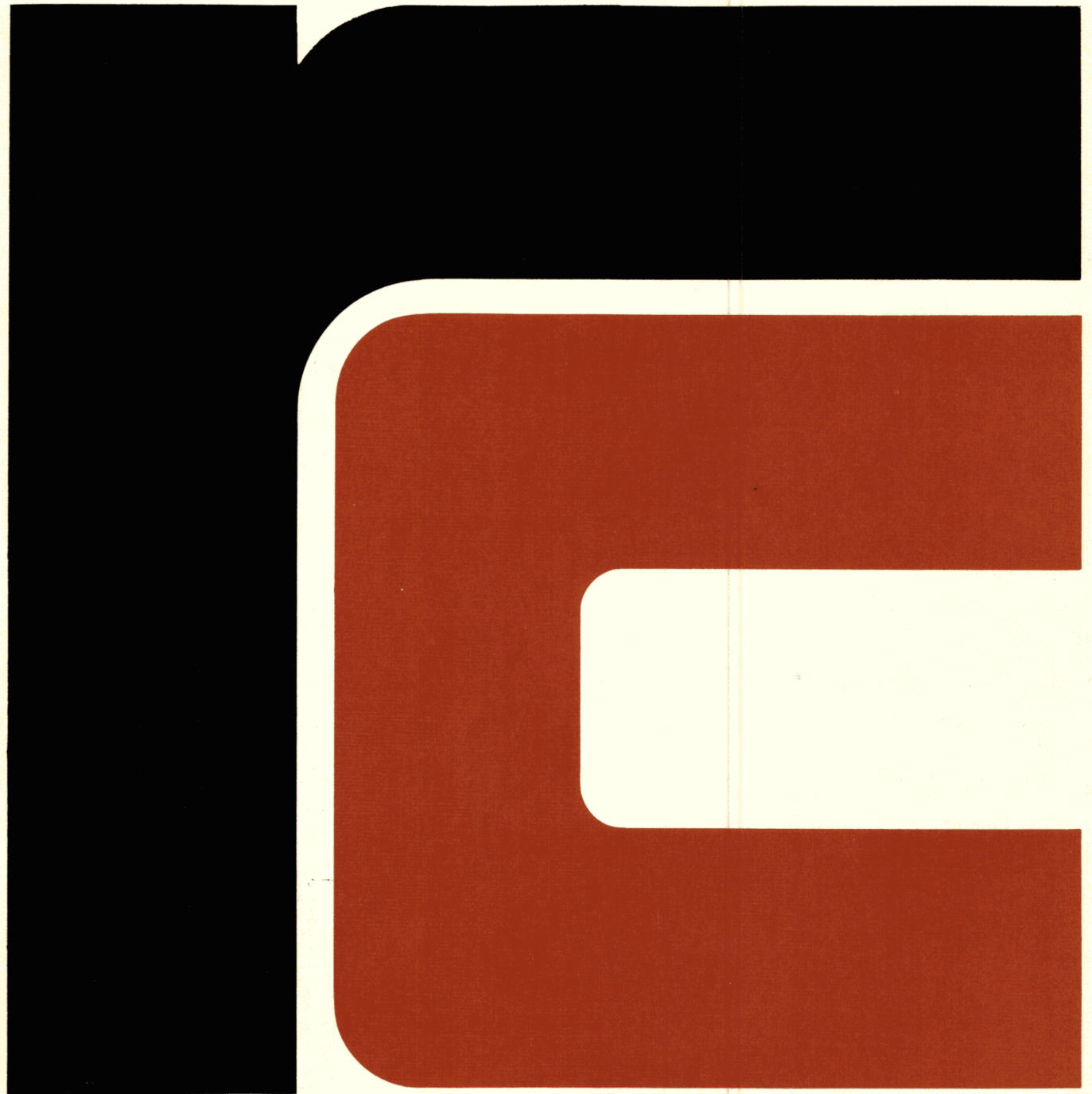


AA GAARD

System Software Architecture

PLATINUM



36000

RC 3600
System Software
Architecture

A/S REGNECENTRALEN
Documentation Department

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Author: Joan Rosenstein
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Text Editor: Anders Marcussen

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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.

Users of this manual are cautioned that the specifications contained herein are subject to change by RC at any time without prior notice. RC is not responsible for typographical or arithmetic errors which may appear in this manual and shall not be responsible for any damages caused by reliance on any of the materials presented.

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1

Introduction

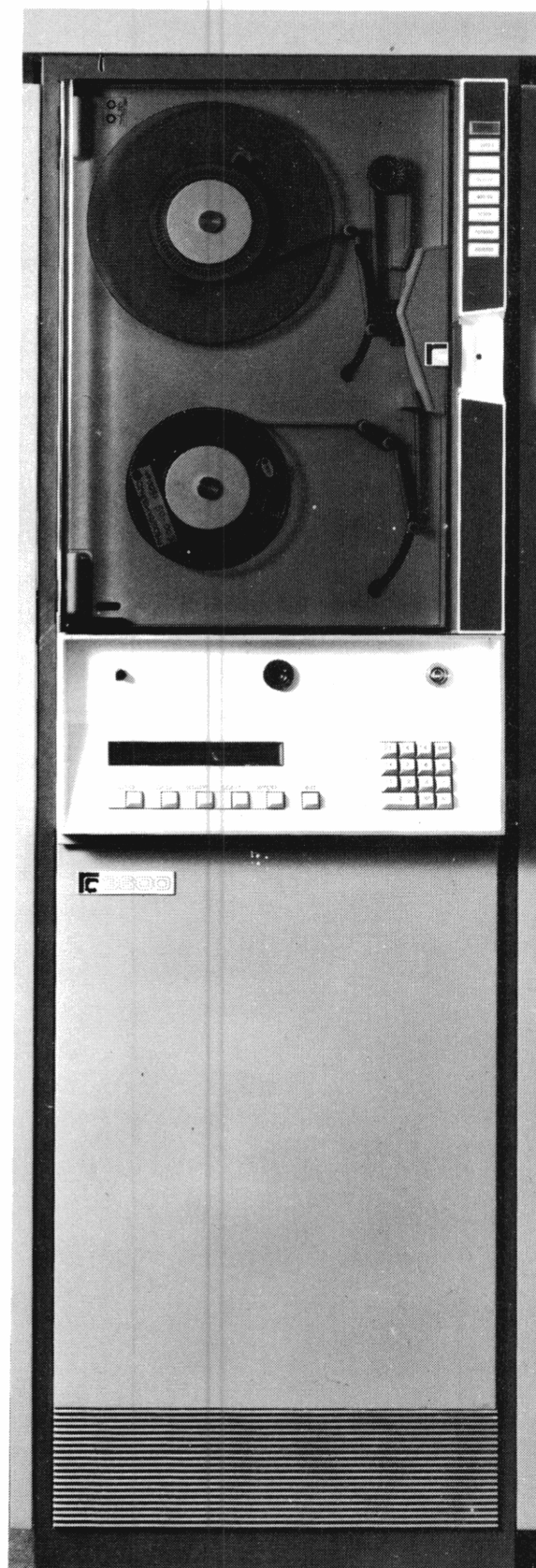
The RC 3600 is a reliable and flexible system that can function as a communications terminal, as a data entry or data collection system, or as a data conversion system in association with a larger host computer.

The RC 3600 is a system composed of both 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 will describe the RC 3600 hardware, systems software, and user software.

An RC 3600 System



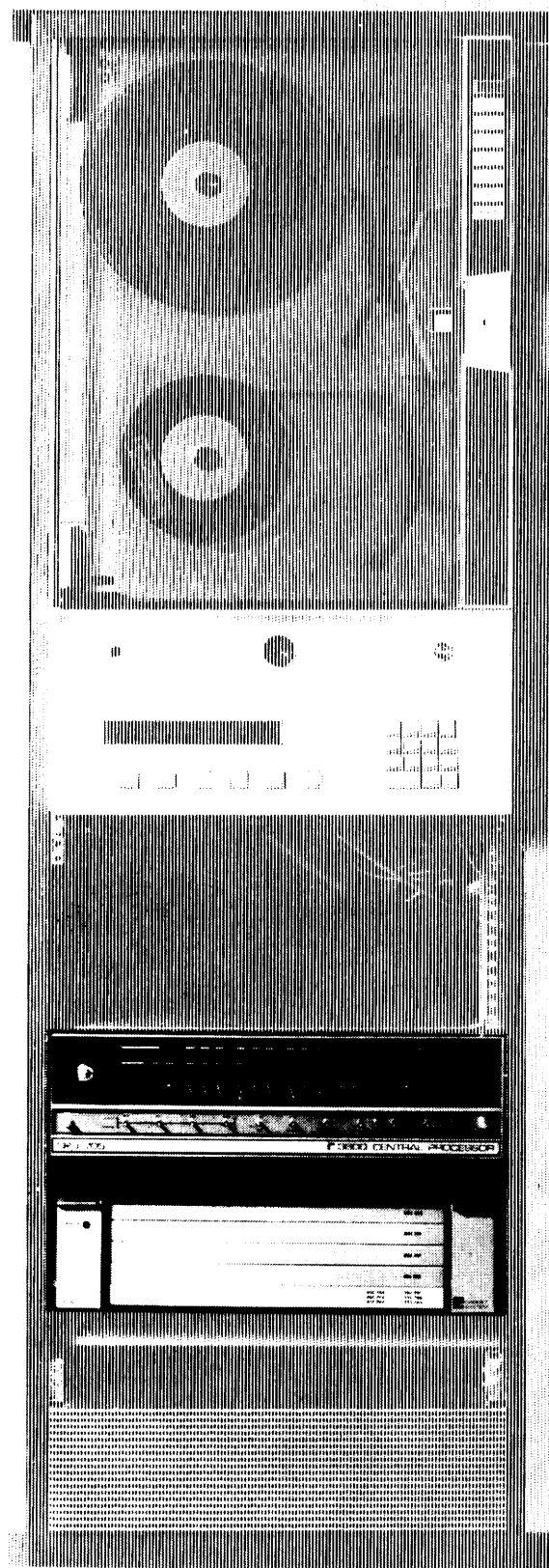
2 The RC 3600 System

2.1 RC 3600 Hardware

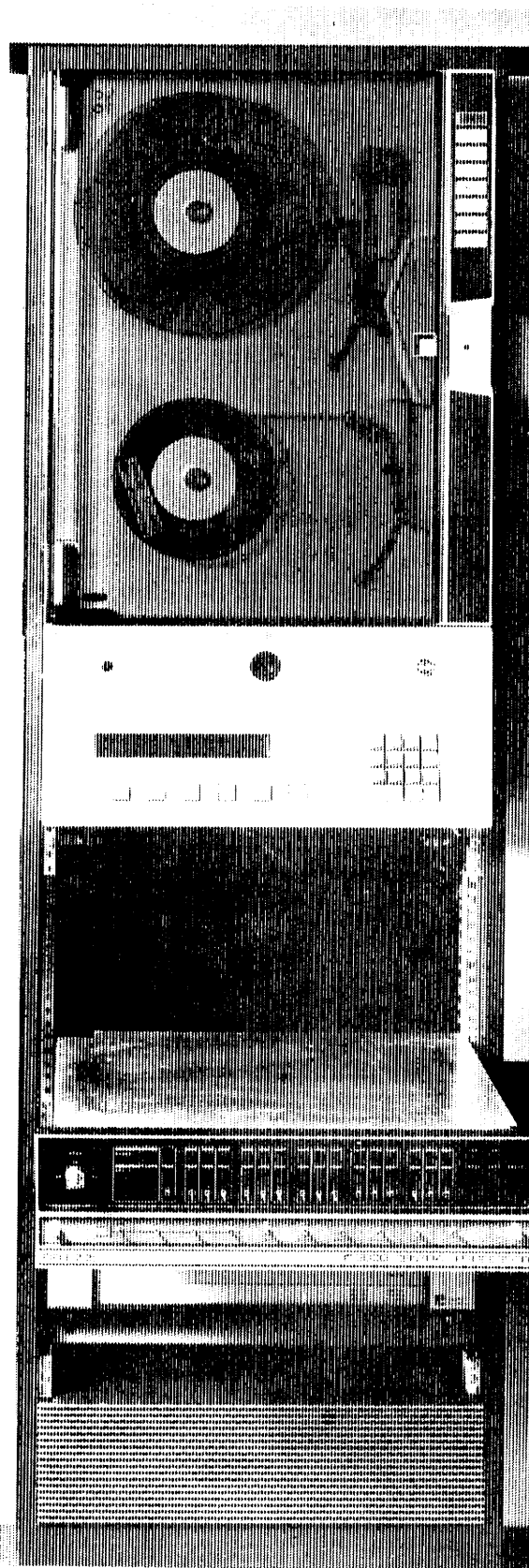
There are five major hardware elements in an RC 3600 system: a sturdy and reliable standard central unit, a core memory that is expandable up to 64 K bytes, an autoloader for reading software into the machine, a real-time clock to allow the timing of internal events, and a set of peripheral equipment for transferring data between the machine and the user. Two central units can be connected in a dual-processor arrangement to provide approximately 128 K bytes of data storage when needed. (The primary use is for data entry.)

- 2.1.1 The central unit is a 16 bit per word machine component. It has the capability of interrupting internal activities when this is made necessary by the operation of the peripherals. This capability is called the "hardware interrupts".

The Central Unit



2.1.2 The memory



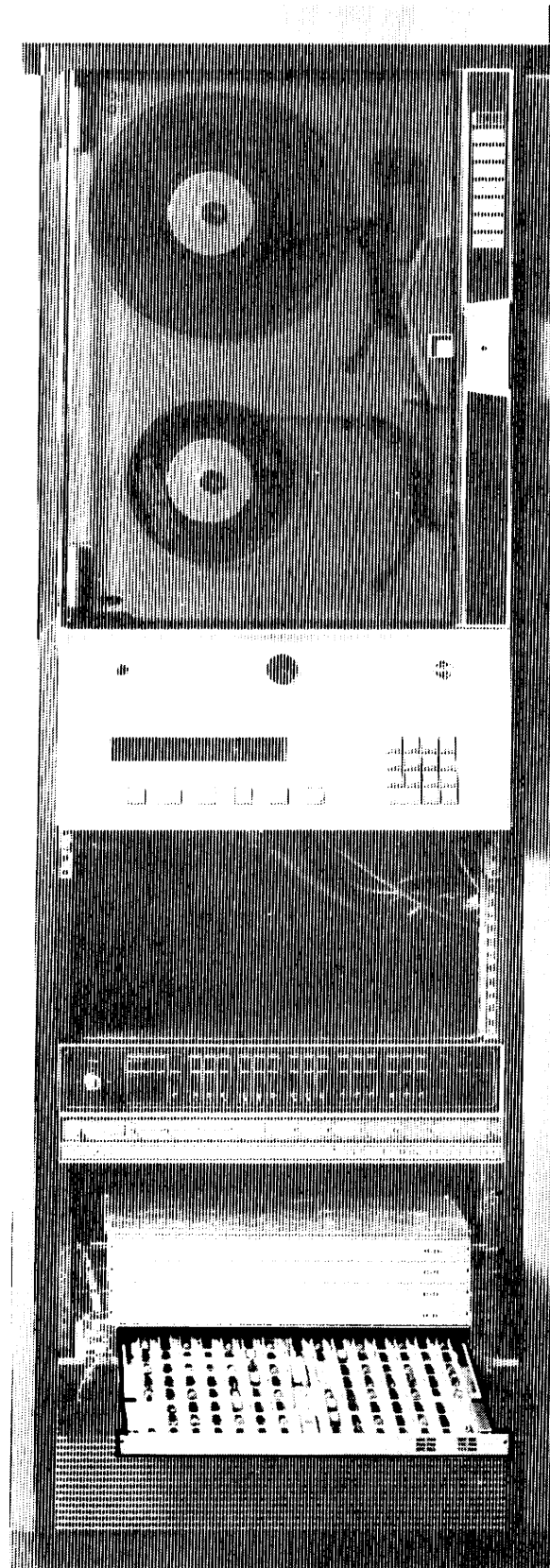
The memory is normally accessed from the central processor, but there is also a Direct Memory Access Channel, which allows the faster peripherals, such as disc units, to access the memory directly. This allows faster data transfers to and from these peripherals.

A Memory Board

2.1.3 The peripheral devices

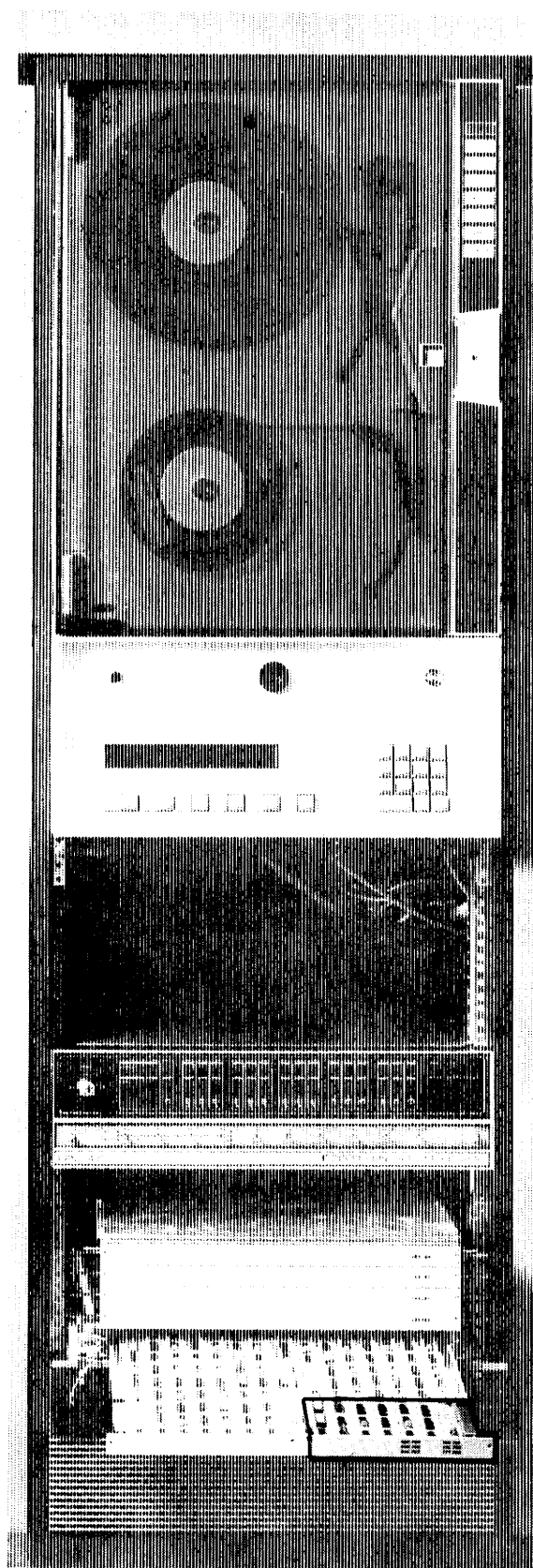
The peripheral devices each interface with the central unit through a circuit board. This circuit board is called a "controller", for its responsibility is to control the flow of data to and from its peripheral device.

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

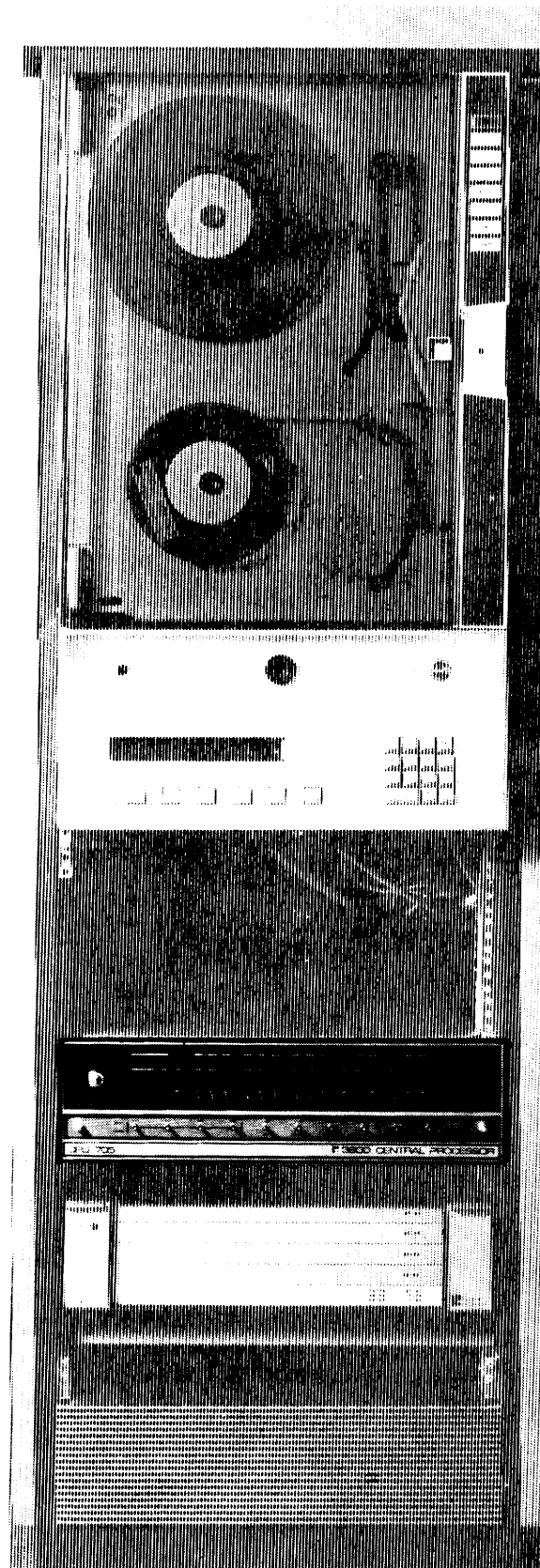


The real-time clock allows interrupts to be established at regular intervals, and this provides the basis for multiprogramming (which we shall discuss below).

The Real-Time Clock

- 2.1.5 Buttons and switches can be found on the hardware. These can be used when the hardware is used alone. In the RC 3600 system, these buttons and switches are used only by maintenance technicians, for their original functions are replaced by systems software.

The Buttons and Switches



With the above-summarized hardware, the user can perform data processing tasks of a large variety, but with hardware alone those tasks would be subject to many limitations and complications that are avoided by the use of systems software.

2.2 RC 3600 Basic Systems Software

The goals of RC 3600 systems 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 one 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.

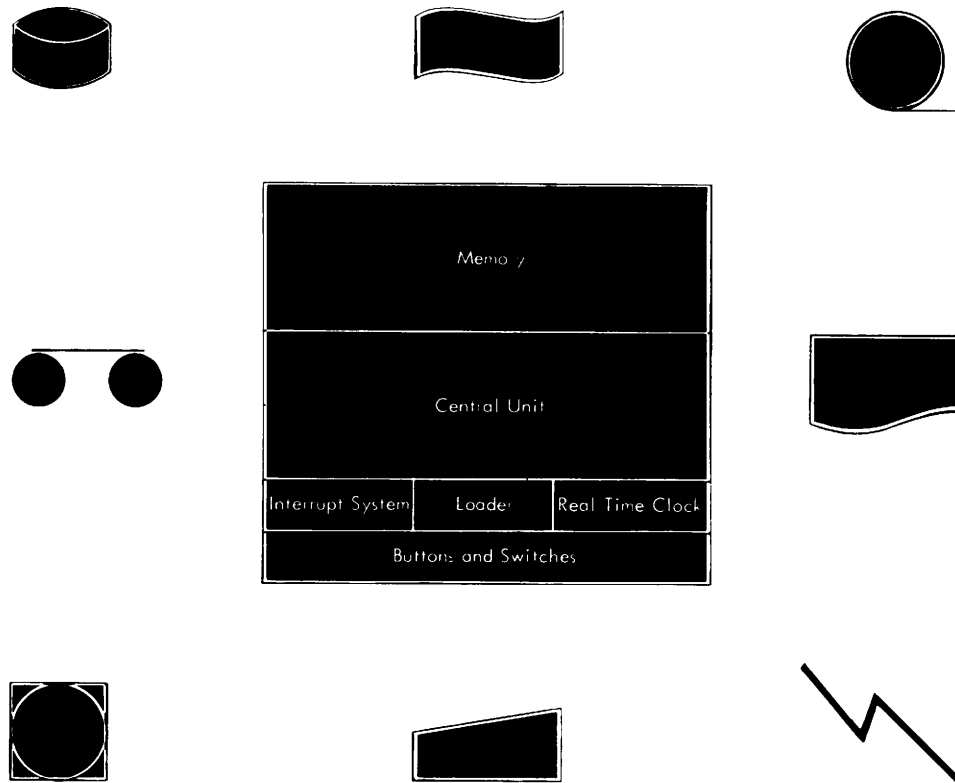
In order to perform in this way, the central unit must be able to regard each job as made up of a number of "processes", so that it can switch its attention among running jobs by concentrating on one process at a time, rather than one full job at a time. Thus, the central unit can use pauses between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

The implementation of multiprogramming is provided for by systems software.

The RC 3600 also uses systems software to allow the use of high-level programming languages.

In order to implement the above-mentioned goals, the RC 3600 systems 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".

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



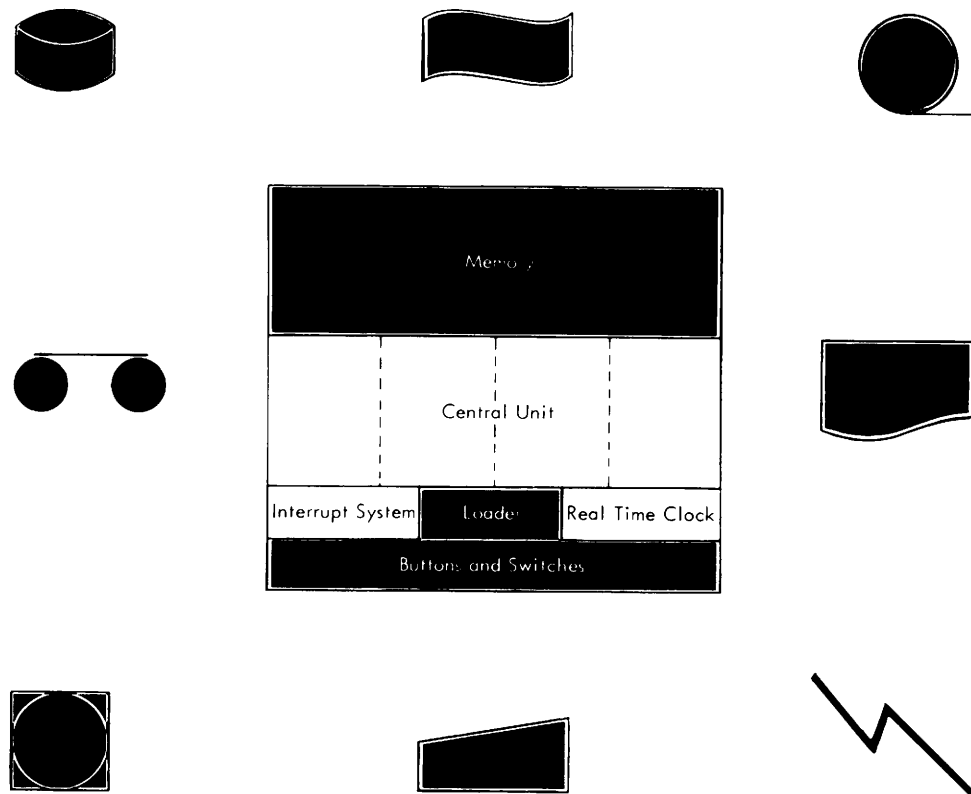
RC 3600 Hardware

- 2.2.1 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 about 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.

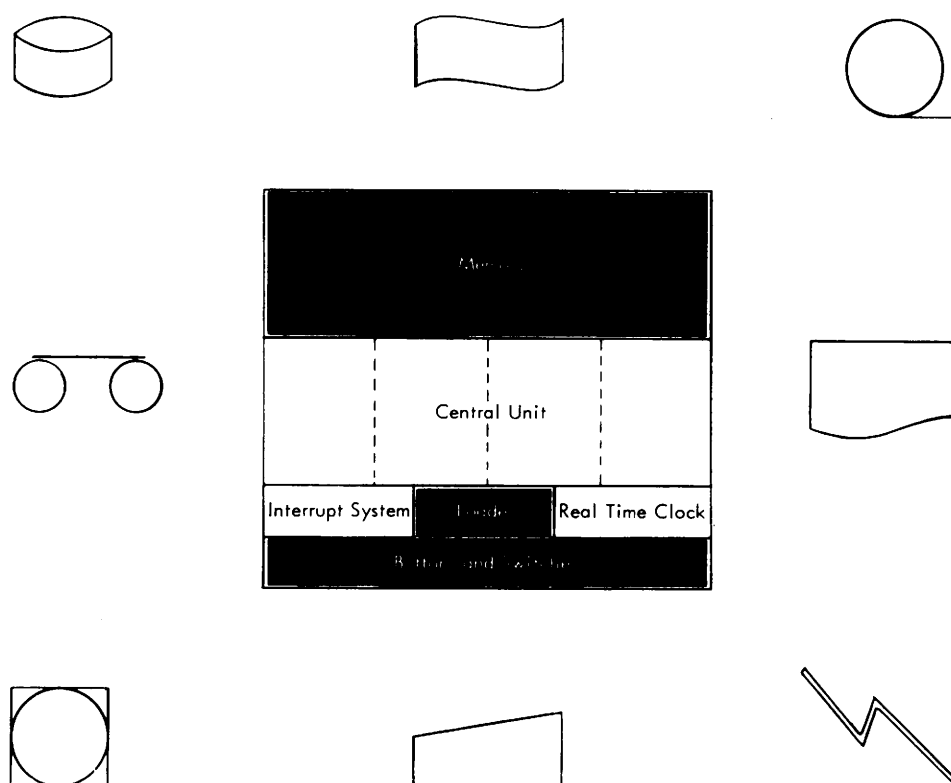
The monitor can also mediate the exchange of information among the various processes. Thus, the monitor is a connecting link among the virtual central processors.

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

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

2.2.2 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.

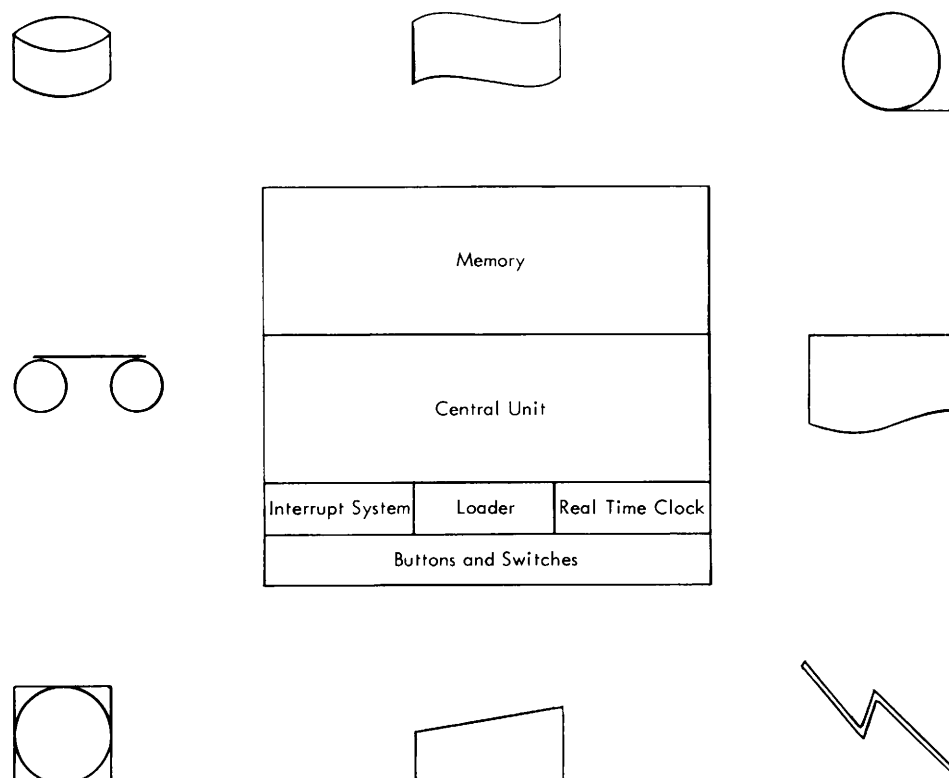


RC 3600 Hardware plus Monitor and Drivers

2.2.3 The System Process S completes the systems software of the RC 3600 system. It replaces the hardware loader, 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 the hardware machine by being a system supervisor through which the operator can communicate with the RC 3600 system, rather than with the hardware alone, which was the function of the buttons and switches originally.

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

2.3 The RC 3600 High-Level Language

The second goal of RC 3600 systems design was to allow high-level programming languages to be used on the system. RC designed its own high-level language. It is called MUSIL.

- 2.3.1 MUSIL is an ALGOL-line programming language that is specifically suited for computer support functions. MUSIL can handle all sorts of I/O tasks and can operate on a character, record, or file level. It is easy to learn and can be learned in stages, for its instructions can be arranged in a hierarchy, with certain instructions being able to call other instructions automatically. 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 the more primitive commands 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 the primitive commands.

- 2.3.2 The MUSIL Compiler 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.

- 2.3.3 The MUSIL Interpreter is responsible for executing MUSIL object code. It provides the direct link with the RC 3600 system for all MUSIL programs.

3 RC 3600 User Software

The RC 3600 system can be put to two kinds of uses: it can run users' jobs and it can be used to create or edit (and then compile) MUSIL programs. In either case the user must have the basic systems software.

Systems software occupies space in memory, and it is desirable that this space be as small as possible. At the same time it is desirable that the systems software be able to perform with maximum flexibility. Finally, the systems software should 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. But two facts must be kept in mind about S.

First, S cannot load itself. For this reason the hardware loader, the "auto-loader", must be used to load S, and the hardware autoloader can load software only from one specific device, the "autoload device".

Secondly, S is so designed as to prefer one device above all others as the program load device. This simplifies program loading. Furthermore, the console device driver is also closely associated with S. This is so because the console driver must be able to communicate with S directly.

It is, therefore, convenient to associate the console and the autoload device drivers very closely with S and to load them also via the hardware loader.

On the other hand, the user would like to be able to choose the type of console and main program load device best suited to his requirements. But if S were constructed to allow this choice directly, then S would be rather large and would have to occupy a good bit of core.

In order to solve these problems, RC 3600 systems software is provided in a variety of "Basic Systems".

3.1 Basic Systems

A Basic System is a package that contains all the systems software described above, and each Basic System is specific to one type of autoloader device, for example 9 track magnetic tape, and one type of console device, either an operator control panel or one of a variety of keyboard devices with printing or VDU capacity. Normally, a Basic System is supplied on a medium that also contains one or more applications programs. Thus, program loading for the day's work is a very simple procedure on an RC 3600.

3.2 Applications Programs

Over 250 applications programs are available from Regnecentralen. These programs may be used directly for tasks involving data conversion, data entry and data collection, and communications. Standard terminal emulation programs are also available for communication with IBM, CDC, UNIVAC, and ICL computers. In addition RC provides hardware/software terminal packages at low cost for the IBM 2780, IBM 3780, IBM HASP Multileaving Work Stations, IBM RES Multileaving Work Stations, and the CDC 200 UT in both BCD and ASCII versions.

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 packages are specific to one emulation, but they can be up-graded to a full-scale RC 3600 system.

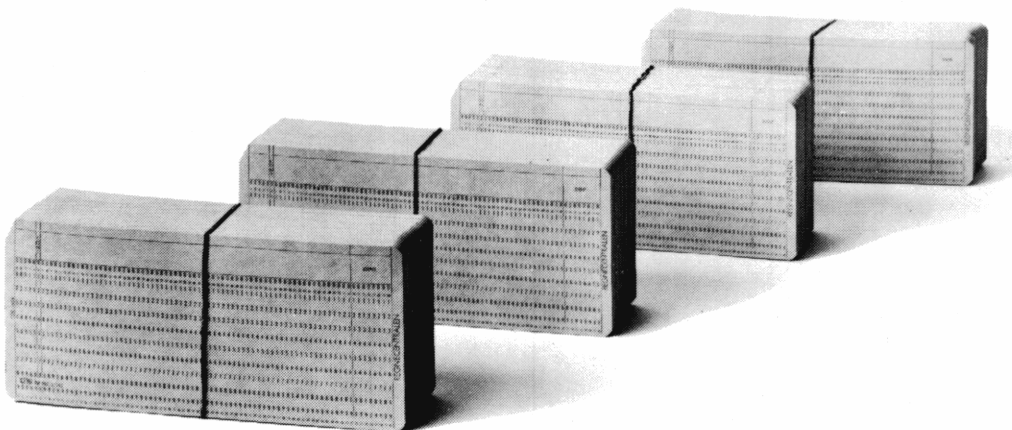
RC applications programs are provided to the user in MUSIL object code. This means, of course, that in order to run them the user must have a MUSIL Interpreter, as well as a Basic System.

RC 3600 applications programs can be run as-is, or they can be customized for special user requirements. In either case, the normal practice is to include them on the same run medium on which the Basic System and the MUSIL Interpreter are written, so as to simplify system operation.

Regnecentralen can also provide the user with custom-made programs.

3.3 User Programming

For the user who wishes to write his own MUSIL programs, RC provides Program Production Packages. Each of these packages contains a MUSIL 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 normal operator actions can be automated if desired. This is particularly useful for runs that involve loading different programs from different types of devices.



4 Operating The RC 3600 System

The user may choose between an Operator Control Panel (OCP) or a keyboard device to use as console to an RC 3600 system. The OCP is used for tasks such as running most of the RC 3600 Standard Programs. The various keyboard devices can run all of the standard programs and can also be used for the creation of MUSIL 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 a system with an OCP by 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 be narrowly controlled by the operator or to proceed almost automatically. One can write a MUSIL 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" that the program presents 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. RC 3600 operation can be learned in a day.

5 The RC 3600 Satellite System

The hardware and software that is made available as the RC 3600 system finds its major use as a satellite system, that is, as a help-mate to a larger host computer system. This function can take many forms.

5.1 As A Communications Terminal

The majority of RC 3600's sold to date are used as communications terminals. As a terminal, an RC 3600 can operate either in emulation as some other device, such as an IBM 2780, a HASP Multileaving Work Station, a CDC 200 UT, etc., or in point-to-point mode with another RC 3600. It can also serve as a second-stage communications device: as a collector of input from a number of other terminal devices or as a front-end or concentrator for a host computer. Finally, it can serve as a node in a data network.

5.2 As A Stand-Alone Support System

The RC 3600 can perform data conversion, including off-line printing, for a central site computer.

5.3 As A Data Entry System

The RC 3600 can be used as an off-line system or be in communication with a host computer. It can utilize either local or remote data entry devices, or both sorts at the same time.

5.4 Data Collection Systems

These can be built using the RC 3600 as a data collection center off-line or on-line to a host computer, since the presence of driver programs allows a wide variety of devices to be used for input to the system.

5.5 As A Peripheral Controller

The RC 3600 is the standard peripheral controller for an RC 8000. For any mainframe the RC 3600 can promote distributed processing and also relieve the load on a mainframe.

5.6 The RC 6000 Minicomputer

This is an extension of the RC 3600 system. Any RC 3600 can be up-graded to an RC 6000 by the addition of software and a minimal amount of hardware.

For other publications of interest, see

- The RC 3600 MUSIL Programming Reference Manual
- The RC 3600 Text Editor, Version Two
- The RC 3600 Program Catalog
- The RC 3600 Hardware Catalog
- The RC 3600 Operating Guide
- The RC 3600 Brochures
- The RC 6000 Brochures
- The RC 8000 Brochures

and the package of information on RC 3600 Data Entry systems.

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