Display

What is a Display?

- A display is a computer output surface and projecting mechanis shows text and often graphic images to the computer user.
  - Using a cathode ray tube (CRT) or
  - Using liquid crystal display (LCD) or
  - Using light-emitting diode or
  - Using gas plasma or other image projection technology.

CRT Display

CRT Fundamentals:

- ✔In the CRT system, an electron gun at the backside of the tube ger beam of electrons.
- ✔The electron beam is directed towards the screen in the front of the tu a high voltage.
- ✔The screen is coated with a phosphor substance, which emits light w electrons strike the substance.
- ✔The color of the emitted light is the characteristics of the phosphor subs

CRT Display System

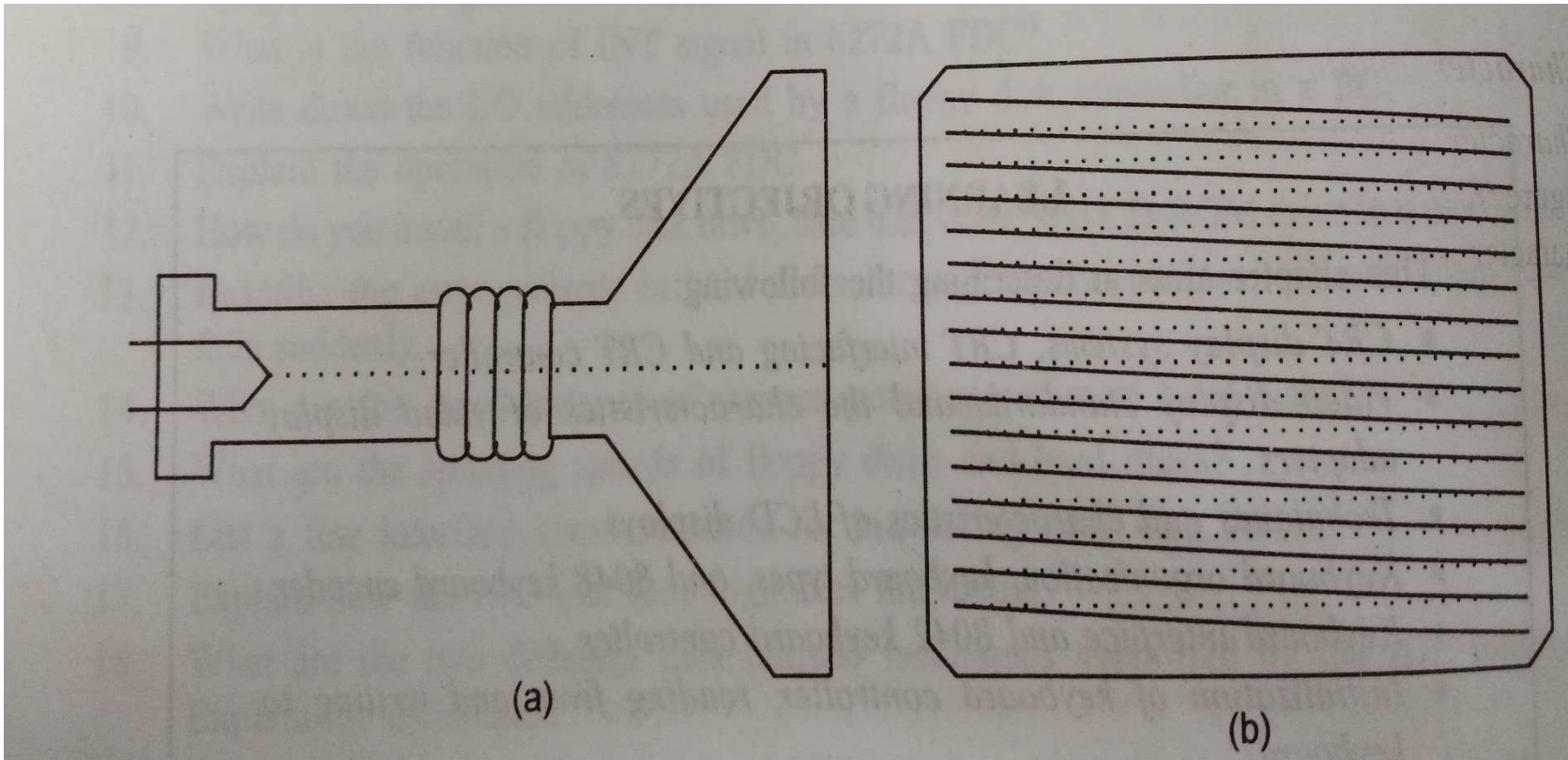


Figure 8.1 CRT display system—(a) cathode ray tube, (b) raster-scan.

Raster-scan

How Images are produced on CRT screen:

- ✔The electron beam is swept from left to right in the ‘X’ direction ac screen by applying a sweep voltage to the horizontal plates of the tube.
- ✔The beam is switched off when it reaches the right most end of the scre
- ✔After that it return back to the left immediately.
- ✔Simultaneously, the beam is swept slowly in the ‘Y’ direction from the t bottom of the screen by applying another sweep voltage to the vertical the tube.
- ✔It makes the beam to trace a new line every time it scans from left to rig

Raster-scan

- The beam is switched off when it reaches the right bottom corner.
- Then return back to the left top corner to start over.
- A CRT display system sweeps the beam at the rate of 15,600 H horizontal direction and 60 Hz in the vertical direction.
- This is known as **raster-scan**.
- The X and Y sweeps make the entire screen light.
- The image is produced on the screen by controlling the intensity of t while it sweeps across the screen.

Raster-scan

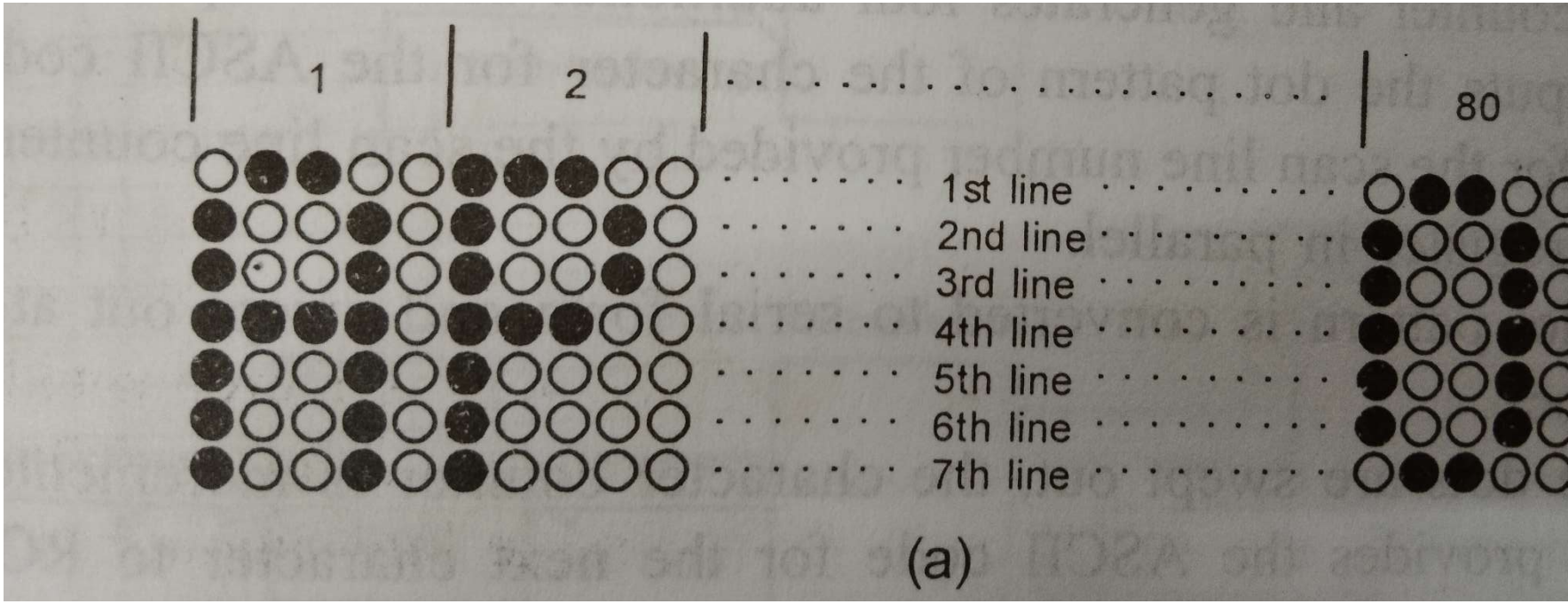
- The display system generates three signals to produce an image screen.
  - Horizontal sweep signal,
  - Vertical sweep signal, and
  - Video signal
- The horizontal and vertical oscillator within CRT monitor g the horizontal sweep signal and vertical sweep signal respe
- A video amplifier within the CRT monitor generates vide that controls the intensity of the beam and produces an i the screen.

Character display

Character Generation:

- ✔Characters are formed on a CRT screen in a dot matrix format.
- ✔Each character is generated with 35 dots (5X7 matrix).
- ✔The characters are formed on the screen by tuning on the beam at place the dots are to be illuminated in each scan line.
- ✔The dot information is serially input to the CRT display.
- ✔CRT displays can generally display 25 rows of characters with 80 char each row.
- ✔High quality monitors use 7X9, 7X12, or 9X14 matrix size for each charac

5 X 7 dot matrix



Character display

Signal Generation:

- ✔The ASCII codes of the characters to be displayed on the entire sc stored in a RAM called data buffer, screen memory or display memory.
- ✔The character generator ROM provides dot patterns for each scan line character.
- ✔The ROM in the figure forms the character of size 7X9 matrix in 9X14 ma
- ✔Extra dots introduce the space between characters.

Character display

Signal Generation – Circuit Operation:

- ✔The character counter and the row counter provides the address of the in screen memory where the ASCII code is stored.
- ✔The ASCII code is given at the address input of the character generator R
- ✔The scan line counter provides the line number for which the dot patt be generated.
- ✔SCL also generates four additional address inputs to the ROM.
- ✔The ROM outputs the dot pattern of the character for the ASCII code by the RAM and for the scan line number provided by the scan line cour
- ✔The parallel dot pattern is converted to serial form.

Character display

Signal Generation – Circuit Operation:

- ✔After the nine dots are swept out, the character counter is incremented
- ✔The screen memory now provides the ASCII code for the next character
- ✔As the scan line counter continues to output the same line number, t now outputs the dot pattern of the next character for the same line.
- ✔This process is repeated till the dot patterns of the scan line for al characters in the row are swept out.
- ✔A HSYNC pulse is produced to bring back the beam to the start of the ne
- ✔The character counter is now reset and the scan line counter is increme

Character display

Signal Generation – Circuit Operation:

- ✔Scanning of the next line begins.
- ✔This process continues to complete all the scan lines of all the characte row.
- ✔The character row counter is now incremented and the above pr repeated till all the scan lines of all the characters to be displayed in row are swept out.
- ✔The same is repeated till all the scan lines of all the characters in all the swept out.
- ✔When the beam reaches the right bottom, a VSYNC pulse is produced back the beam to left top corner to start of new frame.
- ✔The scanning of entire screen is repeated 60 times in one second.

Signal Generation

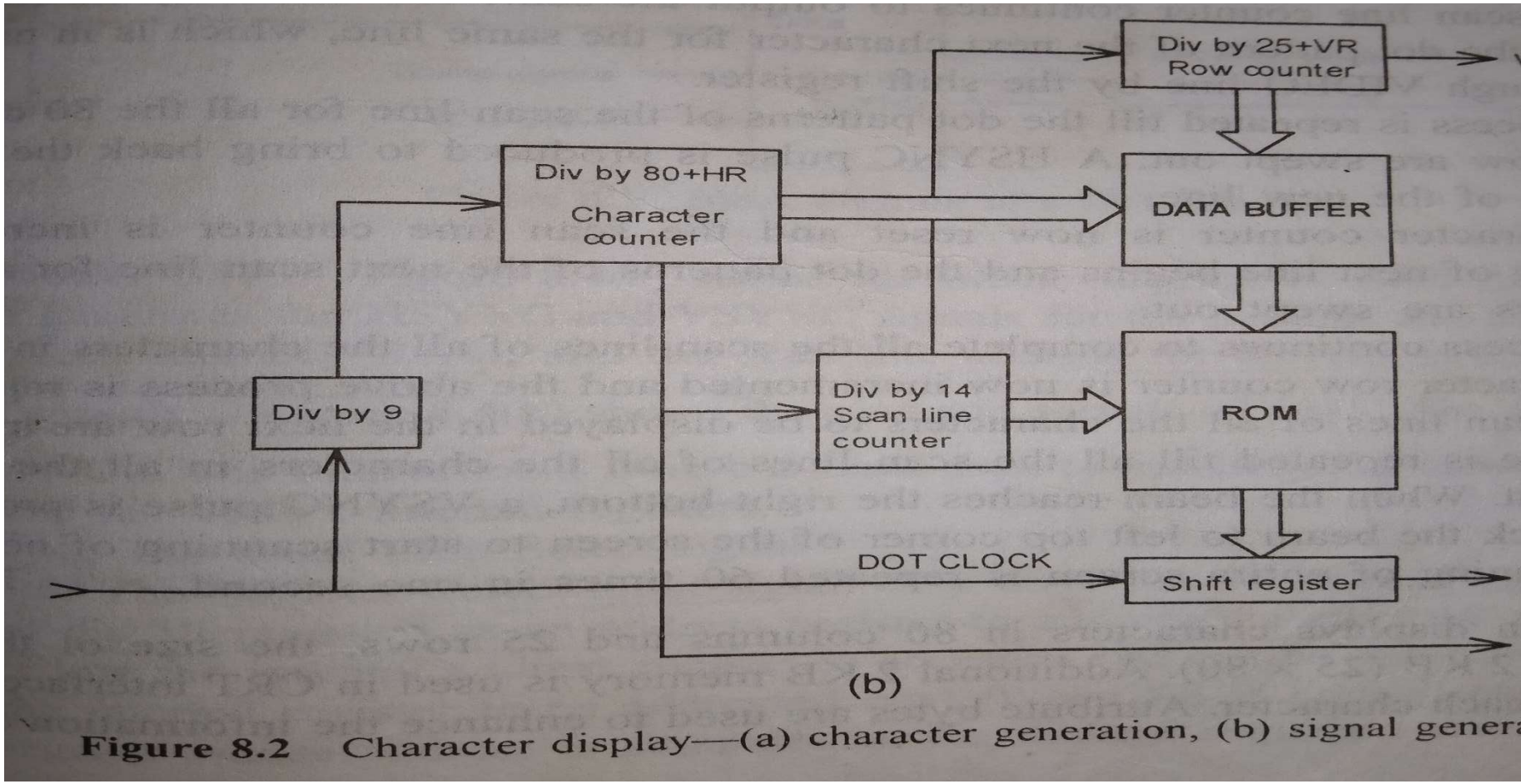


Figure 8.2 Character display—(a) character generation, (b) signal genera

Character display

Signal Generation:

- ✔ As the screen displays characters in 80 columns and 25 rows, the siz screen memory would be 2KB (25X80).
- ✔ Additional 2KB memory is used in CRT interfaces to hold attribute b each character.

Graphics display

- For displaying graphics information in the screen, dot patterns of im
  stored in the display RAM and sent directly to the shift register in se
- Then it turn swept out on VIDEO line.
- The character generator ROM is not used in graphics display.
- Each byte in the RAM providers pattern for eight dots.
- As a dot represents the smallest possible picture element on the
  each dot is called as a *picture element* or simply a *pixel*.
- The number of pixels on the screen depicts the resolution of the scr
- The resolution is denoted as number of horizontal pixels by nu
  vertical pixels.

Graphics display Contd…

- Typical resolutions for common monitors are:
  - 320X200 (CGA – Colour Graphics Adapter),
  - 640X480 (VGA – Video Graphics Array),
  - 800X600 (SVGA – Super VGA) and
  - 1024X768 (XGA – Extended VGA).
- High resolution screens are capable of displaying detailed graphic im

Graphics display Contd…

Monochrome Graphics:

- ✔The pixels are simply illuminated or blackened to display a graphic imag
- ✔Each pixel uses one bit of data in the RAM.
- ✔The eight bits from each location in the screen memory provide dot pa eight successive pixels.
- ✔Each byte is loaded into the shift register in sequence and shifted ou clock rate.
- ✔Known as *bit-mapped raster-scan* display.
- ✔An image of 320X200 resolution requires **320X200 bits = 64,000 bits = 8**
- ✔More space than for text displaying.

Graphics display Contd…

Colour Graphics:

- ✔Three primary colours: Red, Green, Blue.
- ✔R, G, B can be mixed in different intensities to obtain any desired colour
- ✔Each pixel on the screen of a colour CRT tube is divided into three sma rectangles and coated with red, green, and blue phosphors.
- ✔Three different electron guns are used to illuminate the dots.
- ✔When the dots coated with red, green, and blue phosphor are hit by beams, they emit respective colours.
- ✔Three dots are very closely spaced, appear as a single pixel.

Graphics display Contd…

Colour Graphics:

- ✔To represent 16 colours, we need 4 bits.
- ✔To represent 256 colours, we need 8 bits.
- ✔16 bits = 65,536 colours (high colour)
- ✔24 bits = 16,777,216 colours (true colour).

Exercise (1/2)

Example 8.1

Determine the amount of memory needed to display an image in (i) 16 colours a
resolution, and (ii) 256 colours and 640 × 480 resolution.

Solution

(i) Memory needed is 640 × 480 × 4 = 1,228,800 bits = 153,600 bytes ≈ 15
(ii) Memory needed is 640 × 480 × 8 = 2,457,600 bits = 307,200 bytes ≈ 30

Exercise (2/2)

Example 8.2

Compute the dot clock frequency required for refreshing graphics screen resolution with 256 colours at frame refresh rate of 50 Hz.

Solution

Memory required for displaying the image in 640 × 480 resolution and 256 colo
The whole memory should be read 50 times in one second for refreshing the sc
refresh rate. Hence, the frequency is $300 \times 10^3 \times 50 = 15\text{MHz}$.

References

1. Microprocessors, PC Hardware and Interfacing by N. Mathivanan
2. Online materials