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**SECOND COLLEGE ON
MICROPROCESSOR-BASED REAL-TIME CONTROL -
PRINCIPLES AND APPLICATIONS IN PHYSICS
5 - 30 October 1992**

ICTP-COLOMBO BOARD

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ICTP - Board

PART - I:

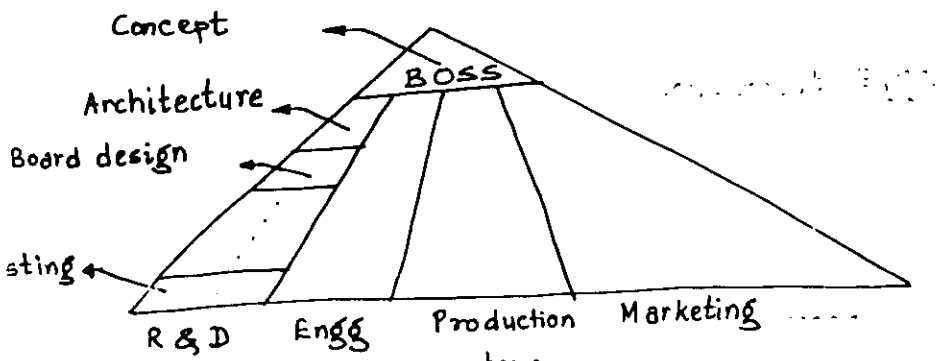
The ICTP board in relation to the course
- where it fits in
- what is the purpose of the board.

PART - II:

Details of what is contained on the board.

Consider a structured system from everyday-life.

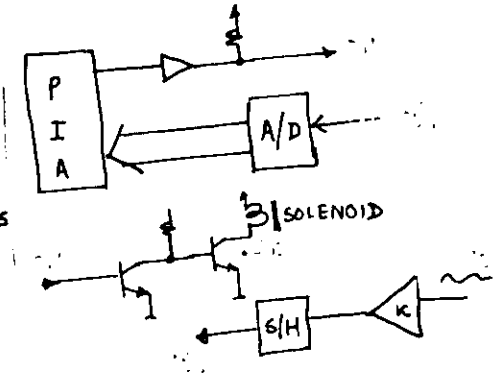
Eg: A strictly hierarchical organisation



Salient feature: Each level has a well defined interface to it's immediate neighbour. ↑ and ↓

- Details can be held invisible to other layers.
- Sufficient to have a well-defined protocol between layers.

STRUCTURED REAL-TIME CONTROL SYSTEM.

LAYER	EXAMPLES
① Application Program.	read( ); write( );
② R-T Operating System.	lbra read. lbra write.
③ Device driver, descriptor.	LDA ..... STA $EC1Ø
④ Digital device interface	
⑤ Analog interface electronics	
⑥ Transducers: sensors, actuators, etc.	SOLENOID. THERMOCOUPLE.
⑦ Real world parameters,	Magnetic field, force. Temperature.

NOTE:

* The separation of functions into layers is dependent on system designer — No standardisation is implied

* The dividing line indicates the end of the programmer's model. i.e. below this layer the rest of the system is:

  EITHER: completely H/W with no S/W

  OR : S/W is fully embedded and invisible to this system. (eg terminal)

* Scope of this course: Mainly the 1st 4 layers

* ICTP Board represents this dividing line.

ICTP board represents:

- lowest programmable level.
- beyond this inputs could come from sensors, detectors through associated electronics.
- These are simulated by switches, A/D converter,
- display simulates an output device.

Details of the board:

- Covered in PART-II.
- Remember to concentrate on the ~~matter~~ concepts (which you can carry home)
- Details of the board are important only to demonstrate the concept and of course useful for as long as the course lasts. (can't take it home!)

→ Concepts that can be demonstrated:

- concurrent processes.
- inter-process communication
- terminating or invoking a process when an event in the external world occurs.
- how nasty details of H/W are hidden

etc. etc....

Colombo/ICTP Board

- It was originally designed for the second College on Microprocessor in 1983 and subsequently modified slightly in 1984 and 1985 for the same series of Microprocessor Colleges.

- We shall use this Board for the Real-time College in the Laboratory for several experiments to illustrate
  - technique of handling nonstandard peripheral devices,
  - implementation of user written device drivers,
  - principle of multitasking,
  - interprocess communication.

- It is a small microcomputer system with several input/output (I/O) devices designed to illustrate the principles of microprocessor and simple I/O device implementation.

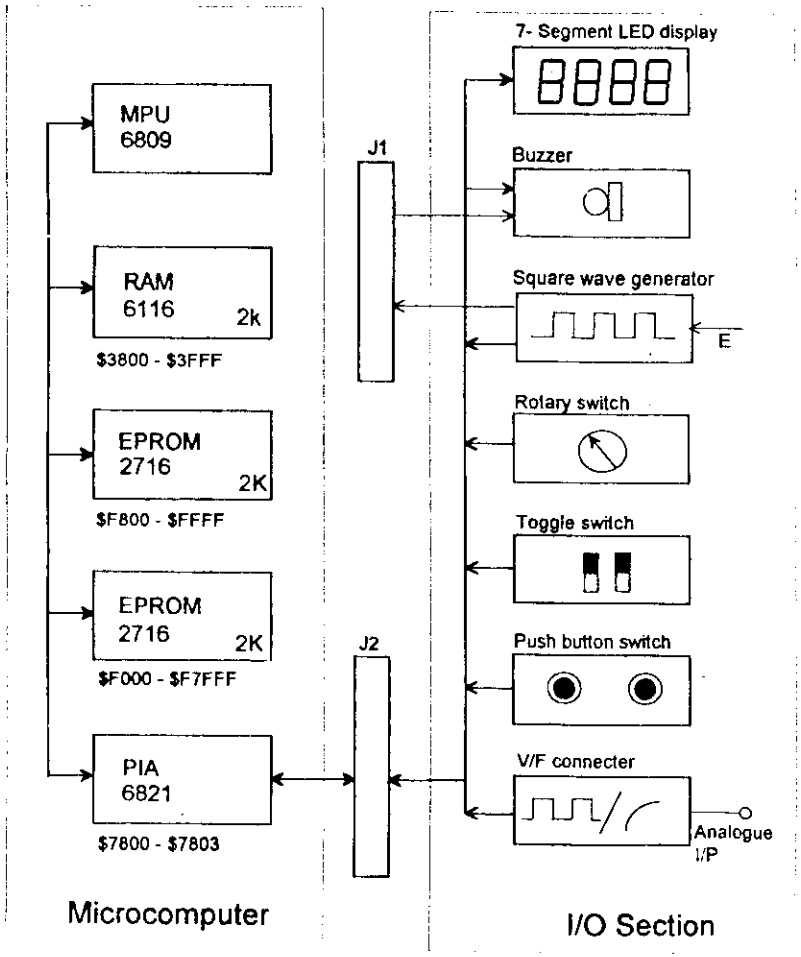
- The microcomputer is a M6809 system consisting of five main ICs (an MPU; a RAM; two EPROMs and a PIA) and a small address decoder. This section of the Board is not used in the designed experiments in this College.

Columbo/ICTP Board I/O Section

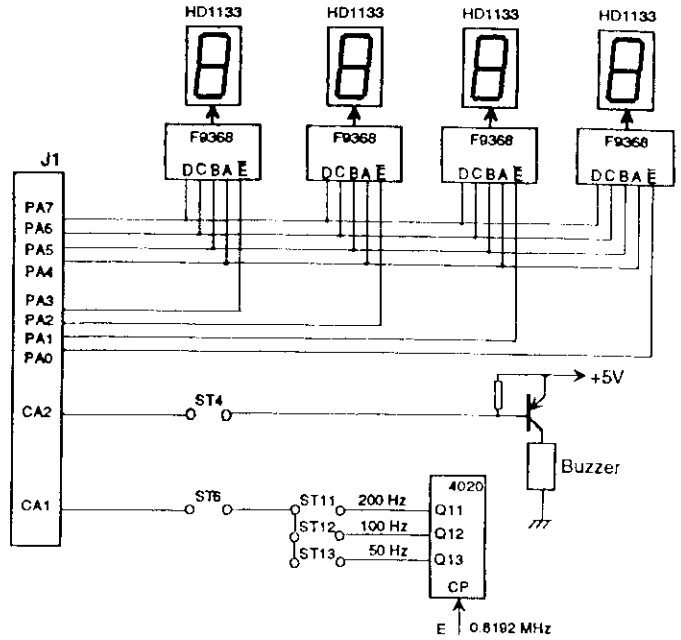
- A separate I/O section of the board has the following devices:
  1. A 4-digit hexadecimal LED display.
  2. A buzzer.
  3. A square wave generator with a jumper selectable output at 50, 100 or 200 Hz.
  4. A 16-position rotary switch with a 4-bit binary encoded output.
  5. Two toggle switches.
  6. Two push-button switches.
  7. A voltage-to-frequency (V/F) converter for measuring voltages in the range of 0-5 volts. The corresponding output is a pulse train of 0 to several kHz.

- The I/O devices are connected to either the on-board PIA or an off-board external PIA via a 26-pin connector (J2).

Colombo/ICTP Board Block Diagram



I/O Section Port A

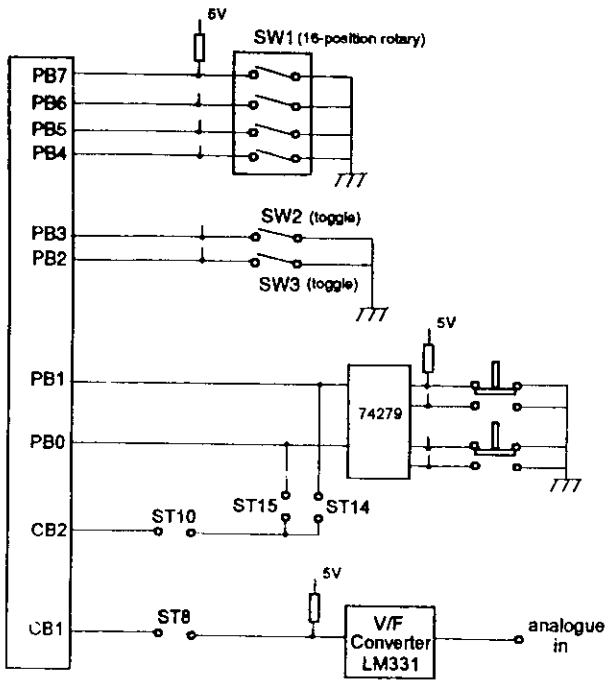


- Each of the four LED displays is driven by a latch with hexadecimal decoder and drivers. The four inputs to the latches/decoders are connected to PA4-7, PA4 being the least significant bit. PA0-3 are used for latching the four data bits in the latches/decoders. PA0 controls the rightmost LED while PA3 the leftmost.

- A buzzer driven by a pnp transistor may be connected to CA2 via a jumper ST4. A low output on CA2 turns on the buzzer.

- A binary counter (4020) is used for generating square waves of 10, 100 and 200 Hz from an input clock of 0.8192 MHz from the MPU. CA1 may be connected to any one of the outputs by etting the appropriate jumpers ST6, ST11, ST12 and ST13.

I/O Section Port B



- SW1 is a 16-position rotary switch with binary encoder producing four bit output which is read by PB4-7.
- SW2 and SW3 are two toggle switches connected to PB3 and PB2 respectively.
- PB1 and PB2 are push-button switches connected to PB1 and PB0 respectively. They may be routed to CB2 by jumpers.
- An LM331 voltage-to-frequency converter converts analogue voltage in the range of 0-5V to square wave input which may be monitored by CB1.

- In our experiments, we shall use the PIA0 in ROSY Junior to control and monitor the I/O devices. This is done by connecting the parallel port P3 of ROSY Junior to J2 of the Columbo/ICTP Board. The port addresses are

$EC10	Port A Output & Direction Registers
$EC11	Port A Control Register
$EC12	Port B Output & Direction Registers
$EC13	Port B Control Register

- When an external PIA is used for interfacing with the I/O devices, the on-board PIA must be either disabled or removed. The former is done by setting the MPU to HALT state and resetting the PIA, thus setting all PIA I/O and control lines as inputs.
- One of the input devices, the square wave generator gets its 0.8192 MHz input clock pulses from the E clock of the MPU. Thus for this device to function, the MPU must be kept running to generate the E clock signal.