System Architecture

3600

RC 3600
System Architecture

A/S REGNECENTRALEN
Information Department

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Author: Henning Christensen
Text editor: David McLeod

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ABSTRACT: This manual describes the structure of the RC 3600 system, both hardware and software, and gives a brief explanation of how the RC 3600 can be used and operated.

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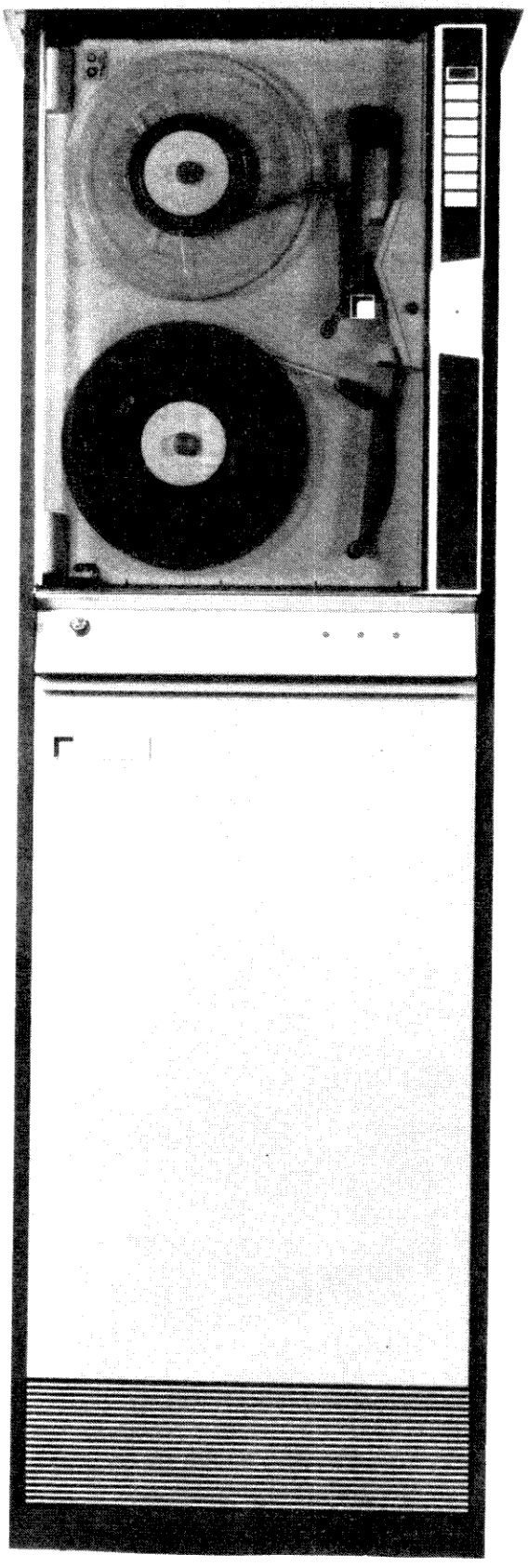
1 Introduction

The RC 3600 is an intelligent system, reliable and flexible. Because of its intelligence, the system possesses a great capability in handling peripheral devices, as well as it may operate as a stand-alone system.

The RC 3600 is a system composed of hardware and software. The underlying hardware supplies reliability and simplicity of operation. The superimposed software provides flexibility and wide capability.

The division of tasks between hardware and software assures the best performance for the lowest cost, each component contributing those performance elements for which it is best suited.

This manual describes the RC 3600 hardware, systems software, and user software, and provides a brief survey of some typical applications.



An RC 3600 System

2 The RC 3600 System

2.1 RC 3600 Hardware

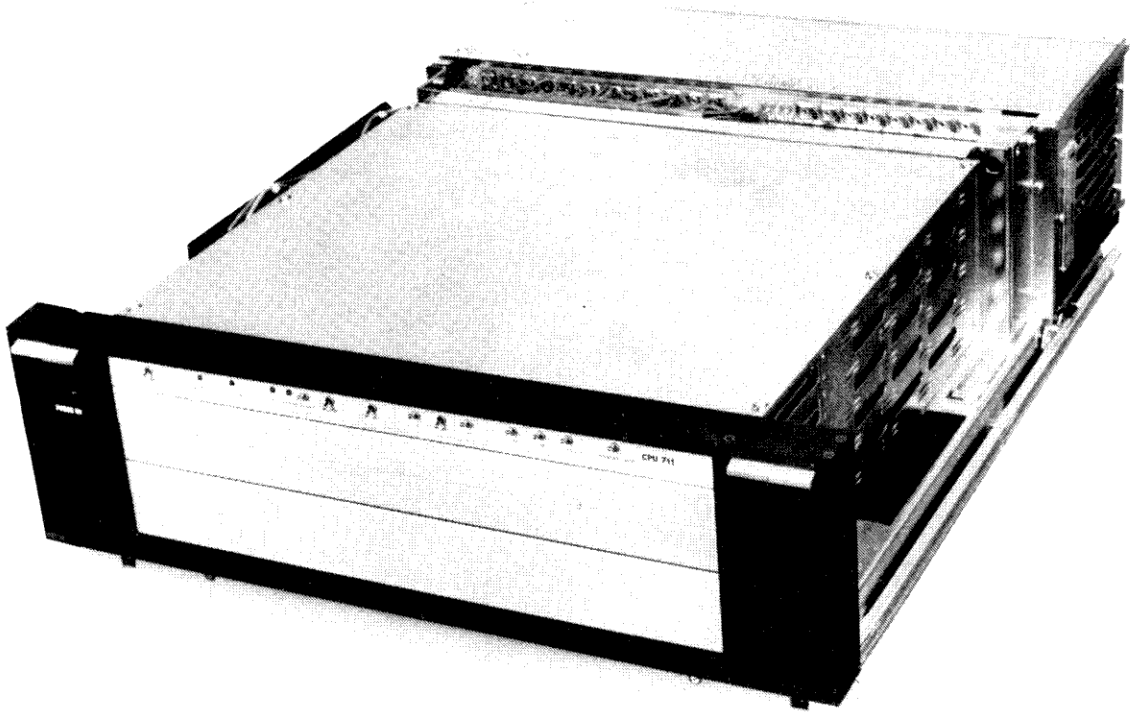
The major hardware elements in an RC 3600 system are: a central processing unit, a memory, a real-time clock and a range of peripheral equipment.

Construction module techniques are applied throughout. Print circuit boards contain the electronics. The boards fit into chassis, which again fit into a cabinet.

2.1.1 The Central Processing Unit

The RC 3600 system operates on a 16-bit word basis, extended with a 2-bit parity feature, checked during memory read cycles, generated during write cycles. Another feature is the "hardware interrupt", which allows interrupt of internal activities when this is made necessary by the operation of the peripherals. These features relate to the microprogramming of the processor.

The CPU systems of the RC 3600's are available in two versions, because of different technologies in manufacturing memories.

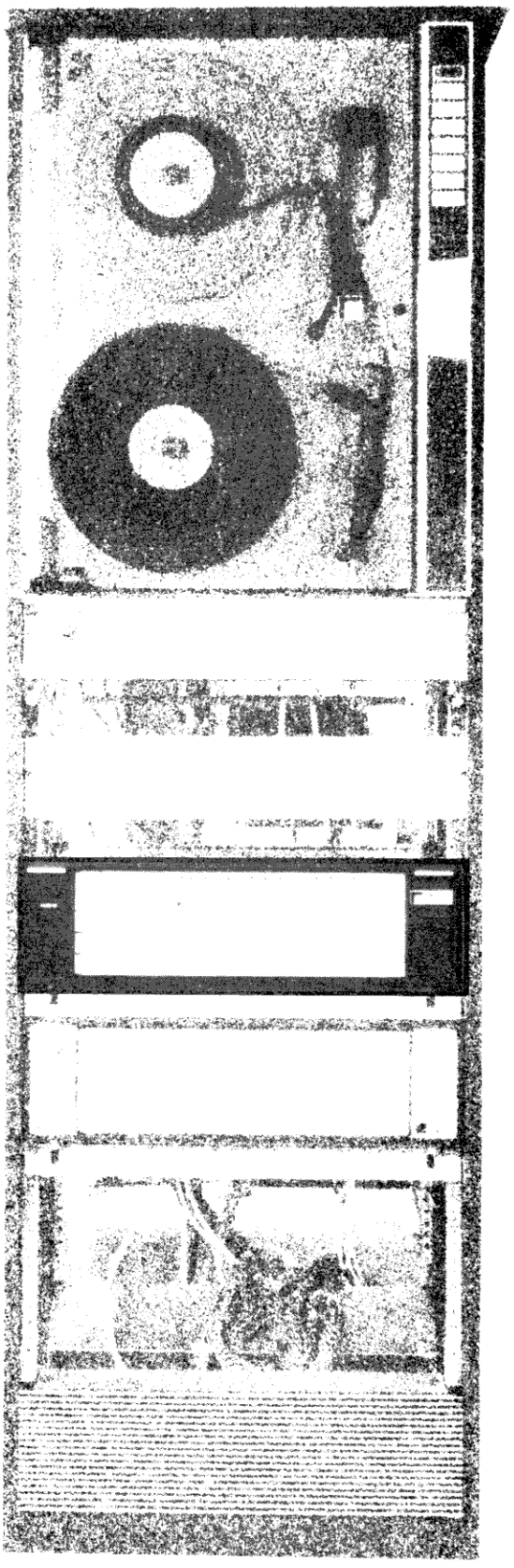


The CPU RC 3703 including semiconductor memory

The CPU RC 3703, supports semiconductor memory and processes the data in a 4-bit sectional way. CPU and memory are incorporated onto one circuit board, leaving space for 4 additional boards in the chassis. Due to this technology the processor is available at a lower price, yet at a high performance.

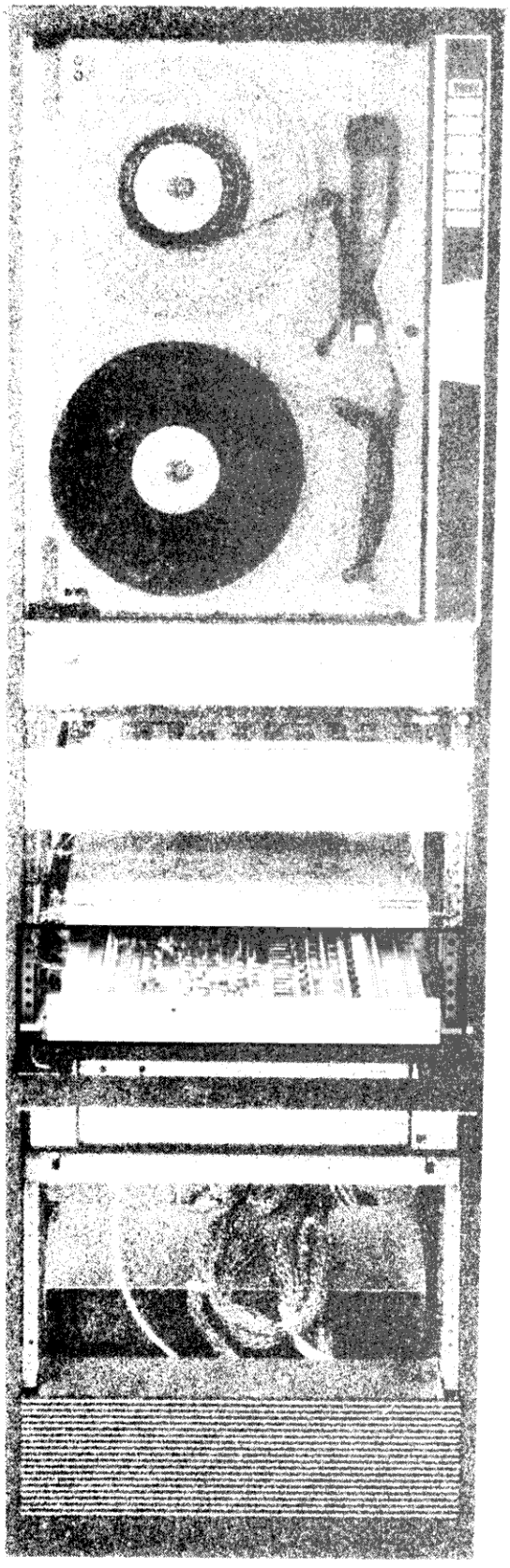
The other opportunity, the CPU RC 3603, offers a higher performance, due to the data word processing in a 16-bit parallel mode.

The CPU RC 3603 supports core memory. The CPU itself occupies one circuit board, the memory one or more boards depending on the memory size. It is often necessary to apply further chassis to accommodate the controllers of applied devices (for instance the system shown comprises an additional chassis).



The CPU RC 3603

2.1.2 The memory



A Memory Board (core memory).

The memory is normally accessed from the central processor, but there is also a Direct Memory Access Channel, which allows the faster peripherals, such as disc units, to access the memory directly. This allows faster data transfers to and from these peripherals.

Memories are either manufactured as core or semiconductor memory.

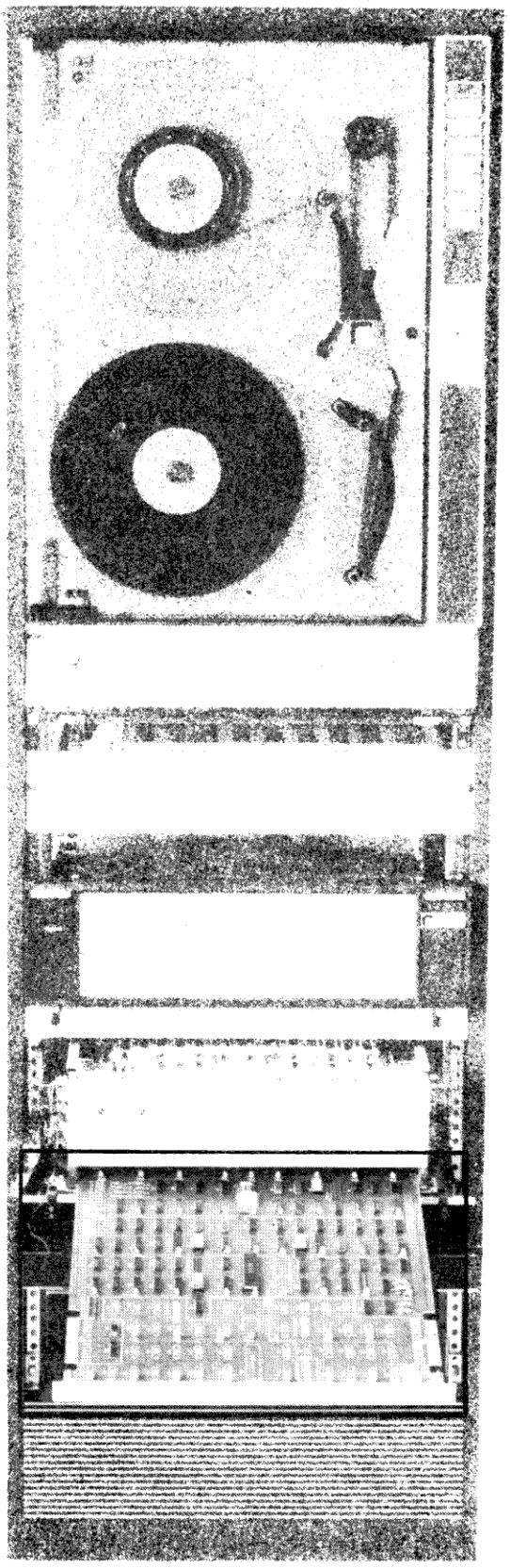
The semiconductor memory is available at a fixed size of 64 Kbytes, supported by the RC 3703 CPU (in fact memory and CPU have been designed onto one circuit board).

Core memory is available ranging from 32 Kbytes to 128 Kbytes, the incremental sizes being 32 or 64 Kbytes. Memory in the range from 64 to 128 Kbytes only stores data, not instructions. The core memory is supported by the RC 3603 CPU. The memory board shown belongs to this type.

2.1.3 The peripheral devices

The peripheral devices each interface with the central unit through a circuit board. This circuit board is called a "controller", for its responsibility is to control the flow of data to and from its peripheral device.

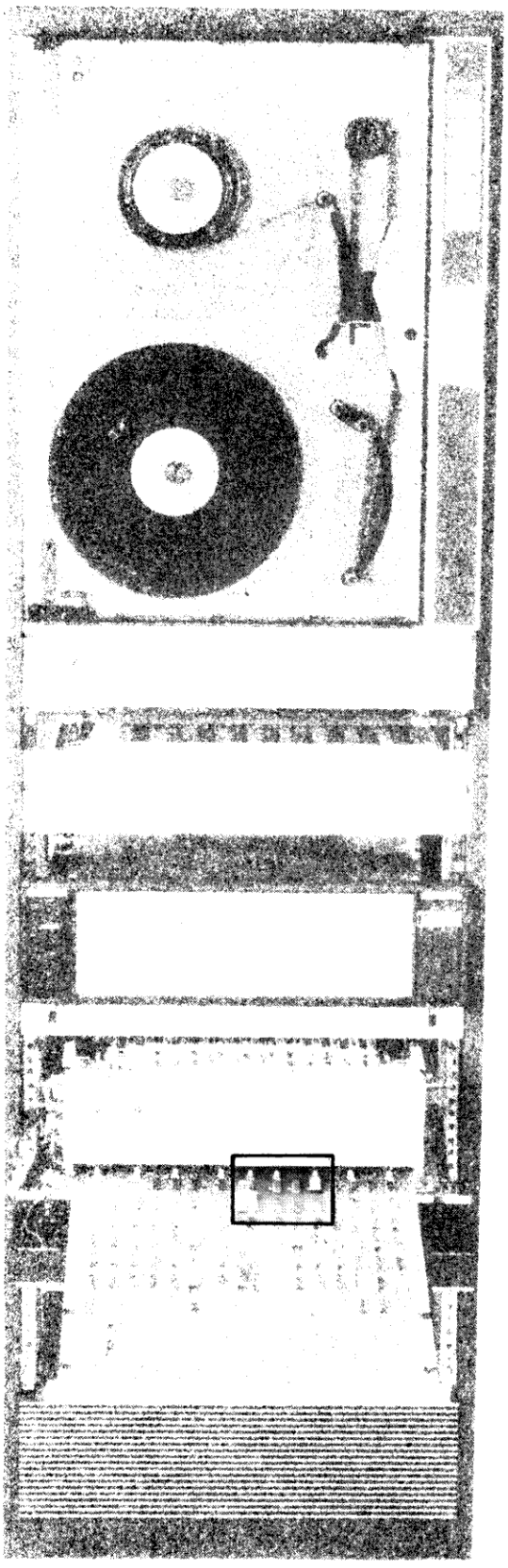
Certain peripherals can employ "channels". These enable more than one device of the same type to share a controller, e.g., more than one tape unit.



A Controller Board

2.1.4 The real-time clock

The real-time clock allows interrupts to be established at regular intervals, and this provides the basis for multiprogramming (which we shall discuss below).



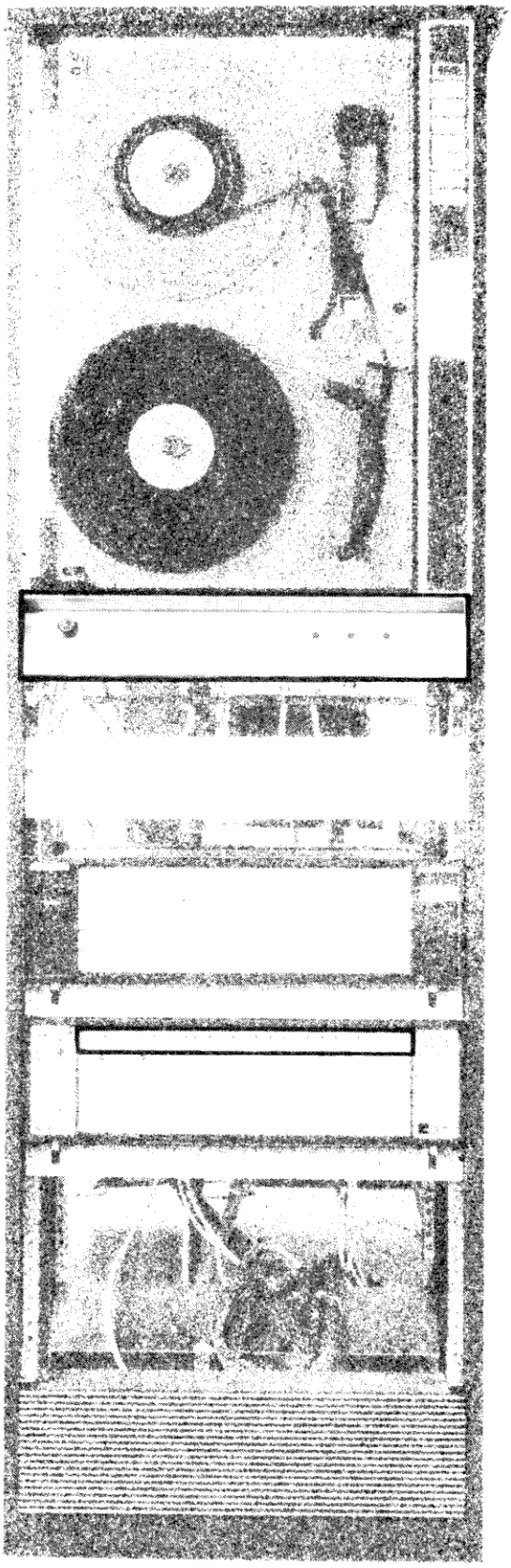
The Real-Time Clock

2.1.5 The hardware load feature

The hardware system explained so far cannot manage any data processing on its own. It has got the ability to perform instructions due to the microprograms laid down in the processor, yet the "rules" according to which these instructions have to be applied are missing - the software is missing.

To furnish the hardware-system with software, the hardware components have to know where to put it and from where to get it.

Powering the equipment initially causes the processor to automatically carryout a function that tells it where to locate a software load in the memory. The switches of the front frame of the CPU allow a preselection of the peripheral device from where the software can be fetched and read into the memory. The procedure is initialised with the autoload button.



Power and Autoload Panel (upper panel)

Switches, CPU front frame (lower panel)

Loading specific software directly would - in principle - enable the system to perform data processing, but subjected to many complications and limitations. For instance, new software would have to be loaded all from "the buttom", whenever a different job had to be run.

To avoid these limitations, the RC 3600 system initially is loaded with basic systems software according to the above proceedure. Once loaded the basic software takes over supervision of the system, calling for the operators attention via a console device, simplifying run-procedures.

2.2 RC 3600 Software

The goals of RC 3600 software are these:

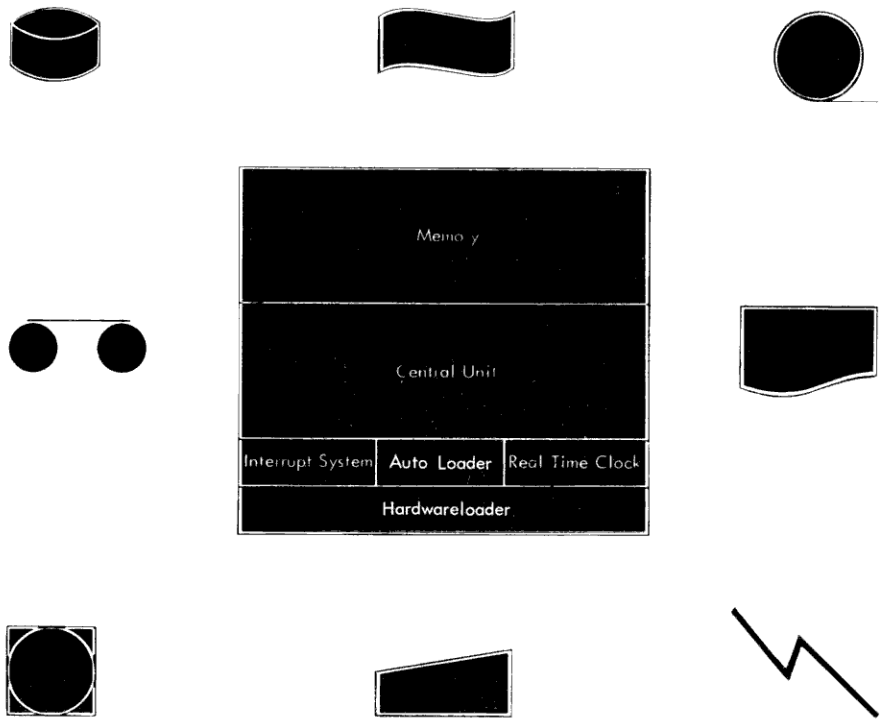
- to allow more than one job to be run at the same time, that is, to implement "multiprogramming".
- to allow high-level languages to be used on the system.

The purpose of multiprogramming is to make the single central unit behave as though it were more than one central unit, that is, multiprogramming simulates multiprocessing. It can do this because no task requires the constant attention of the central unit. By switching its attention among the various tasks it must perform, the central unit can appear to be several central units, or, as one can call it, a "virtual" multiprocessing system.

In order to perform in this way, the central unit must be able to regard each job as made up of a number of "processes", so that it can switch its attention among running jobs by concentrating on one process at a time, rather than one full job at a time. Thus, the central unit can use pauses between the processes of one job to perform a process from another job. Much of the time these pauses are provided by the I/O processes which often must wait for other processes to be completed before they can run to completion.

In order to implement the above-mentioned goals, the RC 3600 software complements each hardware component by a software component. The result is a system that can be thought of as a combined hardware-software "machine". Therefore, we shall call it a "virtual machine" and the software: "systems software".

Up to now we have described only the hardware. We can represent it thus:



RC 3600 Hardware

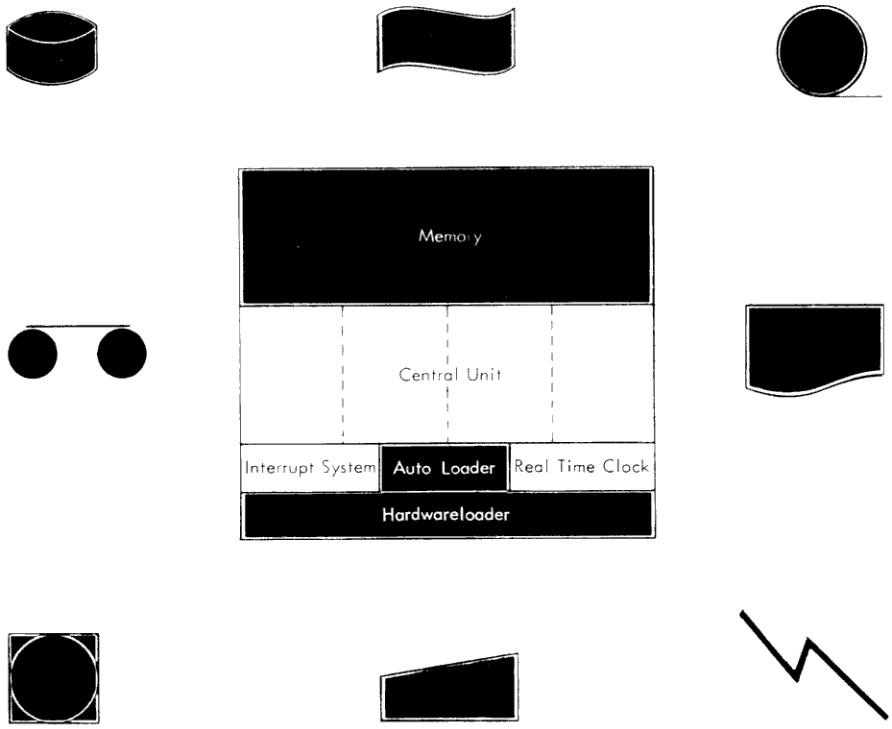
2.2.1 The Monitor

The Monitor is the first software element that we shall discuss. Its job is to implement multiprogramming, that is, to make the single central unit look like a number of central units. To do this, the monitor must collect information of the simultaneous processes, so that they can be scheduled.

The information the monitor collects on a process is called the "process descriptor". Among the information in the process descriptor is the name, priority, and status of the process.

The presence of a clock mechanism allows time intervals to be allotted to each process in turn so that, for example, Process A can be performing data conversion while Process B is printing lines, without Process A having to wait until Process B has printed all its lines. To the observer the processes, then, appear to be running in parallel. In order to do this, the monitor must have control of the hardware interrupts.

The monitor thus overlays the hardware real-time clock and interrupt system with software and replaces the single hardware central processor with a number of virtual processors. Our system looks like this so far:



RC 3600 Hardware plus Monitor

where the dashed lines represent software and the solid lines represent hardware.

The monitor can also mediate the exchange of information among the various processes. Thus, the monitor is a connecting link among the virtual central processors.

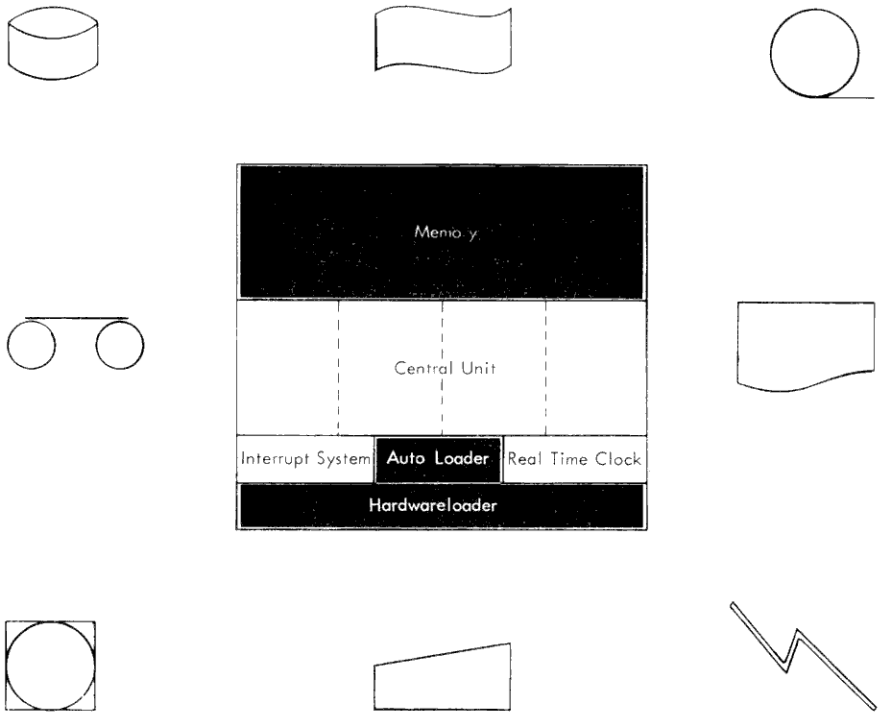
RC 3600 hardware plus the monitor performs like a virtual multiprocessing machine.

In order to handle I/O events and processes in an efficient way, to standardize I/O programming, and to solve reservation problems, each peripheral unit is handled by a dedicated process called a "driver".

2.2.2 Drivers

Drivers are software modules, each of which is dedicated to a specific physical unit. The driver represents the peripheral unit to the RC 3600 system. That is, as far as the system is concerned, the drivers are the peripherals. Since the machine now has to deal only with drivers, and not with peripheral hardware itself, a uniform I/O protocol can be used for all peripherals.

The hardware plus the monitor and the drivers form a virtual multiprocessing machine with attached virtual peripherals.



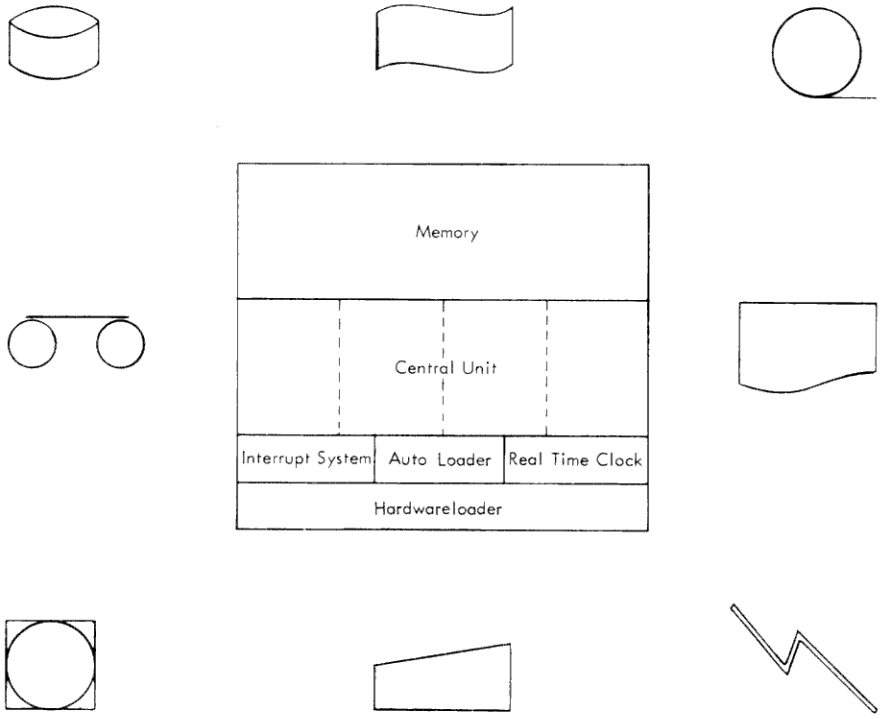
RC 3600 Hardware plus Monitor and Drivers

2.2.3 The System Process -s-

The System Process -s- completes the systems software of the RC 3600 system. It replaces the hardware load feature, which could only load one program into the memory, and from only one device, with a software loader that can load processes into the system dynamically and can allow a variety of program load devices. It does this by assuming control over the allocation of space in memory to the various processes. It keeps track of the processes as they run by creating the process descriptors that the monitor can use.

-s- also replaces the buttons and switches of a typical hardware machine by being a system supervisor through which the operator can communicate with the RC 3600 system, rather than with the hardware alone.

The addition of -s-, the monitor, and the drivers to the underlying hardware creates an RC 3600 system, which is a multiprogramming machine. This was the first goal of RC 3600 systems design.



The RC 3600 System

2.2.4 The Autoload feature

Systems software occupies space in memory, and it is desirable that this space is as small as possible. Still, the systems software should be able to perform with maximum flexibility, as well as be easy to operate. With respect to RC 3600 systems software these considerations revolve around the systems program module -s-.

-s- was described as a program loader and a supervisor through which the operator can communicate with the system.

Furthermore some facts must be kept in mind about -s-:

> -s- cannot load itself. The hardwareload feature must be used to load -s-, which means a load device is preselected.
>
> -s- is designed to prefer one device above all others as the load device in order to simplify operation.
>
> -s- communicates with the operator through a console device, which makes it necessary to associate -s- and the console device driver very closely.

As a result, it is most convenient to associate -s-, load device driver and console device driver, and load them together, using the hardwareload feature.

The system now provides the user with a preferred load device - the "autoloader" - and a direct communication link which makes the system easy to operate and allows -s- to guide further program loads.

To allow the user to choose the autoloader and type of console best suited to his requirements - and still keep the occupied space in memory as small as possible - is asking for the systems software provided in "basic systems" packages.

2.2.5 Basic systems software

The basic systems software package is selected according to the autoload device, which the user regards as his main load device.

MUS (Multiprogramming Utility System) allows four types of devices to be used as autoload devices: a magnetic tape station, a paper tape reader, a card reader or a flexible disc unit. One

of the four is selected as the autoload device, but once this device has loaded the drivers of any of the other devices, they as well may be used to load programs, merely by telling -s- which load device currently is to be used.

DOMUS (Disc Operating MUS) features a disc unit as an autoload device. DOMUS only indirectly allows load from other devices; program loads contained on other data media have to be copied to discs before loading, which, however, is easily accomplished. The driver of the non-disc unit considered has only to be loaded from the disc unit, then the system allows the copy proceedure pre-required to load.

Both basic systems need a console device, which may be selected among several keyboard devices with printing or VDU capability.

2.2.6 Utility programs

The utility programs correspond to the level of basic software and make up software routine facilities of great usability and effectivness - they might be thought of as "selectable" basic software (although, one might as well regard the basic software to be composed of "necessary" utility programs). Whether the user wants to write his own programs or run RC application programs, utility programs are involved.

In fact some commonly used utility programs are included in the basic software packages. Both MUS and DOMUS contain the MUSIL interpreter, which is necessary in order to run MUSIL high-level language programs. Furthermore DOMUS has been equipped with a catalog- and a paging-system.

Briefly mentioned, other utility programs of interest could be:

- MUSIL compiler
- page oriented text editor
- macro assembler
- catalog/file handling routines
- batch processor

3 The RC 3600 User Software

To run user's jobs software is needed beyond the basic system software. Either in form of application programs delivered by RC to be run as-is or user written programs in high-level languages, the second goal of the RC 3600 systems software.

3.1 User Programming

User programs are most conveniently written in high-level languages. The RC 3600 systems support two such langauges: MUSIL and BASIC/COMAL.

3.1.1 Program Production Packages

For the user writing his own programs, RC provides Program Production Packages. Each of these packages contains a Compiler, a Text Editor, any necessary drivers for the compilation and editing tasks, and a Run Generator for placing necessary systems and applications software together on one medium, so that a complete job run is generated. The Run Generator can also place "Command Files" on the medium. These are files containing operator commands, so that operator actions are automated. This is particularly useful for runs that involve loading different programs from different types of devices.

3.1.2 MUSIL

MUSIL is an ALGOL-like programming language that is specifically suited for computer support functions. MUSIL can handle all sorts of I/O tasks and can operate on character, record or file level. It is easy to learn and can be learned in stages, for its instructions can be arranged in hierarchy. This means that the novice programmer can use those instructions that represent complex procedures and are carried out automatically according to standard procedures, while the more experienced programmer can use detailed program instrutions to assume very direct control over program execution.

For example, a standard procedure is provided for handling exceptions, but the programmer may also elect to write his own exception-handling routines. Buffer control, too, can be handled by standard procedures, or the programmer can assume more complete control over I/O by using detailed program instructions.

In the case of MUSIL the program Production Package provides the MUSIL Compiler that takes in MUSIL source code as input and outputs MUSIL object code, which is loadable, but not executable. The compiler provides error diagnostics for program debugging . It also allows assembler-coded subroutines, called "Code Procedures" to be compiled into a MUSIL program, much the same as assembler subroutines can be compiled into a COBOL program. Finally, the MUSIL Compiler allows great flexibility during compilation, for example, parts of one program can be inserted into another program.

In order to execute the MUSIL object code, a MUSIL interpreter is applied. Actually - as mentioned earlier - the interpreter is incorporated in the basic software package.

Altogether these software elements form one of the RC 3600 systems software opportunities, attaining the two design goals. Similar tools are provided in the high-level language BASIC/ COMAL.

3.1.3 BASIC/COMAL

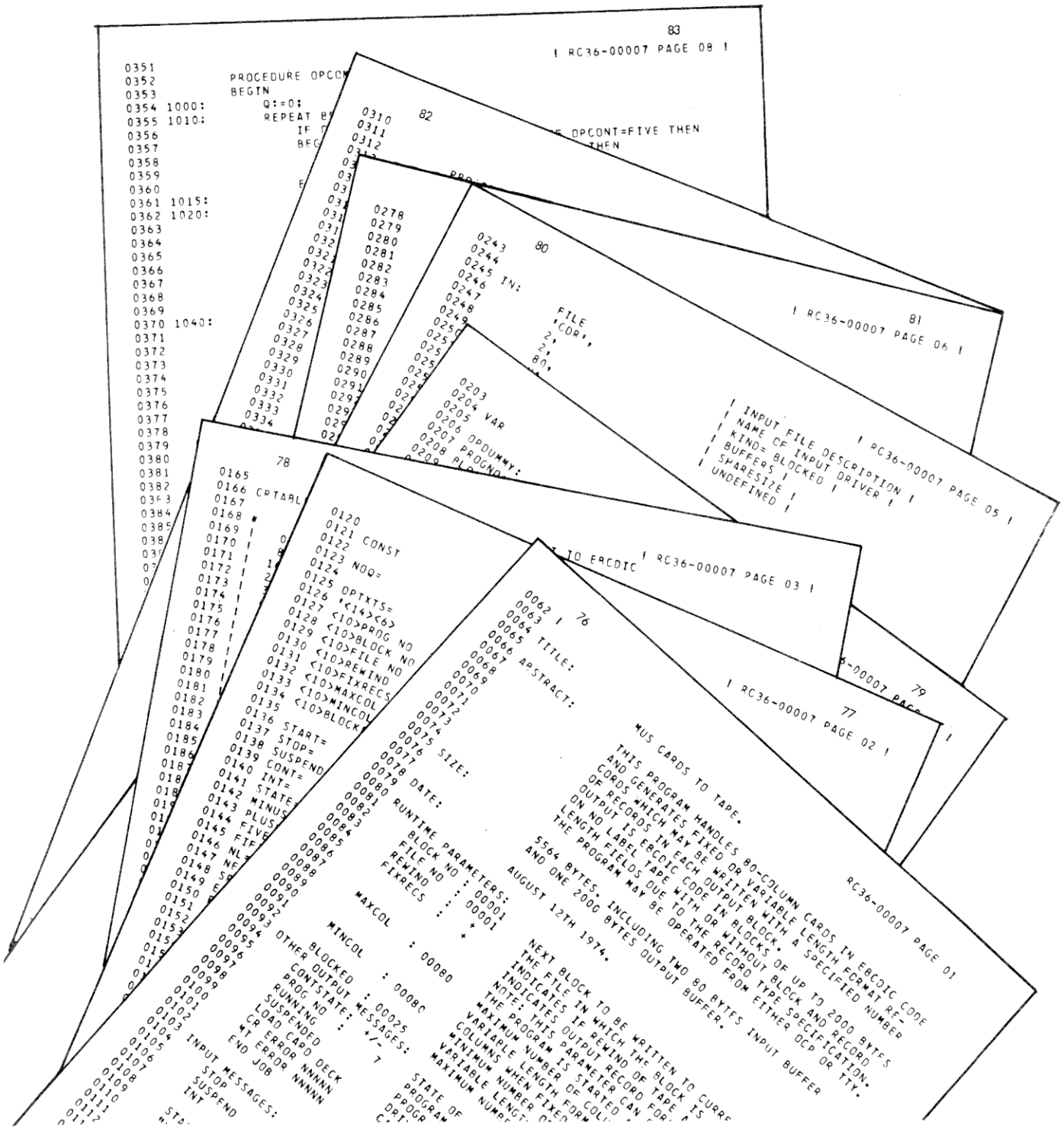
RC BASIC is a structured educational language; it is simple and comprehensive, yet sufficiently advanced to permit demonstration of important programming principles.

The original BASIC has several deficiencies regarding advanced programming. Recently proposals for new and better educational languages have been put forth, among them COMAL (Common Algorithmic Language). COMAL possesses all the features that made BASIC popular, in fact COMAL includes almost all the facilitites of BASIC plus a number of advantageous features.

Incorporating COMAL into RC BASIC provides the following extensions compared to ordinary BASIC:

IF-THEN-ELSE, REPEAT-UNTIL, WHILE-DO and CASE-OF-WHEN.
Eight character variable names.
Structured programming without GOTO line number.
Interactive program execution.
Batch mode program execution.
File input/output.
Matrix operations.
String manipulations.
Output formatting.
Desk calculator functions.

With these features RC BASIC covers the total educational range from the most introductory level to advanced production programming training.



3.2 RC Application Programs

Over 500 applications programs are available from Regnecentralen. These programs may be used directly for tasks involving data conversion, data entry and data collection, data processing, and communications. Standard terminal emulation programs are also available.

The great advantage of using the RC 3600 as a terminal emulator is that RC provides a wider range of peripherals than the corresponding terminals of the mainframe manufacturers, and enables the user to communicate with a variety of mainframes by simply reading in the appropriate emulator program. The hardware/ software terminal configurating are specific to one emulation, but they can be upgraded to a full-scale RC 3600 system.

RC application programs are provided for the user in object code. They can be run "as is", or they can be customized for special user requirements. In either cases, the normal practice is to include them on the same run medium on which the basic systems software is written in order to simplify system operation.

On request RC also may provide the user with programs specified by the user.

4 Operating the RC 3600 System

The user initiates the RC 3600 System at the Power and Autoload Panel. A keyboard device used as console is the operators communication-tool to the system during work. The various keyboard devices can run all of the standard programs and can also be used for the creation of source code programs.

Some of the more complex operator functions that are easily accomplished on a keyboard device, such as changing the program load device, can also be accomplished by the system, having "command files" on the program medium. Command files imitate operator action. They are supplied by RC, or can be developed by the user.

RC 3600 operation is both simple and flexible. Appropriate programming allows a run to proceed almost automatically. One can write a program in such a way that there are points in it at which the program asks the operator to perform some action or to make some decision. Such decisions are made by the operator's assignment of specific pre-determined values to the "run-time parameters" presented to him.

System and program loading is accomplished easily in two or three steps. It is, for example, no more difficult to run an entire magnetic tape than it is to select specific files from that tape. All RC 3600 programs clearly request the actions or information they require and present the alternatives available when necessary.

Furthermore operating and application guides ae provided to comfort the operation of a RC 3600 system. Actually most users learn to utilise the equipment effectively within the first few days.

Certain hardware facilities are also available to simplify operation. An example:

Normally the initial loading of basic software is completed once and for all. Yet certain irregularities in power supply may cause a need for re-load.

Due to technology a semiconductor memory will suffer from power outages, losing the memory-stored information. To enable a quick recovery a hardware module (a Read Only Memory module) can

be supplied, which contains the basic systems software and from where the system can fetch what otherwise would have to be loaded from the hardwareload feature.

The content of a core memory is not erased by power failure, an automatic power restart feature enables the system to continue working.

Particularly in the case of the unattended remote applications an automatic system load feature may be very useful. If the load device is selected to be the adaptor, which links the system to a central site computer, then the automatic system load feature allows a loading to be accomplished from the central site.

5 The RC 3600 System - Applications

As explained in the previous sections any system is composed of hardward and software, and - due to the interaction of hardware/ software - the system design may outline certain capacities to others, thereby offering a large scale of different application skills.

Only a brief survey of applications is given here. Detailed information on topics of interest may be obtained from your RC-contact person. Please ask.

5.1 Stand-Alone System

Mostly an RC 3600 system is applied as a help-mate to a larger computer system. But it well may work as a stand-alone system, supporting a larger system or truely on its own, due to the fact that it autonomously controls the attached devices and is given data treatment capabilities by adding appropriate software.

5.1.1 Data conversion/Data collection/Data entry

The presence of driver programs allow a variety of devices to be used with the RC 3600 system. Relieving a larger system (offline) or utilizing devices not attachable to the larger systems, cause some typical support applications:

- data conversion,
  one type of file may be converted into another, magnetic tape files or other data media files are often printed, proceeding this way.

- data collection,
  data from different device sources may be collected and a file created (merged, organized), for instance to be processed at a larger system.

- data entry,
  data from local or remote keystations may be entered to the system, creating a disc file - the system is distinguished by facilities such as the multi-user feature, record format control and data management functions.

5.1.2 Minicomputer

The hardware and basic software made available as an RC 3600 system may be altered into a true stand-along minicomputer, adding hardware and furnishing the system with appropriate software.

One type, the RC 6000 system, has been developed especially to deal with business data processing. Application programs are available as modules and can be combined to cover all aspects involved in running company affairs.

Another type, the RC 7000 system, was designed to cover the educational and scientific range and is supplied with the software tools belonging to RC BASIC/COMAL.

Both systems offer a number of valuable features: online support of multiple users, mixed batch and online processing, communication facilities - to mention some.

5.2 Device Controller

As a help-mate to a larger computer system the skills in device handling - referred to in describing the stand-alone systems - are extended with the capability of exchanging information online with a host computer.

5.2.1 Front End Processor

As an integral part of the RC 8000 system, known as the front-end processor, the hardware and basic software components of the RC 3600 system together with special software, fully utilize its skills in device handling and in case of remote devices it also provides the communication-link facilitites.

The concept of a front-end processor integrated into the RC 8000 system gives optimum work conditions both on the central and the peripheral sides of the system.

5.2.2 Remote Device Controller/Remote Job Entry

Not all peripherals are local ones, many applications demand remote facilitites. Used as a remote device controller, the RC 3600 applied components possess capabilities equal to a front end processor. Furthermore it is equipped with communications hardware and software, enabling the exchange of information with the central site computer.

Levelled above mere device controlling, the Remote-Job-Entry-issue facilitates the opportunity to "operate" the mainframe from a remote site.

Hence, operators of a mainframe system will find little difference whether working at a local or a remote site.

5.2.3 Emulation

Besides communication between RC equipment, it might be desirable to interface to products of other manufacturers.

As a terminal, the RC 3600 can operate in emulation as some other terminal, such as IBM 2780/3780, IBM HASP/RES Multileaving Workstation, CDC 200 UT BCD/ASCII, UNIVAC NTR, ICL 7020 and others. The emulation programs are software packages corresponding to the terminal configuration, which means that just by changing software the system can simulate different terminals at different times.

Thereby, the RC 3600 system offers independency, optimizing the configuration possibilities. Emulation jobs are likely to run in a system as Remote-Job-Entry terminals.

5.3 Communications Equipment

The stand-alone systems were seen to outline capabilities in device handling, further as "help-mate" systems they gained capabilities in communications handling. However, as communications equipment the systems are applied significantly in order to handle communications.

5.3.1 Terminal Concentrator

Using several terminals often increases cost of running beyond the acceptable, especially if each terminal is allowed to communicate on separate lines.

To concentrate the communication-traffic onto one line the RC 3600 System, equipped as Terminal Concentrator, is applied. A decrease in line-need as well as a better utilization of the lines in use, is the result, minimizing cost of running.

5.3.2 RC NET

To automatize communications, making sure that information exchanges are carried out properly and most effectively, the RC 3600 System has yielded another major task. It has been adopted as the fundamental element of the RC NET.

Within the RC NET network concept an installation with data processing capacity is termed a "host". Associated to each host is a "node" and the nodes are interconnected by communication lines to form a network. RC NET is a packet switching network system by which the host computers can communicate. A message from one host to another is split up ino a number of data packets, which are transmitted by the network. The main function of the nodes is to keep track of the hosts currently connected and their location in the network. The data packets are forwarded from node to node until the node connected to the receiving host is reached.

Thus, performing the node-work, the RC 3600 routes information according to destination and available line capacity.

In conjunction with the previously mentioned applications, the RC 3600s within the network concept interfaces many kinds of data processing equipment, providing flexibility as well as opportunity for extensions.

With the RC 3600 system a vast number of jobs are solved easily, effectively and reliably - at an optimum in cost and performance. And, because of the interaction of hardware/softweare, the components of any application system may be re-used, if upgrading or otherwise re-constructing the current data processing facilities.

RC 3600

READER'S COMMENTS

Systems Software Architecture

RCSL 42-i 0793

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HEADQUARTERS: FALKONER ALLE 1; DK-2000 COPENHAGEN F · DENMARK
Phone: (01) 10 53 66 · Telex: 16282 rc hq dk · Cables: regnecentralen