

**SANYO**

No. 4474B

**LC7940ND, LC7941ND****Dot-matrix LCD Drivers**

## Overview

The LC7940ND and LC7941ND are segment driver LSIs for driving large, dot-matrix LCD displays. They read 4-bit parallel or serial input, display data from a controller into an 80-bit latch, and then generate LCD drive signals corresponding to that data.

The LC7940ND and LC7941ND feature mirror-image pin assignments, allowing them to be used together to increase component density. They are designed to be used with the LC7942ND common driver to drive large LCD panels.

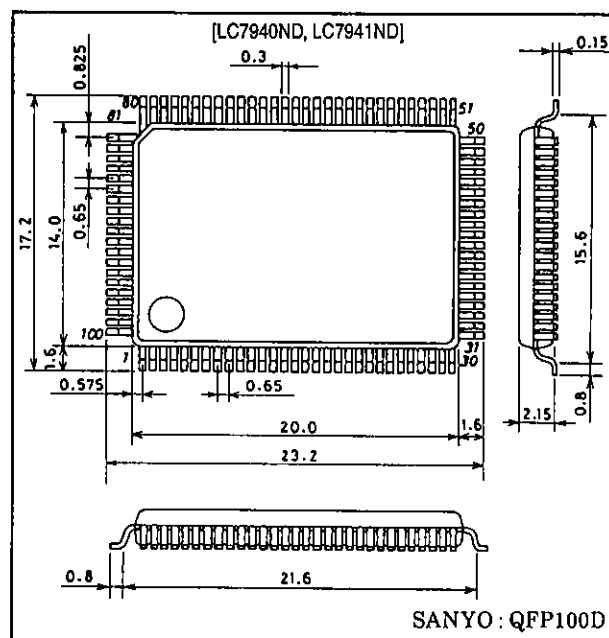
## Features

- 80 built-in LCD display drive circuits
- 1/8 to 1/128 display duty cycle
- Serial or 4-bit parallel data input
- Chip disable for low power dissipation for large-sized panels
- Bias supply voltages can be supplied externally
- Operating supply voltage and ambient temperature
  - $5V \pm 10\%$  logic supply ( $V_{DD}$ ) at  $T_a = -20$  to  $+85^\circ\text{C}$
  - 8 to 20V LCD supply ( $V_{DD} - V_{EE}$ ) at  $T_a = -20$  to  $+85^\circ\text{C}$
- CMOS process
- 100-pin flat plastic package

## Package Dimensions

unit: mm

### 3180-QIP100D



## Specifications

**Absolute Maximum Ratings** at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{SS} = 0V$

Parameter	Symbol	Ratings	Unit
Logic supply voltage	$V_{DD}$ max	-0.3 to +7.0	V
LCD supply voltage. See Note below.	$V_{DD} - V_{EE}$ max	0 to 22	V
Input voltage	$V_I$ max	-0.3 to $V_{DD} + 0.3$	V
Operating temperature range	$T_{opr}$	-20 to +85	$^\circ\text{C}$
Storage temperature range	$T_{slg}$	-40 to +125	$^\circ\text{C}$

### Note

$$V_{DD} \geq V_I > V_3 > V_4 > V_{EE}$$

**Recommended Operating Conditions** at  $T_a = -20$  to  $+85^\circ\text{C}$ ,  $V_{SS} = 0\text{V}$ 

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Logic supply voltage	$V_{DD}$		4.5	–	5.5	V
LCD supply voltage	$V_{DD} - V_{EE}$	See Notes 1 and 2.	8	–	20	V
HIGH-level input voltage	$V_{IH}$	CP, CDI, DI1 to DI3, M, SDI, P/S, DISP OFF and LOAD	$0.8V_{DD}$	–	–	V
LOW-level input voltage	$V_{IL}$	CP, CDI, DI1 to DI3, M, SDI, P/S, DISP OFF and LOAD	–	–	$0.2V_{DD}$	V
CP shift clock frequency	$f_{CP}$		–	–	3.3	MHz
CP pulsewidth	$t_{WC}$		100	–	–	ns
LOAD pulsewidth	$t_{WL}$		100	–	–	ns
DI $_x$ and SDI to CP setup time	$t_{SETUP}$		80	–	–	ns
DI $_x$ and SDI to CP hold time	$t_{HOLD}$		80	–	–	ns
CP to LOAD time	$t_{CL1}$		0	–	–	ns
	$t_{CL2}$		100	–	–	
LOAD to CP time	$t_{LC}$		100	–	–	ns
CP rise time	$t_R$		–	–	50	ns
CP fall time	$t_F$		–	–	50	ns
LOAD rise time	$t_{RL}$		–	–	50	ns
LOAD fall time	$t_{FL}$		–	–	50	ns

**Notes**

1.  $V_{DD} \geq V_1 > V_3 > V_4 > V_{EE}$
2. At turn ON, the LCD supply should be energized after or simultaneously with the logic supply. At turn OFF, the logic supply should be cut after or simultaneously with the LCD supply.

**Electrical Characteristics** at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{SS} = 0\text{V}$ ,  $V_{DD} = 5\text{V} \pm 10\%$ 

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
HIGH-level input current	$I_{IH}$	$V_{IN} = V_{DD}$ ; LOAD, CP, CDI, P/S, DI1 to DI3, SDI, M, and DISP OFF	–	–	1	$\mu\text{A}$
LOW-level input current	$I_{IL}$	$V_{IN} = V_{SS}$ ; LOAD, CP, CDI, P/S, DI1 to DI3, SDI, M, and DISP OFF	–1	–	–	$\mu\text{A}$
CDO HIGH-level output voltage	$V_{OH}$	$I_{OH} = -400 \mu\text{A}$	$V_{DD} - 0.4$	–	–	V
CDO LOW-level output voltage	$V_{OL}$	$I_{OL} = 400 \mu\text{A}$	–	–	0.4	V
O1 to O80 driver ON resistance	$R_{ON}$	$V_{DD} - V_{EE} = 18 \text{ V}$ , $ V_{DE} - V_{OL}  = 0.25 \text{ V}$ . See note.	–	2	4	$\text{k}\Omega$

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
$V_{DD}$ to $V_{SS}$ standby supply current	$I_{ST}$	$CDI = V_{DD}$ , $V_{DD} - V_{EE} = 18\text{ V}$ , $f_{CP} = 3.3\text{ MHz}$ , no output load ; $V_{SS}$	-	-	200	$\mu\text{A}$
$V_{DD}$ to $V_{SS}$ operating supply current	$I_{SS}$	$V_{DD} - V_{EE} = 18\text{ V}$ , $f_{CP} = 3.3\text{ MHz}$ , $f_{LOAD} = 5.156\text{ kHz}$ , $f_M = 52\text{ Hz}$ ; $V_{SS}$	-	-	1.0	$\text{mA}$
$V_{DD}$ to $V_{EE}$ operating supply current	$I_{EE}$	$V_{DD} - V_{EE} = 18\text{ V}$ , $f_{CP} = 3.3\text{ MHz}$ , $f_{LOAD} = 5.156\text{ kHz}$ , $f_M = 52\text{ Hz}$ ; $V_{EE}$	-	-	0.1	$\text{mA}$
CP input capacitance	$C_I$	$f_{CP} = 3.3\text{ MHz}$ ; CP	-	5	-	$\text{pF}$

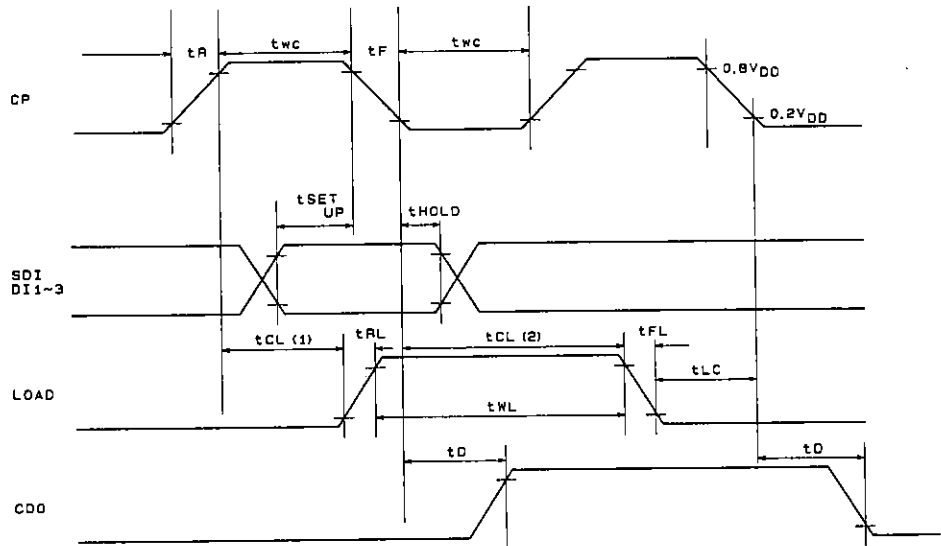
## Note

$V_{DE} = V_1 \text{ or } V_3 \text{ or } V_4 \text{ or } V_{EE}$ ,  $V_1 = V_{DD}$ ,  $V_3 = 9/11 \times (V_{DD} - V_{EE})$ ,  $V_4 = 2/11 \times (V_{DD} - V_{EE})$

**Switching Characteristics** at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $V_{SS} = 0\text{V}$ ,  $V_{DD} = 5\text{V} \pm 10\%$

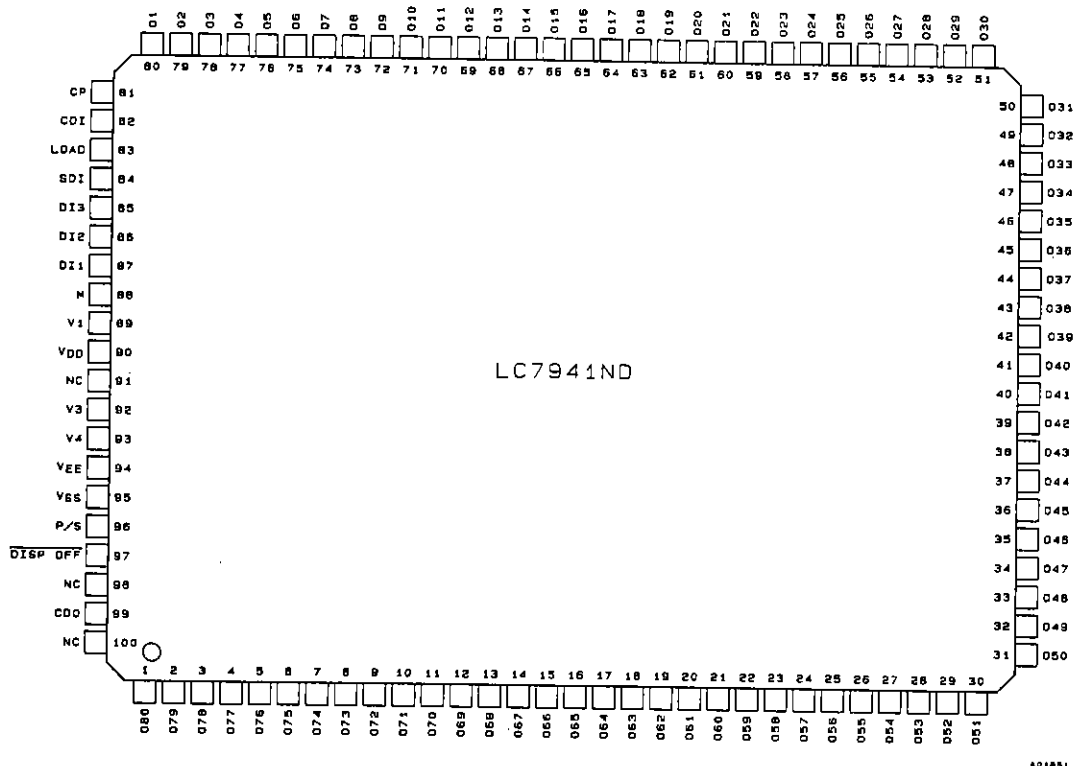
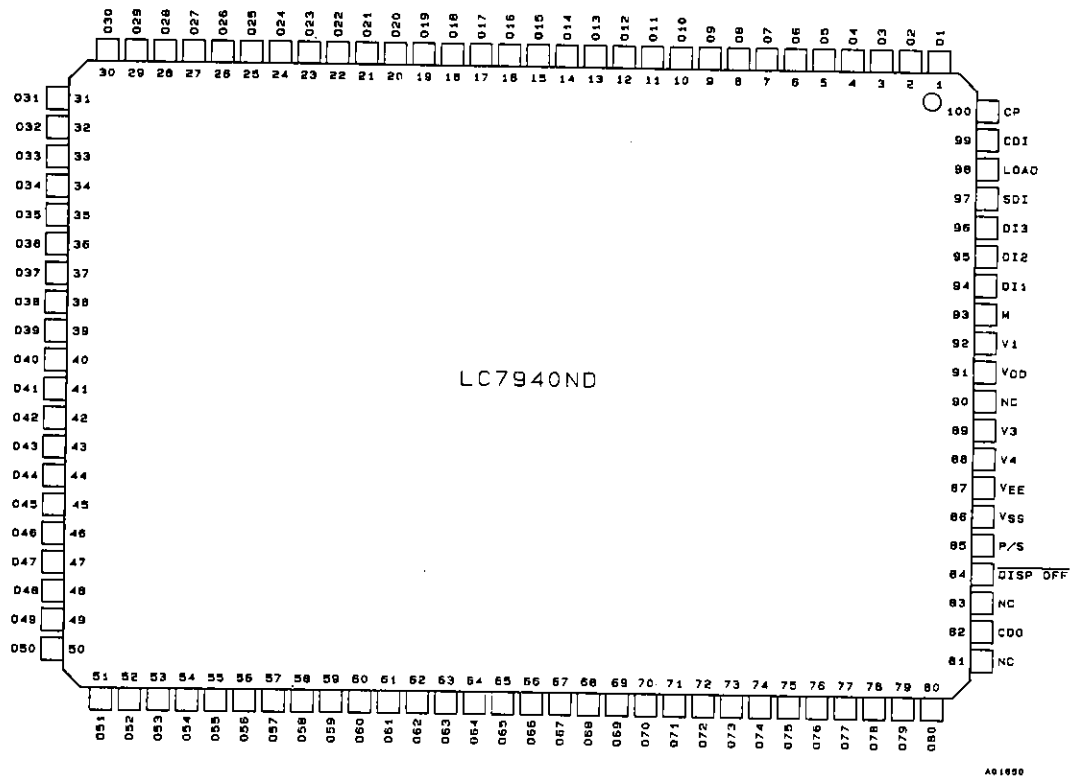
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
CDO output delay time	$t_D$	$C_L = 30\text{ pF}$	-	-	200	ns

## Switching Characteristics Waveform



A01857

# Pin Assignments



Top view

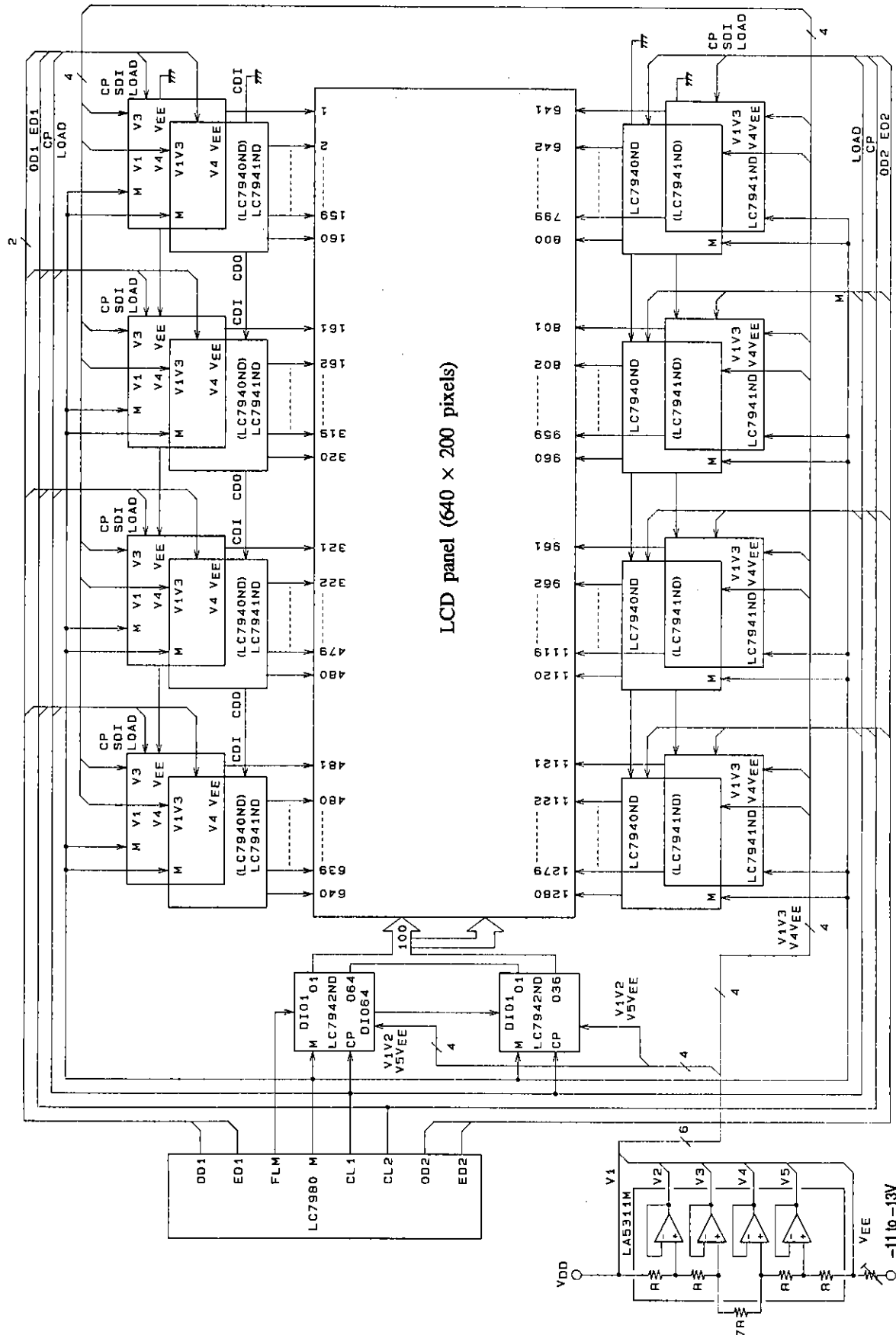


**LC7940ND, LC7941ND**

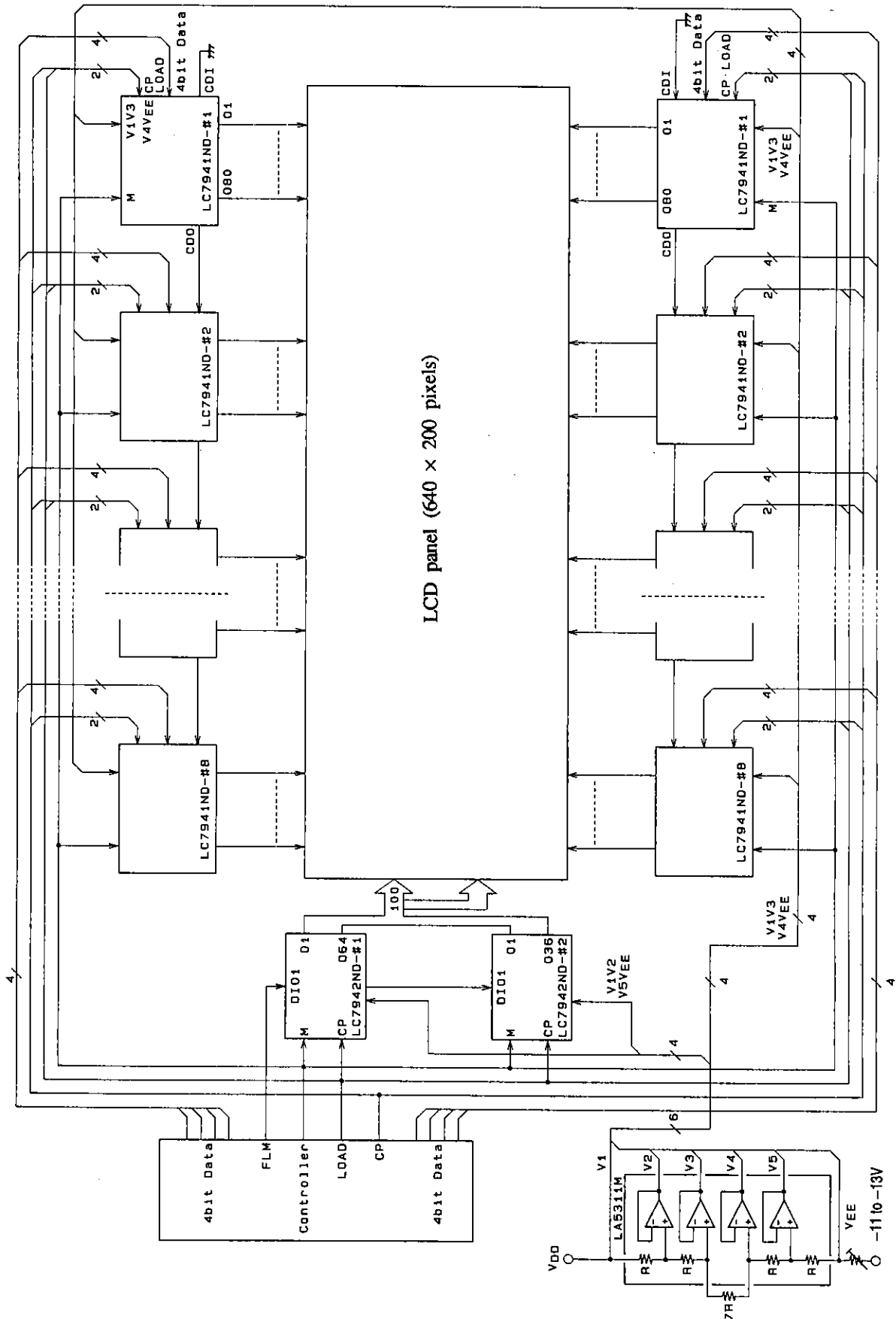
Pin No.		Symbol	I/O	Function																								
LC7940ND	LC7941ND																											
96	85	DI3	I	4-bit parallel data input pins. <table><tr><th>Data input</th><th colspan="4">LCD driver outputs</th></tr><tr><td>SDI</td><td>O4</td><td>O8</td><td rowspan="4">→</td><td>O80</td></tr><tr><td>DI3</td><td>O3</td><td>O7</td><td>O79</td></tr><tr><td>DI2</td><td>O2</td><td>O6</td><td>O78</td></tr><tr><td>DI1</td><td>O1</td><td>O5</td><td>O77</td></tr></table>	Data input	LCD driver outputs				SDI	O4	O8	→	O80	DI3	O3	O7	O79	DI2	O2	O6	O78	DI1	O1	O5	O77		
Data input	LCD driver outputs																											
SDI	O4	O8		→	O80																							
DI3	O3	O7			O79																							
DI2	O2	O6	O78																									
DI1	O1	O5	O77																									
95	86	DI2																										
94	87	DI1																										
In serial data input mode, DI1 to DI3 should all be tied HIGH or LOW.																												
93	88	M	I	LCD panel drive voltage output alternation control signal.																								
85	96	P/S	I	Data input mode select. 4-bit parallel input when HIGH, and serial input when LOW.																								
82	99	CDO	O	Cascade connection pin for extension segment drivers. Data is read out when HIGH. Goes LOW after data is read out. Connected to the CDI input of the next chip.																								
1 to 80	80 to 1	O1 to O80	O	LCD drive outputs. The output drive level is determined by the display data, M signal and $\overline{\text{DISP OFF}}$ input as shown below. <table><tr><th>M</th><th>Q</th><th><math>\overline{\text{DISP OFF}}</math></th><th>Output</th></tr><tr><td>LOW</td><td>LOW</td><td>HIGH</td><td>V<sub>3</sub></td></tr><tr><td>LOW</td><td>HIGH</td><td>HIGH</td><td>V<sub>1</sub></td></tr><tr><td>HIGH</td><td>LOW</td><td>HIGH</td><td>V<sub>4</sub></td></tr><tr><td>HIGH</td><td>HIGH</td><td>HIGH</td><td>V<sub>EE</sub></td></tr><tr><td>×</td><td>×</td><td>LOW</td><td>V<sub>1</sub></td></tr></table>	M	Q	$\overline{\text{DISP OFF}}$	Output	LOW	LOW	HIGH	V <sub>3</sub>	LOW	HIGH	HIGH	V <sub>1</sub>	HIGH	LOW	HIGH	V <sub>4</sub>	HIGH	HIGH	HIGH	V <sub>EE</sub>	×	×	LOW	V <sub>1</sub>
				M	Q	$\overline{\text{DISP OFF}}$	Output																					
				LOW	LOW	HIGH	V <sub>3</sub>																					
				LOW	HIGH	HIGH	V <sub>1</sub>																					
				HIGH	LOW	HIGH	V <sub>4</sub>																					
				HIGH	HIGH	HIGH	V <sub>EE</sub>																					
×	×	LOW	V <sub>1</sub>																									
Note × = don't care (tied HIGH or LOW)																												
84	97	$\overline{\text{DISP OFF}}$	I	O1 to O80 output control input pin. When LOW, V <sub>1</sub> is output on the O1 to O80 outputs. See the truth table.																								
81	91	NC	-	No connection.																								
83	98	NC																										
90	100	NC																										

# Application Notes

## LCD Panel 1



LCD Panel 2



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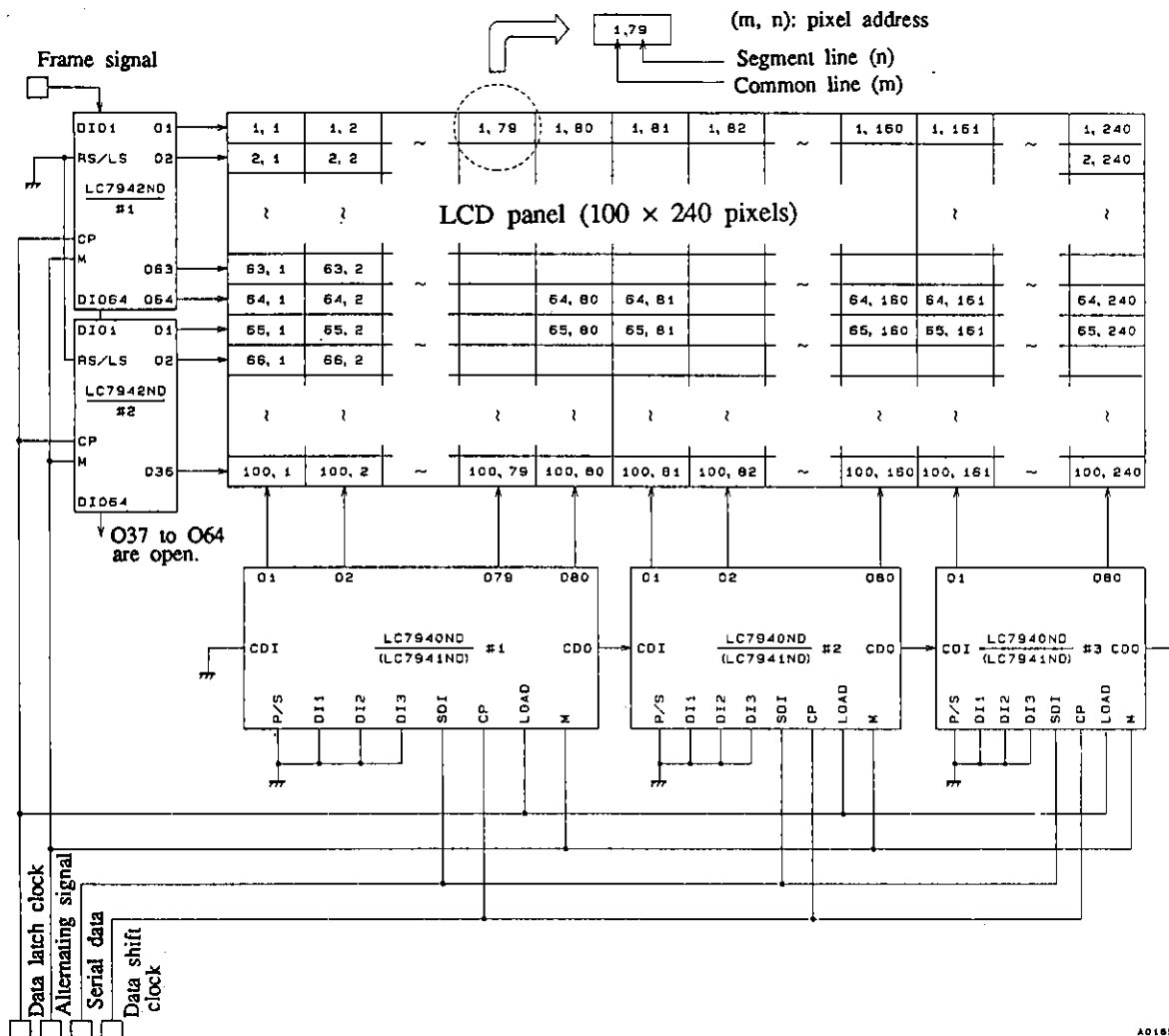


## 100 × 240-pixel LCD Panel Application

A 100 × 240-pixel LCD panel requires the following drivers.

- 3 × LC7940ND (or LC7941ND) drivers
- 2 × LC7942ND drivers

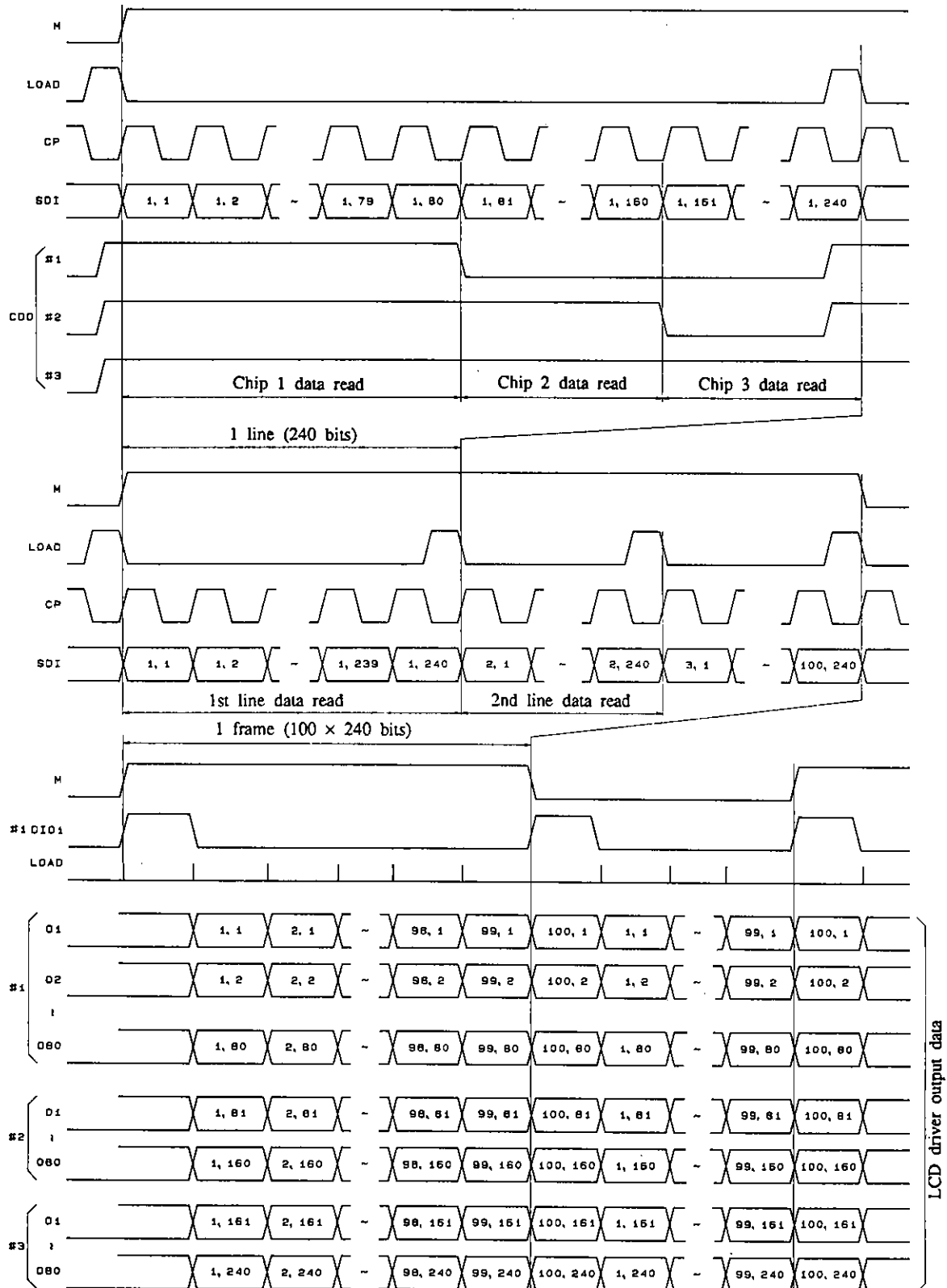
An example using 1/100 duty cycle is shown below.



1. The LC7942ND chips are cascaded by connecting DIO64 on chip 1 to DIO1 on chip 2. For a 100-bit shift register, O37 to O64 on chip 2 are left open.
2. The LC7940ND (or LC7941ND) chips are cascaded by connecting CDO on chip 1 to CDI on chip 2, and

CDO on chip 2 to CDI on chip 3. CDI on chip 1 is tied to GND, and CDO on chip 3 is not used. This configuration allows the input of 240-bit serial data.

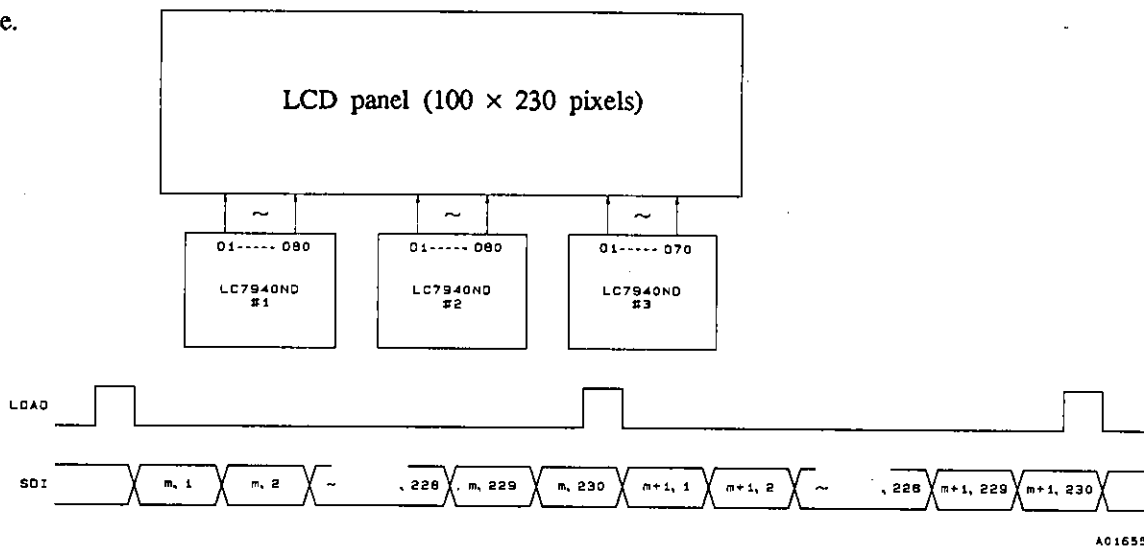
## 100 × 240-pixel LCD Panel Timing Diagram



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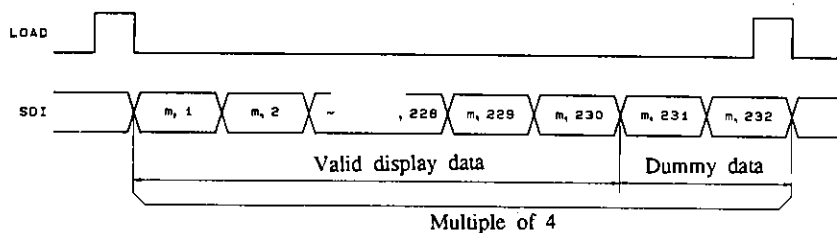
## Segment Data Not Multiples of 4

Example.



If this timing data is sent, data elements (m, 229), (m, 230), (m+1, 229), (m+1, 230)... will not appear in the output (O69 and O70 on chip 3). This is because the LC7940ND (or LC7941ND) converts serial/parallel data

in 4-bit units, which also decreases power dissipation. For data that is not a multiple of 4, like 230, the following scheme is used.



In this case, (m, 231) is output on O71 on chip 3, and (m, 232) on O72 on chip 3. However, these outputs are not connected to the panel and are, therefore, invalid.

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