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FIFTH COLLEGE ON MICROPROCESSORS: TECHNOLOGY AND APPLICATIONS IN PHYSICS

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The Colombo Board

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Colombo Board

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1. Design Philosophy

The Colombo Board was designed for the second College on Microprocessors held in Trieste in 1983 and was at that time called 'Trieste 83' board. It was meant to be a microcomputer for applications, to be build inside some equipment, or as a tool with well defined functions for a microprocessor or physics laboratory.

It is not a development system !

For the College in Colombo in 1984 it was slightly modified and the latest version 'ICTP 1985' has now hexadecimal display instead of a decimal one.

The board contains all the functions to make it a small microcomputer with CPU, EPROM, RAM and an I/O adapter. It also features a simple operator interface in the form of a 4-digit hexadecimal display, a buzzer to make some noise, a 16 position rotary switch, two switches, two push-buttons and a voltage-to-frequency converter. Signals going to control lines are jumper selectable and they can also be connected to some off-board equipment.

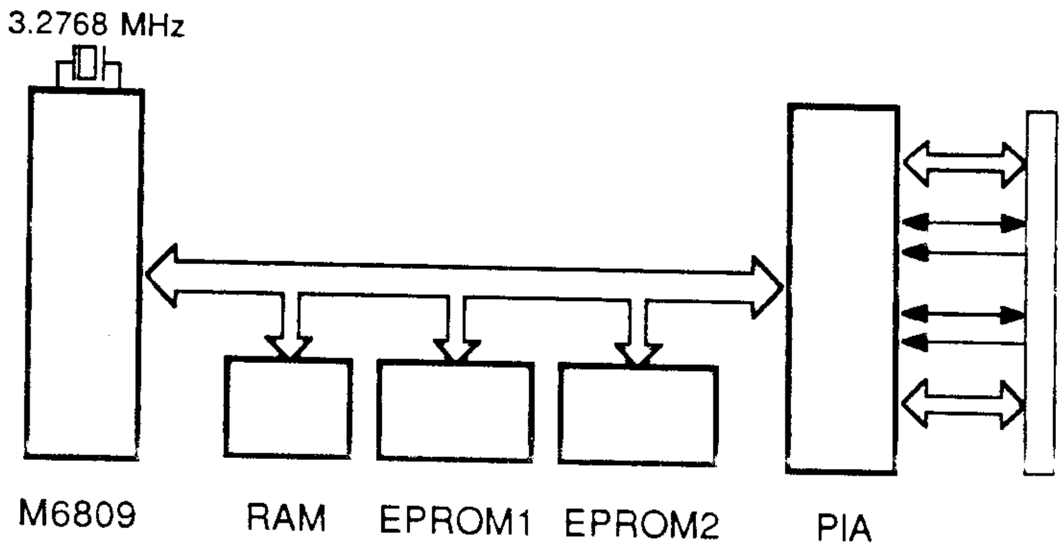
The number of applications is very large and we give just a short list for reference:

- Day-time clock with alarm and calendar
- Up/down counter
- Interval timer
- Stop watch
- Reaction tester
- Pulse and pattern generator
- Digital Voltmeter
- Analog surveyor
- Heat regulator
- Real-time data handler

Several of these functions can be on the board at the same time and the rotary switch may be used for selection. In the following we describe the board in more detail and explain later how to develop application programs using the ROSY station. For reasons which will become clear later, the board has two distinct parts: The microcomputer section and the application section. The application section can be used indepently from the computer section. The board was kept on purpose very simple, not only to keep its cost down, but also to allow beginners to understand it completely.

2. Microcomputer Section

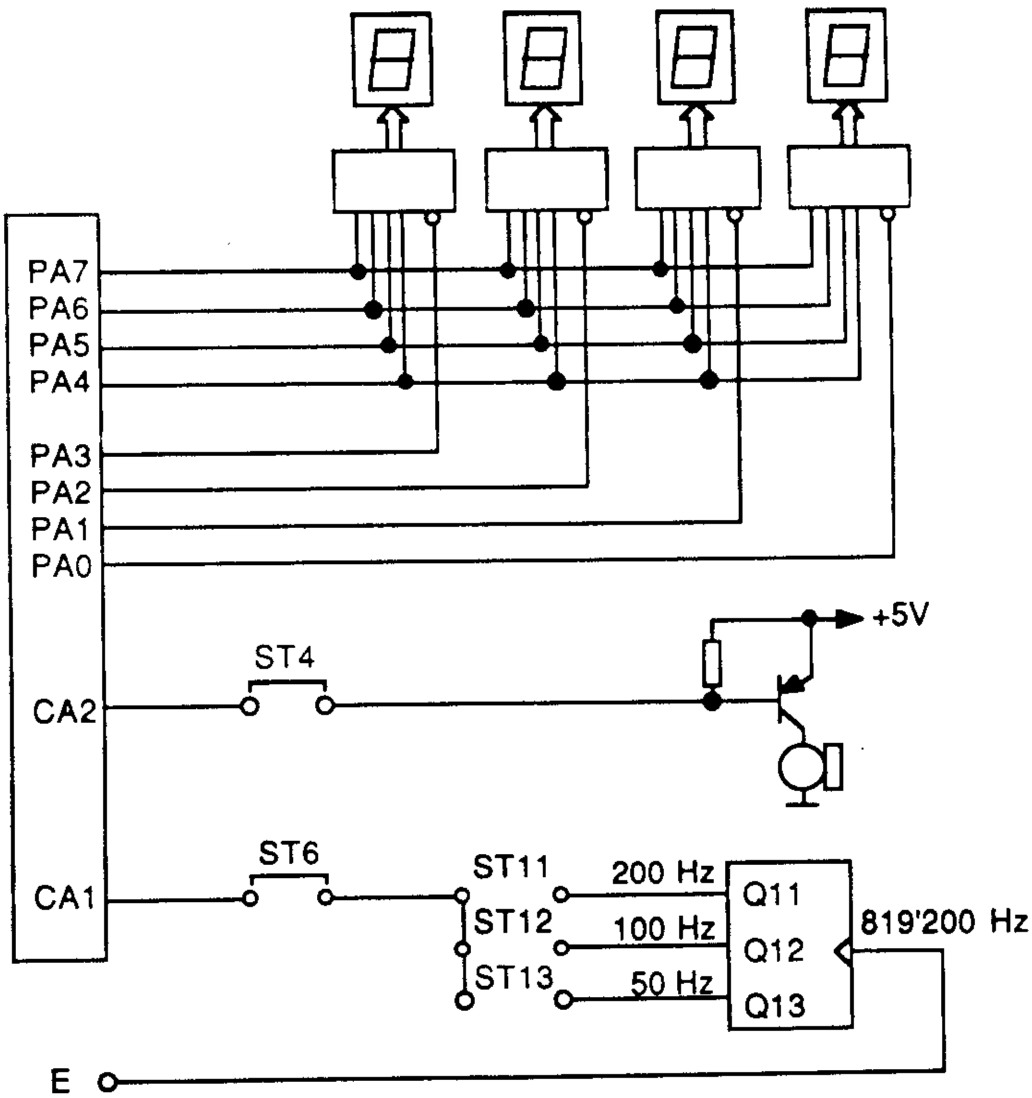
As can be seen from the blockdiagram this section contains the M6809 CPU, a 2K*8 RAM memory, two sockets for 2K*8 EPROM memories, the decoding logic (not shown) and one PIA. Connections to the outside world



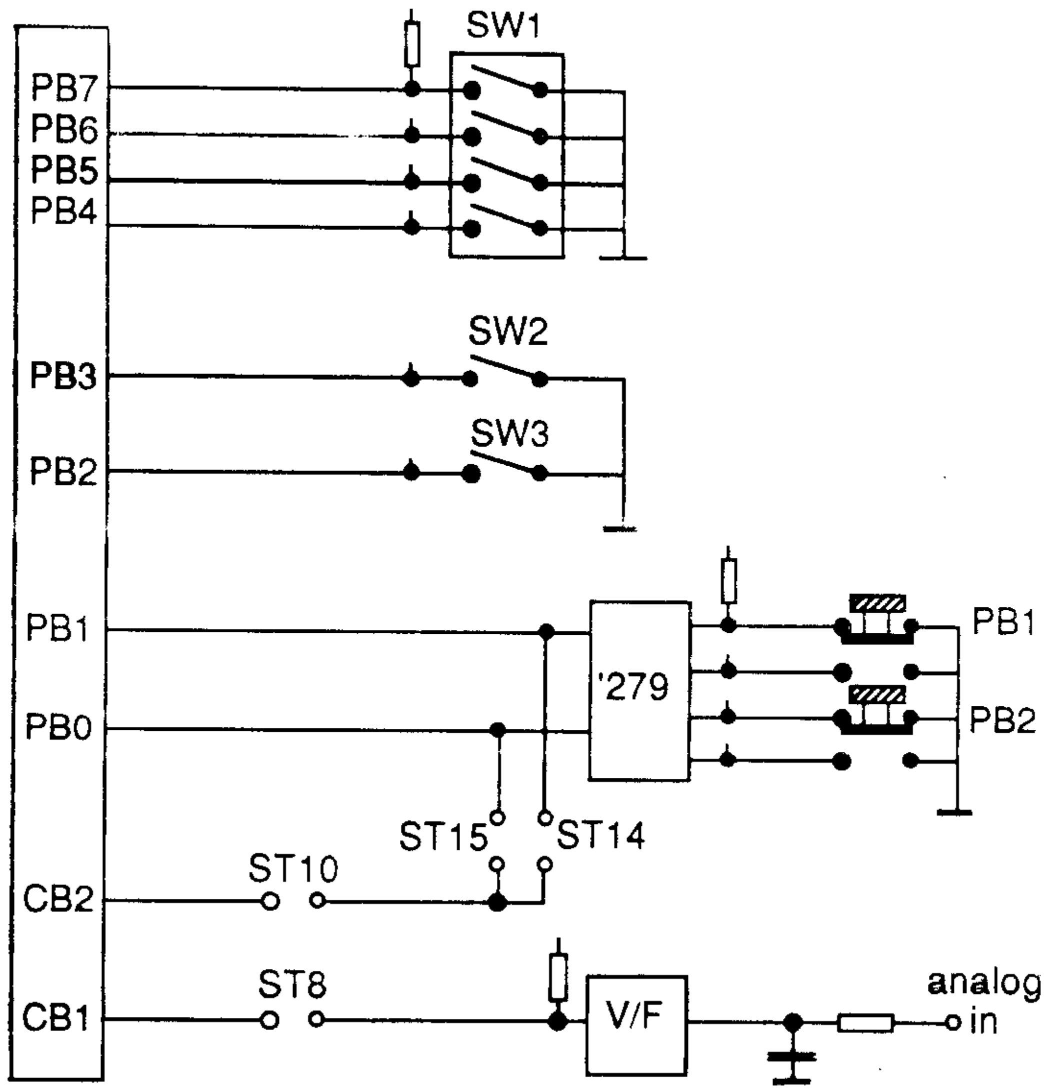
go via a 26-pin connector carrying all the PIA lines, ground and +5Volt. The pin assignment on this connector is identical to the one for the PIA connectors on the ROSY station. The quartz frequency has been chosen to be 3.2768 MHz which is 100*2^15 providing an easy way to generate a 100Hz clock. The system clock E is therefore 0.8192 Mhz. Unused CPU signals are brought out on a connector. We will use the HALT line to disable all CPU activities after power-on for program development.

3. Application Section

The next block diagram shows the output part of the application section. The four hexadecimal display units are controlled via four latches with decoding and driving circuits. The 4-bit data bus, driven by PA4-7, is in common and PA0-3 are used as 'chip select' or 'enable' lines. CA2 can be connected to a buzzer, CA1 may be fed with a pulse train derived from the system clock at 200, 100 or 50 Hz. ST4 and ST6 allow to connect CA1 and CA2 differently.



The second half of the PIA is devoted to the input devices. SW1 is a 16-position rotary switch intended to select 1 out of 16 different programs stored in EPROM. It may of course be used in a different way. Note that the data are read in 1's complement.



The toggle switches SW2, SW3 as well as the push-buttons PB1 and PB2 could be useful to select operating modes or to enter commands. The push-buttons may be connected to CB2 via ST15, ST14 and ST10 and used with interrupts if needed. Finally, a voltage-to-frequency converter V/F is available for analog measurements. The circuit accepts an incoming signal range from 0 to about 5 Volts and it generates a pulse train, who's frequency is proportional to the applied external voltage. A frequency of a few kHz is generated for full-scale input.

4. Development Environment

As stated before, the Colombo board is an end-product running fixed software from EPROM. How does one actually develop and the debug the software for such a project?

The dividing line between the computer section and the application section is the PIA connector. Is is sufficient to put the processor to HALT and to apply a RESET to set the PIA to all inputs. Thereafter, the microcomputer section is quasi non-existing. Any other develoment system with a PIA may be used to develop the application. In our case we use ROSY and FLEX to assemble and debug the program which will execute inside the ROSY station and use only the I/O part of the board. Once the program is supposed to work only a few addresses (RAM, PIA, program start address) have to be changed being different on the two systems. The binary code can then be stored in EPROM and should work. Using position independent code eases this transition.

The Colombo board has shown to be rather versatile. It is a nice tool to get familiar with the basic concepts of system programming on microprocessors at a modest cost (≤ US$ 100.-).