Computer Organization
(Keyboard & Display Control, and Printers)

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Printing history

1. Printing press 1454
2. Lithography 1796
3. Chromolithography 1837
4. Rotary press 1843
5. Flexography 1873
6. Mimeograph 1876
7. Hot metal typesetting 1886
8. Offset press 1903
9. Screen-printing 1907
10. Dye-sublimation 1957
11. Phototypesetting 1960s
12. Photocopier 1960s
13. Pad printing 1960s
14. Dot matrix printer 1964
15. Laser printer 1969
16. Thermal printer 1970s
17. Inkjet printer 1976
18. 3D printing 1986
19. Stereolithography 1986
20. Digital press 1993

Classification

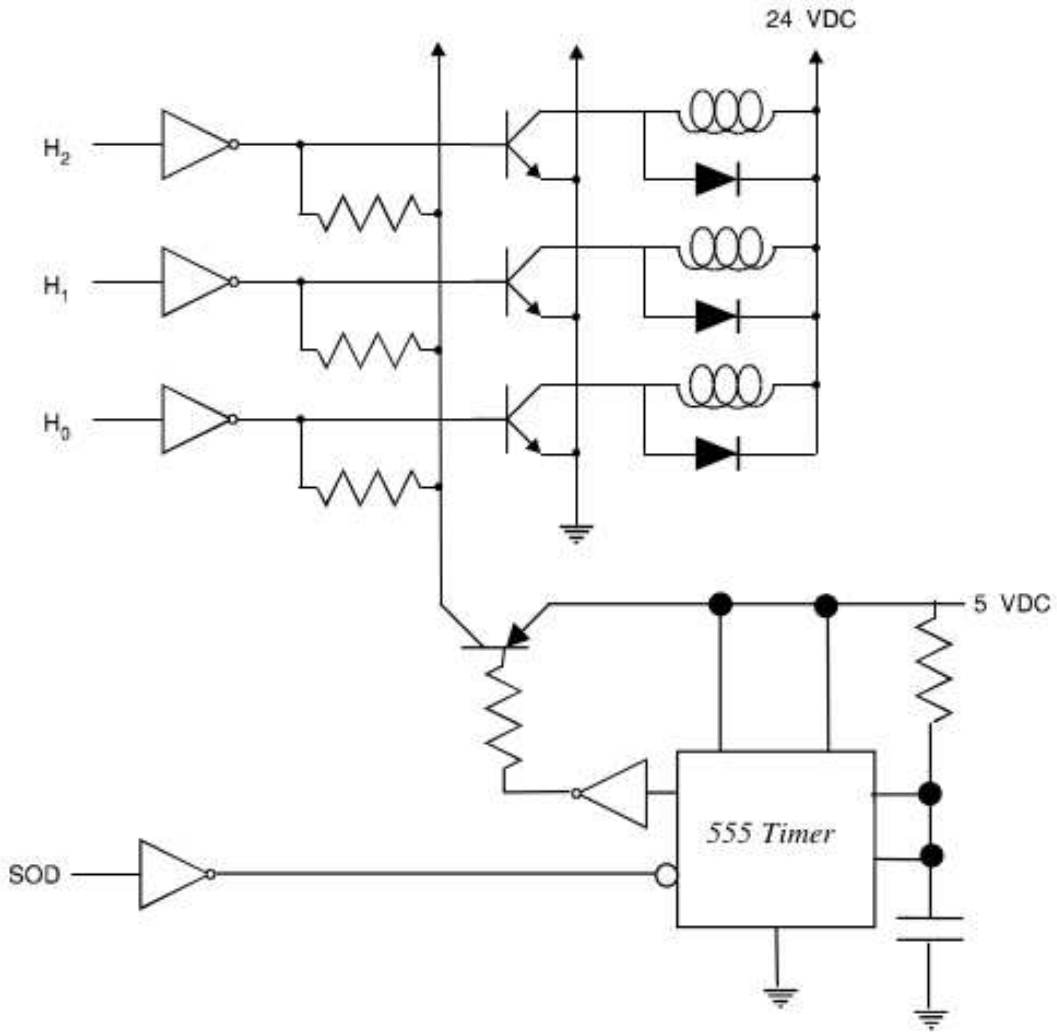
- All printers have three main components: printing mechanism itself, paper feed mechanism, and the control and interface electronics.

1. **Impact Printers**
- Line printers
    1. Dot matrix: Comb, Multihead
    2. Engraved: Drum, Band, Belt
- Character printers
    1. Dot matrix: 9-pin, 24-pin
    2. Engraved: Teletype, Daisy wheel
2. **Non-impact printers**
    1. Inkjet
    2. Thermal
    3. Electrophotographic(Laser)
    4. other

Dot matrix printer

- Print head runs back and forth, on the page and prints by impact, striking an ink-soaked cloth ribbon against the paper, much like the print mechanism on a typewriter.
- Letters are drawn out of a dot matrix, and thus, varied fonts and arbitrary graphics can be produced.
- Printing speed: 50 - 500 cps.
- Each dot is produced by a tiny metal rod, (called a "wire" or "pin"), driven forward by the power of a tiny electromagnet/solenoid, either directly or through small levers
- Moving print head, generally prints one line of text at a time.
- Most dot matrix printers have a single vertical line of dots, others have a few interleaved rows in order to improve dot density.
- Types: Near Letter Quality (NLQ), 24-pin printers
- The desktop impact printers were gradually replaced by the Inkjet/Laser printers.

Printer-head driver Electronics (Dot Matrix Printer)



Working of dot matrix printers

- Concept: Each character is mapped to a matrix of 7×9 columns
- A matrix can have elements 0 or 1, which maps to white or dark spaces on paper
- A ROM can be used to produce encoded o/p corresponding to a character into the 8-bytes
- The ROM stores bytes as per the character and font type
- Such an arrangement has the advantage that different fonts can be printed
- Changing the ROM can also print characters other than those in English
- ROM encoding for Z:

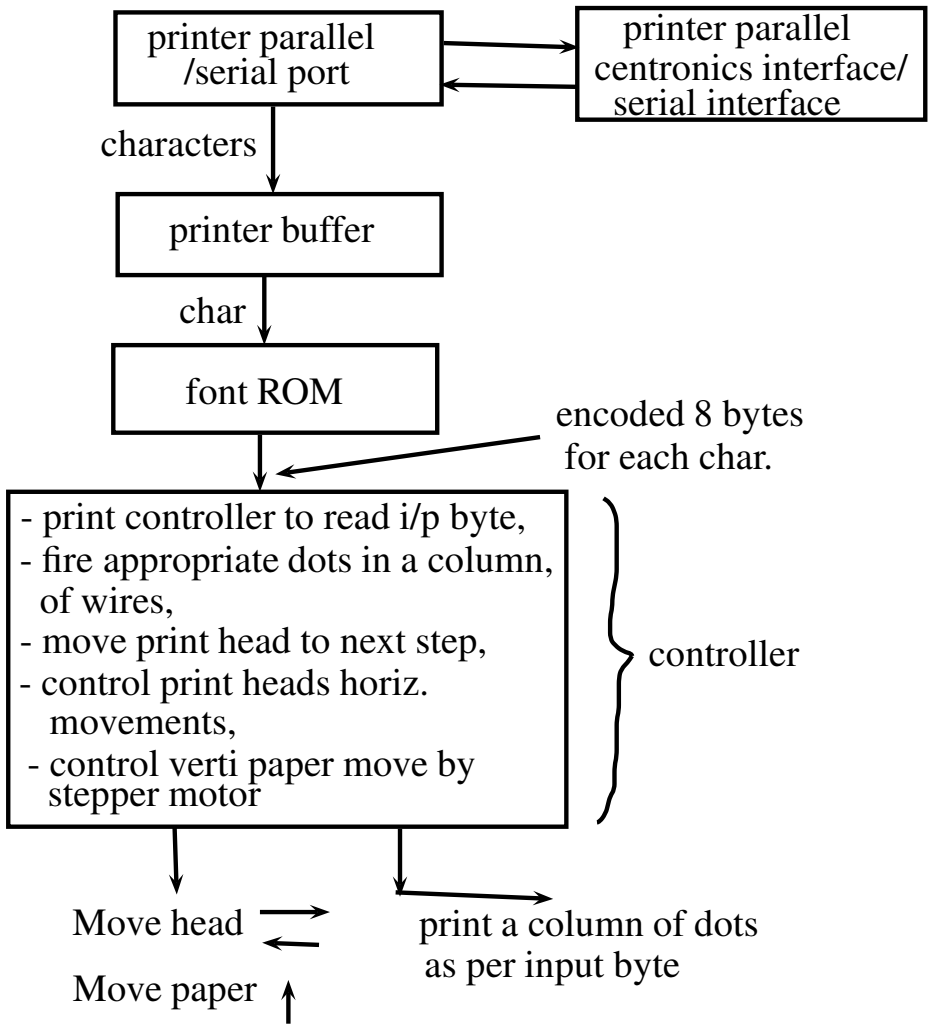
1	1	1	1	1	1	1
					1	
				1		
			1			
		1				
	1					
1	1	1	1	1	1	1

Dot matrix, when not using the ROM encoded outputs, can be used for graphic printing also

Printer Controller

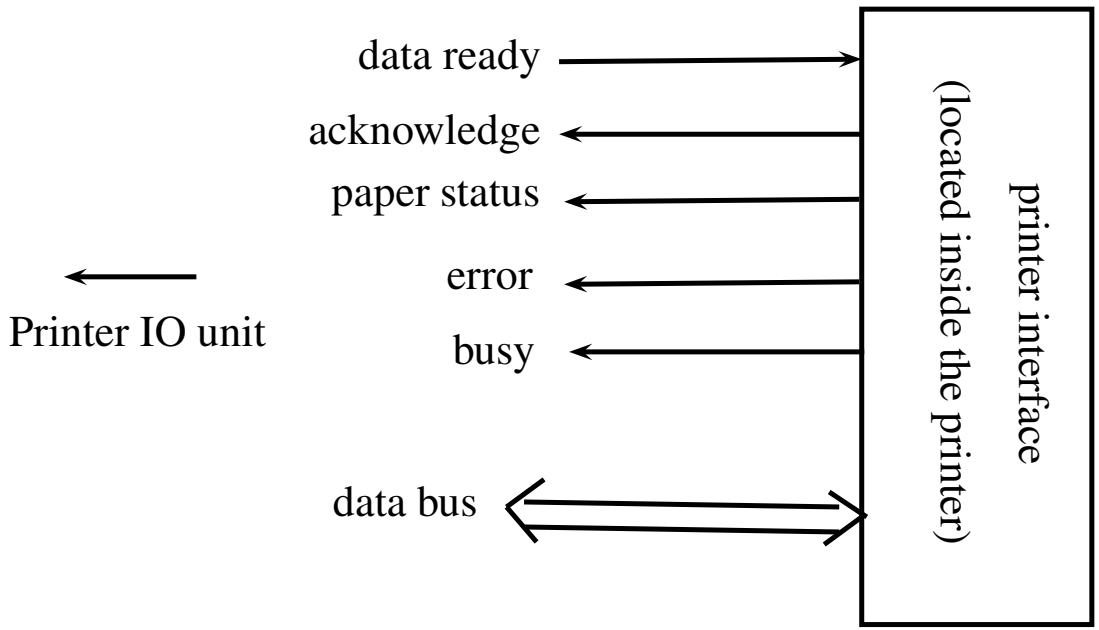
- Reads the input byte from the encoder and fires an appropriate set of dots
- The dots in a set are mapped to a column of wires, which are pressed on the ribbon to print a column each and move the print head one step to next column
- Controls the print head movements on the horizontal axis
- A stepper motor moves the print head horizontally forward in odd lines and back on the even lines, of a page
- A line feed character advances a line on the page
- A vertical-roll stepper-motor rolls the paper on each line feed or page change

Working of dot matrix printers



Communication and control: Dot matrix printers

- Uses Centronics standard 36-pin interface as parallel port
- Or RS232C serial asynchronous UART based standard interface
- The printer port gives the input to a print buffer
- The print buffer stores the ASCII codes (bytes) sent by the computer printer interface
- The buffer output byte, which gives 8-bytes for the encoded output, is given to the ROM as its address input



Inkjet Printer

- Uses a droplet, which is ejected through a thin nozzle. It is a non-impact technology
- Droplets fired through the nozzle as per the character
- A bubble jet nozzle has a mini-heater, which when it heats, evaporates the ink drop in the jet to mark the paper where it condenses on the colder surface
- Colour Ink jet printer
  1. Three nozzles for three different colors: red,green, and blue

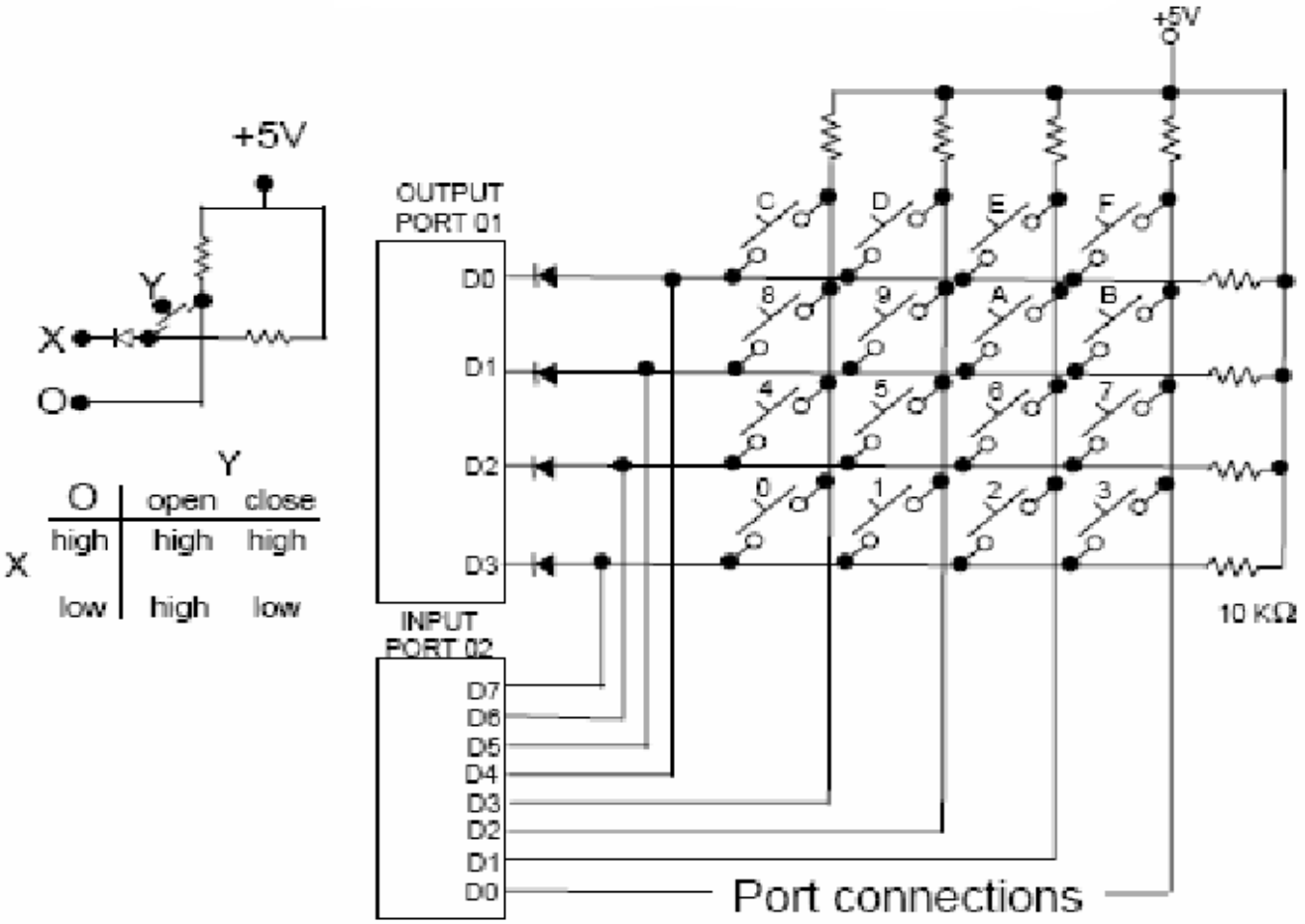
Laser printer functioning

- A commonly used printer, produces high quality text and graphics on plain paper, at speed
- Image is produced by the direct scanning of a laser beam across the printer's photoreceptor.
- A drum is coated with photoconductive material (selenium) that gets positively charged
- On illumination by a laser beam falling onto tiny areas, the photoconductive material in that area starts electrically conducting
- The charge in that area annihilates (discharges)
- The (negatively charged) ink powder particles get attracted only to the area not discharged on illumination by laser beam (photocopier principle)
- The illumination comes from those areas that are white and therefore the ink powder does not stick there
- When the laser beam falls only on areas where no prints (white spaces) should be there, the drum prints the page areas where the beam has not fallen
- Speed: 200 monochrome pages or more per minute

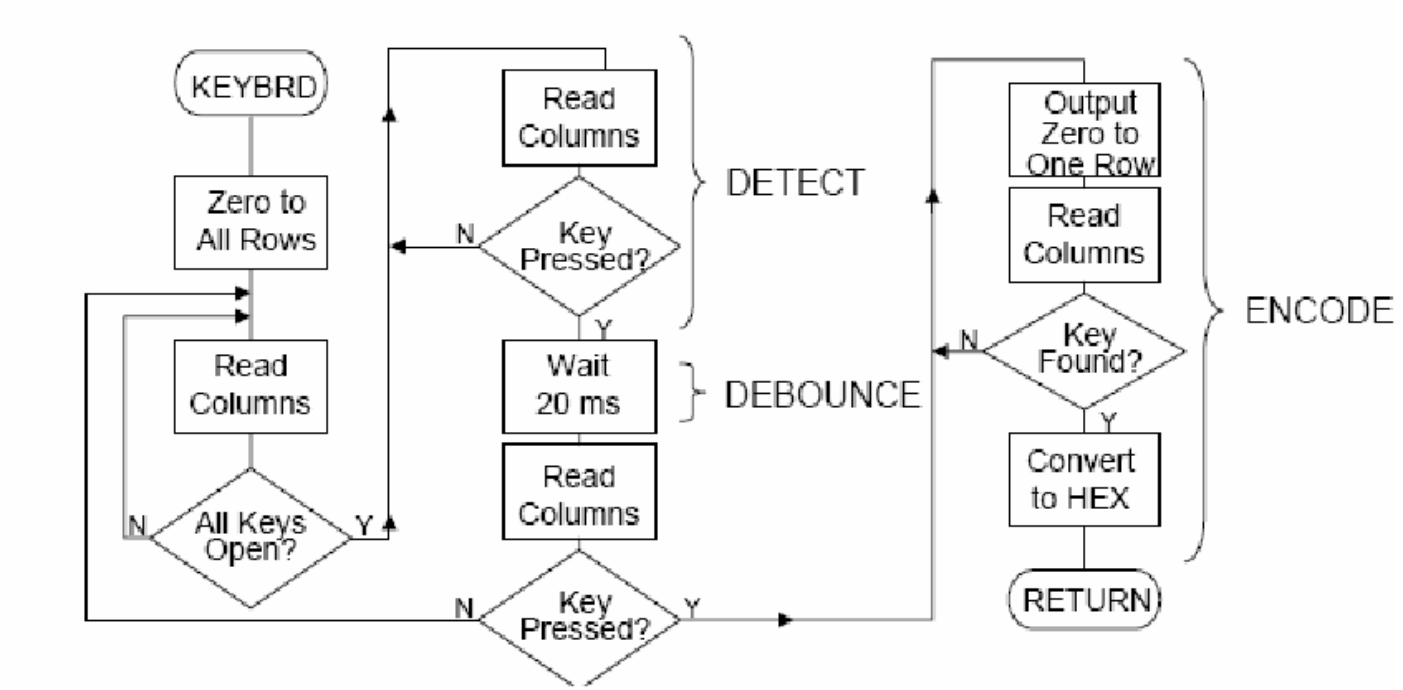
Matrix Keyboard and Multiplexed Display Interface

- A matrix keyboard is a commonly used input as device when more than eight keys are necessary
- A matrix keyboard reduces the number of connections and hence reduces the number of interfacing devices
- The rows and columns do not have any connection and the connection occurs when a key is pressed
- The interfacing of a matrix keyboard requires one input port and one output port
- Rows are connected to the output port and columns are connected to the input port (?)

Matrix Keyboard and Multiplexed Display Interface



- Steps involved:
  1. Check whether all keys are open
  2. Check a key closure
  3. Identify the key
  4. Find the binary key code for the key



Intel 8279 Keyboard/Display Controller

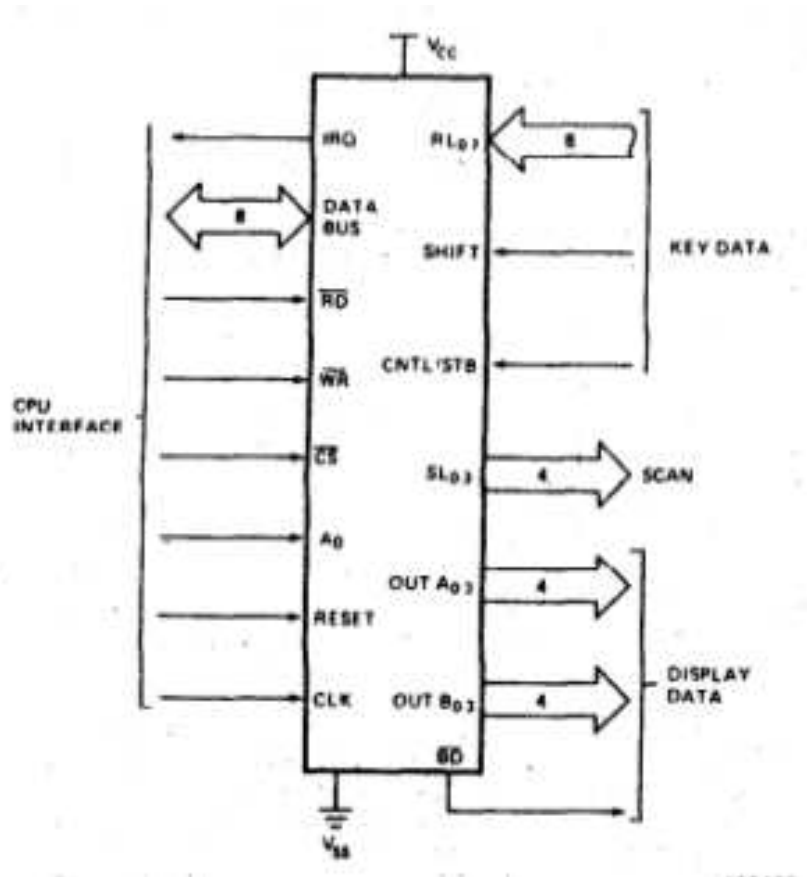
- Intel 8279 is the keyboard /display controller (used to interface keyboard and display to the microprocessor)
- It is able to drive the signals for both the keyboard and display and hence it is possible for the microprocessor to concentrate in its routine tasks
- 8279 provides four scan lines and eight return lines for interfacing keyboards, and a set of eight output lines for interfacing display
- The keyboard portion can provide a scanned interface to a 64-contact key matrix
- The keyboard portion interfaces an array of sensors or a strobed interface keyboard
- Keyboard entries are debounced and strobed in an 8-charcter FIFO
- If more than 8 characters are entered, overrun status is set
- Key entries set the interrupt output line to the CPU

Intel 8279 Display Section

- The display portion provides a scanned display interface for LED, incandescent and other popular display technologies
- Both numeric and alphanumeric segment displays may be used as well as simple indicators
- The 8279 has 16*8 display RAM which can be organized into dual 16*4
- The RAM can be loaded or interrogated by the CPU
- Both right entry, calculator and left entry typewriter display formats are possible
- Both read and write of the display RAM can be done with auto-increment of the display RAM address

Keyboard and Display Controller

- Simultaneous keyboard and display operations
- scanned keyboard mode
- 8-char keyboard buffer FIFO
- Dual 8/16-numeric display
- mode programmable from CPU
- keyboard interface provides 64-contact key matrix
- Display provides scanned display interface for LED/other disp.
- 16x8 display RAM
- connects directly to the BUS of 8085 processor



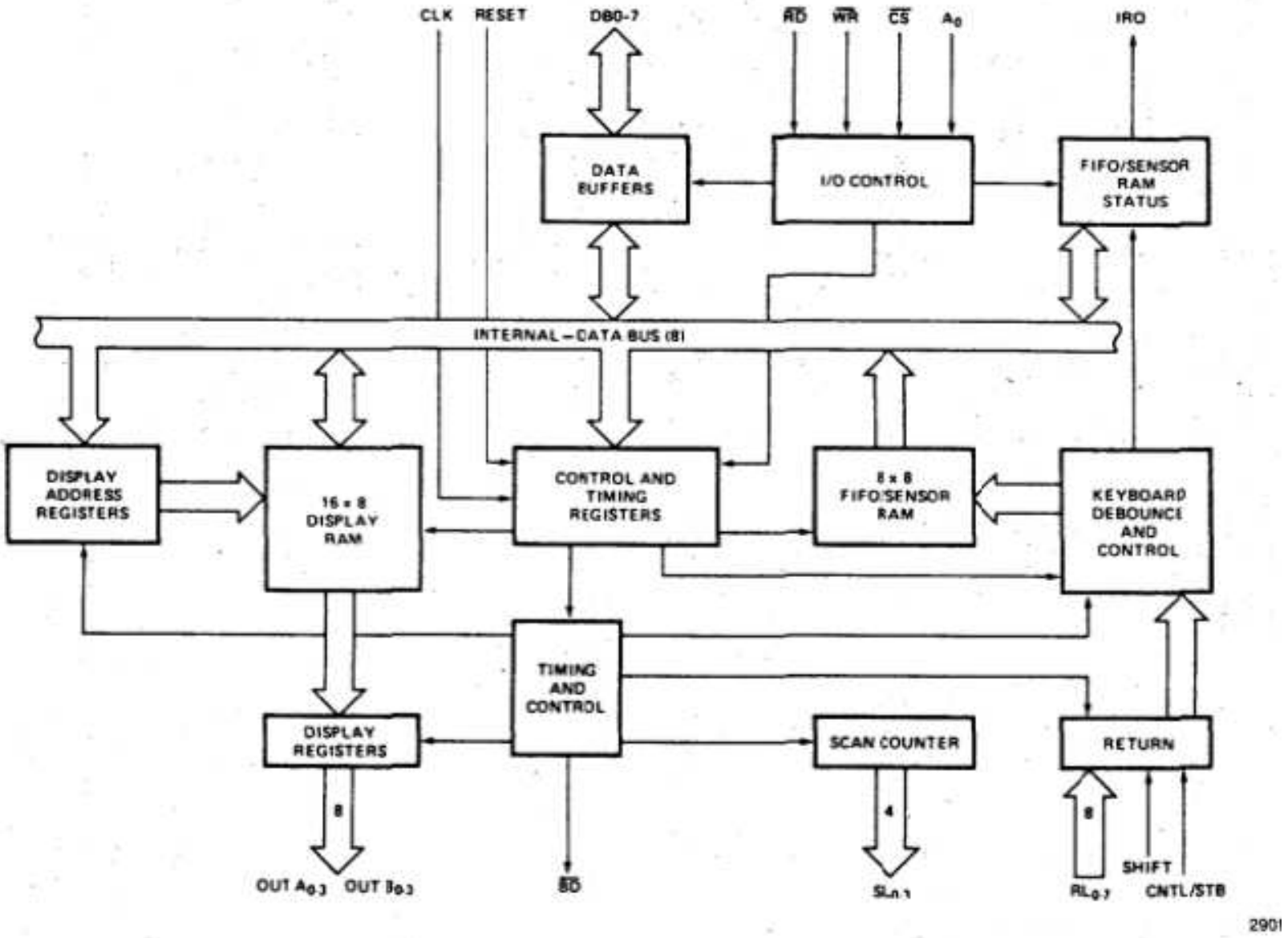
Pinout Definition 8279

- A0: Selects data (0) or control/status (1) for reads and writes between microprocessor and 8279.
- BD: Output that blanks the displays.
- CLK: Used internally for timing. Max is 3 MHz.
- CN/ST: Control/strobe, connected to the control key on the keyboard.
- CS: Chip select that enables programming, reading the keyboard, etc.
- DB7-DB0: Consists of bidirectional pins that connect to data bus on micro.
- IRQ: Interrupt request, becomes 1 when a key is pressed, data is available.
- OUT A3-A0/B3-B0: Outputs that sends data to the most significant/least significant nibble of display.
- RD(WR): Connects to micro's IORC or RD signal, reads data/status registers.
- RESET: Connects to system RESET.
- RL7-RL0: Return lines are inputs used to sense key depression in the keyboard matrix.
- Shift: Shift connects to Shift key on keyboard.
- SL3-SL0: Scan line outputs scan both the keyboard and displays.

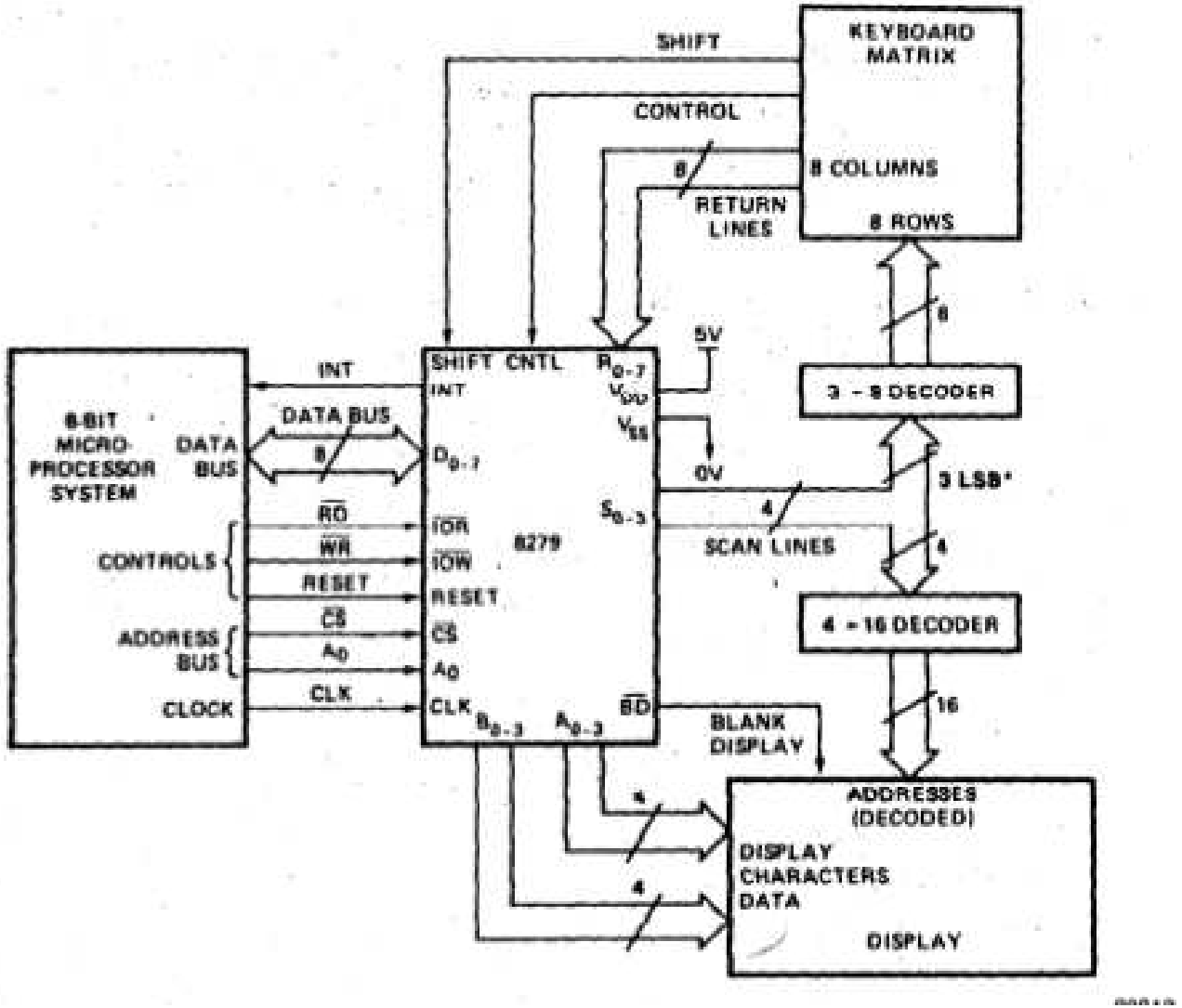
Keyboard and Display Controller

- CPU can program all I/O modes of 8279.
- Input Modes:
  Scanned keyboard: 8X8 keyboard scanned lines. Key depression generates 6-bit encoding of key position.
- Output Modes:
  1. 8/16 character multiplexed display
  2. Interrupt output to CPU when keyboard/sensor data is available
  3. An 8-byte FIFO to store the keyboard data
  4. 16-byte internal display RAM for display refresh (can be read by CPU)
- A_0: 1 $\rightarrow$ status/command, 0 $\rightarrow$ data (are bidirectional)
- Control and timing Registers: Stores keyboard and display modes
- Keyboard scan @ 5.1 msec.

Keyboard and Display Controller



Keyboard and Display Controller



Exercises

1. Specify the data transmission media, data formats, and signalling protocols used for each of the following communication tasks: linking the CPU and memory of a new computer; linking a detached keyboard to a user terminal; connecting terminal to a remote computer via the public telephone network. Provide a brief justification for each of the communication.
2. Compare and contrast synchronous and asynchronous buses from the viewpoints of data bandwidth, interface circuit cost, ans reliability.
3. Explain each of the following in context of bus design: handshaking, lock signal, master unit, skew, tristate, wait-state.
4. Analyze the three bus arbitration bus methods, daisy-chaining, polling, and independent requesting, with respect to communication reliability in the event of hardware failures.
5. What is difference between a subroutine, and an interrupt service routine.

Exercises

6. The devices A, B, and C are connected to the bus of a computer. I/O transfer for all three devices use interrupt control. Interrupt nesting for devices A and B is not allowed, but interrupt requests from C may be accepted while either A or B is being serviced. Suggest different ways in which this can be accomplished in each of the following cases.
   - 6.1 The computer has one interrupt request line.
   - 6.2 Two interrupt request lines, $INTR1$, and $INTR2$, are available, with INTR1 having higher priority.

   Specify when and how interrupts are accepted and disabled in each case.
7. Consider a computer in which several devices are connected to a common interrupt request line. Explain, how you would arrange for interrupts from device j to be accepted before the execution of the interrupt-service routine for device i is completed. Comment in particular on the times at which interrupts must be enabled and disabled at various points in the system.

Bibliography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