

instruction or cursor shift instruction (only with DD RAM), just before reading out execute the "read" instruction from the second time the "read" instruction is serial.

■ HOW TO USE THE HD44780

● Interface to MPU

(1) Interface to 8-bit MPU

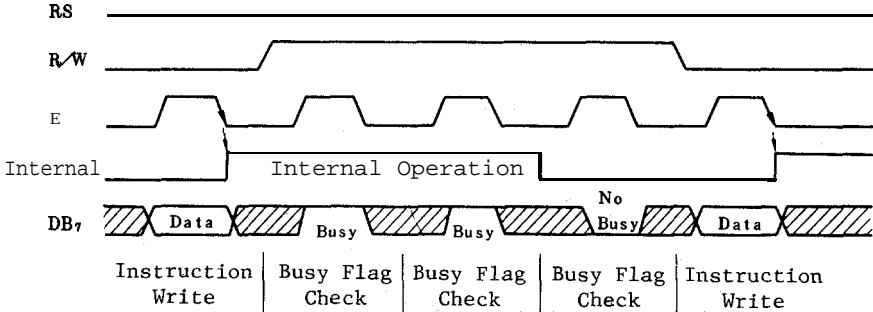
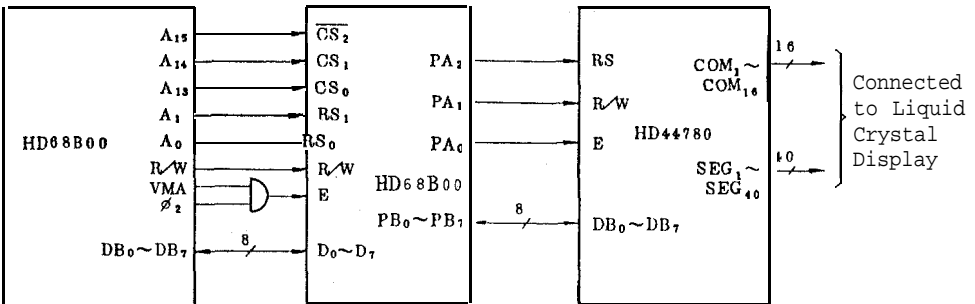


Fig. 5 Example of Busy Flag Check Timing Sequence

① When connecting to b-bit MPU through PIA

Fig. 6-2 is an example of using a PIA or I/O port (for single chip microcomputer) as an interface device. Input and output of the device is TTL compatible.

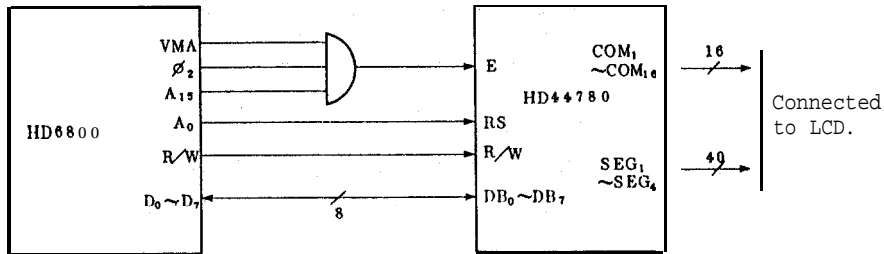
In the example, PB0 to PB7 are connected to the data buses DB0 to DB7 and PA0 to PA2 are connected to E, R/W and RS respectively. Pay attention to the timing relation between E and other signals when reading or writing data and using PIA as an interface.



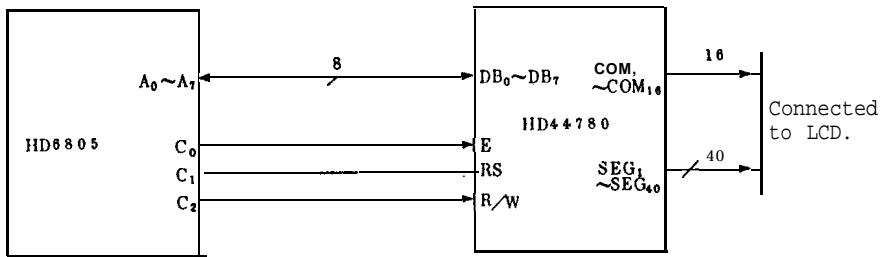
HD68B00: 8 bit CPU

Fig. 6 Example of Interface to HD68B00 Using PIA (HD68B21)

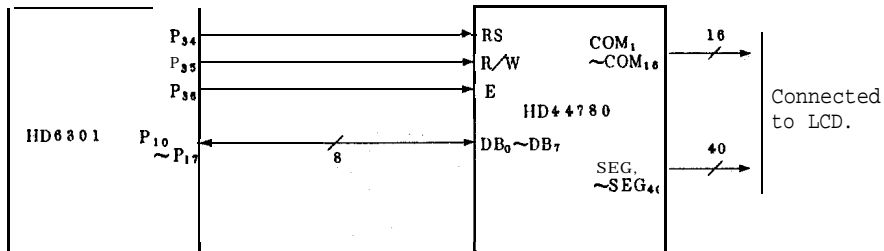
② Connecting directly to the 8-bit MPU bus line



③ Example of interfacing to the HD6805



④ Example of interfacing to the HD6301



(2) Interface to 4-bit MPU

The HD44780 can be connected to a 4-bit MPU through the 4-bit MPU I/O port. If the I/O port has enough bits, data can be transferred in b-bit lengths, but if the bits are insufficient, the transfer is made in two operations of 4 bits each (with designation of interface data length for 4 bits). In the latter case, the timing sequence becomes somewhat complex. (see Fig. 7)

Fig. 8 shows an example of interface to the HMCS43C.

Note that 2 cycles are needed for the busy flag check as well as the data transfer. 4-bit operation is selected by program.

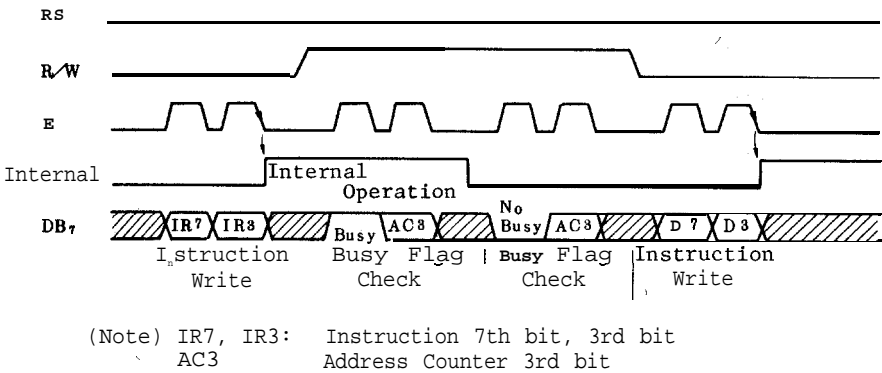
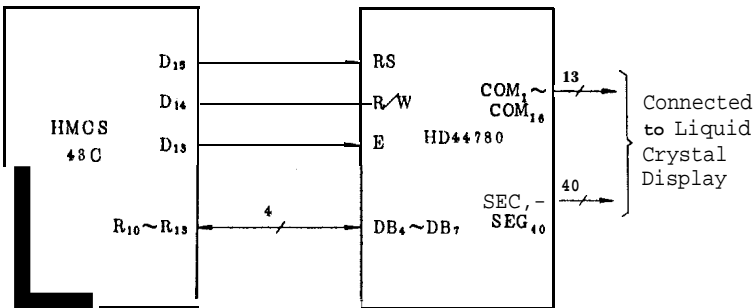


Fig. 7 An Example of 4-bit Data Transfer Timing Sequence



HMCS43C: Hitachi 4-bit single-chip microcomputer

Fig. 8 Example of Interface to the HMCS43C

Interface to Liquid Crystal Display

(1) Character Font and Number of Lines

The HD44780 can perform 2 types of display, 5 x7 dots and 5 x10 dots as character font, with a cursor on each.

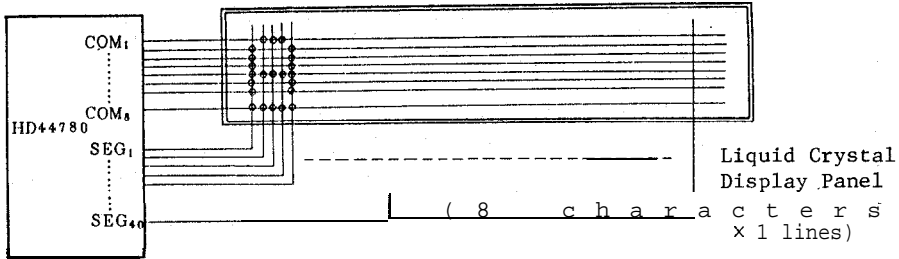
Up to 2 lines are displayed with 5 x7 dots and 1 line with 5 x10 dots. Therefore, three types of common signals are available:

Number of Lines	Character Font	Number of Common Signals	Duty Factor
1	5 x7 dots + Cursor	8	1/8
1	5 x10 dots + Cursor	11	1/11
2	5 x7 dots + Cursor	16	1/16

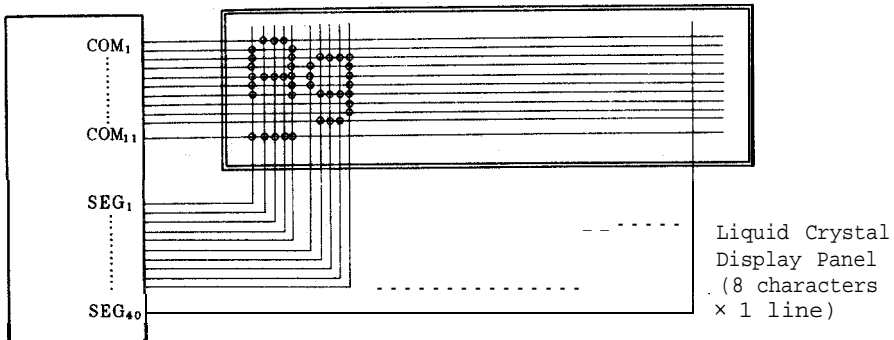
Number of lines and font types can be selected by program.
(See to Table 5 Instruction)

(2) Connection to HD44780 and Liquid Crystal Display

Fig. 9 (1) and (2) show connection examples.

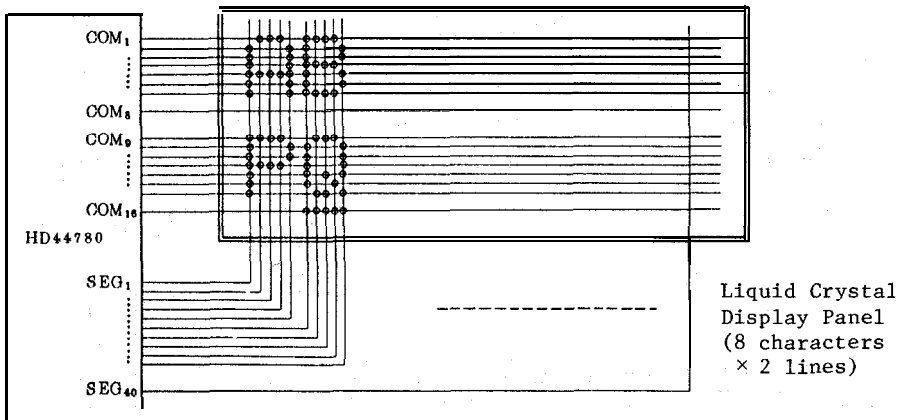


(a) Example of a 5 x7 dot, 8 character x 1 line Display
(1/4 Bias, 1/8 Duty)



(b) Example of a 5 x10 dot, 8 character x 1 line Display
(1/4 Bias, 1/8 Duty)

Fig. 9 (1) Liquid Crystal Display and Connections to HD44780

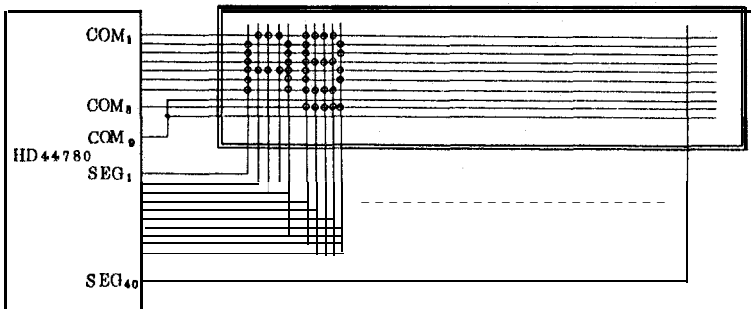


(c) Example of 5 x7 dot, 8 character x 2 lines Display (1/5 Bias, 1/16 Duty)

Fig. 9 (2) Liquid Crystal Display and Connection to HD44780

Since 5 signal lines at the SEG can display one digit, one HD44780 can display up to 8 digits for 1-line display and 16 digits for 2-line display.

In Fig. 9 examples (a) and (b), there are unused common signal terminals, non-selection waveforms which always output. When the liquid crystal display panel has unused extra scanning lines, avoid undesirable influences due to cross-talk in the floating state by connecting the extra scanning lines to these common signal terminals.

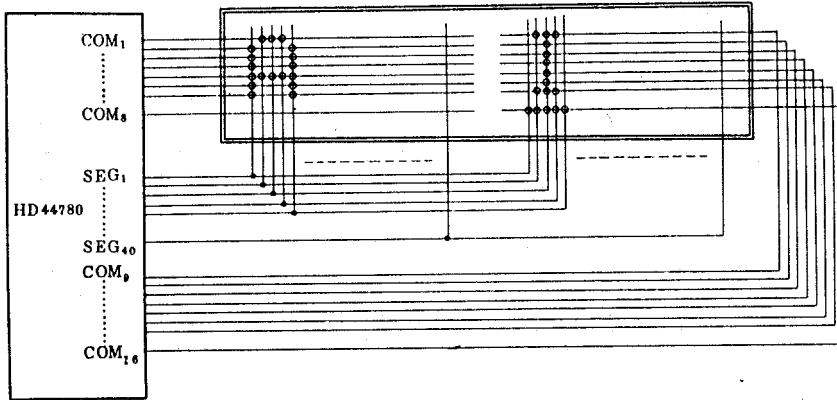


5 x7 dot, 8 character x 1 line Display (1/4 Bias, 1/8 Duty)

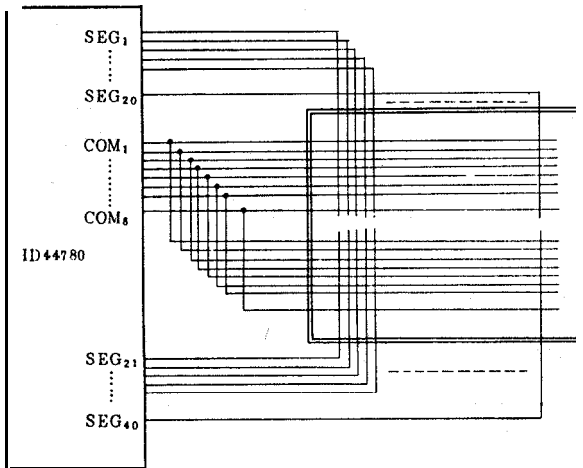
Fig. 10 Using COM₉ to Avoid Cross-talk on Unneeded Scanning Line

(3) Connection of Changed Matrix Layout

In the preceding examples, the number of lines was matched to the number of scanning lines. The following display types are possible by changing the matrix layout in the liquid crystal display panel.



(a) 5 x 7 dot, 16 character x 1 line Display
(1/5 Bias, 1/16 Duty)



(b) 5 x 7 dot, 4 character x 2 line Display
(1/4 Bias, 1/8 Duty)

Fig. 11 Changed Matrix Layout Displays

In either case, the only change is the layout. Display characteristics and the number of liquid crystal display characters are dependent on the number of common signals (or duty factor). Note that the display data RAM (DD RAM) addresses for 8 characters x 2 lines and 16 characters x 1 line are the same as shown in Fig. 9.

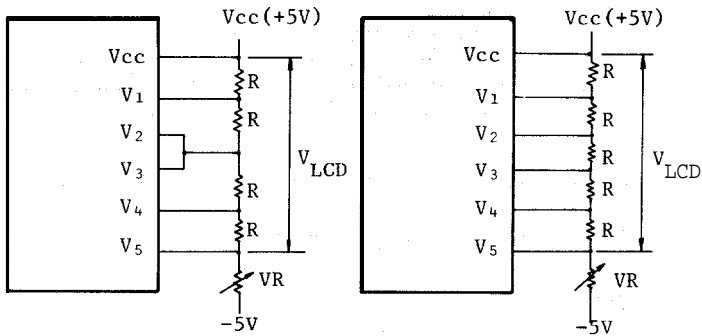
● **Power Supply for Liquid Crystal Display Drive**

Various voltage levels must be applied to HD44780 terminals V₁ to V₅ to obtain liquid crystal display drive waveforms. The voltages must be changed according to duty factor. Table 6 shows the relation.

Table 6 Duty Factor and Power Supply for Liquid Crystal Display Drive

Duty Factor	$\frac{1}{8}, \frac{1}{11}$	$\frac{1}{5}$
Power Supply Bias	$\frac{1}{4}$	$\frac{1}{5}$
V ₁	$V_{CC} - \frac{1}{4} V_{LCD}$	$V_{CC} - \frac{1}{5} V_{LCD}$
V ₂	$V_{CC} - \frac{1}{2} V_{LCD}$	$V_{CC} - \frac{2}{5} V_{LCD}$
V ₃	$V_{CC} - \frac{3}{4} V_{LCD}$	$V_{CC} - \frac{3}{5} V_{LCD}$
V ₄	$V_{CC} - \frac{1}{4} V_{LCD}$	$V_{CC} - \frac{4}{5} V_{LCD}$
V ₅	$V_{CC} - V_{LCD}$	$V_{CC} - V_{LCD}$

V_{LCD} gives the peak values for liquid crystal display drive waveforms. Resistance dividing provides each voltage as shown in Fig. 13.



(a) 1/4 Bias
(1/8, 1/11 Duty)

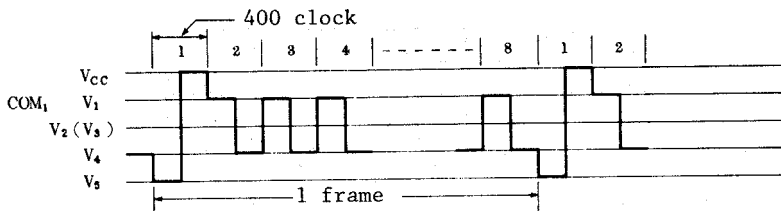
(b) 1/5 Bias
(k/16 Duty)

Fig. 13 Drive Voltage Supply Example

● **Relation between Oscillation Frequency and Liquid Crystal Display Frame Frequency**

The following examples of liquid crystal display frame frequency apply only when oscillation frequency is 250kHz. (1 clock = 4μs)

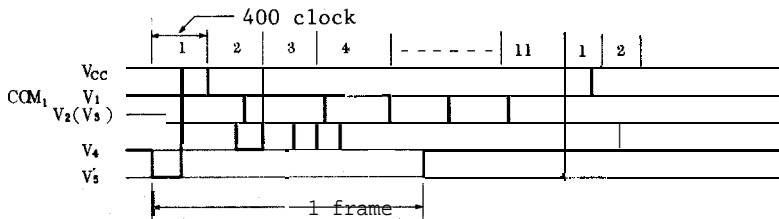
(1) 1/8 Duty



$$1 \text{ frame} = 4 (\mu\text{s}) \times 400 \times 8 = 12800 (\mu\text{s}) = 12.8 (\text{ms})$$

$$\text{Frame frequency} = \frac{1}{12.8 (\text{ms})} = 78.1 (\text{Hz})$$

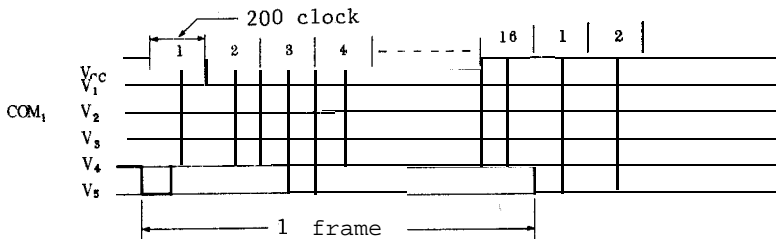
(2) 1/11 Duty



$$1 \text{ frame} = 4 (\mu\text{s}) \times 400 \times 11 = 17600 (\mu\text{s}) = 17.6 (\text{ms})$$

$$\text{Frame frequency} = \frac{1}{17.6 (\text{ms})} = 56.8 (\text{Hz})$$

(3) 1/16 Duty



$$1 \text{ frame} = 4 (\mu\text{s}) \times 200 \times 16 = 12800 (\mu\text{s}) = 12.8 (\text{ms})$$

$$\text{Frame frequency} = \frac{1}{12.8 (\text{ms})} = 78.1 (\text{Hz})$$

- **Connection with Driver LSI HD44100H**

You can increase the number of display digits by externally connecting a liquid crystal display driver LSI HD44100H to the HD44780.

When connected to the HD44780, the HD44100H is used as segment signal driver. The HD44100H can be connected to the HD44780 directly since it supplies CL₁, CL₂, M and D signals and power for liquid crystal display drive. Fig. 14 shows a connection example.

Caution: Connection of voltage supply terminals V₁ through V₆ for liquid crystal display drive is complicated.

Up to 9 units of the HD44100H can be connected for 1-line display (duty factor 1/8 or 1/11) and up to 4 units for the 2-line display (duty factor 1/16). RAM size limits the HD44780 to a maximum of 80 character display digits. The connection method in Fig. 14 remains unchanged for both 1-line and 2-line display or both 5 × 7 and 5 × 10 dot character fonts.

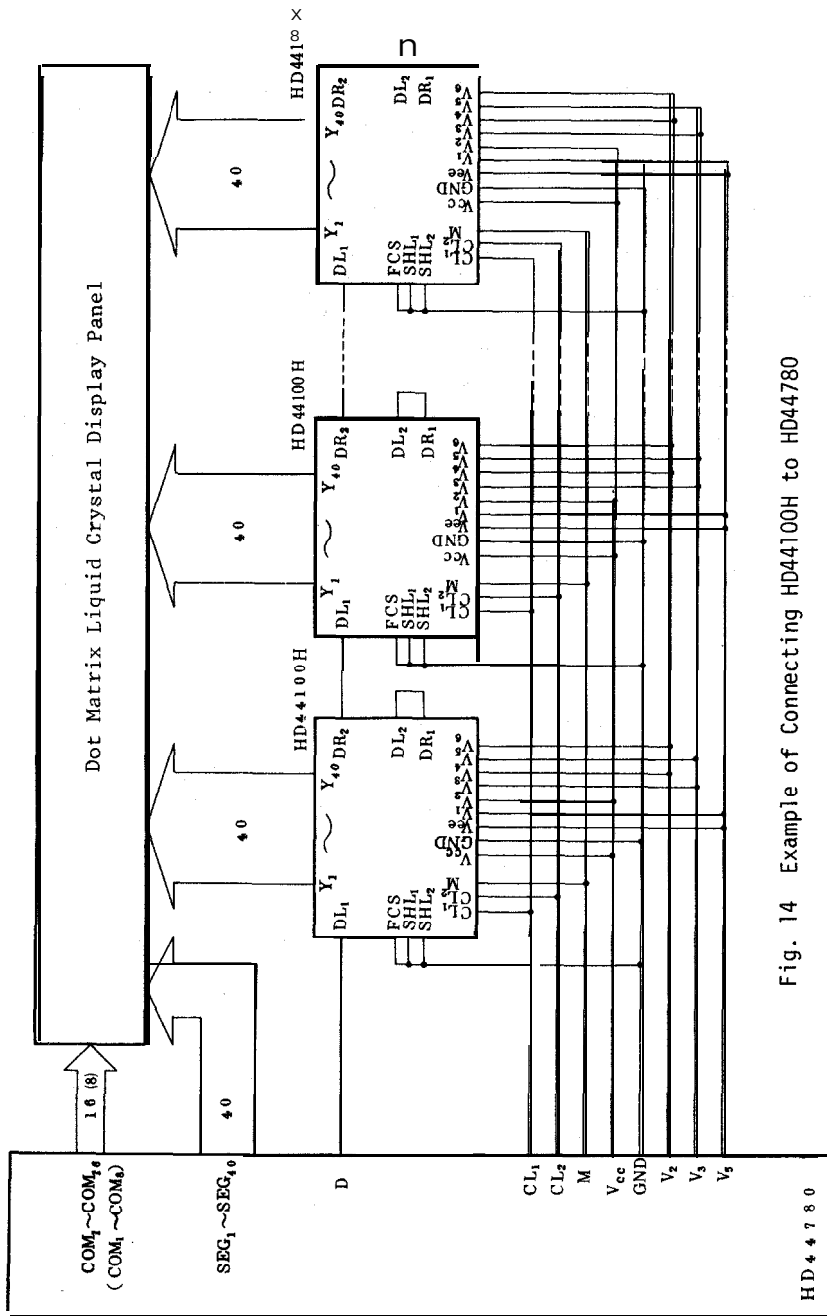


Fig. 14 Example of Connecting HD44100H to HD44780