A3)$ but F9 and F25 may optionally also generate a Q response to make this unit compatible with previous scalers.

An 'N' lamp and a Gate lamp are provided to indicate when the module is addressed and when the counting gates are open for signals exceeding threshold to be counted.

A manual reset button is provided that will reset all scalers. An optional electrical reset is available.

Ref. Joerger Enterprises

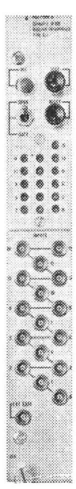
Universal Scaler, Presettable Up-Down Counter

Model S2 is intended to be a general purpose scaler. It has a capacity of 24 bits and a counting speed in excess of 25MHz. It will perform as a gateable 'Up-Down' counter with individual inputs for each, and it will also function as a presetable counter. In this mode, the preset number is loaded on command, the counter then counts up and when this number is reached an output signal is generated. At this time a LAM latch is also set. An output signal is provided whose width is equal to the time from the first pulse to when the preset number is reached, a pulse train output is also supplied with the number of pulses equalling the preset number.

The unit can be gated or reset either electrically or manually. Visual indicators are provided for module address and the state of the gate. A 'carry' output is also provided at the front panel. All signals are CAMAC levels. The function codes and unaddressed commands used are F0, 2, 8, 9, 10, 16, 24, 25, 26 and C.I.Z.

Ref. Joerger Enterprises

Pattern Unit (021)



This double-width module(021) contains a 16-bit register, which stores the pattern of input signals at the front panel input socket at the time of an external gate signal. The register may be read and cleared from the CAMAC Dataway and may also be cleared from the front panel. The register may be loaded with all '1's either by dataway command or by means of a front panel 'Test' push button. The manual controls are:

Gate/Open Switch. The position 'Gate' conditions the input by the 'Ext Gate' Signal. The position 'OPEN' is used on gated inputs.

Test Button. When pressed this injects artificially a '1' into all 16 inputs. The Gate/Open switch must be in position 'OPEN'.

Reset Button. This resets all sixteen memories of the 16 input channels.

The front panel signals are:
Inputs, 0-15, IL2 signals.
Ext. Gate, IL2 signal.
Maximum repetition rate 50 MHz at 50/50 duty cycle.
Minimum pulse on input to latch memory is 5 nS at $-12mA$ level.
The function Codes used are: F0, 2, 6, 9, 25. Only Subaddress '0' is used.

Ref. Nuclear Enterprises

Dual I/O Registers

The 9041 is a dual 24-bit input register that can be loaded from front panel connectors.

Data strobe and data received signals are provided for control purposes and an interrupt is generated each time the data register is loaded provided that that particular register has been enabled from the dataway.

The 9042 is a dual 24-bit output register capable of sinking 40mA at 30 V via front panel connectors. Other power requirements could be met if required.

The 072 is a dual 16-bit input register built to the specification of CERN NP CAMAC Note 33.00. It has been designed to meet the requirements of a versatile but inexpensive register. It accepts data either sampled or continuous through a multiway connector. A number of modes of operation are available.

Ref. Nuclear Enterprises

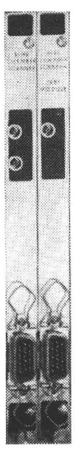
Wire Detecter Scanner + Scanner Test Module

The Scanning Module WCS-200 provides complete digital readout of wire spark-chambers of the 'Shift Register' capacity readout type, the magnetostrictive types, and the MWPC's which employ shift register data output.

Position information read into the scanner module is stored in its own 64 word by 16-bit buffer memory for later transfer through the CAMAC system. Up to 8192 resolution elements are scanned at frequencies up to 40 MHz, defined by an internal crystal oscillator. Data format for position information is 13 bits for position and 3 bits for spread. (Spread indicates the number of adjacent wires set; and in the case of magnetostrictive operation, it measures the position and width of the analogue input signal for improved spatial resolution.)

Two test modes are built into the scanner to facilitate automatic testing, as well as to measure the first and last wire of each wire detector under computer control. For complete checkout of the over 1000bits of memory in the scanning module, a CAMAC test module 'WCS-201' may be used as a memory exerciser and tester.

Cabling to the wire chamber detectors consists of one cable, thus making the use of the system straight forward.



The Scanner Test Module WCS-201 generates a double pulse, under computer control, to simulate spark chamber shift register data for testing of the WCS-200. The operating sequence is to first load the test module with a simulated spark chamber event; this requires four data transfers from the CAMAC computer to the test module. Once the test event is loaded, a normal scan sequence is initiated by a computer start command to either the test module or the wire chamber scanner. At the completion of the scan sequence the Scanner's output is compared to the test input.

With this arrangement one is able to thoroughly test the Scanner's address register, spread circuits, and memory. The memory tests are most important because with over 1000 bits of memory to be tested, manual tests are not possible.

Ref. Nano Systems

CRATES, SUPPLIES

Extra Rigid, Heavy Duty CAMAC Crates

A complete range of heavy duty crates has been developed to ensure continuous rigidity whether or not the crate is supported in a rack. The front (tapped) profiles are of solid brass extrusion and steel extruded sections are inlaid in the moulded runner guides to give added strength. To further enhance the rigidity, the side cheeks are of 6,3 mm Aluminium.

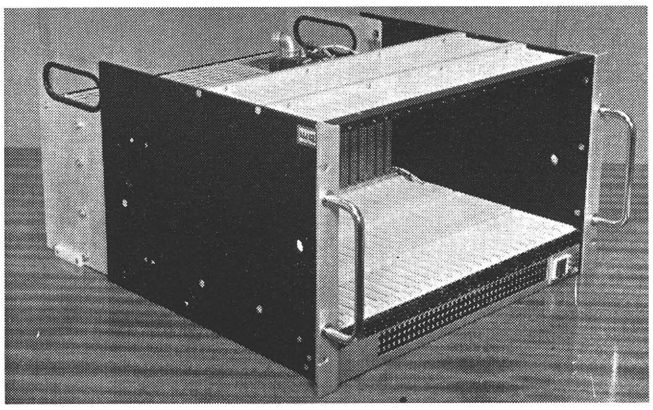
An important feature of the normal service crate has been maintained, i.e. the one piece extruded connector rail is located from, and attached to, the critical datum face of the lower runner guides. Interchangeability of Dataways between Willsher & Quick crates is therefore assured.

All crates have a 25-station capability and are available plain, or ventilated. The ventilation area can be 1U or 2U in height and an attractive grille can be supplied with adequate face area for mounting switches, indicators etc.

Three forms of side cheek are available:

(a) Standard 380 mm depth.
(b) 525 mm depth with side cheeks in two components, the rear 145 mm being detachable and suitable for enclosing power packs etc.
(c) 525 mm depth with one piece side cheeks.

All these crates will, of course, accept any module compatible with CAMAC Specs. EUR4100. The photograph shows a 6U heavy duty standard-depth crate with power supply.



Ref. Willsher & Quick Ltd.

Improved CAMAC Crate

The new series 100 CAMAC crate (N.S.I. 875 CC 100) is an improved version of the model N.S.I. 875DB/WV which has gained wide acceptance over the last few years. Now that CAMAC has become more accepted in the United States, it has been possible to improve the tooling involved and, thereby providing better alignment and fixturing than was possible before. Some new features of this crate include:

(1) Improved Guide Rails — These new rails allow units to be installed or removed much easier than was possible before and without losing grounding between the crate and unit rails.
(2) Starter Guides — This is an extension of the guide rails which brings each guide further forward to allow easier alignment and starting of a unit into a crate.
(3) Station Numbers — Station numbers have been added for convenience.
(4) Increased Extender Depth — This extra depth allows the user more room in which to do his patching and extra wiring when required and also insures proper mating with the new AEC typical CAMAC power supplies.
(5) New Connector Mounting Arrangement — This arrangement eliminates the provision for mounting the extra 36-pin edge-card connector which was previously supplied. The additional space provided allows the use of the 52-pin connectors now recommended by the AEC NIM-CAMAC Working Group.

Ref. Nuclear Specialties Inc.

Powered Crate

The Powered Crate (PCS) is a completely tested and assembled system consisting of a Power Supply and Blower Unit (1410S) and a crate (WCS). Both units are designed to the latest USAEC-CAMAC recommendations for typical equipment.

The Power Supply and Blower Section (2U high) includes design features such as narrow width and height behind front panel to facilitate use with side-mounted slides (10-32 nuts already attached to supply and blower section) or bottom support rails, all input and output options, modular construction, metering of all standard output voltages and currents, optional front-panel test points of all output voltages, high temperature warning lamp and 4 front-mounted fans with dust filter. The power supply output is limited to 300 watts at 50°C.

The crate (5U high) contains features such as special non-galling finish on guide rails, rear guide bar for easy unit PC board insertion into connecttors, multilayer printed circuit board for dataway capabilities with all 14 bus bars attached to power and spare lines, 6-32 and 4mm helicoil inserts, lowest insertion force connectors, bus bars on pins 1 & 3 per latest specification change and station numbers printed on front face of upper guide rack.

Specifications:

Input: 117 or 220V+10%−12%
47-53 or 57-63 Hz 3.3/6.6A
Ambient Temperature: 0 to 50°C
Outputs ±6V @ 25A Current Shared
±24V @ 6A Current Shared
Optional ±12V @ 3A Shared w/±24V
+200V @ 0.1A Unregulated
Weight: 33 kg

Ref. Standard Engineering Corporation

Crate Blower Unit

This 2U blower unit is for use with crates powered from sources other than a typical CAMAC supply. The front panel contains the AC power switch, metering switches and elements for standard voltages and currents, and thermal and power-on lamps.

The removable plug-in rear panel provides a mounting surface for current sense resistors, power cord, AC fuses and fuse holders, switched AC outlet and connector for attachment of metered voltages.

The unit is sectioned into quarters and provides four fans at 43 CFM free air into each section. Under the worst allowable conditions, the maximum temperature rise will not exceed 15°C above ambient.

Ref. Standard Enginering Corporation

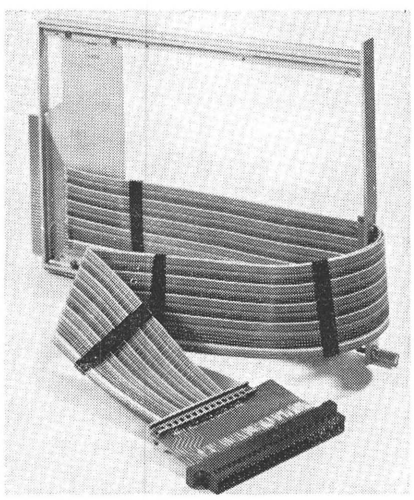
COMPONENTS

CAMAC Extender

The new CAMAC extender now available from TEKDATA Limited offers many advantages over the types presently offered. It is in use at various establishments already in the U.K. and is very competitively priced.

Some of the main features are:

(a) Heavy gauge wire is used for the power lines, avoiding excessive voltage drop.
(b) FibaTEK, flat flexible ribbon cable is used giving a very clean and neat appearance.
(c) The extender can have any length of cable to suit individual requirements, enabling units to be tested on work benches.
(d) Because of the construction, no weight is applied to the rack or connectors.
(e) Units can be single- or double-width.
(f) CAMAC metalwork and connectors are used.



Ref. Tekdata Ltd

New CAMAC Units

A new series of CAMAC units is now available from N.S.I. (875CM-100). These offer more complete protection and shielding than before. They consist of a front and rear panel, 2 insulated side panels. 2 extruded rails, spacers to establish module width, and hardware, including for the first time on N.S.I. units, a jacking screw for easy extraction of modules. The units may be purchased with the rear panel blank as standard or prepunched for the 52-pin double-density connector recommended by the AEC NIM-CAMAC Working Group.

Ref. Nuclear Specialties Inc.

CAMAC Printed Cards

Standard printed cards are now available with 5μ gold-plated edge-connector contacts and an overall length of $286^{+0,5}$ mm. The card has been developed by GFK Karlsruhe, Germany and is a useful tool for design studies, especially in laboratories.

Ref. Hans Knürr K.G.

Dataway Male Connector

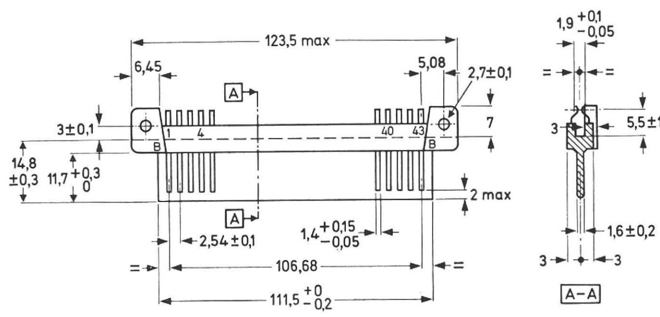
Philips supply the socket connectors:

— w.w.-version, ref. no. 2422 061 64334;
— dip-solder version, ref. no. 2422 061 64354;
— hand-solder version, ref. no. 2422 061 64314;

and now also offer the possibility of increasing the reliability of the equipment by the introduction of connector plugs mating the EUR 4100 (1972) connector sockets.

Brief reference data of this connector plug are:

Contact pitch	: 2,54 mm (0,1 in);
Number of connections	: 1 or 2 × 43;
Terminations	: solder tags;
Category	: 65/125/56;
Body material	: glass fibre filled polyester;
Mechanical endurance	: 500 insertions;
Contact finish	: 3,5 micron gold;
Type number, double-sided	: 2422 060 14314.



Ref. Philips Ned. N.V.

Index to Manufacturer's News and New Products

MEMBERSHIP OF THE ESONE COMMITTEE

This list shows the member organisations and their nominated representative on the ESONE Committee. Members of the Executive Group are indicated thus*.

International	European Organization for Nuclear Research (CERN)	*F. Iselin**	Geneva, Switzerland
	Centro Comune di Ricerca (Euratom)	*L. Stanchi*	Ispra, Italia
	ESONE Secretariat	*W. Becker**	
	Bureau Central de Mesures Nucléaires (Euratom)	*H. Meyer**	Geel, Belgique
	Institut Max von Laue - Paul Langevin	*A. Axmann*	Grenoble, France
Austria	Studiengesellschaft für Atomenergie	*R. Patzelt*	Wien
Belgium	Centre d'Etude de l'Energie Nucléaire	*L. Binard*	Mol
Denmark	Forsögsanläg Risö	*Per Skaarup*	Roskilde
England	Atomic Energy Research Establishment	*H. Bisby**	Harwell
	Culham Laboratory	*A.J. Vickers*	Abingdon
	Daresbury Nuclear Physics Laboratory	*B. Zacharov*	Warrington
	Rutherford High Energy Laboratory	*M.J. Cawthraw*	Chilton
France	Centre d'Etudes Nucléaires de Saclay	*P. Gallice**	Gif-sur-Yvette
	Centre d'Etudes Nucléaires de Grenoble	*J. Lecomte*	Grenoble
	Laboratoire de l'Accélérateur Linéaire	*Ph. Briandet*	Orsay
Germany	Deutsche Studiengruppe für Nukleare Elektronik c/o Physikalisches Institut der Universität	*B.A. Brandt*	Marburg
	Deutsches Elektronen-Synchrotron	*D. Schmidt*	Hamburg
	Hahn-Meitner-Institut für Kernforschung	*H. Klessmann*	Berlin
	Kernforschungsanlage Jülich	*K.D. Müller**	Jülich
	Gesellschaft für Kernforschung	*K. Tradowsky*	Karlsruhe
	Institut für Kernphysik der Universität	*W. Kessel*	Frankfurt/Main
Greece	Demokritus' Nuclear Research Centre	*Ch. Mantakas*	Athens
Hungary	Central Research Institute for Physics	*J. Biri*	Budapest
Italy	Comitato Nazionale Energia Nucleare (CNEN)	*B. Rispoli**	Roma
	CNEN Laboratori Nazionali	*M. Coli*	Frascati
	CNEN Centro Studi Nucleari	*F. Fioroni*	Casaccia
	Centro Studi Nucleari Enrico Fermi	*P.F. Manfredi*	Milano
	Centro Informazioni Studi Esperienze	*P.F. Manfredi*	Milano
	Istituto di Fisica dell'Università	*G. Giannelli*	Bari
Netherlands	Reactor Centrum Nederland	*P.C. van den Berg*	Petten
	Instituut voor Kernphysisch Onderzoek	*E. Kwakkel*	Amsterdam
Poland	Instytut Badan Jadrowych	*R. Trechcinski*	Swierk K/Otwocka
Sweden	Aktiebolaget Atomenergi Studsvik	*Per Gunnar Sjölin*	Nyköping
Switzerland	Schweizerische Koordinationstelle für die Zusammenarbeit auf dem Gebiet der Elektronik	*H.R. Pidber*	Basel
Yugoslavia	Boris Kidrič Institute of Nuclear Sciences	*M. Vojinovic*	Vinča Belgrade
Affiliated Laboratory			
Canada	TRIUMF Project, University of British Columbia	*W.K. Dawson*	Vancouver

LIAISON WITH THE USAEC NIM COMMITTEE IS MAINTAINED THROUGH:

L. Costrell (Chairman), National Bureau of Standards – Washington, DC.

F.A. Kirsten (NIM-CAMAC Dataway Working Group), Lawrence-Berkeley Laboratory – Berkeley, California.

S. Dhawan (NIM-CAMAC Software Working Group), Yale University – New Haven, Connecticut.

D.A. Mack (NIM-CAMAC Mechanics Working Group), Lawrence-Berkeley Laboratory – Berkeley, California.

D.I. Porat (NIM-CAMAC Analogue Signals Working Group), Stanford Linear Accelerator Center – Stanford, California.

PAPER ABSTRACTS TRANSLATIONS

A Decade with ESONE

W. Becker CCR Euratom, Ispra, Italy

Summary

The secretary of the ESONE Committee reviews a decade of increasing activity and membership, during which the Committee has formulated two modular systems; the ESONE standard for nuclear instrumentation and CAMAC for data handling.

Zusammenfassung

Der Sekretär des ESONE-Komitees gibt einen Überblick über zehn Jahre ESONE-Geschichte, in deren Verlauf die Zahl der Mitglieder und der Umfang der Tätigkeit des Komitees stetig zugenommen haben und zwei Modularsysteme von ihm entwickelt worden sind: das ESONE-System für nukleare Instrumentierung und das CAMAC-System für Datenverarbeitung.

Résumé

Le secrétaire du Comité ESONE fait le point des dix ans d'existence du Comité, période pendant laquelle son activité et le nombre des membres s'est accru sans cesse. Il a défini 2 systèmes modulaires : le standard ESONE pour l'instrumentation nucléaire et le système CAMAC pour le traitement des données.

Riassunto

Il Segretario del Comitato ESONE passa in rassegna un decennio di attività quale membro del Comitato, ha formulato due sistemi modulari: lo standard ESONE per la strumentazione nucleare e il CAMAC per il trattamento dei dati.

Samenvatting

De secretaris van het ESONE-Comité geeft een overzicht van de wijze waarop de activiteiten en het aantal leden in de afgelopen tien jaren zijn uitgebreid. In deze periode heeft het Comité twee modulesystemen ontwikkeld, nl. de ESONE-standaard voor kerninstrumentatie en het CAMAC-systeem voor informatieverwerking.

Use of the Q Response for controlling Block Transfers

M. Cawthraw H.E.P. Electronics Group
Rutherford High Energy Laboratory, Chilton, Berkshire, U.K.

Summary

The Response (Q) line in the CAMAC Dataway may be used to control block transfers. This paper describes the three types of block transfers named in EUR 4100e (1972) and makes recommendations concerning their implementation.

Zusammenfassung

Die Signale auf der Q-Leitung des Camac "Dataway" können für die Steuerung der Übertragung von Datenblöcken verwendet werden. Dieser Artikel beschreibt die 3 Arten einer Blockübertragung, welche in den EUR 4100e (1972) Spezifikationen angeführt sind, und gibt Empfehlungen für deren Adaptierung.

Résumé

La ligne de réponse Q de l'«Interconnexion» CAMAC peut être utilisée pour contrôler les transferts de bloc. Ce document décrit les trois types de transferts de bloc mentionnés dans le document EUR 4100e (1972) et formule des recommandations relatives à leur mise en œuvre.

Riassunto

La linea di risposta Q nell'Interconnessione del CAMAC può essere utilizzata per controllare trasferimenti in blocco. Il presente articolo descrive i tre tipi di trasferimenti di blocchi di dati indicati nella pubblicazione EUR 4100e (1972) e fornisce raccomandazioni concernenti il loro adempimento.

Samenvatting

De Q-responsielijn in de CAMAC Dataway kan worden gebruikt voor het regelen van bloktransporten. In dit rapport wordt een beschrijving gegeven van de drie types van bloktransport, die zijn aangegeven in document EUR 4100e (1972) en worden aanbevelingen geformuleerd betreffende hun verwezenlijking.

Acquisition de Mesure en CAMAC (Camac Data Logging)

J. Rion
Centre d'Études Nucléaires de Cadarache, France.

Summary

A set of modules has been developed to permit analogue data logging stations to be implemented in CAMAC. The principal characteristics of these modules are summarised.

Zusammenfassung

Ein Satz von Einschüben wurde entwickelt, welche die Verwirklichung von Messplätzen für analoge Eingangssignale im CAMAC System ermöglichen. Die wichtigsten Eigenschaften dieser Einschüben werden beschrieben.

Résumé

Un ensemble de modules a été développé pour permettre la réalisation en système CAMAC de centrales d'acquisitions de données analogiques; les principales caractéristiques en sont résumées dans le présent article.

Riassunto

E' stato sviluppato un gruppo di moduli per permettere la realizzazione di centrali di acquisizione di dati analogici in CAMAC. Le principali caratteristische dei moduli sono indicate nel presente articolo.

Samenvatting

Een serie CAMAC modules werd ontwikkeld voor het loggen van analoge signalen. De voornaamste karakteristieken van deze modules worden beschreven.

A CAMAC-based Data-Processing System: LABCOM

A.M. Deane*, C. Kenward and A. J. Tench***
Chemistry Division* and Materials Physics Division**
Atomic Energy Research Establishment, Harwell, U.K.

Summary

A laboratory-oriented computer system (LABCOM) is operating in a laboratory with a number of different working areas. The system accepts and displays data at CAMAC terminals remote from the computer. It operates in a timesharing mode which allows several data acquisition and processing tasks to be handled simultaneously.

Zusammenfassung

Ein für Laboratoriumszwecke angepasstes Rechnersystem (LABCOM) ist in einem Laboratorium mit verschiedenen Arbeitsbereichen in Verwendung. An vom Rechner entfernten CAMAC Endstellen werden vom System Daten akzeptiert und dargestellt. Der Betrieb erfolgt im "timesharing" Verfahren und erlaubt dadurch mehrere Datenerfassungs- und -verarbeitungsaufgaben gleichzeitig durchzuführen.

Résumé

Un système calculateur spécialisé (LABCOM) fonctionne dans un laboratoire comprenant plusieurs aires de travail différentes. Ce système reçoit et affiche des données sur des terminaux CAMAC éloignés de l'ordinateur. Il fonctionne en temps partagé, ce qui permet d'effectuer simultanément plusieurs opérations de saisie et de traitement de données.

Riassunto

Un sistema di trattamento dei dati per uso di laboratorio (LABCOM) è in funzione in un laboratorio con diverse aree di lavoro. Il sistema riceve e indica i dati nei terminali CAMAC situati a distanza dal calcolatore. Esso funziona in partizione di tempo, per cui è possibile effettuare contemporaneamente varie operazioni di acquisizione e di trattamento dei dati.

Samenvatting

Een voor laboratoriumgebruik ontwikkeld computersysteem (LABCOM) werkt in een laboratorium met verschillende afdelingen. Het systeem neemt gegevens op en maakt deze zichtbaar bij van de computer verwijderde CAMAC terminals. Het systeem werkt volgens het principe van de timesharing zodat verschillende taken inzake opname en verwerking van gegevens gelijktijdig kunnen worden uitgevoerd.

The HELIOS Search Coil Magnetometer and its Test Equipment using CAMAC

G. Schirenbeck
Institut für Nachrichtentechnik der Technischen Universität, Braunschweig, Germany.

Summary

The test equipment for the HELIOS search coil magnetometer experiment uses CAMAC, and is described as an example of computerised functional testing of a space experiment.

Zusammenfassung

Die Testeinrichtung für das HELIOS Induktionsspulenmagnetometer benutzt das CAMAC-System. Ihre Beschreibung soll als ein Beispiel für den Rechnergesteuerten Funktionstest eines Raumfahrtexperimentes dienen.

Résumé

L'équipement de test de l'expérience avec le magnétomètre à bobine de recherche HELIOS, utilisant CAMAC, est décrit comme un exemple de dispositif de test fonctionnel avec calculateur dans une expérience spatiale.

Riassunto

Le apparecchiature di collendo del magnetometro HELIOS a bobina mobile impiega no il CAMAC e sono descritte come un esempio di metodo di prova funzionale su calcolatore di un esperimento spaziale.

Samenvatting

Bij de testapparatuur van de magneetspoelmagnetometer wordt gebruik gemaakt van CAMAC. Dit experiment wordt beschreven als een voorbeeld van een test van de werking van een ruimte-experiment door middel van een computer.

CAMAC Activities in the Netherlands

P. C. van den Berg
Reactor Centrum Nederland, Petten (N-H) the Netherlands.

Summary

The article describes the CAMAC activities of six institutions in the Netherlands.

Zusammenfassung

Der Artikel beschreibt die Tätigkeiten von 6 holländischen Institutionen in Bezug auf die Anwendung von CAMAC Systemen.

Résumé

Cet article décrit les activités CAMAC de six instituts néerlandais.

Riassunto

L'articolo descrive le attività CAMAC di sei istituzioni dei Paesi Bassi.

Samenvatting

In het artikel wordt een beschrijving gegeven van de werkzaamheden met betrekking tot CAMAC die bij zes Nederlandse instellingen worden verricht.

Digital Modules for Physics Experiments and Measurements in the CAMAC System

V. A. Arefiev, M. P. Belyakova, A. G. Grachev, I. F. Kolpakov, A. P. Kryachko, N. M. Nikityuk, G. M. Susova, E. V. Tchernych, and L. A. Urmanova.
Laboratory of High Energies, Joint Institute for Nuclear Research, Dubna, U.S.S.R.

Summary

The Laboratory of High Energies has developed CAMAC units for measurement and control applications associated with physics experiments. The 16 types of units described include controllers for TPA 1001 and HP 2116B computers.

Zusammenfassung

Das Laboratorium für Hochenergiephysik hat für Mess- und Steuerungsanwendungen in Zusammenhang mit physikalischen Experimenten Camac Einschübe entwickelt. Die im Artikel beschriebenen 16 Einschubtypen beinhalten auch "Crate" Kontrolleinheiten für die Rechner TPA 1001 und HP 2116B.

Résumé

Le Laboratoire des Hautes Energies a mis au point des tiroirs CAMAC pour des applications de mesure et de contrôle qui interviennent dans les expériences de physique. Parmi les 16 types de tiroirs décrits ci-dessous, figurent des contrôleurs pour calculateurs TPA 1001 et HP 2116B.

Riassunto

Il Laboratorio di Alte Energie ha sviluppato unità CAMAC per misure e controlli in relazione ad esperimenti di fisica. I 16 tipi di unità descritte comprendono moduli di controllo per i calcolatori TPA 1001 e HP 2116B.

Samenvatting

Het Laboratorium voor Hoge Energieën heeft CAMAC-modules ontwikkeld voor metingen en besturingen in verband met fysische experimenten. De 16 typen waarvan een beschrijving wordt gegeven, omvatten besturingseenheden voor TPA 1001 en HP 2116B computers.

A Microprogrammed Branch Driver for a PDP-11 Computer

L. R. Biswell
Los Alamos Scientific Laboratory
University of California, Los Alamos, New Mexico, U.S.A.

Summary

A microprogrammed branch driver has been developed for data acquisition systems in experimental areas of the Los Alamos Meson Physics Facility (LAMPF). The unit couples a CAMAC branch to a PDP-11 computer through multiple direct-memory-access (DMA) channels.

Zusammenfassung

Ein auf die Anwendung von Microprogrammen basierende "Branch" Kontrolleinheit wurde für Datenerfassungssysteme zur Durchführung von Experimenten der Los Alamos Meson Physics Facility (LAMPF) entwickelt. Die Einheit verbindet den Camac "Branch" mit einem PDP-11 Rechner über mehrere Kanäle, welche direkten Speicherzugriff (DMA) erlauben.

Résumé

Une unité de commande de branche microprogrammée a été mise au point pour les systèmes d'acquisition de données dans les zones d'expérimentations de Los Alamos Meson Physics Facility (LAMPF). Cette unité relie une branche CAMAC à un calculateur PDP-11 par l'intermédiaire de canaux multiples d'accès direct à la mémoire (DMA).

Riassunto

E' stato sviluppato un «branch driver» microprogrammato per sistemi di acquisizione di dati nelle aree sperimentali dell'Impianto di Fisica dei Mesoni di Los Alamos (LAMPF). L'unità comprende un CAMAC branch collegata ad un calcolatore PDP-11 attraverso canali multipli di accesso diretto alla memoria (DMA).

Samenvatting

Een microgeprogrammeerde branch driver werd ontwikkeld voor data-opslagsystemen bij de experimenten van de Los Alamos Meson Physics Facility (LAMPF). Door deze eenheid wordt een CAMAC-branch gekoppeld aan een PDP-11 computer over meervoudige kanalen die met directe geheugentoegang (DMA) werken.

TRIUMF Control System Software

D. P. Gurd and W. K. Dawson
TRIUMF, University of Alberta
Edmonton, Alberta, Canada.

Summary

The control system for the TRIUMF cyclotron makes extensive use of CAMAC. The structure of the software for this control system is described. A similar structure has been used successfully for operating the full-scale "Center Region Model" cyclotron.

Zusammenfassung

Das Steuersystem des TRIUMF Zyklotrons wendet weitgehend die CAMAC-Spezifikationen. Der Aufbau der "Software" für dieses Steuersystem wird beschrieben. Eine ähnliche Struktur wurde mit Erfolg für den Betrieb des vollausgebauten Zyklotrons nach dem "Center Region Model" verwendet.

Résumé

Le système de contrôle de cyclotron de TRIUMPF, dont on décrit ici la structure des programmes, utilise largement CAMAC. Une structure semblable a été utilisée avec succès pour faire fonctionner le cyclotron de grande puissance «Center Region Model».

Riassunto

Il sistema di controllo del ciclotrone del TRIUMF a ampio uso del CAMAC. Si descrive la struttura del software per tale sistema di controllo. Una struttura analoga è stata utilizzata con successo nel funzionamento del ciclotrone a piene dimensioni "Center Region Model".

Samenvatting

Bij het regelsysteem van het TRIUMF cyclotron wordt uitgebreid gebruik gemaakt van CAMAC. Een beschrijving wordt gegeven van de opbouw van de software voor dit systeem. Een soortgelijke opbouw werd met succes gebruikt voor de besturing van het "Center Region Model" cyclotron.

PDP-8 Operating System for non-Time-critical CAMAC Experiments

K. Zwoll, E. Pofahl and H. Halling
Zentrallabor für Elektronik der KFA Jülich GmbH, Germany.

Summary

An operating system for non-time-critical applications has been developed for the PDP-8 computer. The system is based on the FOCAL (8k) interpretive language. It provides control of CAMAC, flexible programming, simple data handling, and program chaining.

Zusammenfassung

Ein Betriebssystem für Anwendungen bei welchen die Schnelligkeit des Ablaufs von Operationen unkritisch ist, wurde für den Rechner PDP-8 entwickelt. Das System basiert auf der interpretativen Sprache, FOCAL (8k). Es steuert CAMAC Systeme, ermöglicht einfache Programmierung, Datenverarbeitung und Programm-Kettung.

Résumé

Un système d'exploitation pour des applications non-critiques en temps a été mis au point pour l'ordinateur PDP-8. Ce système repose sur le langage interpréteur FOCAL (8k). Il permet le contrôle du système CAMAC, une programmation souple, le traitement simple des données et le chaînage des programmes.

Riassunto

E' stato sviluppato per il calcolatore PDP-8 un sistema operativo per applicazioni non critiche nel tempo. Il sistema è basato sul linguaggio interpretativo FOCAL (8k) e assicura il controllo del CAMAC, una programmazione flessibile, un semplice trattamento dei dati, e la concatenazione dei programmi.

Samenvatting

Een besturingssysteem voor niet-tijd-kritische toepassingen werd ontwikkeld voor de PDP-8 computer. Het systeem is gebaseerd op de FOCAL (8k) vertolktaal. Het voorziet in controle voor CAMAC, soepele programmering, eenvoudige verwerking van gegevens en programmakoppeling.

Camacro - An Aid to CAMAC Interface Programming

F. R. Golding*, A. C. Peatfield and K. Spurling****
*** Applied Computer Systems Limited, Manchester, U.K.**
**** Daresbury Nuclear Physics Laboratory, U.K.**

Summary

A translator incorporating macro commands to simplify the programming of peripherals interfaced through the CAMAC system is in regular use at the Daresbury Laboratory, where it was developed.

Zusammenfassung

In den Laboratorien von Daresbury wird regelmässig ein dort entwickelter Übersetzer verwendet, welcher Macrobefehle beinhaltet. Er vereinfacht das Programmieren von peripheren Geräten, die über das CAMAC System an Rechner angeschlossen sind.

Résumé

Un traducteur comprenant des macro-instructions pour simplifier la programmation des périphériques connectés au calculateur par le système CAMAC est utilisé couramment au Laboratoire de Daresbury, où il a été mis au point.

Riassunto

Un traduttore con macroistruzioni per semplificare la programmazione delle periferiche collegate attraverso il sistema CAMAC viene utilizzato regolarmente nel laboratorio di Daresbury, dove è stato realizzato.

Samenvatting

Een vertaler met macro-opdrachten ter vereenvoudiging van de programmering van de perifere apparatuur, die via het CAMAC systeem is verbonden, is regelmatig in gebruik bij het laboratorium te Daresbury, waar hij werd ontwikkeld.

CAMAC PRODUCT GUIDE

(products available up to September 5, 1972)

CAMAC Bulletin No. 5

CAMAC PRODUCT GUIDE

This guide consists of a list of CAMAC equipment which is believed to be offered for sale by manufacturers in Europe and the USA. The information has been taken from a CAMAC Product Reference compiled by CERN-NP-EL II from manufacturers' catalogues, advertisements and written communications available to them on 5th September 1972.

The number of items of commercially available CAMAC equipment is still increasing, the current list containing some 230 more items than in issue No. 4 of the Bulletin. Every effort has been made to ensure the completeness and accuracy of the list, and it is hoped that most products and manufacturers have been included. Inclusion in this list does not necessarily indicate that products are fully compatible with the CAMAC specifications nor that they are recommended or approved by the ESONE Committee. Similarly, omission from this list does not indicate disapproval by the ESONE Committee. Users are advised to obtain detailed information from the manufacturers or their agents in order to check the compatibility and operational characteristics of equipment.

Names of some manufacturers appearing in earlier lists have changed, the appropriate reference is given in the Index of Manufacturers at the end of this guide.

The general arrangement of the equipment list is based on a classification according to the main operational application of each item. This has the advantage that the main classes of unit (such as scalers, I/O registers and gates, crates, etc.) are grouped together. Some other units are difficult to classify using the available information, and readers are therefore advised to search under several categories.

Remarks on some columns in the Index of Products

Column

N/C – N is new, C is corrected entry.

WIDTH – NA indicates other format, normally 19 inch rack mounted chassis,
– 24 or 25 indicates number of stations available in a crate,
– Blank, the width has no meaning,
– 0 indicates unknown width.

NPR – Number in brackets is issue number of the Bulletin in which the item was or is described in the New Products section.

DELIV – Date on which item became or will become available.

CLASSIFICATION GROUPS

INDEX OF PRODUCTS

BRANCH HIGHWAY RELATED SYSTEM UNITS
(Computer Couplers, Crate Controllers, Terminations)

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	INTERFACE/SYSTEM CONTROLLER TO HP2100, 2114, 2115, 2116	2201	BORER	NA	/71	(4)
	INTERFACE/SYSTEM CONTROLLER TO DEC PDP9 (PROGR, SEQUENT AND BLOCK TRANSFERS)	2202	BORER	NA	/71	(4)
	INTERFACE/SYSTEM CONTROLLER TO DEC PDP15 (PROGR, SEQUENT AND BLOCK TRANSFERS)	2203	BORER	NA	/71	(4)
	INTERFACE FOR VARIAN 620I/L/F COMPUTER (PROGR, SEQUENT AND BLOCK TRANSFERS)	2204	BORER	NA	/72	
	PDP-11 CAMAC CONTROLLER (SEQUENTIAL READ/WRITE, 24 GRADED-L INTERRUPT DIRECTLY)	CA 11-A	D E C	NA	05/71	(2)
	PDP-15 CAMAC INTERFACE (18/24BIT, PROGR, SEQUENT ADDR AND BLOCK TRANSFER MODES)	CA 15 A	D E C	NA	05/71	(1)
	PDP-9 CAMAC INTERFACE (SOMEWHAT MODIFIED CA 15 A)	CA 15 A/PDP-9	D E C	NA	07/71	
	PDP-11 BRANCH DRIVER (EUR 4600 COMPATIBLE, PROGRAMMED AND SEQUENT ADDR MODES)	BD-011	EG+G	NA	/71	
	MULTICRATE INTERFACE SYSTEM COMPRISING		GEC-ELLIOTT		01/72	
C	EXECUTIVE CONTROLLER	MX-CTR-1		2		
C	BRANCH COUPLER	BR-CPR-1		2		
	AND THE FOLLOWING INTERFACES TO PDP-11					
C	PROGRAMMED TRANSF INTERFACE, CTR MODULE	PTI-11C		1		
	PROGRAMMED TRANSF INTERFACE, DATA MODULE	PTI-11D		1		
C	UNIBUS TERMINATION UNIT	TRM-11		1		
C	INTERRUPT VECTOR GENERATOR (SERVICES UP TO 4 BRANCHES AND SETS RE-ENTRY TRAP)	IVG-11		1		
	MULTICRATE INTERFACE SYSTEM COMPRISING		GEC-ELLIOTT		01/72	
C	EXECUTIVE CONTROLLER	MX-CTR-1		2	01/72	
C	BRANCH COUPLER	BR-CPR-1		2	01/72	
	AND THE FOLLOWING INTERFACES FOR					
N	PROGRAMMED TRANSF INTERFACE, CTR MODULE	PTI-NC		1	07/72	
N	PROGRAMMED TRANSF INTERFACE, DATA MODULE	PTI-ND		1	07/72	
N	I/O BUS TERMINATION MODULE	TRM-N		1	07/72	
N	INTERRUPT VECTOR GENERATOR (SERVICES UP TO 4 BRANCHES AND SETS RE-ENTRY TRAP)	IVG-N		1	07/72	
	DISPLAY DRIVER (CONTROLS 72A DISPLAY, ALSO CRATE CTR AND BRANCH DRIVER)	72A	JORWAY	3	07/71	
	PDP-11 BRANCH DRIVER	KS 0011	KINETIC SYSTEMS	NA	/71	(4)
N	BRANCH DRIVER (24BIT, PROGR, SEQUENT AND BLOCK TRANSFER MODES, MAX 7 CRATES)	5400	LABEN	4		
N	H316/DDP516 CAMAC BRANCH HIGHWAY DRIVER (MEETS EUR 4600 SPECS)		MICRO CONSULTANTS	NA		
	PDP 11 INTERFACE AND BRANCH DRIVER SYSTEM		NUCL. ENTERPRISES	0		
N	BRANCH INTERFACE	9031	NUCL. ENTERPRISES	2	11/72	
N	PDP 11 INTERFACE CARD (USED IN CONJUNCTION WITH 9032)		NUCL. ENTERPRISES	1	10/72	
	INTERFACE CAMAC-PDP 11 (PROGRAMMED, BLOCK TRANSFER AND SEQUENTIAL ADDR MODES)	ICP 11/CP 11 A	SAIP-CRC	NA	/71	(4)
	NOVA COMPUTER TO CAMAC MASTER BRANCH HIGHWAY DRIVER (ONE TO THREE BRANCHES)	MC-2010	TECHCAL	4	11/71	
	SLAVE BRANCH HIGHWAY DRIVER	MC-2016		2	11/71	
N	MICROPROGRAMMED BRANCH DRIVER FOR PDP-11	MBD-11	TMA ELECTRONICS	NA		(5)
N	NOVA BRANCH DRIVER		TMA ELECTRONICS	NA		(5)
C	CRATE CONTROLLER /ESONE TYPE A1/ (CONFORMS TO EUR4600 SPECS)	1501	BORER	2	01/71	
	ESONE TYPE A CRATE CONTROLLER (CONFORMS TO EUR 4600 SPECS)	CC 2404-1	GEC-ELLIOTT	2	01/71	
N	CRATE CONTROLLER TYPE A-1 (CONFORMS TO EUR4600 SPECS)	CCA-1	JOERGER	2	06/72	(5)
	BRANCH CRATE CONTROLLER/TYPE A (CONFORMS TO EUR 4600 SPECS)	70	JORWAY	2	01/71	
	CRATE CONTROLLER	3901	KINETIC SYSTEMS	2	/72	

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	CRATE A CONTROLLER (CONFORMS TO EUR 4600 SPECS)	9016	NUCL. ENTERPRISES	2		(4)
	CRATE CONTROLLER TYPE A (CONFORMS TO EUR4600 SPECS)	C 106	RDT	2	06/71	
	CONTROLEUR DE CHASSIS TYPE A (CONFORMS TO EUR4600 SPECS)	J CRC 50	SAIP-CRC	2	02/71	(1)
	A CRATE CONTROLLER (CONFORMS TO EUR4600 SPECS)	ACC 2034	SEN	2	06/71	
	CRATE CONTROLLER A (CONFORMS TO EUR 4600 SPECS)	C72451-A1446-B1	SIEMENS	2	10/70	(1)
N	TYPE A-1 (ESONE) CRATE CONTROLLER	CC-A1	TECHCAL	2	02/72	
C	CAMAC CRATE CONTROLLER TYPE A-1 (CONFORMS TO EUR4600 SPECIFICATIONS)	CC101	EG+G	2	07/72	
	TERMINATION UNIT	1591	BORER	2	/71	
	TERMINATOR MODULE (BRANCH HIGHWAY TERMINATOR)	TC024	EG+G	2	/71	
	BRANCH HIGHWAY TERMINATION MODULE(MOUNTS DIRECTLY ON BRANCH HIGHWAY ASSEMBLY)	CD 18107	EMIHUS	NA	/72	
	BRANCH TERMINATION UNIT	BT 6601	GEC-ELLIOTT	2	01/71	
N	BRANCH TERMINATION UNIT (LED DISPLAY WITH MEMORY)	BT 6502	GEC-ELLIOTT	2	04/72	
N	BRANCH TERMINATION UNIT (NON INDICATING)	BT 6503	GEC-ELLIOTT	2	04/72	
N	DIFFERENTIAL BRANCH EXTENDER (TO CA 3KM)	DBE 6501	GEC-ELLIOTT	2	/71	
N	VISUAL BRANCH TERMINATOR	VBT	JOERGER	2	06/72	
N	BRANCH TERMINATOR	BT	JOERGER	2	06/72	
	BRANCH TERMINATION	50	JORWAY	2	01/71	
	TERMINAISON DE BRANCHE CAMAC	J BT 20	SAIP-CRC	2	11/71	
	BRANCH HIGHWAY TRANSCEIVER FOR LONG DISTANCE TRANSMISSION	J BHT 10	SAIP-CRC	2		(4)
C	CRATE CONTROLLER BUS TERMINATOR FOR *A* CRATE CONTROLLER ACC 2034	BT 2042	SEN	2	04/72	
	BRANCH TERMINATION UNIT	C 72451-A 1454-A1	SIEMENS	NA		(3)
N	BRANCH HIGHWAY TERMINATOR	BT-001	TECHCAL	1	02/72	

DATAWAY RELATED SYSTEM UNITS
(Computer Couplers, Controllers)

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
N	SINGLE CRATE CONTROLLER TO HP (CERN TYPE 066)	1531	BORER	2	08/72	
	CRATE CONTROLLER/PDP11 UNIBUS INTERFACE	1533	BORER	2	05/72	(4)
N	UNIBUS EXTENDER, TRANSMITTER	1594	BORER	2	07/72	
N	RECEIVER (FOR DISTANCES UP TO 200 METRE OR MORE)	1595		2	07/72	
N	SINGLE-CRATE PDP-11 INTERFACE COMPRISING		GEC-ELLIOTT		01/72	
	EXECUTIVE CONTROLLER	MX-CTR-1		2		
	PROGRAMMED TRANSF INTERFACE, CTR MODULE	PTI-11C		1		
	PROGRAMMED TRANSF INTERFACE, DATA MODULE	PTI-11D		1		
	UNIBUS TERMINATION UNIT	TRM-11		1		
	INTERRUPT VECTOR GENERATOR	IVG-11		1		
N	SINGLE-CRATE NOVA/SUPERNOVA INTERFACE COMPRISING		GEC-ELLIOTT		07/72	
	EXECUTIVE CONTROLLER	MX-CTR-1		2	01/72	
	PROGRAMMED TRANSF INTERFACE, CTR MODULE	PTI-NC		1	07/72	
	PROGRAMMED TRANSF INTERFACE, DATA MODULE	PTI-ND		1	07/72	
	I/O BUS TERMINATION MODULE	TRM-N		1	07/72	
	INTERRUPT VECTOR GENERATOR	IVG-N		1	07/72	
N	VARIAN-CAMAC INTERFACE CRATE CONTROLLER (16BIT SEQUENT+BLOCK TRANSF, 1 CC/CRATE)		INFORMATEK	2		
	CONTROLEUR DE CHASSIS MULTI 8-CAMAC (24BIT,PROGR,SIMULT I/O,INTERRUPT MODES)	JCM 8	INTERTECHNIQUE	3	09/71	
N	UNIBUS CRATE CONTROLLER PDP-11	3911	KINETIC SYSTEMS	2	/72	
N	CRATE CONTROLLER 320	C 72451-A6	SIEMENS	3	/72	
C	CRATE CONTROLLER TYPE D (CONFORMS TO EUR 4100, USED WITH DO 280 COMPUTER SYSTEM)	DO 200-2901	DORNIER	2	11/71	
	CRATE CONTROLLER FOR NOVA COMPUTER	CC 2023A/B	SEN	2	/70	
	CRATE CONTROLLER BUS TERMINATOR FOR CC 2023A/B (ONE PER SYSTEM)	BT 2022		0	11/71	

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	DATAWAY CONTROLLER DDP-516(PART OF 7000-SER SYSTEM WITH EXT CONTROL HIGHWAY)	7022-1	NUCL. ENTERPRISES	4	/70	
	DATAWAY CONTROLLER PDP-8 (PART OF 7000-SER SYSTEM WITH EXT CONTROL HIGHWAY)	7048-2	NUCL. ENTERPRISES	2	/70	
	AUXILIARY CONTROLLER	7047-1		1	/70	
N	16-BIT CONTROLLER	9030	NUCL. ENTERPRISES	3	10/72	
	COMPUTER INTERFACE		INTERDATA	0	07/71	
	OTHER SYSTEM UNITS					
	START-STOP CONTROLLER(START,STOP AND RESET OUTPUTS,MANUAL OR DATAWAY CONTROL)	FHC 1304A	BF VERTRIEB	1	01/71	(1)
N	SYSTEM 3000 CONTROLLER (FOR DISTRIBUTED INTERFACE SYSTEM, SERIAL MODE)	1551	BORER	2	09/72	
N	SYSTEM 3000 CONTROLLER (FOR DISTRIBUTED INTERFACE SYSTEM, PARALLEL MODE)	1552	BORER	2	09/72	
	COMMANDE *ARRET-MARCHE* (START-STOP UNIT ,START,STOP,CLOCK, AND GATE OUTPUTS)	J AM 10	SAIP-CRC	1	01/71	
	FOUR FOLD BUSY DONE (START SIGNAL INITIATED BY COMMAND,DEVICE RETURNS LAM)	4BD 2021	SEN	1	02/71	
	PROGRAMMED DATAWAY CONTROLLER (PART OF 7000-SER SYSTEM WITH EXT CONTR HIGHWAY)	7025-2	NUCL. ENTERPRISES	2	/70	
	SEQUENTIAL COMMAND GENERATOR	7037-1		2	/70	
	COMMAND GENERATOR	7062-1		2	/71	
	TRANSFER REGISTER	7063-1		1	/70	
	PROGRAM CONTROL UNIT	0362-2		NA	/70	
	PLUGBOARD STORE	0361-2		NA	/70	
	WIRED STORE	7044-1		1	/70	
	STORE INTERFACE	7067-1		0	/71	(2)
	PLUGBOARD STORE	7077-1		3	/71	
	(MULTICRATE SYSTEM WITH EXTERNAL CONTROL HIGHWAY,COMPRISING)	7000-SERIES	NUCL. ENTERPRISES		/70	
	LOCAL INTERCRATE INTERFACE	7033-1		2		
	LOCAL SLAVE DATAWAY CONTROLLER	7034-1		2		
	REMOTE INTERCRATE INTERFACE	7035-1		2		
	REMOTE SUB-MASTER DATAWAY CONTROLLER	7036-1		2		
	DIGITAL CONTROL MODULE(BIDIRECTIONAL CON TROL VIA R/W-LINES OF FOUR 4BIT DEVICES)	TC-0440	TECHCAL	2	11/71	
	DIGITAL CONTROL MODULE(BIDIRECTIONAL CON TROL VIA R/W-LINES OF FOUR 8BIT DEVICES)	TC-0840	TECHCAL	2	11/71	
N	LAM GRADER (24 BIT MASK REGISTER, PLUG-IN PATCH BOARD)	LG 2401	GEC-ELLIOTT	1	01/72	
C	LAM GRADER (DESIGNED TO EUR 4600 SPECS)	064	NUCL. ENTERPRISES	1	/72	(4)
	LAM GRADER (CERN SPECS 064)	C 107	RDT	1	06/71	
N	LAM GRADER (CERN SPECS 064)	LG 2001	SEN	1	/72	
	MANUAL CONTROLLERS AND TEST EQUIPMENT					
N	MANUAL CRATE CONTROLLER	MCC	JOERGER	5	07/72	
N	MANUAL BRANCH DRIVER	MBD	JOERGER	5	07/72	
	MANUAL DATAWAY CONTROLLER	7024-1	NUCL. ENTERPRISES	8	/70	
	CONTROLEUR MANUEL DE CHASSIS (MANUAL TEST MODULE)	J CMC 10	SAIP-CRC	8	06/71	(1)
	DISPOSITIF DE CONTROLE MANUEL DE DATAWAY (MANUAL CONTROLLER/DISPLAY SYSTEM)	D AI 10	SAIP-CRC	1	11/71	
	TIROIR DE PRISE D'INFORMATION (INTERFACE TO DATAWAY)	J DA 10		1	11/71	
	CHASSIS DE CONTROLE ET AFFICHAGE (CONTROL AND DISPLAY CHASSIS)	C AI 10		NA	11/71	
	CHASSIS DE CONTROL MANUEL DE BRANCHE (COMPR TYPES CC0810/TCM810/TIC10/TIC20)	C CMB 10	SAIP-CRC	NA	09/71	(1)
N	MANUAL 24 BIT CRATE CONTROLLER	MCC-240	TECHCAL	2	02/72	(5)
N	PDP-11 SIMULATOR		TMA ELECTRONICS	NA		(5)
N	ADDRESS SCANNER (MANUAL CONTROL OF CRATE OPERATIONS)	C-AS-20	WENZEL ELEKTRONIK	2		
	CAMAC DATAWAY DISPLAY (DATAWAY SIGNAL PATTERN STORED/DISPLAYED,2 TEST MODES)	1801	BORER	1	/71	(1)
N	DATAWAY TEST MODULE (TESTS DATAWAY FOR OPEN LINES AND SHORTS)	DT086	EG+G	3	12/72	

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
C	TEST MODULE (USED IN SYSTEM TEST OF READ/WRITE CAPABILITY)	TM024	EG+G	2	/71	
	MANUAL CRATE CONTROLLER	GFK-LEM	EISENMANN	8	11/71	
	BRANCH HIGHWAY TEST POINT MODULE(24 DIRECT,22 INDIRECT ACCESS POINTS FOR TEST)	CD 18104	EMIHUS	NA	10/71	(3)
	BRANCH HIGHWAY REMOVE INHIBIT MODULE (REMOVES INHIBIT FROM BCR/BA/BF/BN/BTA)	CD 18105	EMIHUS	NA	10/71	(3)
	DATAWAY TEST MODULE (NEON INDICATION OF STATE OF ALL DATAWAY LOGIC LINES)	DTM 1	GEC-ELLIOTT	2	01/71	
N	DATAWAY TEST MODULE (WITH LED DISPLAY AND MEMORY)	DTM 3	GEC-ELLIOTT	1	06/71	
N	SYSTEM TEST UNIT (TESTS SINGLE AND MULTICRATE SYSTEMS)	SC-TST-1	GEC-ELLIOTT	3	04/72	
C	DYNAMIC TEST CONTROLLER (GENERATES ALL POSSIBLE CAMAC COMMANDS IN SINGLE CRATE)	TC 2403	GEC-ELLIOTT	4	01/71	
N	DATAWAY DISPLAY (TESTING AND MONITORING)	DD	JOERGER	1	07/72	
	DATAWAY DISPLAY (INDICATES LOGIC STATE OF DATAWAY LINES)	9019	NUCL. ENTERPRISES	NA	/71	(1)
	DATAWAY BUFFER (OUTPUTS TO 9019 DATAWAY SIGNALS ACCESSIBLE IN NORMAL STATION)	9018		1	/71	(1)
C	DYNAMIC TEST CONTROLLER (2 SIMULT TRANSF SINGLE,STEP-BY-STEP AND CONTINUOUS MODE)	C 108	RDT	8	06/71	(4)
C	TEST MODULE FOR CRATE CONTROLLER CC 2023A/B	DTM 2040	SEN	1	04/72	
N	DATAWAY DISPLAY MODULE	DD-001	TECHCAL	1	01/72	(5)
	DATAWAY DISPLAY	3290	KINETIC SYSTEMS	1	/72	

SERIAL INPUT MODULES (Scalers)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	COUNTING REGISTER (1X24BIT,15MHZ,TTL/NIM SIGNALS,EXT INHIBIT IN,CARRY OUT)	7070-1	NUCL. ENTERPRISES	1	/70	
	ECHELLE BINAIRE 24 BITS(SCALER,20MHZ NIM OR 10MHZ TTL I/P,EXT INHIBIT IN,OVF O/P)	J EB 10	SAIP-CRC	1	01/71	
	MINISCALER (2X16BIT,30MHZ,SEPARATE GATES AND EXTERNAL RESET,NIM LEVELS)	002	NUCL. ENTERPRISES	1		
N	DUAL 24-BIT COUNTING REGISTER	C-DS-24	WENZEL ELEKTRONIK	1		
	MINISCALER (2X16BIT,30MHZ,SEPARATE GATES AND EXTERNAL RESET,NIM LEVELS)	1002	BORER	1	11/69	
	MINISCALER(2X16BIT,30MHZ,SEPARATE GATES AND EXT RESET,NIM LEVELS)	C 104	RDT	1	06/71	
	DUAL 150 MHZ 16 BIT SCALER (ONE 50 OHMS, ONE UNTERMINATED NIM INPUT PER SCALER)	2S 2024/16	SEN	1	/70	
	DUAL 100MHZ SCALER (2X24 BIN BITS OR 2X6 BCD DIGITS,DISCR LEVEL -0.5V)	80A	JORWAY	1	10/70	(1)
	DUAL 150 MHZ 24 BIT SCALER (ONE 50 OHMS, ONE UNTERMINATED NIM INPUT PER SCALER)	2S 2024/24	SEN	1	/70	
	TIME DIGITIZER(5X16BIT,CLOCK RATE 40MHZ, WITH CENTER FINDING LOGIC)	TD 2031	SEN	1	02/72	
	TIME DIGITIZER (4X16BIT,CLOCK RATE 70/85MHZ,NIM LEVELS)	TD 2041	SEN	1	02/72	(4)
	MICROSCALER (4X16BIT,2X32BIT SELECTABLE, 25MHZ,COMMON GATE,NIM LEVELS)	1003	BORER	1	05/69	
	QUAD CAMAC SCALER (4X16BIT OR 2X32BIT, 40MHZ)	1004	BORER	1	03/72	
C	QUAD SCALER (4X16BIT,SELECTABLE 2X32BIT, 50MHZ,COMMON GATE,NIM LEVELS, CERN 003)	S416	EG+G	1	/71	
	QUAD 16-BIT SPARK READ-OUT REGISTER (20MHZ RATE,TTL LEVELS)	SR 1604	GEC-ELLIOTT	1	01/71	
	SERIAL REGISTER (4X16BIT,2X32BIT SELECTABLE,25MHZ,COMMON GATE,NIM LEVELS)	SR 1605	GEC-ELLIOTT	1	01/71	
	QUAD 40 MHZ SCALER (4X16BIT,2X32BIT SELECTABLE,COMMON GATE,NIM LEVELS)	SR 1606	GEC-ELLIOTT	1	01/71	
	SERIAL REGISTER (4X16BIT,2X32BIT SELECTABLE,100MHZ,COMMON GATE,NIM LEVELS)	SR 1608	GEC-ELLIOTT	1	/71	
N	QUAD 100 MHZ SCALER (4X24BIT, WITH CARRY AND 16TH/24TH BIT OVF OUT, NIM SIGNALS)	S1	JOERGER	1	06/72	(5)

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	MICROSCALER (4X16 BIT,25MHZ,OPTIMIZED INPUT,3 NSEC,GIVES TYP 80MHZ COUNTING)	003-4	NUCL. ENTERPRISES	1	/71	(5)
	QUAD SCALER	9015	NUCL. ENTERPRISES	C	/71	(5)
	MICROSCALER(4X16BIT,2X32BIT SELECTABLE, 25MHZ,COMMON GATE,NIM LEVELS)	C 102	RDT	1	06/71	
	ECHELLE BINAIRE 4 X 16 BITS(SCALER,30MHZ 2X32BIT SELECTABLE,COMMON GATE,NIM/TTL)	J EB 20	SAIP-CRC	1	01/71	
	FOUR-FOLD SCALER (4X16BIT,2X32BIT SELECTABLE,50MHZ,COMMON GATE,NIM LEVELS)	4 S 2003/50	SEN	1	/69	
	FOUR-FOLD SCALER(4X16BIT,2X32BIT SELECT-ABLE,100MHZ,COMMON GATE,NIM LEVELS)	4 S 2003/100	SEN	1	/70	
	FOUR-FOLD CAMAC SCALER (4X16BIT,40MHZ, INPUTS A AND B-NIM RESP TTL-ARE ANDED)	4 S 2004	SEN	1	/70	
	QUAD 25 MHZ SCALER (4X16BIT,2X32BIT SELECTABLE,COMMON GATE,NIM LEVELS)	QS-003/25	TECHCAL	1	11/71	
C	QUAD 70 MHZ SCALER (4X16BIT,2X32BIT SELECTABLE,COMMON GATE,NIM LEVELS)	QS-003/70	TECHCAL	1	11/71	
	QUAD 100 MHZ SCALER (4X16BIT,2X32BIT SELECTABLE,COMMON GATE,NIM LEVELS)	QS-003/100	TECHCAL	1	11/71	
	CAMAC SCALER(4X16BIT,2X32BIT SELECTABLE, 30MHZ,COMMON GATE,LAM MASK,TTL AND NIM)	C-Z4-16	WENZEL ELEKTRONIK	1	11/71	
C	QUAD SCALER (4X24BIT,150/125MHZ,DATAWAY AND/OR EXT FAST INHIBIT,NIM LEVELS)	S424B	EG+G	1	/71	
	QUAD 100MHZ SCALER (4X24BIT,DISCR LEVEL -0.5V,TIME-INTERVAL APPL.NIM INHIB I/P)	84	JORWAY	1	03/71	(2)
	QUAD 100 MHZ SCALER(4X16/24BIT,-0.5V I/P THRESHOLD,COMMON EXT FAST INHIBIT,NIM)	2550B	LRS-LECROY	1	08/70	
	QUAD COUNTING REGISTER(4X24BIT,NIM INPUT TTL INHIBIT IN,TTL CARRY AND OVF OUT)	709-2	NUCL. ENTERPRISES	1	/71	
	DUAL COUNTING REGISTER (2X4 DECADES, SEPARATE EXT INHIBIT AND RESET,OVF OUT)	700-1	NUCL. ENTERPRISES	1	/71	
	DUAL COUNTING REGISTER (2X3 DECADES, SEPARATE EXT INHIBIT AND RESET,OVF OUT)	7040-1	NUCL. ENTERPRISES	1	/70	
	DOUBLE ECHELLE 6 DECADES-100 MHZ A AFFICHAGE REPORTE(SCALER WITH REG O/P)	J EA 10	SAIP-CRC	1	11/71	
	QUAD SIX-DECADE COUNTER WITH VARIABLE THRESHOLD AND INPUT FILTER, SLOW)	1007	BORER	1	/72	(4)
	QUAD BCD SCALER (4X6 DECADES,30MHZ)	9021	NUCL. ENTERPRISES	0	/71	
	OCTAL SCALER (12BITS,8 INPUTS,50MHZ,EACH SCALER GIVES EXT INHIBIT,NIM LEVELS)	S812	EG+G	1	/71	
	DUAL COORDINATE RECORDER	XYRCDR/042	SAIP-CRC	1	10/70	
	DUAL INCREMENTAL POSITION ENCODER (2X20 BIT X-Y DIGITIZATION BY UP-DOWN COUNTER)	2IPE 2019	SEN	1	04/71	

PRESET COUNTING MODULES (Scalers, Timers)

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	24BIT BCD PRESET-SCALER/TIMER (10MHZ,NIM OR TTL INPUTS,MANUAL OR DATAWAY PRESET)	FHC 1301A	BF VERTRIEB	2	01/71	(1)
	24BIT BCD PRESET-SCALER/TIMER (10MHZ,NIM OR TTL INPUTS,DATAWAY PRESET)	FHC 1302A	BF VERTRIEB	1	01/71	(1)
	PRESET COUNTING REGISTER (16BIT,10MHZ, NIM/TTL I/P,TTL INHIB + O/P,DATAWAY SET)	7039-1	NUCL. ENTERPRISES	1	/70	
C	SCALER 50 MHZ (12/16/18/24BIT,PRESET WITH OVF LINE,CONSTANT DEADTIME)	C 72451-A1330-A2	SIEMENS	1	01/72	
C	SCALER 300 MHZ (12/16/18/24BIT,PRESET WITH OVF LINE,CONSTANT DEADTIME)	C 72451-A1448-A2	SIEMENS	1	01/72	
N	PRESETTABLE SCALER (24BIT)	C-PS-24	WENZEL ELEKTRONIK	1		
	PRESET SCALER(24BIT,30MHZ,DATAWAY PRESET COUNT/TIME,INPUT GATED,NIM LEVELS)	1001	BORER	1	06/71	(1)
	PRESET COUNTING REGISTER (24BIT,10MHZ, DATAWAY SET,NIM/TTL INPUT,TTL O/P+INHIB)	703-1	NUCL. ENTERPRISES	1	/71	
	REAL TIME CLOCK (NEEDS EXT CLOCK,MAX 100 DAYS PERIOD WITH 1HZ PULSES IN,TTL I/O)	712	NUCL. ENTERPRISES	1	/71	
	CAMAC PRESET-SCALER(24BIT,30MHZ,NIM SIGNAL AND GATE,EXT INHIBIT,MAN RESET)	C-ZE-24 K	WENZEL ELEKTRONIK	1	11/71	

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
N	PRESET SCALER (20MHZ,8DECADE BCD,7 SEGM LED INDICATES CONTENTS AND PRESET NO)	PSR 0801	GEC-ELLIOTT	1	08/72	
N	UP/DOWN PRESETTABLE COUNTER(24BIT,25MHZ, GATED,SEPARATE UP/DOWN COUNT INPUTS)	S2	JOERGER	1	07/72	(5)
	PRESET SCALER(10MHZ,8 DECADE BCD,DISPLAY OF 2 SIGNIF NUMBERS+EXP,MAN PRESET,NIM)	C 103	RDT	3	06/71	
	ECHELLE 6 DECADES A PRESELECTION(SCALER, MAN/DATAWAY PRESET,1MHZ,START/STOP O/P)	J EP 20	SAIP-CRC	2	01/71	

PARALLEL INPUT REGISTERS

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	PARALLEL-INPUT-REGISTER (SINGLE 16/24BIT OPTION,READY SIGNALS,I/O TTL,ADC APPL)	MS PI 1 1230/1	AEG-TELEFUNKEN	1	10/70	(1)
	PARALLEL-INPUT-REGISTER (SINGLE 16/24BIT OPT,READY SIGNALS,I/O TTL,CONTROL BUS)	MS PI 2 1230/1	AEG-TELEFUNKEN	1	10/70	(1)
	PARALLEL REGISTER (SINGLE 16BIT INDICAT, 50NS OVERLAP REQUIRED,TTL LEVELS)	PR 1601-1	GEC-ELLIOTT	1	06/71	
	PRIORITY INPUT REGISTER(12BITS CRED TO LAM,FAST COINC LATCH APPL,NIM LEVELS)	63	JORWAY	2	10/70	
	INPUT REGISTER 24-BIT	3470	KINETIC SYSTEMS	1	/71	(4)
N	PRIORITY INTERRUPT REGISTER 16 BIT	3475	KINETIC SYSTEMS	1		
	INTERRUPT REQUEST REGISTER	EC 218	NUCL. ENTERPRISES	0		
	INTERRUPT REQUEST REGISTER (8BIT, TTL INPUTS TO REGISTER,ANY INPUT GIVES LAM.	7013-1	NUCL. ENTERPRISES	1	/70	
	PARALLEL INPUT REGISTER (16BIT,CONTINU- OUS OR STROBED MODES CONTROLLED BY REG)	7014-1	NUCL. ENTERPRISES	1	/70	
	STROBED INPUT REGISTER (12BIT CCINC AND LATCH,NIM LEVELS,PATTERN AND L-REQ APPL)	SIR 2026	SEN	1	/70	
N	DIGITAL INPUT 16 BIT POT. FREE	C 76451-A8	SIEMENS	0		
N	SINGLE 16 BIT PARALLEL INPUT REGISTER	PR-601	TECHCAL	1	01/72	
N	SINGLE 24 BIT PARALLEL INPUT REGISTER (BOTH WITH LED DISPLAY OPTION)	PR-603		1	01/72	
	INPUT REGISTER (24BIT,NON-ZERO CONTENT SETS LAM,REGISTER E/D FROM DATAWAY)	FHC 1308A	BF VERTRIEB	1	11/71	
	UNIVERSAL INPUT/OUTPUT REGISTER (36BIT DATA+RANGE IN,12BIT REG O/P FOR CONTROL)	1031	BORER	1	05/72	(3)
C	24-BIT INTERRUPT REGISTER (STATUS COMPARED,CHANGE GIVES LAM)	1051	BORER	1	05/72	(3)
	PARALLEL REGISTER (DUAL 16BIT INDICAT, 6NS OVERLAP REQUIRED,NIM LEVELS)	PR 1602	GEC-ELLIOTT	2	01/71	
	DUAL PARALLEL REGISTER (2X16BIT INDICAT, 6NS OVERLAP REQUIRED,NIM LEVELS)	PR 1604	GEC-ELLIOTT	3	01/71	
N	DUAL INPUT DUAL OUTPUT REGISTER (16BIT, TTL IN, OPEN COLL TTL OUT, MAX 40MA,30V)	C110	RDT	1	05/72	
N	DUAL 16 BIT INPUT REGISTER (CERN SPECS 072)	2IR 2002	SEN	1	/72	
	DUAL 16 BIT INPUT REGISTER(EXT STROBE OR DATAWAY COMMAND STORES DATA,TTL LEVELS)	2IR 2010	SEN	1	/70	
	DUAL 16 BIT INPUT REGISTER(CONTINUOUS, STROBED AND ONE-STROBE DATA ENTRY,TTL)	PR-602	TECHCAL	1	11/71	
	DUAL 16 BIT PARALLEL INPUT REGISTER (WITH LED DISPLAY OPTION)	PR-604	TECHCAL	1	/72	
C	DUAL 24 BIT INPUT REGISTER (TTL, HANDSHAKE)	RI-224	EG+G	1	06/72	
N	INPUT REGISTER (2X24BIT)	IR	JOERGER	1	08/72	
	DUAL PARALLEL INPUT REGISTER(2X24BIT,EXT LOAD REQUEST,4 OPER MODES,TTL LEVELS)	60	JORWAY	1	10/70	
N	24-BIT DUAL PARALLEL INPUT REGISTER	9041	NUCL. ENTERPRISES	1	10/72	(5)
	COINCIDENCE BUFFER (2X12BIT,ONE STROBE PER 12BITS,MIN 2NS OVERLAP,NIM INPUTS)	C212	EG+G	2	/71	
	FAST COINCIDENCE LATCH(16BIT,DISCR I/P, MIN 2 NSEC STROBE-SIGNAL OVERLAP)	64	JORWAY	1	01/71	(1)
C	16 FOLD DCR(I/P DISCR,STROBE-INPUT OVER- LAP 2NSEC,CH1-8 AND CH9-16 SUM O/P,NIM)	2340B	LRS-LECROY	2	05/71	(2)
	16-CH COINCIDENCE REGISTER (16 CHANNELS, STROBE-INPUT OVERLAP 2NSEC,NIM LEVELS)	2341	LRS-LECROY	2	01/71	(4)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	PATTERN UNIT (16 INDIV NIM INPUTS,COMMON NIM GATE)	021	NUCL. ENTERPRISES	2	/71	(5)
N	PATTERN B (16BIT REGISTER WITH COMMON STROBE/GATE,NIM I/P,BIT-ADDR CONV OPER)	072	NUCL. ENTERPRISES	1		(5)
	PATTERN UNIT(16BIT,I/P STROBED WITH COMMON GATE,10 NSEC OVERLAP,NIM LEVELS)	C 101	RDT	2	06/71	
	PATTERN UNIT 16 BIT (16 INDIVIDUAL NIM INPUTS,COMMON NIM GATE)	16P 2007	SEN	2	/70	
N	16 BIT PATTERN UNIT (CERN SPECS 071)	16P 2047	SEN	1	/72	
N	INPUT READER (4X16BIT OR 64 BITS, TTL, 1=LOW, CONNECTORS OPTIONAL)	151	WALLAC	1		
N	(SAME BIT WITH 4X24BIT OR 96 BITS)	152		1		
N	(SAME BUT WITH 8X16BIT OR 128 BITS)	153		1		
N	(SAME BUT WITH 8X24BIT OR 192 BITS)	154		1		
N	(SAME BUT WITH 16X8BIT OR 128 BITS)	155		1		
N	(SAME BUT WITH 16X16BIT OR 256 BITS)	156		1		

PARALLEL INPUT GATES (Dataway connecting)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	INPUT GATE 24-BIT	3420	KINETIC SYSTEMS	1	/71	(4)
N	BALANCED INPUT REGISTER WITH ADDRESSING	3430	KINETIC SYSTEMS	1	/72	
	PARALLEL INPUT GATE (16BIT,TTL INPUT,EXT STROBE TO INPUT GATES)	7018-1	NUCL. ENTERPRISES	1	/70	
N	SINGLE 16 BIT PARALLEL INPUT GATE	PG-601	TECHCAL	1	01/72	
N	SINGLE 24 BIT PARALLEL INPUT GATE (BOTH WITH LED DISPLAY OPTION)	PG-603		1	01/72	
	INPUT DATA GATE (24BIT NEGATIVE LOGIC TTL INPUT,1=LOW)	713	NUCL. ENTERPRISES	1	/71	
	INPUT DATA GATE (24BIT POSITIVE LOGIC TTL INPUT,1=HIGH)	714	NUCL. ENTERPRISES	1	/71	
	PARALLEL INPUT GATE (24BIT STATIC DATA, INTEGRATED FOR 1 USEC,TTL LEVELS)	7059-1	NUCL. ENTERPRISES	1	/70	
	PARALLEL INPUT GATE (22BIT STATIC DATA, 500 NSEC INTEGRATION,STROBE SETS L,TTL)	7060-1	NUCL. ENTERPRISES	1	/70	
N	DUAL 16 BIT PARALLEL INPUT GATE	PG-602	TECHCAL	1	01/72	
N	DUAL 24 BIT PARALLEL INPUT GATE (BOTH WITH LED DISPLAY OPTION)	PG-604		1	01/72	
	PARALLEL INPUT GATE (3X16BIT INPUT FROM ISOLATING CONTACTS)	1061	BORER	1	05/72	(4)
C	DIGITALES EINGANGSREGISTER(5X8BIT PARALL INPUT GATES,5TH BYTE SETS L,TTL,1=H)	DO 200-2001	DORNIER	1	11/71	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-2201		1	/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-2101		1	/72	
C	DIGITALES EINGANGSREGISTER(5X8BIT PARALL INPUT GATES,5TH BYTE SETS L,HLL,1=H)	DO 200-2002	DORNIER	1	09/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-2202		1	09/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-2102		1	09/72	
C	DIGITALES EINGANGSREGISTER MIT OPTOKOPP-LER(4X8BIT PARALLEL INPUT GATES,WITH L)	DO 200-2003	DORNIER	1	/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-2203		1	/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-2103		1	/72	
	DUAL PARALLEL STROBED INPUT GATE(2X24BIT HANDSHAKE MODE TRANSFER TO DATAWAY,TTL)	61	JORWAY	1	10/70	
	DUAL PARALLEL INPUT GATE (2X24BIT,NON-INTERLOCK CONTROL TRANSF TO DATAWAY,TTL)	61-1	JORWAY	1	10/70	
N	INPUT GATE DUAL 24 BIT	3472	KINETIC SYSTEMS	1		
N	PARALLEL INPUT GATE(16X16BIT,TTL, 1=LOW)	IG 25601	GEC-ELLIOTT	2	10/72	

MANUAL INPUT MODULES

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	PARAMETER UNIT 12 BIT (PROVIDES 12 BIT COMMUNICATION,PUSH BUTTON L-REQUEST)	P 2005	SEN	1	/70	
N	16 BIT WORD GENERATOR	WGR-160	TECHCAL	1	01/72	
C	24 BIT WORD GENERATOR	WGR-240	TECHCAL	1	/72	
	WORD GENERATOR (24BIT WORD MANUALLY SET BY SWITCHES)	WG 2401	GEC-ELLIOTT	1	01/71	
	PARAMETER UNIT (QUAD 4-DECADE BCD PARAMETERS MANUALLY SET)	022	NUCL. ENTERPRISES	4	/71	(2)
	WORD GENERATOR (24 BITS OF BINARY DATA, SWITCH SELECTED)	9020	NUCL. ENTERPRISES	1	/71	(2)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	PARAMETER UNIT (QUAD 4 DECADE BCD PARAMETERS MANUALLY SET)	C 105	RDT	4	06/71	
	DATA STORAGE MODULES					
N	CAMAC 16 WORD 24 BIT MEMORY	MC 5202	MICRO CONSULTANTS	2	05/72	
	16 WORD STORE	CS 0003	NUCL. ENTERPRISES	1		(4)
	MEMOIRE TAMPON (BUFFER MEMORY,256 13BIT BYTES,USED WITH J CAN 20C/H)	J MT 10	SAIP-CRC	1	11/71	
	PARALLEL OUTPUT MODULES					
	12 BIT OUTPUT REGISTER(DC OR PULSE O/P, UPDATING STROBE OUTPUT,NIM LEVELS)	41	JORWAY	1	03/71	(2)
N	DIFFERENTIAL OUTPUT REGISTER	3030	KINETIC SYSTEMS	1	/72	
C	24-BIT OUTPUT REGISTER	3071	KINETIC SYSTEMS	1	06/72	
N	12-BIT OUTPUT REGISTER (WITH OPTICAL ISOLATION,OPEN COLL O/P, MAX 30V/100MA)	3082	KINETIC SYSTEMS	1		
C	12-BIT OUTPUT REGISTER WITH ISOLATED RELAY	3087	KINETIC SYSTEMS	1	/71	(4)
	OUTPUT REGISTER (12BIT, NIM PULSES OR LEVELS OUT)	OR 2027	SEN	1	/70	
N	DIGITAL OUTPUT 16 BIT POTH 24V	C 76451-A9-A1	SIEMENS	0		
N	DIGITAL OUTPUT 16 BIT RELAYS	C 76451-A9-A2	SIEMENS	0		
N	SINGLE 16 BIT PARALLEL OUTPUT REGISTER (WITH LED DISPLAY OPTION)	PR-609	TECHCAL	1	/71	
N	SINGLE 24 BIT PARALLEL OUTPUT REGISTER (WITH LED DISPLAY OPTION)	PR-611	TECHCAL	1	5 /71	
N	PARALLEL-OUTPUT REGISTER (24BIT, OPEN COLLECTOR OUTPUT, HANDSHAKE FACILITY)	MS PO 2 1230/1	AEG-TELEFUNKEN	1	10/72	(4)
	PARALLEL OUTPUT REGISTER (24BIT TTL OUTPUT VIA 25-WAY CONNECTOR)	7054-3	NUCL. ENTERPRISES	1	/70	
N	SINGLE 16 BIT PARALLEL OUTPUT REGISTER/DRIVER(WITH LED DISPLAY OPTION)	PR-609-A	TECHCAL	1	5 /71	
N	DUAL 16 BIT PARALLEL OUTPUT REGISTER (WITH LED DISPLAY OPTION)	PR-610	TECHCAL	1	5 /71	
N	DUAL 24 BIT PARALLEL OUTPUT REGISTER (WITH LED DISPLAY OPTION)	PR-612	TECHCAL	1	5 /71	
	OUTPUT REGISTER (2X16BIT VIA ISOLATING CONTACTS)	1082	BORER	1	05/72	(4)
N	DUAL INPUT DUAL OUTPUT REGISTER (16BIT, TTL IN, OPEN COLL TTL OUT, MAX 40MA,30V)	C110	RDT	1	05/72	
N	SINGLE 24 BIT PARALLEL OUTPUT REGISTER/DRIVER(WITH LED DISPLAY OPTION)	PR-611-A	TECHCAL	41	5 /71	
C	DIGITALES AUSGANGSREGISTER(4X8BIT PARALL OUTPUT REGISTER,NO L,TTL,1=H)	DO 200-2501	DORNIER	1	11/71	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-2701		1	/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-2601		1	/72	
C	DIGITALES AUSGANGSREGISTER(4X8BIT PARALL OUTPUT REGISTER,NO L,OPEN COLL O/P,1=H)	DO 200-2502	DORNIER	1	09/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-2702		1	09/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-2602		1	09/72	
C	DIGITALES AUSGANGSREGISTER(4X8BIT PARALL OUTPUT REGISTER,NO L,OPEN COLL O/P,1=L)	DO 200-2503	DORNIER	1	09/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-2703		1	09/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-2603		1	09/72	
	DUAL 16 BIT OUTPUT REGISTER (TTL LEVELS, OPEN COLL OUTPUTS VIA CABLE)	2OR 2008	SEN	1	/70	
N	DUAL 16 BIT PARALLEL OUTPUT REGISTER/DRIVER(WITH LED DISPLAY OPTION)	PR-610-A	TECHCAL	1	5 /71	
N	DUAL 24 BIT PARALLEL OUTPUT REGISTER/DRIVER(WITH LED DISPLAY OPTION)	PR-612-A	TECHCAL	41	5 /71	
C	PARALLEL-OUTPUT-REGISTER (DUAL 24BIT, OR QUAD 12BIT,OPEN COLLECTOR OUTPUT)	MS PO 1 1230/1	AEG-TELEFUNKEN	1	10/70	(1)
	OUTPUT REGISTER (2X24BIT DATA OUT,DATA-READY + BUSY FORM HANDSHAKE, TTL)	RO-224	EG+G	1	04/72	
N	OUTPUT REGISTER (2X24BIT, TTL OPEN COLL OUT AS STANDARD)	OR	JOERGER	1	08/72	

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	DUAL 24 BIT OUTPUT REGISTER(DC OR PULSE O/P,UPDATING O/P STROBE,TTL OPEN COLL)	40	JORWAY	1	07/71	(2)
N	DUAL 24-BIT OUTPUT REGISTER (OPEN COLL DRIVERS, MAX 24V OR 250MA, REAR OUTPUTS)	3072	KINETIC SYSTEMS	0		
N	24-BIT DUAL OUTPUT REGISTER	9042	NUCL. ENTERPRISES	1	10/72	(5)
N	OUTPUT REGISTER/DRIVER (2X24BIT,OPTION ON POLARITY AND OPEN COLLECTOR OUTPUTS)	171	WALLAC	1		
C	DIGITALES AUSGANGSREGISTER MIT REED-RELAIS(4X8BIT OUTPUT REG,OPEN CONTACT=0)	DO 200-2504	DORNIER	1	11/71	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-2704		1	/71	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-2604		1	/71	
	SWITCH (12BIT DATAWAY CONTROLLED RELAY REGISTER FOR SWITCHING AND MULTIPLEXING)	7066-1	NUCL. ENTERPRISES	1	/71	
N	OUTPUT DRIVER(2X16BIT,40MA SINKING,1=LO)	OD1611	GEC-ELLIOTT	1	04/72	
N	(SAME,1=HI)	OD 1612		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=LO)	OD 1613		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=HI)	OD 1614		1	04/72	
N	OUTPUT DRIVER(2X16BIT,125MA SINK, 1=LO)	OD 1615	GEC-ELLIOTT	1	04/72	
N	(SAME, 1=HI)	OD 1616		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=LO)	OD 1617		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=HI)	OD 1618		1	04/72	
N	OUTPUT DRIVER (2X16BIT, CAN DRIVE 30 TTL LOADS)	OD 1619	GEC-ELLIOTT	1	04/72	
N	(SAME, ALSO READ VIA DATAWAY)	OD 1620		1	04/72	
	DRIVER (16BIT,OPEN COLLECTOR OUTPUT VIA MULTIWAY CONNECTOR,MAX 150MA/LINE)	9002	NUCL. ENTERPRISES	1	/71	
	DRIVER (24BIT OUTPUT REGISTER,SET AND READ BY COMMAND,24BIT I/P DATA ACCEPTED)	9013	NUCL. ENTERPRISES	1	/71	
N	OUTPUT DRIVER(2X24BIT,40MA SINKING,1=LO)	OD 2401	GEC-ELLIOTT	1	04/72	
N	(SAME, 1=HI)	OD 2402		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=LO)	OD 2403		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=HI)	OD 2404		1	04/72	
N	OUTPUT DRIVER(2X24BIT,125MA SINK,1=LO)	OD 2405	GEC-ELLIOTT	1	04/72	
N	(SAME, 1=HI)	OD 2406		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=LO)	OD 2407		1	04/72	
N	(SAME, READ VIA DATAWAY, 1=HI)	OD 2408		1	04/72	
N	OUTPUT DRIVER (2X24BIT, CAN DRIVE 30 TTL LOADS)	OD 2409	GEC-ELLIOTT	1	04/72	
N	(SAME, ALSO READ VIA DATAWAY)	OD 2410		1	04/72	
	DRIVER (24BIT OUTPUT REGISTER,SET AND READ BY COMMAND,24BIT I/P DATA ACCEPTED)	9017	NUCL. ENTERPRISES	1	/71	(1)

DISPLAY MODULES AND UNITS

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	DISPLAY (24BIT BCD DISPLAY OF ONE SCALER FHC1301/02,SPEC CONNECTION TO SCALER)	FHC 1305A	BF VERTRIEB	1	01/71	(1)
	DISPLAY (6 DECADE NIXIE FOR ONE OF 12 SCALERS FHC1301/02,SPEC BUS TO SCALERS)	FHC 1306A	BF VERTRIEB	2	01/71	(1)
	CRT DECIMAL DISPLAY SYSTEM (INCLUDING)	72A	JORWAY	NA	07/71	(2)
	DISPLAY DRIVER	72A		3		
	DISPLAY SYSTEM COMPRISING		KINETIC SYSTEMS		/71	(4)
	DISPLAY SYNCHRONIZING	3200		1	/71	
	DISPLAY TIMING	3205		1	/71	
	DISPLAY CONTROL	3210		1	/71	
	DISPLAY REFRESH (ALPHANUMERIC + GRAPHS)	3212		1	/71	
N	DUAL LIGHT PEN INTERFACE	3225		1	/72	
	DISPLAY DRIVER (TWO 10BIT DAC,OUTPUT RANGE +5V TO -5V,TWO OPERATION MODES)	7011-2	NUCL. ENTERPRISES	2	/70	(1)
	DECIMAL DISPLAY UNIT (ADDRESS AND 5 DATA DECADES + MULTIPLIER DISPLAYED)	9007	NUCL. ENTERPRISES	NA	/71	
	DISPLAY CONTROLLER (FOR 9007,INCLUDES BIN TO DECIMAL CONVERTER)	9006		2	/71	
	INDICATOR (1X16BIT OR 2X8BIT,INDICATES STATE OF REGISTER LOADED FROM DATAWAY)	9014	NUCL. ENTERPRISES	1	/71	
	STORAGE OSCILLOSCOPE (DRIVER FOR TEKTRONIX 611 OR 601,USED WITH 7011)	9028	NUCL. ENTERPRISES	0	/71	(2)
	AFFICHAGE DECIMAL PAR L'INTERMEDIAIRE D' UN CALCULATEUR (DISPLAY OF 24BIT WORD)	J AF 15	SAIP-CRC	2	01/71	
	AFFICHAGE BINAIRE MANUEL (CONTENT OF A REGISTER DISPLAYED,EXT MULTIWAY CONN)	J AF 20	SAIP-CRC	1	01/71	

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	SCOPE DISPLAY DRIVER X-Y-Z (SYSTEM)	FDD 2012	SEN	1	04/71	(1)
	STORAGE DISPLAY DRIVER FOR TEKTRONIX 611 OR 601	SDD 2015		1	04/71	(1)
	CHARACTER GENERATOR	CG 2018		1	04/71	(1)
	VECTOR GENERATOR	VG 2028		1	05/71	(1)
	LIGHT PEN FOR FDD 2012 OR CD 2018	LP 2035		NA	06/71	
N	STORAGE DISPLAY DRIVER	3260	KINETIC SYSTEMS	1	/72	

PERIPHERAL INPUT/OUTPUT MODULES

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	TYPEWRITER DRIVE UNIT	TD 0801	GEC-ELLIOTT	0	08/71	(1)
	INPUT-OUTPUT-INTERFACE(TELETYPE-DATAWAY I/O TRANSF OR 12 SCALER O/P ON SPEC BUS)	FHC 1307A	BF VERTRIEB	2	01/71	(1)
	TELETYPE INTERFACE	90	JORWAY	0	10/71	
	TELETYPEWRITER DRIVER (FOR ASR 33)	7043-1	NUCL. ENTERPRISES	1	/70	
	TELETYPEWRITER INTERFACE(I/O DATA TRANSF AND CONTROL,LAM USED AS TWO-WAY FLAG)	7061-1	NUCL. ENTERPRISES	1	/70	(1)
	TELETYPEWRITER TERMINAL	TWTML/045	SAIP-CRC	1	10/70	
N	TELETYPE INTERFACE	C-TIF	WENZEL ELEKTRONIK	1		
	PAPER TAPE PUNCH OUTPUT DRIVER (FOR FACIT 4070)	TP 0801	GEC-ELLIOTT	1	06/71	(1)
	TAPE READER INTERFACE UNIT (FOR ELECTROGRAPHIC READER)	TR 0801	GEC-ELLIOTT	1	01/71	(1)
	B.S.INTERFACE READER (8BIT DATA + PARITY BIT,BRITISH STANDARD)	7057-1	NUCL. ENTERPRISES	1	/71	
	B.S.INTERFACE DRIVER (8BIT DATA + PARITY BIT,BRITISH STANDARD)	7058-1	NUCL. ENTERPRISES	1	/71	(1)
	PERIPHERAL READER(8BIT PARALLEL DATA IN, NEG OR POS TTL,HANDSHAKE CONTROLS)	7064-1	NUCL. ENTERPRISES	1	/71	(1)
	PERIPHERAL DRIVER (8BIT DATA OUT,NEG OR POS TTL,HANDSHAKE CONTROLS)	7065-1	NUCL. ENTERPRISES	1	/71	(1)
	UNIVERSAL INPUT/OUTPUT REGISTER (36BIT DATA+RANGE IN,12BIT REG O/P FOR CONTROL)	1031	BORER	1	05/72	(3)
	INTERFACE CAMAC POUR CODEUR CA25/CA13/ C97 (INTERFACING PULSE ADC TO CAMAC)	J CCA 10	SAIP-CRC	2	01/71	
	STEP MOTOR DRIVER (MAX 32768 STEPS,RATE, ROTATION AND START/STOP FULLY COMMANDED)	1161	BORER	1	06/72	(3)
	OUTPUT REGISTER (16 OR 24 BIT TTL DRIVER FOR FAST-ROUTING MULTIPLEXER SYSTEM)	CM 665	J AND P	1	07/71	
C	STEPPING MOTOR CONTROLLER, DUAL	3360	KINETIC SYSTEMS	1	/72	(4)
C	STEPPING MOTOR DRIVER (USED WITH 7045)	0709	NUCL. ENTERPRISES	1	/71	
	DELAYED PULSE GENERATOR (4 TTL O/P,0.042 HZ-40KHZ RATE,LEVEL AND DIRECTION CONTR)	7045-1	NUCL. ENTERPRISES	1	/70	
	MCA INTERFACE (I/O MODULE FOR MULTI-CHANNEL ANALYSER)		PACKARD	3		(4)
	PROPORTIONAL CHAMBER READ-OUT (USED WITH SPEC CONTROLLER TYPE COFIL OR ALONE)	REFIL	SAIP-CRC	2	/71	
	SEQUENTIAL OUTPUT REGISTER (SERIAL-CODED NIM PULSES OUT,LOGIC 0=40NSEC,1=150NSEC)	SOR	SAIP-CRC	1	/71	
	SEQUENTIAL INPUT REGISTER(16 8BIT BYTES, STORES CODED NIM PULSES,0=40,1=150NSEC)	SIRE	SAIP-CRC	1	/71	
	SPARK CHAMBER READ OUT (POSITION AND ADDRESS CODING OF MULTIPLE SPARK SITES)	SCRO-041	SAIP-CRC	2	10/70	
	SPARK CHAMBER READ OUT TERMINAL	SCRO TML-043		5	10/70	
	PLUMBICON READ OUT (5 SCALERS RECORD DIGITIZED OUTPUTS FROM PLUMBICON CAMERA)	PLUM	SAIP-CRC	1	/71	
	PLUMBICON READ OUT TERMINAL	PUDDING		1	/71	
	DUAL INCREMENTAL POSITION ENCODER (2X20 BIT X-Y DIGITIZATION BY UP-DOWN COUNTER)	2IPE 2019	SEN	1	04/71	
	CAMAC COMMUNICATIONS CONTROLLER INTERFACE UNIT	MC 4036	MICRO CONSULTANTS	1	08/71	(2)
	CAMAC VID-MOS INTERFACE UNIT	MC 4037	MICRO CONSULTANTS	1	08/71	(2)
C	CAMAC MOD 15 INTERFACE UNIT (TO IN-HOUSE PRODUCED A-D EQUIPMENT)	MC 5201	MICRO CONSULTANTS	1	08/71	(2)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
N	WIRE DETECTOR SCANNER(64X16BIT MEMORY STORES 13BIT POSITION+3BIT CLUSTER DATA)	WCS-200	NANO SYSTEMS	1	/72	(5)
N	SCANNER TEST MODULE	WCS-201		1	/72	(5)
	MULTIPLEXERS					
	15 CHANNEL MULTIPLEXER (ANALOGUE SIGNALS ROUTED TO ADC/DVM,DIRECT + SCAN MODES)	1701	BORER	1	05/72	(3)
C	32-CHANNEL FAST MULTIPLEXER (FET SWITCHES FOR ADC 1242 AND 1243)	1703	BORER	1	06/72	(4)
C	16-CHANNEL FAST MULTIPLEXER (FET SWITCHES FOR ADC 1242 AND 1243)	1704	BORER	1	06/72	(4)
	SEE ALSO DORNIER ADC TYPES		DORNIER			
C	ELEKTRONISCHER MULTIPLEXER (16 CHANNELS, MAX +OR-10V,DATAWAY SET+INCR ADDRESS)	DO 200-1031	DORNIER	2	09/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-1231		2	09/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-1131		2	09/72	
C	ELEKTRONISCHER MULTIPLEXER (32 CHANNELS, MAX +OR-10V, DATAWAY SET+INCR ADDRESS)	DO 0200-1032	DORNIER	2	09/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-1232		2	09/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-1132		2	09/72	
C	ELEKTRONISCHER MULTIPLEXER (8 DIFF I/P, MAX +OR-10V, DATAWAY SET+INCR ADDRESS)	DO 200-1033	DORNIER	2	09/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-1233		2	09/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-1133		2	09/72	
C	ELEKTRONISCHER MULTIPLEXER(16 DIFF I/P, MAX +OR-10V, DATAWAY SET+INCR ADDRESS)	DO 200-1034	DORNIER	2	09/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-1234		2	09/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-1134		2	09/72	
C	RELAISMULTIPLEXER (16 CHANNELS,MAX 200V/ 750MA OR 10VA, DATAWAY SET+INCR ADDRESS)	DO 200-1035	DORNIER	2	11/71	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-1235		2	/71	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-1135		2	/71	
N	RELAIMULTIPLEXER (16 CHANNELS, MAX 200V, 750MA OR 10VA, DATAWAY SET+INCR ADDRESS)	DO 200-1036	DORNIER	1	/72	
N	(WITH FRONT PANEL CONNECTOR)	DO 200-1236		1	/72	
N	(CABLE WITH CONNECTOR FROM REAR)	DO 200-1136		1	/72	
N	ANALOG MULTIPLEXER (15 CHANNELS,MANUALLY AND DATAWAY SELECTED)	AM	JOERGER	2	08/72	
	MULTIPLEXER-SOLID STATE (16 SINGLE-ENDED OR 8 DIFF CHAN,RANDOM OR SEQUENT ACCESS)	9026	NUCL. ENTERPRISES	1	/71	
N	12 INPUT MULTIPLEXER	MX 2025	SEN	0	/72	
C	MULTIPLEXER (32 CHANNEL, 2 CONTACTS)	C 76451-A4-A1	SIEMENS	2		
N	MULTIPLEXER (32 CHANNEL, 4 CONTACTS)	C 76451-A4-A2	SIEMENS	2		
	CODE CONVERTERS					
	BINARY TO-BCD-CONVERTER (24BIT BIN,8 DECIMAL DIGIT OUTPUT VIA TWO CONNECTORS)	7068-1	NUCL. ENTERPRISES	1	/70	(2)
	BINARY TO BCD-CONVERTER(24BIT TO 8 DECA-DE,DISPLAY,CONV 4USEC,TTL LEVEL OUT,1=H)	C-BBC-2	WENZEL ELEKTRONIK	2	11/71	
	ANALOGUE-TO-DIGITAL CONVERTERS (ADC, DVM)					
C	ANALOGE EINGAENGE(MULTIPLEXER-ADC,8 I/P TO ONE ADC,+/-10V RANGE,7BITS/20V+SIGN)	DO 200-1011	DORNIER	2	/72	
N	(SAME WITH 8 DIFFERENTIAL INPUTS)	DO 200-1013		2	/72	
N	ANALOGE EINGAENGE(MULTIPLEXER-ADC,8 I/P TO ONE ADC,+/-5V RANGE,7BITS/10V+SIGN)	DO 200-1014	DORNIER	2	/72	
N	(SAME WITH 8 DIFFERENTIAL INPUTS)	DO 200-1016		2	/72	
N	ANALOGE EINGAENGE(MULTIPLEXER-ADC,8 I/P TO ONE ADC, +10V RANGE,8BITS/10V)	DO 200-1017	DORNIER	2	/72	
N	(SAME WITH 8 DIFFERENTIAL INPUTS)	DO 200-1019		2	/72	
N	ANALOGER EINGANG (ADC, +/-10V RANGE, 7BITS/20V+SIGN)	DO 200-1027	DORNIER	2	/72	
N	(SAME FOR +/-5V RANGE, 7BITS/10V+SIGN)	DO 200-1028		2	/72	
N	(SAME FOR +10V RANGE, 8BITS/10V)	DO 200-1029		2	/72	
C	ANALOGUE TO DIGITAL INTEFACE (WITH PLUG-IN CONVERTER CARDS ADC/8Q, ADC/10Q AND ADC/12Q FOR 8, 10 AND 12 BIT CONVERSION)	ADC 1201	GEC-ELLIOTT	1	/71	(1)
	MULTI-MODE LINEAR ADC (8BIT,40MHZ CLOCK, AREA AND PEAK MODES,NIM LEVELS)	2243A	LRS-LECROY	1	08/70	(2)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	OCTAL ADC (8 FAST I/P,8BIT/CH, 150USEC CONVERSION,COMMON GATE,NIM LEVELS)	2248	LRS-LECROY	1	10/71	
	ANALOGUE TO DIGITAL CONVERTER(8BIT, I/P RANGE 0 TO +5V OR 0 TO -5V,25 USEC CONV)	7028-1	NUCL. ENTERPRISES	1	/70	
	OCTAL ADC (MIN 5 NSEC PULSES, PCS OR NEG 8BIT/100 PC RESOLUTION, 250 USEC CONV)	9040	NUCL. ENTERPRISES	1	/72	(4)
	CONVERTISSEUR ANALOGIQUE NUMERIQUE A 512 CANAUX(PULSE ADC,10MHZ CLOCK,0.1/10V)	J CAN 31	SAIP-CRC	3	01/71	
C	DIGITALVOLTMETER (RANGES: DC0.02 TO 20V, 5 MA TO 100 MA,AC 0.01 TO 20 V BOTH POL)	C 76451-A13-A1	SIEMENS	2		
N	DIGITAL VOLTMETER (SAME AS TYPE C 76451-A13-A1 WITH DISPLAY)	C 76451-A13-A2	SIEMENS	2		
N	SINGLE 8 BIT A/D CONVERTER	S-AD-008	TECHCAL	1	04/72	
N	DUAL 8 BIT A/D CONVERTER	D-AD-008	TECHCAL	1	04/72	
N	SINGLE 10 BIT A/D CONVERTER	S-AD-010	TECHCAL	1	04/72	
N	DUAL 10 BIT A/D CONVERTER	D-AD-010	TECHCAL	1	04/72	
N	CAMAC ADC/DAC UNIT (PC CARD FOR SAMPLE-HOLD 12BIT ADC AND DAC CIRCUITS)	MC 5200	MICRO CONSULTANTS	1	05/72	
N	SINGLE 12 BIT A/D CONVERTER	S-AD-012	TECHCAL	1	04/72	
N	DUAL 12 BIT A/D CONVERTER	D-AD-012	TECHCAL	1	04/72	
	DUAL SLOPE ADC (+AND- 0.01/1/10V RANGES, 11BIT RESOLUTION,20MS CONV TIME)	1241	BORER	2	05/72	(3)
C	SUCCESS. APPROX. ADC (11BIT+SIGN, +AND-10V DIFF IN, 20 USEC CONVERSION)	1242	BORER	2	06/72	(4)
N	SUCCESS. APPROX. ADC (AS 1242 BUT WITH SAMPLE AND HOLD)	1243	BORER	2	08/72	
C	ANALOGE EINGAENGE (MULTIPLEXER-ADC,8 I/P TO ONE ADC,+/-10V RANGE,11BITS/20V+SIGN)	DO 200-1001	DORNIER	2	/72	
C	(SAME WITH 8 DIFFERENTIAL INPUTS)	DO 200-1003		2	/72	
C	ANALOGE EINGAENGE(MULTIPLEXER-ADC,8 I/P TO ONE ADC,+/-5V RANGE,11BITS/10V+SIGN)	DO 200-1004	DORNIER	2	/72	
N	(SAME WITH 8 DIFFERENTIAL INPUTS)	DO 200-1006		2	/72	
N	ANALOGE EINGAENGE(MULTIPLEXER-ADC,8 I/P TO ONE ADC, +10V RANGE, 12BITS/10V)	DO 200-1007	DORNIER	2	/72	
N	(SAME WITH 8 DIFFERENTIAL INPUTS)	DO 200-1009		2	/72	
N	ANALOGER EINGANG (ADC, +/-10V RANGE, 11BITS/20V+SIGN)	DO 200-1024	DORNIER	2	/72	
N	(SAME FOR +/-5V RANGE,11BITS/10V+SIGN)	DO 200-1025		2	/72	
N	(SAME FOR +10V RANGE,12BITS/10V)	DO 200-1026		2	/72	
	A/D CONVERTER (12BIT,MAX 20 USEC CONVER-SION, +AND-5V, +AND-10V, +10V RANGES)	30	JORWAY	2	06/71	(2)
	ANALOGUE TO DIGITAL CONVERTER (12BIT, 20 MSEC CONVERSION,RANGE -5V TO +5V)	7055-1	NUCL. ENTERPRISES	1	/70	
C	ANALOGER EINGANG(DUAL SLOPE ADC, +/-10V RANGE,14BITS/20V+SIGN,0.1SEC CONVERSION)	DO 200-1021	DORNIER	1	12/72	
	CONVERTISSEUR ANALOGIQUE NUMERIQUE RAPI-DE A 8000 CANAUX(PULSE ADC,100MHZ CLOCK)	JCAN20C/JCAN20H	SAIP-CRC	6	01/71	
	INTERFACE POUR CODEUR J CAN 20 ET BLOC MEMOIRE BM 96 (ADC-MEMORY INTERFACE)	J CAN 20 I		2	01/71	

DIGITAL-TO-ANALOGUE CONVERTERS (DAC)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
C	ANALOGER AUSGANG (DAC, 12BIT RESOLUTION, +10V OUTPUT RANGE, 20MA)	DO 200-1501	DORNIER	2	11/71	
N	(SAME BUT WITH +AND-10V OUTPUT RANGE)	DO 200-1503		2	/71	
N	(SAME BUT WITH +AND-5V OUTPUT RANGE)	DO 200-1505		2	/71	
C	ANALOGE AUSGAENGE (DAC,12BIT RESOLUTION, +10V OUTPUT RANGE,2 OUTPUTS, 20MA)	DO 200-1502	DORNIER	2	11/71	
N	(SAME BUT WITH +AND-10V OUTPUT RANGE)	DO 200-1504		2	/71	
N	(SAME BUT WITH +AND-5V OUTPUT RANGE)	DO 200-1506		2	/71	
	D/A CONVERTER (12BIT,5 USEC CONVERSION, O/P RANGES +AND-2.5V/5V/10V AND +5V/10V)	31	JORWAY	1	06/71	(2)
N	CAMAC ADC/DAC UNIT (PC CARD FOR SAMPLE-HOLD 12BIT ADC AND DAC CIRCUITS)	MC 5200	MICRO CONSULTANTS	1	05/72	
	DUAL DIGITAL-TO-ANALOG CONVERTER (10BIT, OUTPUT 0 TO +10V OR -5 TO +5V)	2DAC 2011	SEN	1	04/71	
N	SLAVE BOARD DUAL D/A CONVERTER	DA-2001	TECHCAL	1	/71	
	DUAL DIGITAL TO ANALOG CONVERTER (10BIT RESOLUTION,10MSEC CONV TIME,O/P 5V MAX)	DA-2000	TECHCAL	1	11/71	

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	TIME-TO-DIGITAL CONVERTERS					
	QUAD CAMAC SCALER (4X16BIT OR 2X32BIT, 40MHZ)	1004	BORER	1	03/72	
	TIME-TO-DIGITAL CONVERTER(4X14BIT,CLOCK RATE 20MHZ,QUAD/DUAL/SINGLE CONFIG)	1005	BORER	1	03/72	
	QUAD 16-BIT SPARK READ-OUT REGISTER (20MHZ RATE,TTL LEVELS)	SR 1604	GEC-ELLIOTT	1	01/71	
	QUAD TIME-TO-DIGITAL CONVERTER(9BIT/CH, 102/510NSEC RANGES,13USEC CONVERS,NIM)	2226A	LRS-LECROY	1	10/70	(2)
	TIME DIGITIZER(5X16BIT,CLOCK RATE 40MHZ, WITH CENTER FINDING LOGIC)	TD 2031	SEN	1	02/72	
	TIME DIGITIZER (4X16BIT,CLOCK RATE 70/85MHZ,NIM LEVELS)	TD 2041	SEN	1	02/72	(4)
	OTHER ANALOGUE AND/OR DIGITAL MODULES					
N	SAMPLE-AND-HOLD VERSTAERKER(DUAL DIFF AMPL,+/-10V RANGE,20MA OUT,5USEC SETTL)	DO 200-1040	DORNIER	2	/72	
N	(SINGLE AMPL VERSION, BOTH TYPES HAVE HOLD AND TRACK MODES)	DO 200-1041		2	/72	
N	PROGRAMMIERBARER VERSTAERKER(256 STEPS OF DATAWAY-SET GAIN, MAX+/-10V INPUT)	DO 200-1050	DORNIER	2	/72	
	FAN-OUT UNIT (2 ORED INPUTS PROVIDE 8 TRUE,2 COMPLEM OUTPUTS,NIM SIGNALS)	FO 0801	GEC-ELLIOTT	1	01/71	
C	POWER SUPPLY CONTROLLER 10-BIT	3155	KINETIC SYSTEMS	1	/71	(4)
N	POWER SUPPLY CONTROLLER 12-BIT	3156	KINETIC SYSTEMS	1	/72	
	HEX IL2 TO IL1 CONVERTER (6 NIM SIGNALS IN,6 TTL SIGNALS OUT)	7051-1	NUCL. ENTERPRISES	1	/70	
	HEX IL1 TO IL2 CONVERTER (6 TTL SIGNALS IN,6 NIM SIGNALS OUT)	7052-1	NUCL. ENTERPRISES	1	/70	
	QUIN L1 TO IL1 CONVERTER(5 HARWELL STANDARD L1 SIGNALS IN 5 TTL SIGNALS OUT)	7053-1	NUCL. ENTERPRISES	1	/70	
	DIFFERENTIAL AMPLIFIER (RANGES +0.1V TO -0.1V AND 0.5/5/50/500C BOTH POLARITIES)	9027	NUCL. ENTERPRISES	2	/71	
	SIX-FOLD CONTROLLED GATE (INDIV GATING, FAN-IN AND FAN-OUT CONTROLLED BY 3 REGS)	6CG 2017	SEN	1	11/71	(4)
C	STROMGENERATOR (CURRENT SOURCE)	C 76451-A5	SIEMENS	2		
	PULSE GENERATORS AND CLOCKS					
	TIMER (1HZ TO 1MHZ PULSES-7 DECADES-OVER 7 TTL OUTPUTS,LAM BY 1,10 OR 100 HZ)	FHC 1303A	BF VERTRIEB	1	01/71	(1)
	CLOCK/TIMER (0.001S TO 10 HRS TIME INTERVAL,REAL-TIME OUTPUT)	1411	BORER	1	05/72	(3)
	CRYSTAL CONTROLLED PULSE GENERATOR(7 DECADES-1HZ TO 1MHZ-500NS PULSES OUT,TTL)	PG 0001	GEC-ELLIOTT	1	01/71	
C	TEST PULSE GENERATOR (5 TO 50 NSEC NIM O/P PULSE DERIVED FROM S1.F(25) OR EXT)	TPG 0202	GEC-ELLIOTT	1	01/71	
	CLOCK PULSE GENERATOR (7 OUTPUTS-1HZ TO 1MHZ-IN DECADE STEPS,10MHZ EXT IN,TTL)	7019-1	NUCL. ENTERPRISES	1	/70	
C	CLOCK PULSE GENERATOR(7 DECADES-1HZ TO 1MHZ-500 NSEC PULSES OUT,TTL AND NIM)	C 109	RDT	1	11/71	
	HORLOGE A QUARTZ 1 MHZ(CLOCK,7 O/P-1HZ TO 1MHZ-200 TO 800 NSEC WIDTH,TTL LEVEL)	J HQ 10	SAIP-CRC	1	01/71	
	REAL TIME CLOCK (3.8 USEC TO 18.2 HRS, PRESET-TIME AND PRESET-COUNT MODES)	RTC 2014	SEN	1	04/71	
	DUAL PROGRAMMED PULSE GENERATOR(50HZ/2KHZ/5MHZ PULSE TRAIN,LENGTH BY COMMAND)	2PPG 2016	SEN	1	04/71	
	TIME BASE (70 MHZ, USED WITH TD 2031 AND TD 2041)	TB 2032	SEN	0	11/71	
	MULTIPULSER (0.5-300 MHZ BURSTS,NIM SIGNAL,TTL TRIGGER,NIM OUT,600PSEC RISE)	C 72454-A1450-A1	SIEMENS	2	/72	
C	CLOCK/TIMER	C 76451-A14	SIEMENS	1	01/72	
	CAMAC-CLOCK-GENERATOR(7 DECADES-10MHZ TO 1HZ,50/500 NSEC O/P PULSES,2.8V/50 OHMS)	C-CG-10	WENZEL ELEKTRONIK	1	11/71	

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	LOGIC FUNCTION MODULES					
	DUAL GATE (4 INPUTS/GATE,LOGICAL AND/OR, NAND/NOR PERFORMED UNDER CONTROL)	7020-1	NUCL. ENTERPRISES	1	/70	
	FAN-OUT (3 INPUTS IN LOGICAL COMBINATION A.OR.B,A.OR.C,EACH WITH FAN-OUT OF 4)	7021-1	NUCL. ENTERPRISES	1	/70	
	SIX-FOLD CONTROLLED GATE (INDIV GATING, FAN-IN AND FAN-OUT CONTROLLED BY 3 REGS)	6CG 2017	SEN	1	11/71	(4)
	DELAY AND ATTENUATOR UNITS					
N	PROGRAMMIERBARER ABSCHWAECHER(256 STEPS OF DATAWAY-SET ATTENUATION,MAX +/-1000V)	DO 200-1051	DORNIER	2	/72	
	DUAL ATTENUATOR(50 OHMS,DATAWAY CONTROL-LED,RANGE 0DB TO 31DB IN 1DB STEPS)	9004	NUCL. ENTERPRISES	1	/71	
	ATTENUATEUR PROGRAMMABLE(MAN AND DATAWAY CONTROL OF ATTENUATION,0 DB TO 60 DB)	J AT 10	SAIP-CRC	3	10/70	
	CRATES- NO POWER, NO DATAWAY					
	CAMAC CRATE (EMPTY)	2.080.000.6	KNUERR	25	10/70	(2)
	CAMAC CRATE (EMPTY,INCL HARDWARE SUPPLY CHASSIS AND VENTILATION PANEL)	2.086.000.6		25		(2)
	CHASSIS CAMAC (6 UNITES AVEC FENTE DE VENTILATION, 525 MM PROFONDEUR)	9905-1-05	OSL	25	05/71	
	(360 MM PROFONDEUR)	9905-2-05		25	05/71	
	CHASSIS CAMAC POUR TIROIRS MODULAIRES, VIDES (EMPTY CRATES)		POLON	25	08/71	
	CAMAC SYSTEM BIN (WITH MODULAR SUPPLY)		RO ASSOCIATES	25	03/70	
	CRATE, EMPTY	C 76455-A3	SIEMENS	25	01/72	
N	CAMAC CRATE (EMPTY CRATE)	C	STND ENGINEERING	25		
N	CAMAC CRATE (EMPTY CRATE)	CS		25		
N	CAMAC CRATE (EMPTY)	WC	TECHCAL	25	/71	
	CHASSIS CAMAC NORMALISE 5U (EMPTY CRATE,360 MM DEEP)	CM 5025 30	TRANSRACK	25	10/70	
	(460 MM DEEP)	CM 5025 40		25		
	(525 MM DEEP)	CM 5025 50		25		
	CHASSIS CAMAC 5U UTILES (EMPTY CRATE,6U TOTAL,360MM DEEP,VENTILATION HARDWARE)	CM 5125 30	TRANSRACK	25	10/70	
	(460 MM DEEP)	CM 5125 40		25		
	(525 MM DEEP)	CM 5125 50		25		
	CHASSIS CAMAC 5U UTILES (EMPTY CRATE, TOTAL 6U,360 MM DEEP,WITH ONE FAN)	CM 5125 31	TRANSRACK	25	10/70	
	(460 MM DEEP)	CM 5125 41		25		
	(525 MM DEEP)	CM 5125 51		25		
	CHASSIS CAMAC 5U UTILES (EMPTY CRATE,6U TOTAL,360MM DEEP,WITH TWO FANS)	CM 5125 32	TRANSRACK	25	10/70	
	(460 MM DEEP)	CM 5125 42		25		
	(525 MM DEEP)	CM 5125 52		25		
C	CRATE (5U,EMPTY, 25 STATIONS)	MCF/5CAM/S/25	IMHOF-BEDCO	25	06/71	
N	(SAME BUT WITH 24 STATIONS)	MCF/5CAM/S/24		24	/72	
C	CRATE (6U,EMPTY,WITH VENTILATION BAFFLE, 25 STATIONS, HARWELL TYPE 7000)	MCF/6CAM/SV/25		25	/71	
N	(SAME BUT WITH 24 STATIONS)	MCF/6CAM/SV/24		24	/72	
C	CRATE (6U,EMPTY,WITH VENTILATION BAFFLE, REMOVABLE PANEL, 25 STNS, HARWELL 7000)	MCF/6CAM/SVR/25		25	/71	
N	(SAME BUT WITH 24 STATIONS)	MCF/6CAM/SVR/24		24	/72	
	CAMAC COMPATIBLE CRATE	NSI 875 DB/WV	NUCL. SPECIALTIES	25	02/70	
N	CAMAC CRATE	NSI 875 CC 100	NUCL. SPECIALTIES	25		(5)
C	VENTILATED CRATE NO POWER NO DATAWAY (TWO FANS)	CCHN	RDT	25	06/71	
N	(SAME WITH 3 FANS)	CCHNA		25	01/72	
	CAMAC CRATE (5U NON-VENTILATED,380 MM DEEP)	5UCAM	WILLSHER + QUICK	25	10/71	(2)
	(6U VENTILATED,NO FAN,380 MM DEEP)	6UCAM		25		(2)
	(6U VENTILATED RECESSED,NO FAN,430 MM)	6URCAM		25		(2)

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	CAMAC HEAVY DUTY CRATE (WITH DEPTH OPTIONS: *=S FOR 380MM, *=E FOR 525MM, *=TP FOR 525MM 2-PIECE VERSION)		WILLSHER + QUICK			
N	5U NON VENTILATED	HD5U CAM(*)		25	/72	(5)
N	6U VENTILATED(**=G FOR ADDITIONAL GRILL)	HD6U CAM(*)**		25	/72	(5)
N	7U VENTILATED(**=G FOR ADDITIONAL GRILL)	HD7U CAM(*)**		25	/72	(5)

CRATES- WITH DATAWAY, NO POWER

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	CAMAC-RAHMEN MIT DATENWEG	1250-0001	DUCKERT	25	/72	
	VENTILATED CRATE	VC 0010	GEC-ELLIOTT	24		
N	VENTILATED CRATE	VC 0020	GEC-ELLIOTT	25	04/72	
	CAMAC CRATE VERDRAHTET (EMPTY CRATE WITH WIRED DATAWAY)	2.084.000.6	KNUERR	25	10/70	(2)
C	UNPOWERED CRATE WITH F.P.C. DATAWAY	9	MB METALS	25	01/72	
	CRATE	7005-2	NUCL. ENTERPRISES	24	/70	
C	UNPOWERED CRATE WITH DATAWAY ( )	CM 5125/33/AW	SAPHYMO-SRAT	25	/71	
C	(360 MM)	CM 5125/33/DW		25		
C	( )	CM 5125/53/AW		25		
C	(525 MM)	CM 5125/53/DW		25		
	UNPOWERED CRATE WITH DATAWAY AND CONNECTORS	UPC 2029	SEN	25	/70	
N	CRATE (WIRED CRATE)	WCS	STND ENGINEERING	25		(5)

CRATES- WITH DATAWAY AND POWER

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	CRATE, POWERED (SEE 1902,1912,1922)	1902/12/22	BORER	25	/70	
	CRATE MAINFRAME (CRATE SYSTEM INCLUDING THE FOLLOWING)	1902	BORER	25	12/69	
	POWER PACK, 270 VA	1912			12/69	
	VOLTAGE REGULATION MODULE (+AND- OF 6V/9A,12V/8A,24V/7A)	1922			12/69	
C	REGULATOR (+OR-6V, 25A, 200W RATING)	1925			/71	
	ALARM UNIT	1930			12/69	
	ALARM UNIT (ALTERNATIVE TO 1930)	1931			12/69	
	CRATES WITH DATAWAY AND POWER	1250-0006	DUCKERT	25	06/71	
	CAMAC-RAHMEN MIT DATENWEG UND DREHSTROMNETZGERAET (POWERED CRATE)	1250-0021	DUCKERT	25	/72	
	CAMAC-RAHMEN MIT DATENWEG UND 220 V 50 HZ NETZGERAET (POWERED CRATE)	1250-0022	DUCKERT	25	/72	
	POWERED CRATE	MC100	EG+G	25	/71	
N	VENTILATED CRATE (WITH POWER)	VC 1010	GEC-ELLIOTT	24	/71	
N	VENTILATED CRATE (WITH POWER)	VC 1020	GEC-ELLIOTT	25	04/72	
	POWERED CRATE (+AND-6V/25A,+AND-24V/6A)	CPU/8	GRENSON	24	09/71	(2)
C	CRATE WITH F.P.C. DATAWAY AND POWER RAIL ASSEMBLY	TYPES 1,2,5,6	MB METALS	25	01/72	
	POWER CRATE (7005-2 CRATE WITH 9022 POWER SUPPLY)	9023	NUCL. ENTERPRISES	24	/71	(2)
	CHASSIS ET TIROIRS AVEC ALIMENTATION (POWERED CRATE)		POLON	25	08/71	
	POWERED CRATE	CCHN-CSAN	RDT	25	10/71	
	CHASSIS ALIMENTATION (POWERED CRATE, VENTILATED,+6V/25A,-6V/15A,+AND-24V/3A)	C ALJ 40	SAIP-CRC	25	11/71	
	POWERED CRATE(SEE P4 ALJ 13)	C4 ALJ 13 D	SAPHYMO-SRAT	25	/71	(1)
	POWERED CRATE(SEE P6 ALJ 13)	C6 ALJ 13 D		25		(1)
C	POWERED CRATE(SEE P7 ALJ 13)	C7 ALJ 13 DW		25		(1)
C	POWER SUPPLY (CAMAC CRATE)	CM5125/53/DW/BIP	SAPHYMO-SRAT	25	/72	
C	POWER SUPPLY (CAMAC CRATE)	CM5125/53/AW/BIP		25		
	POWER CRATE (200W MAX,+6V/25A,-6V/10A, +AND-12V/3A,+AND-24V/3A,200V/0.05A)	PC 2006/B	SEN	25	05/70	
	POWER CRATE (200W MAX,+6V/25A,-6V/10A, +AND-24V/3A,200V/0.05A)	PC 2006/C		25	11/71	
	POWERED CRATE (7U,VENT,+AND-6V/26A,+AND-12V/6.5A,+AND-24V/6.5A,200V/0.1A,200W)	C 76455-A2	SIEMENS	25	10/71	(3)
	POWERED CRATE (SAME BUT WITH 117V AC)	C 76455-A1		25	10/71	
N	POWERED CRATE (+AND-6V/25A, +AND-24V/6A, OPTIONAL +AND-12V/3A,+AND-200V/0.1A)	PCS	STND ENGINEERING	25		(5)

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
N	POWERED CRATE SYSTEM	1410-PPC	TECHCAL	25	/71	

POWER SUPPLIES AND SUPPLY CONTROLS

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	POWER SUPPLY (+AND-6V/25A,+AND-24V/5A,200V)	PS 0002	GEC-ELLICTT		01/71	
	COMPACT POWER SUPPLY UNIT 200/300W	PS 0003	GEC-ELLIOTT		10/71	
	CAMAC POWER SUPPLY (+6V/20A,-6V/5A,+AND-24V/5A,200V/0.05A)	CPU/2	GRENSCN		04/71	
	SAME WITH SWITCHED METERING	CPU/2M			04/71	
	POWER SUPPLY (+6V/20A,-6V/5A, +AND-12V/2A,+AND-24V/3A)	CPU/5	GRENSCN		04/71	
	POWER SUPPLY (RACK MOUNTING,+6V/25A, -6V/15A,+AND-24V/5A,200V/0.1A)	CPU/6	GRENSON		07/71	
	POWER SUPPLY (RACK MOUNTING,+6V/25A, -6V/15A,+AND-24V/5A,+AND-12V)	CPU/7	GRENSCN		07/71	
	CRATE WITH F.P.C. POWER RAIL ASSEMBLY	TYPES 3,4,7,8	MB METALS		01/72	
	POWER SUPPLY (+6V/20A,-6V/5A, +AND-24V/5A,200V/0.05A)	9001	NUCL. ENTERPRISES		/71	
	POWER UNIT (+6V/15A,-6V/3A, +AND-24V/2A,200V/0.05A)	9022	NUCL. ENTERPRISES		/71	(2)
	POWER SUPPLY (+AND-6V/25A SHARED,+AND-12V/2A,+AND-24V/6A SHARED,200V)	1031	B.L.PACKER		02/71	
	POWER SUPPLY (+6V/25A,-6V/5A, +AND-12V/2A,+AND-24V/3A,200V/0.1A)	C 303	RDT		06/71	
	POWER SUPPLY UNIT (+6V/10A,-6V/2A,+AND-24V/1.5A)	P4 ALJ 13	SAPHYMC-SRAT		/71	
	(+6V/5A,-6V/1.5A,+AND-12V/1.5A, +AND-24V/1.5A)	P6 ALJ 13				
	(+6V/25A,-6V/10A,+AND-12V/3A, +AND-24V/3A,+200V/0.1A,MAX 200W)	P7 ALJ 13				
	SUPPLY (+AND-6V/26A,+AND-12V/6.5A,+AND-24V/6.5A,200V/0.1A,117V AC, 200W MAX)	C 76455-A4	SIEMENS		01/72	
	SUPPLY (SAME BUT WITHOUT 117V AC)	C 76455-A5			01/72	
N	POWER SUPPLY AND BLOWER UNIT	1410 S	STND ENGINEERING			(5)
N	CAMAC POWER SUPPLY(+AND-6V/25A MAX 150W, +AND-24V/6A MAX 150W,12V AND 200V CPT)	1410	TECHCAL		/71	
	POWER SUPPLY FLEXIBLE SYSTEM COMPRISING	CPU/1	GRENSCN		07/71	
	BASIC CRATE(FOR SUPPLY MODULES,INCLUDES REFERENCE,CONTRCL AND 200V/0.1A)	CFC				
	SUPPLY MODULE (+6V/6A)	CFP/6				
	(-6V/6A)	CFM/6				
	(+12V/3A)	CFP/12				
	(-12V/3A)	CFM/12				
	(+24V/3A)	CFP/24				
	(-24V/3A)	CFM/24)				
	POWER UNIT(FOR SUPPLY MODULES)		RO ASSCCIATES		06/71	
	CAMAC SYSTEM POWER SUPPLY MODULE (+AND-12V/72W, OR +12V/6A OR +24V/3A)	C 301			03/70	
	(6V/10A)	C 210			03/70	
	(6V/5A AND 24V/1A)	C 211			03/70	
	(6V/5A, +12V/0.4A, -12V/0.4A)	C 213			03/70	
	(12V/4A)	C 250			06/71	
	(24V/2A)	C 251			06/71	
	POWER SUPPLY SYSTEM (CRATE) (MODULE OPTIONS AS FCLLOWS)	C4 BIP 203	SAPHYMC-SRAT		/72	
	POWER SUPPLY MODULE 6 V 10 A	BIP B6 10				
	6 V 15 A	BIP C6 15				
	6 V 20 A	BIP D6 20				
	6 V 40 A	BIP E6 40				
	12 V 7 A	BIP B12 7				
	12 V 10 A	BIP C12 10				
	12 V 15 A	BIP D12 15				
	12 V 25 A	BIP E12 25				
	24 V 3.5A	BIP B24 35				
	24 V 6 A	BIP C24 6				
	24 V 9 A	BIP D24 9				
	24 V 15 A	BIP E24 15				

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	SUPPLY CHASSIS 2KW (RAW SUPPLY FOR REGULATOR MODULES)	ALB/10	SAPHYMO-SRAT		/72	(2)
	FAN UNIT	VALB/10				
	WIRED RACK 42 U	BC 42				
	POWER SUPPLY MODULE 6 V 5 A(REGULATOR)	BPR 605				
	6 V 10 A	BPR 610				
	6 V 25 A	BPR 625				
	12 V 2 A	BPR 122				
	12 V 5 A	BPR 125				
	24 V 3 A	BPR 243				
	24 V 5 A	BPR 245				
	VOLTAGE MONITOR PANEL	MP 1	GEC-ELLIOTT	1	01/71	
	MAINS SWITCH ASSEMBLY	MS 3	GEC-ELLIOTT	NA	01/71	
N	POWER SUPPLY MONITOR PANEL (WITH MAINS SWITCH, TEST POINTS AND LED INDICATION)	PS/MP 1	GEC-ELLIOTT	NA	04/72	
	SUPPLY CONTROL INDICATOR		B.L.PACKER	1	07/71	
	TIROIR MODULAIRE DE COMMANDE (SUPPLY CONTROL MODULE)	TCM 525	TRANSRACK	1	10/70	
N	POWER SUPPLY CRATE (STANDARD)	MCF/4/PPC	IMHOF-BEDCO	NA	/71	
N	POWER SUPPLY CRATE (WIRED)	MCF/PPC/WV		NA	/71	
	NETZTEILCHASSIS (EMPTY SUPPLY CHASSIS)	2.082.000.6	KNUERR		10/70	
	POWER UNIT CRATE	0700	NUCL. ENTERPRISES		01/71	
	POWER SUPPLY CRATE(FOR SEPARATE SUPPLY)	CSAN	RDT		06/71	

VENTILATION EQUIPMENT

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
N	COOLING DRAWER (2 FANS,FITS 6U CRATE)	CDR 1	GEC-ELLIOTT		04/72	
N	COOLING DRAWER (WITH SWITCH,FUSE,TEST SOCKETS,LEDS AND FANS, FOR PS 0003)	CDR 2	GEC-ELLIOTT		04/72	
N	VENTILATION UNIT	CAM/FV	IMHOF-BEDCO		01/73	
	LUFTEREINHEIT (VENTILATION UNIT,COMPLETE WITH 3 FANS AND FILTER)	2.081.000.6	KNUERR		10/70	
	(VENTILATION UNIT,NO FAN,NO FILTER)	2.085.000.6				
	FAN UNIT (FOR ALB/10 SUPPLY SYSTEM)	VALB/10	SAPHYMO-SRAT		/72	
N	CRATE BLOWER UNIT		STND ENGINEERING			(5)
	VENTILATION UNIT	1UVCAM	WILLSHER + QUICK		10/71	(3)
N	1U VENTILATION GRILL	1 UG	WILLSHER + QUICK		/72	
N	2U VENTILATION GRILL	2 UG			/72	

EXTENDERS AND ADAPTERS

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
C	EXTENSION FRAME	EF 1-1	GEC-ELLIOTT	1	10/71	
N	EXTENDER MODULE	EX	JOERGER	1	06/72	
	EXTENDER MODULE	11	JORWAY	1	01/71	
	EXTENDER CARD	1000	KINETIC SYSTEMS	1	/71	(4)
	EXTENSION UNIT	7007-1	NUCL. ENTERPRISES	1	/70	
	EXTENDER	CEX	RDT	1	/72	
	MODULE EXTENDER	ME 2030	SEN	1	03/70	
N	EXTENDER (XX=LENGTH OF CABLE IN CM BEYOND RACK)	CAMEX/XX	TEKDATA	1	05/72	(5)
	PROLONGATEUR POUR TIROIRS CAMAC (EXTENDER)		TRANSRACK	1	10/70	
	NIM ADAPTOR	7009-2	NUCL. ENTERPRISES	NA	/70	
	CAMAC NIM ADAPTOR	CNA 2033	SEN	NA	03/71	
	NIM-CAMAC ADAPTOR	CAN	RDT	NA	06/71	

MODULE PARTS

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	BLANK MODULE KIT (SINGLE WIDTH)	BM 1	GEC-ELLIOTT	1	01/71	
	(DOUBLE WIDTH)	BM 2		2		
	(TRIPLE WIDTH)	BM 3		3		
	(QUADRUPLE WIDTH)	BM 4		4		

	NC DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	SINGLE CARD MOUNTING KIT (EMPTY MODULE)	BCK/5CAM/CM1	IMHOF-BEDCC	1	06/71	
	DOUBLE CARD MOUNTING KIT	BCK/5CAM/CM2		2		
	TRIPLE CARD MOUNTING KIT	BCK/5CAM/CM3		3		
	QUADRUPLE CARD MOUNTING KIT	BCK/5CAM/CM4		4		
	DOUBLE ENCLOSED BIN KIT (EMPTY MODULE)	BCK/5CAM/BM2	IMHOF-BEDCC	2	06/71	
	TRIPLE ENCLOSED BIN KIT	BCK/5CAM/BM3		3	06/71	
	QUADRUPLE ENCLOSED BIN KIT	BCK/5CAM/BM4		4	06/71	
N	SINGLE CARD MOUNTING KIT (EMPTY MODULE, SHORT SCREEN PLATE)	CAM/M1/A	IMHOF-BEDCC	1	09/72	
N	(SAME WITH LONG SCREEN PLATE)	CAM/M1/B		1	09/72	
N	DOUBLE CARD MOUNTING KIT (EMPTY MODULE, SHORT SCREEN PLATE)	CAM/M2/A		2	01/73	
N	(SAME WITH LONG SCREEN PLATE)	CAM/M2/B		2	01/73	
N	TREBLE CARD MOUNTING KIT (EMPTY MODULE, SHORT SCREEN PLATE)	CAM/M3/A		3	01/73	
N	(SAME WITH LONG SCREEN PLATE)	CAM/M3/B		3	01/73	
N	QUADRUPLE CARD MOUNTING KIT (EMPTY MODULE WITH SHORT SCREEN PLATE)	CAM/M4/A		4	01/73	
N	(SAME WITH LONG SCREEN PLATE)	CAM/M4/B		4	01/73	
	KLUGE CARD (FOR CREATING YOUR OWN CAMAC MODULES)	2000		1	/71	(4)
	CAMAC-KASSETTE (EMPTY MODULE,WIDTH 1/25)	2.090.001.8	KNUERR	1	10/70	(2)
	(WIDTH 2/25)	2.090.002.8		2		
	(WIDTH 3/25)	2.090.003.8		3		
	(WIDTH 4/25)	2.090.004.8		4		
	(WIDTH 5/25)	2.090.005.8		5		
	(WIDTH 6/25)	2.090.006.8		6		
	MODULE KIT (EMPTY MODULE,1 UNIT WIDTH)	9005-1	NUCL. ENTERPRISES	1	/71	
	(EMPTY MODULE,2 UNIT WIDTH)	9005-2		2	/71	
	CAMAC COMPATIBLE MODULE (EMPTY MODULE,1 UNIT WIDTH)	NSI 875 DM	NUCL. SPECIALTIES	1	02/70	
	(2 UNIT WIDTH)			2		
	(3 UNIT WIDTH)			3		
N	CAMAC MODULE (EMPTY MODULE HARDWARE, APACERS ESTABLISH MODULE WIDTH)	NSI 875 CM-100	NUCL. SPECIALTIES			(5)
	TIROIR MODULAIRE (W=1/25)	9905-1-L	OSL	1	05/71	
	(W=2/25)	9905-2-L		2	05/71	
	(W=3/25)	9905-3-L		3	05/71	
	(W=4/25)	9905-4-L		4	05/71	
	(W=5/25)	9905-5-L		5	05/71	
	(**=06,08,10 AND 12 FOR CORRESP WIDTH)	9905-**-L			05/71	
	EMPTY MODULE 1 UNIT	CCA 1	RDT	1	10/70	
	2 UNITS	CCA 2		2		
	3 UNITS	CCA 3		3		
	4 UNITS	CCA 4		4		
N	MODULE HARDWARE (EMPTY MODULE, W=1/25)		STND ENGINEERING	1		
N	(W=2/25)			2		
N	(W=3/25)			3		
N	(WIDTHS UP TO 8/25)					
	BLANK MODULE WITH 60 WIRE-WRAP SOCKETS	WW-001	TECHCAL	2	/72	
	BLANK MODULE WITH 56 WIRE-WRAP SOCKETS AND COMPLETE DECODING OF A AND F LINES	WW-002		2	/72	
	TIROIR MODULAIRE (EMPTY MODULE,W=1/25)	TM 50125	TRANSRACK	1	10/70	
	(W=2/25)	TM 50225		2		
	(W=3/25)	TM 50325		3		
	(W=4/25)	TM 50425		4		
	(W=5/25)	TM 50525		5		
	(**=06,08,10 AND 12 FOR CORRESP WIDTH)	TM 5**25				
	CAMAC MODULE (EMPTY,1/25 CARD MODULE)	CAMCAS 1	WILLSHER + QUICK	1	10/71	(2)
	(2/25)	CAMCAS 2		2	10/71	(2)
	(3/25)	CAMCAS 3		3		(2)
	(4/25)	CAMCAS 4		4		(2)
N	CAMAC MODULE (EMPTY,1/25 CARD MODULE)	CAMCAS 1-G	WILLSHER + QUICK	1	/72	
N	(2/25)	CAMCAS 2-G		2	/72	
N	(3/25)	CAMCAS 3-G		3	/72	
N	(4/25)	CAMCAS 4-G		4	/72	
N	CAMAC MODULE(EMPTY,1/25 SCREENED MODULE)	CAMMOD 1-G	WILLSHER + QUICK	1	/72	
N	(2/25)	CAMMOD 2-G		2	/72	
N	(3/25)	CAMMOD 3-G		3	/72	
N	(4/25)	CAMMOD 4-G		4	/72	
	CAMAC MODULE(EMPTY,2/25 SCREENED MODULE)	CAMMOD 2	WILLSHER + QUICK	2	10/71	(2)
	(3/25)	CAMMOD 3		3		(2)
	(4/25)	CAMMOD 4		4		(2)
	BLANK MODULE(COMPLETE WITH PRINTED BOARD FOR 69 INTEGRATED CIRCUITS,1 U WIDTH)	BM 2020/1U	SEN	1	/70	
	(SAME,2U WIDTH)	BM 2020/2U		2	/70	
	CAMAC HARDWARE	CH-001	KINETIC SYSTEMS	1	/71	(4)
	TIROIR MODULAIRE POUR COMMANDE	9905-TC-1	OSL	1	05/71	
C	CAMAC-UNIVERSALKARTE (PRINTED CARD MODULE WITH 28 14-PIN + 28 16-PIN SOCKETS)	DO 200-2900	DORNIER	2	11/71	

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	PC BOARD (MX B1 HAS 68 SITES, MX B2 HAS 80 SITES)	MX B1/MX B2	GEC-ELLIOTT	NA	10/71	
	(MX B3 HAS 68 SITES,MX B4 HAS 80 SITES, MX B3/MX B4 INCLUDE 5V CIRCUIT)	MX B3/MX B4		NA	10/71	
	GENERAL PURPOSE IC PATCHBOARD (MAX 33 14/16-PIN AND 5 24-PIN DIP,WIRE WRAP)	CAMAC CG 164	GSPK	NA	12/70	(2)
	PRINTED CIRCUIT TEST BOARD	10	JORWAY	NA	01/71	
	EXPERIMENTIERPLATTE (PRINTED CIRCUIT BOARD)	4.000.002.0	KNUERR	NA	10/70	
N	TIROIR MODULAIRE A CARTES BASCULANTES (EMPTY MODULE WITH HINGED CARDS, W=2/25)	9905-TCB2	OSL	2	/71	
N	(SAME, W=3/25)	9905-TCB3		3	/71	
C	MODULE PRINTED CIRCUIT BOARDS(TAKE 24,16 OR 14 PIN, ON THE WHOLE 1092 PINS)	CBP 1	RDT	NA	01/72	
C	(SAME, WITH MINI-WRAP TO OV AND +6V)	CBP 2	RDT	NA	01/72	
N	EXPERIMENT PLATE	C 72468-A453-A1	SIEMENS	0		
	CONTROLEUR SORTIE DATAWAY (DATAWAY TEST MODULE)		TRANSRACK	1	10/70	
	CARTE CIRCUIT IMPRIME CAMAC (PRINTED CIRCUIT BOARD FOR CAMAC MODULE)		TRANSRACK	NA	10/70	
N	CAMAC PRINTED CARD		KNUERR			(5)

DATAWAY COMPONENTS

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
C	DATAWAY CONNECTOR, EDGE TYPE II	163633	AMP-HOLLAND		/70	
	DATAWAY CONNECTOR,FLOWSOLDER TERMINATION (ADD MOUNTING BRACKETS R500014900000000)	R500014800000000	CARR FASTENER		10/70	
	MINI WRAP TERMINATION	R500016800000000			10/70	
	SOLDER SLOT TERMINATION				10/70	
	CONNECTEUR,FUTS DROITS (DATAWAY CONNECTOR,STRAIGHT PINS)	K/47995	FRB CONNECTRON		01/70	
	FUTS WRAPPING (WIRE WRAP PINS)	K/48326				
	FUTS A SOUDER (SOLDER PINS)	K/49016				
	CAMAC-LEISTE(DATAWAY CONNECTOR,MINIWRAP)	4.000.000.0	KNUERR		10/70	
	(SOLDER PINS)	4.000.001.0				
	DATAWAY CONNECTOR,MINI-WRAP	2422 061 64334	PHILIPS		09/71	(5)
	BOARD SOLDER	2422 061 64354				(5)
	WIRE-SOLDER	2422 061 64314				(5)
N	DATAWAY MALE CONNECTOR (MATING THE CRATE MOUNTED 86-WAY CONNECTOR SOCKET)	2422 060 14314	PHILIPS			(5)
	DATAWAY CONNECTOR (MINIWRAP)	EAA 043 D301	SABCA		06/71	(2)
	CONNECTEUR 254 DOUBLE FACE (DATAWAY CONNECTOR,WIRE WRAP)	254 DF 43 AWV	SOCAPEX		01/70	
	(MOTHERBOARD SOLDER)	254 DF 43 AYV			01/70	
	(WIRE SOLDER)	254 DF 43 AZV			01/70	
	DATAWAY CONNECTOR (**=15 FOR MINIWRAP, ALSO SOLDER LUG AND FLOW SOLDER TYPES)	86068621**000	SOURIAU		11/71	
	DATAWAY CONNECTOR (*=2 FLOW SOLDER,*=3 SOLDER LUGS,*=4 MINIWRAP,AU PLATING)	C 288* CSP 221	UECL		11/71	
	(FLOW SOLDER,NI + AU PLATING)	C 2885 CSP 221				
	(13 M2NIWRAP CONTACTS,OTHER ARE FLOW SOLDER,NI + AU PLATING)	C 2886 CSP 221				
	(*=7 MINIWRAP,*=8 SOLDER LUGS, NI + AU PLATING)	C 288* CSP 221				
N	MOUNTING BRACKETS FOR ABOVE	C 8523				
	DATAWAY SOCKET (MOTHERBOARD COMPLETE WITH 25 CONNECTORS)	CIM	RDT		/70	
	DATAWAY ASSEMBLY (FILM WIRE PACKAGING)		MB METALS		07/71	(3)
C	DATAWAY MINI WRAPPING (MOTHERBOARD WITH 25 DATAWAY CONNECTORS)	J/DW	SAPHYMO-SRAT		11/71	
	CAMAC MULTILAYER (DATAWAY MOTHERBOARD)	CM-8-69	TECH AND TEL		08/71	

BRANCH HIGHWAY COMPONENTS

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	BRANCH HIGHWAY CONNECTOR (FIXED MEMBER,SOCKET MOULDING)	WSS0132S00BN000	EMIHUS-SABCA		10/70	
	(FREE MEMBER,PIN MOULDING, PXX YYY SELECTS JACKSCREW)	WSS0132PXXBNYYY				
	HOOD (FOR FREE MEMBER)	WAC 0132 H005				
	BRANCH HIGHWAY CABLE (132-WAY)	LIY-Y72X2X0.088	LEONISCHE		04/72	

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
N	BRANCH HIGHWAY CABLE ASSEMBLY (COMPLETE WITH CONNECTORS, LENGTH 27 CM)	BHC 27	BENNEY		05/72	
N	(SAME, XXX=LENGTH IN CM, 040,100 ETC)	BHC XXX			05/72	
N	BRANCH HIGHWAY CABLE	BH001	EG+G		/71	
	BRANCH HIGHWAY CABLE (COMPLETE PTFE CABLE ASSEMBLY,27CM LONG)	CD 18067-27	EMIHUS		10/70	
	(1 METER LONG)	CD 18067/107			11/71	
	(2 METERS LONG)	CD 18067/207			11/71	
N	BRANCH HIGHWAY CABLE (WITH CONNECTORS, 27 CM LONG)	BHC 027	GEC-ELLIOTT		04/72	
N	(SAME, 67 CM LONG)	BHC 067			04/72	
N	(SAME, 107 CM LONG)	BHC 107			04/72	
N	(SAME, 207 CM LONG)	BHC 207			04/72	
N	EXTENDED BRANCH CABLE ONLY (IN METRES)	EBC XXXX	GEC-ELLIOTT		04/72	
	BRANCH CABLE WITH CONNECTOR (1.5 FT LONG)		JORWAY		03/71	
	CABLE FOR BRANCH HIGHWAY (PVC JACKET)	132 PE 189	PRECICABLE BOUR		10/71	
	(BRAIDED RILSAN JACKET)	132 PE 210				
	BRANCH HIGHWAY CABLE ONLY (PLAIN PVC JACKET)	66 POL PB	SABCA		06/71	
C	BRANCH HIGHWAY CABLE ASSEMBLY (WITH CONNECTORS,27 CM LONG)	CC 66 POL PB-27	SABCA		06/71	
	(XX CM LONG,PVC JACKET)	CC 66 POL PB-XX				
	CABLE POUR BRANCH HIGHWAY (66 PAIRES TORSADEES,66 TWISTED PAIRS)	CL 90	SAIP-CRC		11/71	
	BRANCH HIGHWAY CABLES(COMPLETE WITH CONNECTOR,XXX = LENGTH IN METERS)	2000/S/0132/XXX	TEKDATA		08/71	(4)
	CABLE EXTENSION MODULE (JOINS TWO BRANCH HIGHWAY CABLES)	CD 18106	EMIHUS		/72	

OTHER STANDARD CAMAC COMPONENTS

NC	DESIGNATION + SHORT DATA	TYPE	MANUFACTURER	WIDTH	DELIV.	NPR
	COAXIAL CONNECTOR	RA 00 C50	LEMO		01/70	(4)
	52-WAY DOUBLE DENSITY CONNECTOR (FIXED MEMBER WITH PINS.LAM GRADER CONNECTOR)	2 DB 52 P	CANNON		10/70	
N	LAM GRADER CABLE (20CM, WITH CONNECTORS)	LGC 20	GEC-ELLIOTT		04/72	
N	(40CM, WITH CONNECTORS)	LGC 40			04/72	

Note

Manufacturers requiring their new products to appear in the PRODUCT GUIDE Section or intending to complete or correct information presented already should submit data on each item separately and, preferably, in the format used in this issue.

INDEX OF MANUFACTURERS

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N Nano Systems
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C Nuclear Enterprises Ltd.
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C Nuclear Specialties Inc.
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OSL — See Société Outillage

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Packer – See B. L. Packer

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Centre d'Instrumentation Nucléaire
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C Souriau et Cie
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N Standard Engineering Corporation
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Fremont, California 94 538, USA

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Technograph and Telegraph Ltd.
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Highbridge, Somerset, England

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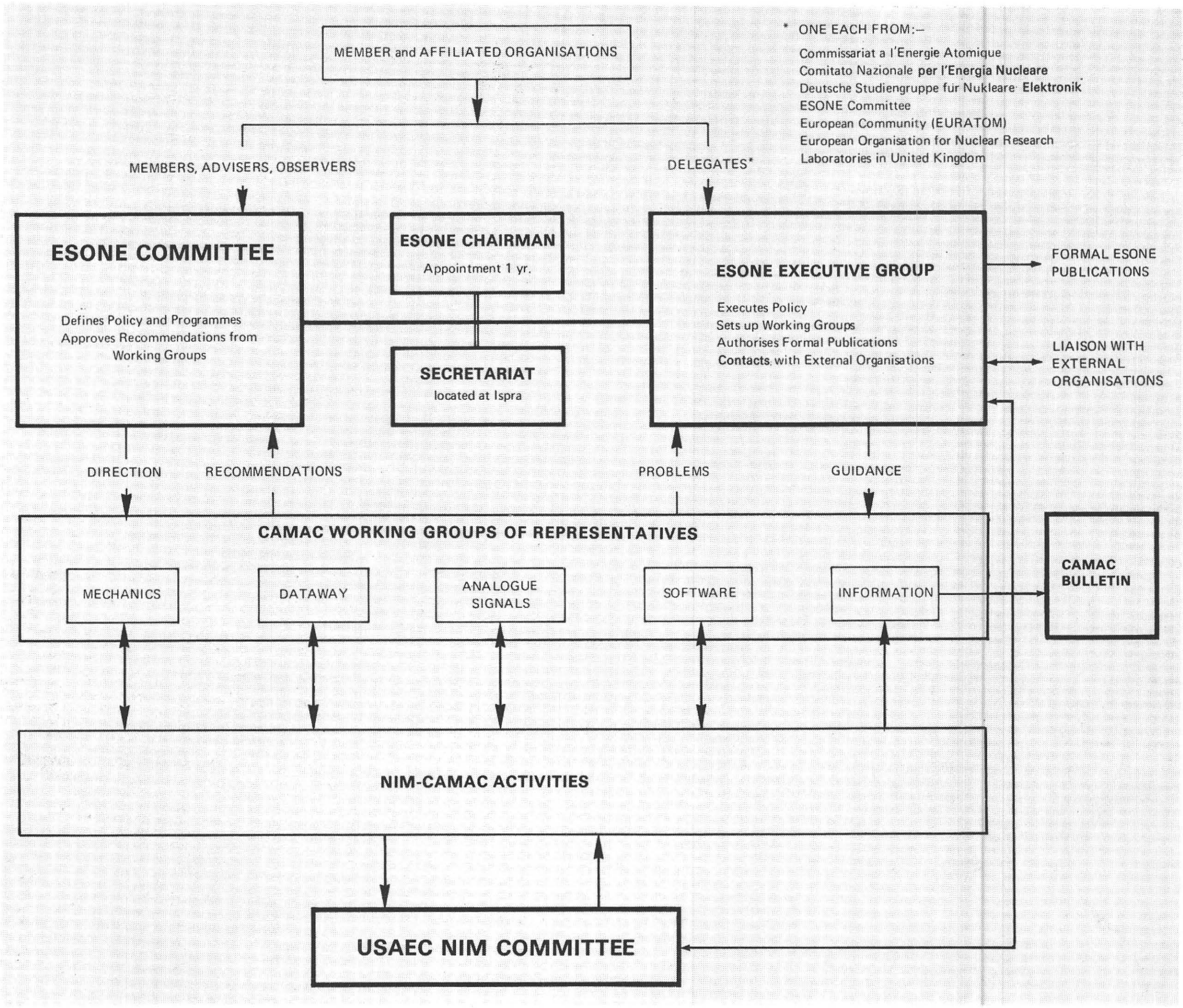

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