CAMAC—system design made easy

Not so many years ago oscilloscopes were being designed and built by research scientists for use in their own experiments. Today such a situation is rare. Oscilloscopes have become standard items that are commercially available but the need for complex electronics to collect data and control experiments has increased. Many research groups are once again facing the problem of designing and building complex data processing systems.

The use of small on-line computers is not a complete solution. A computer is often necessary to handle the volume and rate of data but it must still be connected to the experiment. To make progress in research an experimenter must acquire considerable expertise in computer science and electronics engineering. The problem first became acute in nuclear physics, and a standardised solution was sought. Big science could afford to provide professional support teams to design and build interface electronics and the expertise and experience of these teams have ensured that the solution is tailored to the needs of the research scientist.

The solution is called CAMAC. It has been commercially produced for some years now, it works and is available internationally at a reasonable price. More and more areas of research are turning to computer based systems and the existence of CAMAC ensures that the link between the computer and the experiment can be implemented painlessly.

The following three articles, written by recognised experts in the field, introduce the CAMAC system. They illustrate what CAMAC is, why it is used and how it is used. We hope that this introduction will remove many of the problems often associated with the use of small computers and will ensure that progress in research will be able to take full advantage of progress in electronics.

CAMAC specifications are now available as international and national standards. Further information and details of how to obtain documentation can be obtained from the following:

L. Costrell
National Bureau of Standards,
Washington, D.C. 20234

H. Meyer
ESONE/ECA Secretariat
Commission des Communautés Européennes,
CCR–BCMN, B–2440 Geel, Belgium

Introduction to the interface standards

Formally, the name 'CAMAC' denotes a set of standards for computer interface equipment. Informally it is applied to 'CAMAC equipment' which conforms to these standards and to 'CAMAC systems' assembled from this equipment. The CAMAC standards were originally developed to meet the needs of large-scale data acquisition systems for nuclear physics research. There have been other large-scale applications in computer control of processes and plant in industry and laboratories.

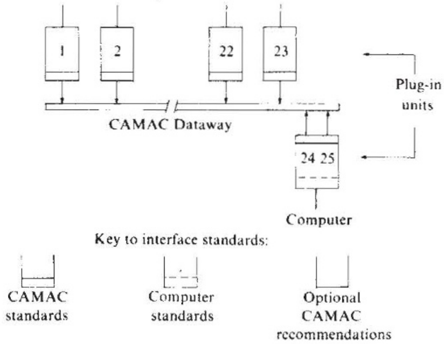
The following description of CAMAC is concerned mainly with the important but less spectacular field of application to small or medium computer-systems for automated control and data-acquisition in a wide variety of laboratories. On-line systems involve connections between the computer and various control and measuring devices. These may use analogue signals (voltage, frequency, time, pulse-rate, and so on) or digital signals. The connection to the computer must use the particular input–output interface standard adopted by the computer manufacturer. CAMAC offers a powerful and flexible means of matching the differing standards of the computer and the external devices.

The basic principle of CAMAC (Fig. 1) is an assembly of plug-in modular units, one of which is connected to the computer and the others to various external devices and signals. The units are linked by a multi-wire highway (the CAMAC Dataway) which is an integral part of the chassis housing the plug-ins. Each plug-in occupies a multiple of 1/25th of the width of the chassis (Fig. 2), and generally has front-panel connections to external devices and signals, and rear connections to the Dataway highway. The Dataway carries signals for digital data and for control of data transfers, and also distributes power. The specification defines the mechanical dimensions of the plug-ins and their interface to the highway in just sufficient detail to ensure that any plug-in will fit into the chassis and communicate by the highway. It leaves complete freedom to design plug-ins with a wide variety of facilities and external interfaces, and to use appropriate materials, components and styling. A typical highway operation takes 1 μs to address a plug-in module and transfer to or from the computer a data word containing up to 24 bits. This is faster than the sustained data rate of most computers, but slow enough to be technically conservative.

The symmetrical name 'CAMAC' was chosen to symbolise this assumbly of plug-ins facing in one direction to the computer and the other to the external devices. The name is now usually assumed to stand for 'computer automated measurement and control', which is a good indication of the main areas of application.

The CAMAC standards were developed by an international group representing users' interests in developing and applying laboratory instrumentation systems. The main standards[1–3] and other subsidiary standards were published by the Commission of the European Communities, and were also published in identical form in the US. They are now being re-issued by the International Electrotechnical Commission and by various national standards organisations.

Fig. 1 Basic small CAMAC system.



CAMAC is a standard that encourages manufacturers to produce compatible products which can then be assembled into systems by or for the users. It has led to the commercial production of over 1,000 plug-ins, together with supporting products such as the chassis, by 29 firms in many countries, often with the assistance and involvement of major users.

The main strength of CAMAC lies in the many hundreds of different types of plug-ins that face outwards to the external devices and signals. The functional characteristics and external interfaces of these plug-ins are determined by the users' needs and by market forces, rather than by the CAMAC specification. They range from quite simple units in one module of width through to highly complex units that may occupy two or more modules of width and may include a microprocessor. Some indication of the rich variety of these units can be seen from the following examples:

- General purpose units to accept or deliver digital signals, typically following CAMAC recommended practice for front-panel interfaces based on TTL circuit technology, and so suitable for use with the majority of modern items of equipment.
- Units to accept or deliver specialised signals, such as peak-sensing analogue-to-digital converters for the nuclear field.
- Units that are instruments in their own right, such as digital voltmeters in CAMAC units.
- Units that communicate with external instruments, for example through parallel digital interfaces or the General Purpose Instrument Bus.
- Units that are connected by communication links to peripherals such as teletypes or VDUs, or to a host computer.