(ARIPUC 9, 1975)

A SURVEY ON THE COMPOSITION OF A MINICOMPUTER SYSTEM IN THE LABORATORY

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1. Introduction

In January 1973 a minicomputer, PDP/8e with operator's console (DECwriter LA30) was installed in the laboratory. Since then the computer system has been expanded with several peripherals, some bought from computer equipment suppliers, others constructed in the laboratory.

2. System description

The computer with its peripherals now compose a rather powerful system for calculations, on-line data acquisition and signal processing.

The present system consists of:

PDP/8e Central Processing Unit	(CPU)
8k of core memory	
Extended Arithmetic Element	(EAE)
Paper Tape Reader	(PTR)
Paper Tape Puncher	(PTP)
Operator's Console (typewriter)	(LA30)
Teletype (typewriter)	(TTY)
Dual DECtape	(DTA)
Real Time Clock	(RTC)
Analog-to-Digital Converter	(ADC)
Digital-to-Analog Converter	(DAC)

The configuration with the possible data and control paths are shown in figure 1.

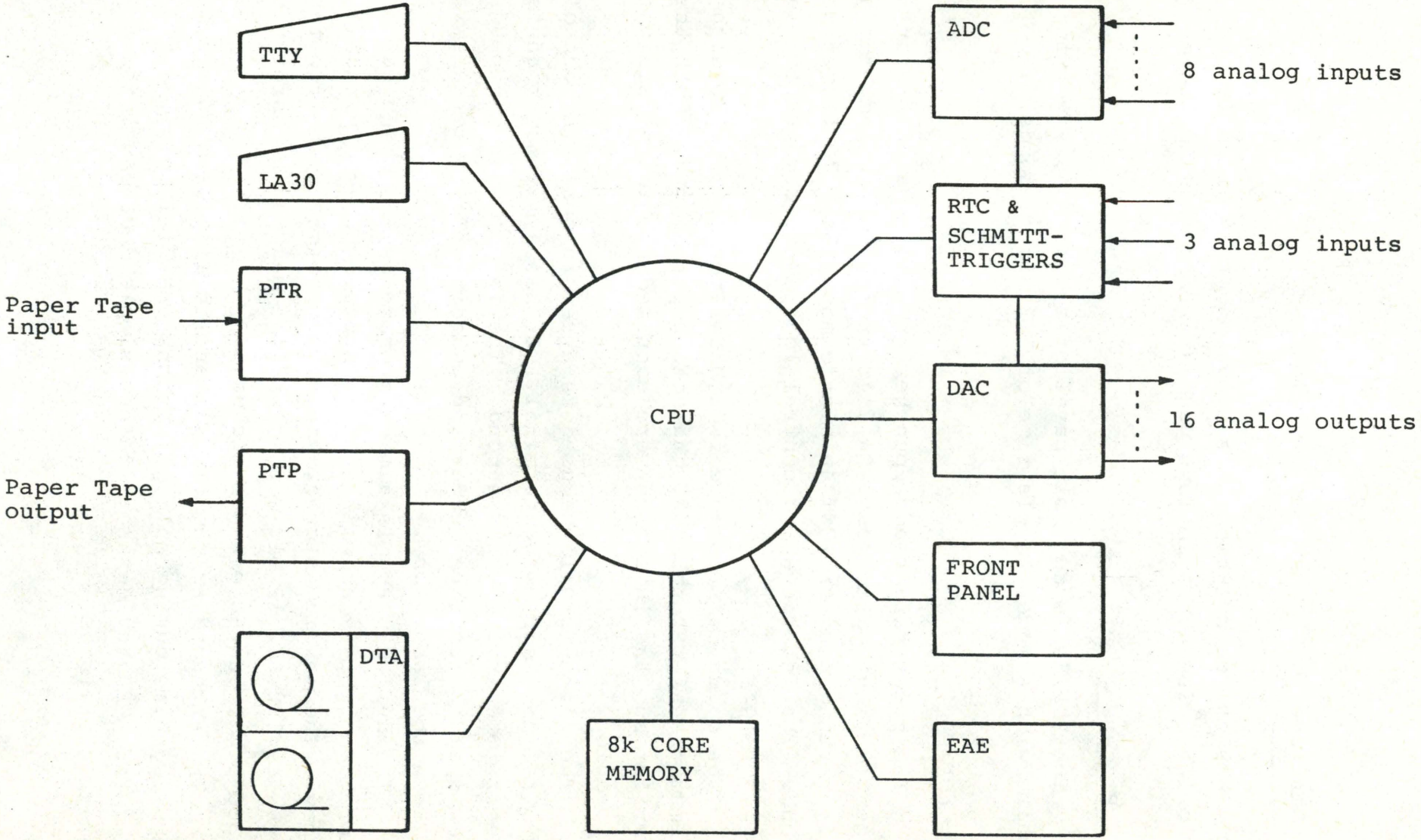

Fig. 1 System configuration.

3. Hardware

A short description of the equipment is given in the following. The abbreviations used are those listed above.

3.1 Processor

The PDP/8e is a 12 bit parallel synchronously working machine with a memory cycle time of 1.2 microseconds.

3.2 Peripherals

The paper tape reader/puncher appears as a self-starting reader (GNT Automatic model 24), 40 frames per second, and a self-starting puncher (GNT Automatic model 34), 70 frames per second. The interface and control logic were constructed in the laboratory.

The operator's console is a DECwriter model LA30 with a maximum transfer rate of 30 characters per second. Both the DECwriter and the interface were supplied by Digital Equipment Corporation.

The Teletype will be used as a remote operating console and off-line programming terminal. It has a maximum transfer rate of 10 characters per second. The Teletype is equipped with a low speed paper tape reader and puncher. The interface was built in the laboratory.

The dual DECtape is a mass storage device which can be used as program library as well as data storage or as a virtual memory. The maximum storage capacity on each of the two tape drives is 188,672 12 bit words, and the maximum transfer rate is 33,300 3 bit characters per second.

The Extended Arithmetic Element is installed to minimize computing time during multiplications and divisions. Furthermore, the EAE provides some rather simple double precision operating features.

The Real Time Clock, the Analog-to-Digital Converter and the Digital-to-Analog Converter are interconnected and thus constitute a set of very powerful input/output media for signal processing.

The RTC is a standard DEC supplied DK8-EP Programmable Real Time Clock, which includes three Schmitt trigger circuits monitoring three analog inputs. The RTC is controlled by the CPU, i.e. by the program executed in the computer. Under program control the RTC can trigger the CPU, the ADC, or the DAC with trigger-frequencies between 0.024414 Hz and 1 MHz. Furthermore, the RTC can be used for measuring time intervals between external events, detected by the Schmitt trigger inputs.

To minimize time jitter during sampling lapses the connection between the RTC and the ADC - or between the RTC and the DAC - can carry the trigger-pulses, which means that the timing of the sampling can be made totally independent of the CPU (within certain frequency limits).

The ADC is a standard DEC supplied AD8-EA Analog-to-Digital Converter with a AM8-EA 8 Channel Analog Multiplexer. The sample acquisition time is approximately 3 microseconds, and the conversion time is 20 microseconds. The multiplexer allows the ADC to be connected to any of the 8 differential-input amplifiers which have an input voltage range from -1 to +1 volt.

The DAC was designed and built in the laboratory as a general purpose DAC. However, great care has been taken in the design to make the DAC well suited as interface between the PDP/8e and the speech synthesizer constructed in this laboratory during the years 1966 to 1972 by J. Rischel and S.E. Lystlund (see particularly Rischel 1967 and Rischel and Lystlund 1972). These considerations have been decisive in the choice of the number of channels, the output range and some of the special features of the DAC which are too complex to be described in all details here.

The DAC appears as a 16 channel 10 bit converter with digital demultiplexer. The settling time for each converter is less than 10 microseconds, and the output voltage range goes from -10 to +10 volts. The demultiplexer and the data-loading logic can be controlled individually.

One of the special DAC features should be mentioned. The demultiplexer logic may be set in an autoincremental-mode, i.e. every data-loading instruction will cause an incrementing of the demultiplexer within a certain "loop limit" which may be set initially. This means that a preset loop, e.g. channels 0 - 8, will be scanned automatically just by repetitive data-loading instructions. By means of this feature an arbitrary number of channels (less than 17, of course) may be scanned with maximum speed. The logic allows the programmer to load DAC-channels outside the loop without disturbing the loop setting.

4. Software

To take full advantage of the peripherals it is necessary to write the programs in machine code or assembler language. However, a program library is being established. Several programs are already available, e.g. assembler-coded routines to handle certain peripherals, routines which can be called as subroutines from programs written in FORTRAN II, subroutines for high precision calculations, and programs for statistic calculations.

The program library is still expanding. It can be mentioned that a rather complex system of programs for sampling and signal-processing of electromyographic recordings is under development. The development of programs to control the speech synthesizer has been planned for some time, and the implementation has recently started.

A number of programs are available as programming aids: Editors, compilers (FORTRAN, FOCAL, BASIC), assemblers, loaders and debugging programs.

These utility programs are part of an operating system which makes communication with the machine very simple.

References

Rischel, Jørgen 1967: "Instrumentation for vowel synthesis", ARIPUC 1/1966, p. 15-21

Rischel, Jørgen and Svend-Erik Lystlund 1972: "A Formant-coded speech synthesizer", ARIPUC 6, p. IX-XXIX