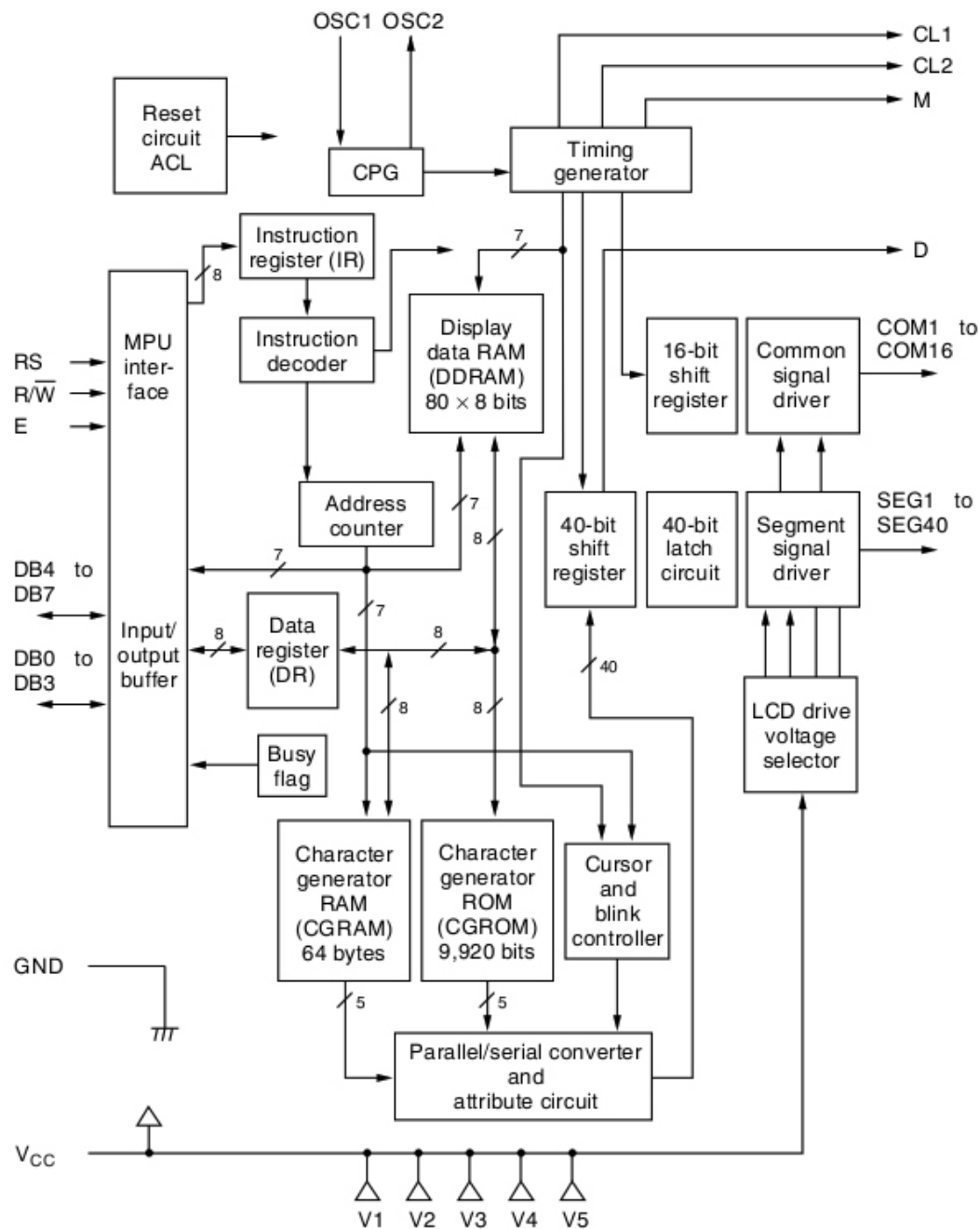# Liquid Crystal Display (LCD)

- **for QwikFlash board**
  - ☐ display is from Optrex
  - ☐ controller is Hitachi 44780 which is attached to the underside of the LCD

- **Reading:**
  - ☐ Text: Chapter 7 Parallel Ports
    - ■ section 7.7 The HD44780 LCD Controller
  - ☐ HD44780U: LCD-II - Dot Matrix Liquid Crystal Display Controller/Driver [pdf, 60pp; Hitachi]
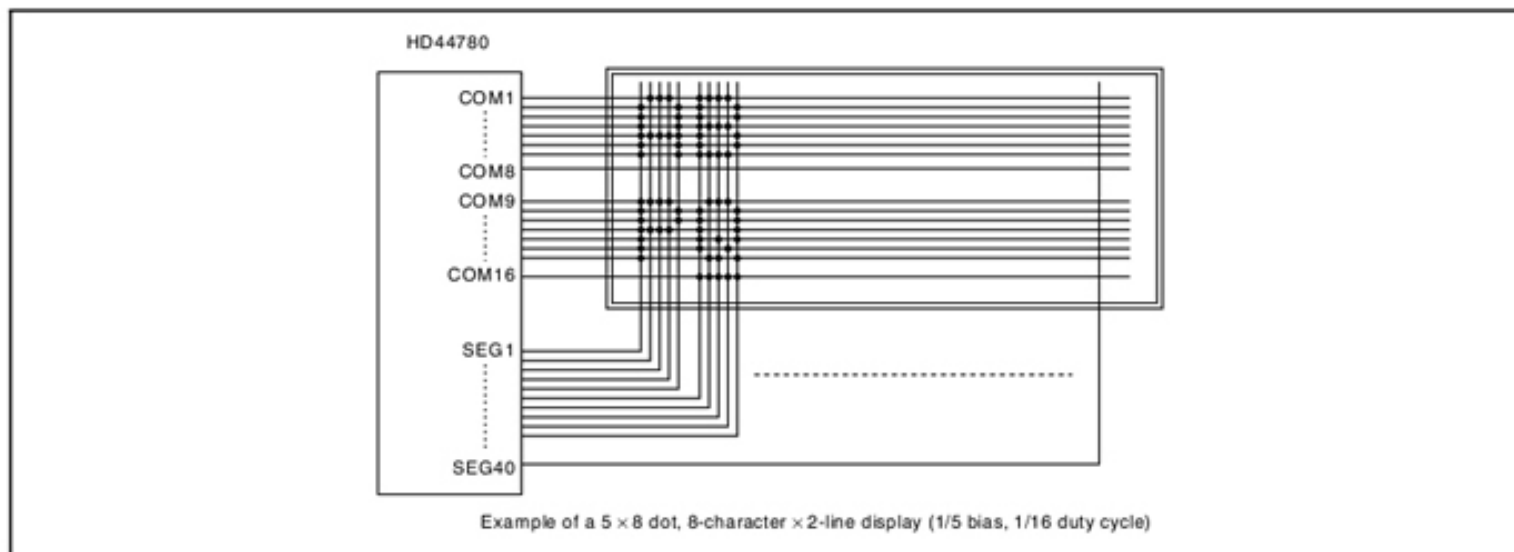 - ☐ Dot Matrix Character LCD Module User's Manual [pdf, 58pp; Optrex Corp.]

HD44780

COM1
COM8
COM9
COM16
SEG1
SEG40

Example of a 5 × 8 dot, 8-character × 2-line display (1/5 bias, 1/16 duty cycle)

Figure 20 Liquid Crystal Display and HD44780 Connections (cont)

Cursor

5 × 8 dot
character font

5 × 10 dot
character font

Alternating display

Cursor display example
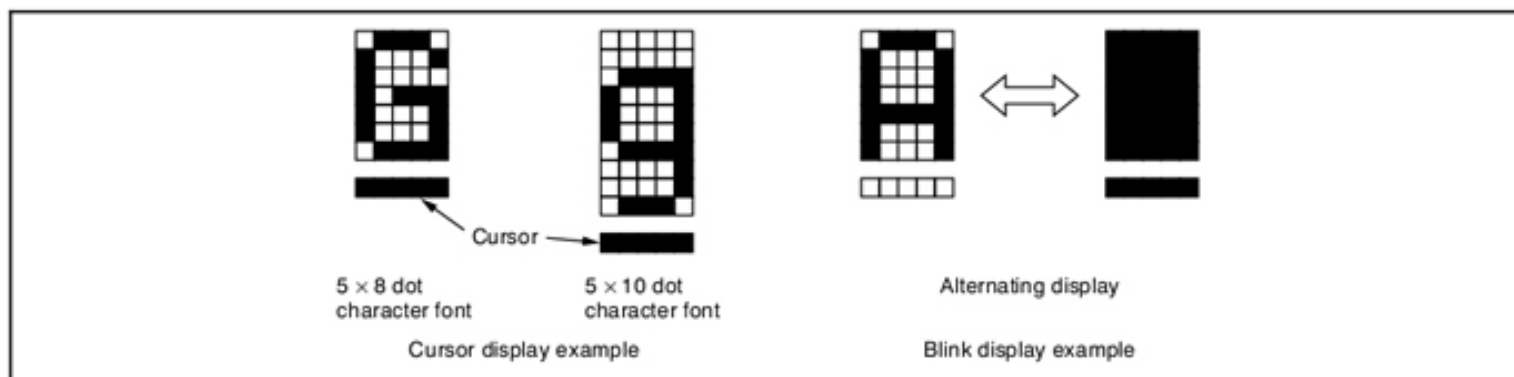
Blink display example

Figure 21 Using COM9 to Avoid Crosstalk on Unneeded Scanning Line

To use LCD

Need to determine
- size of display

- interface connection

■ connections

LCD pin   Port pin

Initialization of Ports

- Port D
  - use as simple 8 bit port (not as parallel slave)
  - set data direction; TRISD =

- Port E
  - use as simple 3 bit port
  - set data direction; TRISE =

Initialization of LCD

- from Hitachi p213 for flow and p191 for commands
- from Optrex p33 for flow and P39 for commands

- Note:
  - both the PIC and the LCD have POR routines
  - LCD will start initializing before PIC is stable
  - must *initialize by instruction* for LCD
    - complex initialization since display device
    - be sure to use the correct *initialize by instruction* as it is interface dependent

Initialization of LCD

1. Wait more than 15ms after Vcc = 4.5V;
   Wait more than 40ms after Vcc = 2.7V
   → wait 0.1 seconds (QwikFlash specs)

2. Function Set Command - Interface is 8 bits long
   E ← 1 (enable)
   RS ← 0 (cmd)

   R/W ← 0 ???

   $<D_7:D_4>$ ← 0011_2
   E ← 0 (disable)

Initialization of LCD

3. Wait more than 4.1ms

4. Function Set Command - Interface is 8 bits long
   $E \leftarrow 1$, $RS \leftarrow 0$
   $<D_7:D_4> \leftarrow 0011_2$
   $E \leftarrow 0$

5. Wait more than 100µs

6. Function Set Command - Interface is 8 bits long
   $E \leftarrow 1$, $RS \leftarrow 0$
   $<D_7:D_4> \leftarrow 0011_2$
   $E \leftarrow 0$

7. Wait more than 40µs

Initialization of LCD

8. Function Set Command - Set interface to be 4 bits long
    $E \leftarrow 1, RS \leftarrow 0$
    $<D_7:D_4> \leftarrow 0010_2$
    $E \leftarrow 0$

9. Wait more than 40μs

10. Function Set Command – Set display
    4 bit interface
    2 line display
    5x8 dot font

    high half first   low half next
    $E \leftarrow 1, RS \leftarrow 0$ $E \leftarrow 1, RS \leftarrow 0$
    $<D_7:D_4> \leftarrow$ $<D_7:D_4> \leftarrow$
    $E \leftarrow 0$ $E \leftarrow 0$

Initialization of LCD

Note: BF should be checked before each of the instructions starting with Display OFF.

11. Wait more than 40μs

12. Display off

13. Wait more than 40μs

14. Display clear

15. Wait more than 1.52 (Hitachi) or 15.2 (Optrex)?

Initialization of LCD

16. Entry mode set
    cursor direction
    display shift

17. Wait more than 40µs

18. Display on
    display on
    cursor
    blink