Ordering number: EN 4474B

CMOS LSI

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.

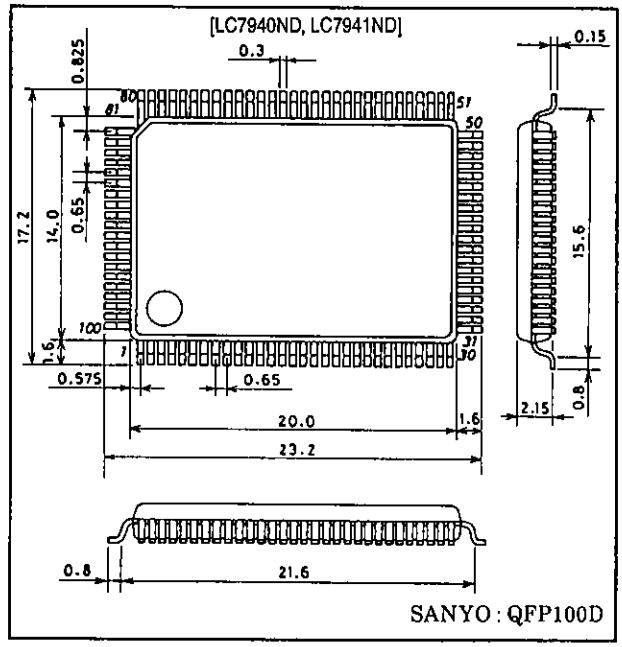
Features

- 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 voltags can be supplied externally
- Operating supply voltage and ambient temperature
  - 5V ± 10% logic supply (V_{DD}) at Ta = –20 to +85°C
  - 8 to 20V LCD supply ($V_{DD} - V_{EE}$) at Ta = –20 to +85°C
- CMOS process
- 100-pin flat plastic package

Package Dimensions

unit: mm

3180-QIP100D



Specifications

Absolute Maximum Ratings at Ta = 25 ± 2 °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	Topr	–20 to +85	°C
Storage temperature range	T_{stg}	–40 to +125	°C

Note

$V_{DD} \geq V_1 > V_3 > V_4 > V_{EE}$

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Recommended Operating Conditions at Ta = −20 to +85°C, V_{SS} = 0V

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, $\overline{\text{DISP OFF}}$ and LOAD	0.8V_{DD}	–	–	V
LOW-level input voltage	V_{IL}	CP, CDI, DI1 to DI3, M, SDI, P/S, $\overline{\text{DISP OFF}}$ 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*n* and SDI to CP setup time	t_{SETUP}		80	–	–	ns
DI*n* 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 Ta = 25 ± 2°C, V_{SS} = 0V, V_{DD} = 5V ± 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 $\overline{\text{DISP OFF}}$	–	–	1	μA
LOW-level input current	I_{IL}	$V_{IN} = V_{SS}$: LOAD, CP, CDI, P/S, DI1 to DI3, SDI, M, and $\overline{\text{DISP OFF}}$	–1	–	–	μA
CDO HIGH-level output voltage	V_{OH}	I_{OH} = −400 μA	V_{DD} – 0.4	–	–	V
CDO LOW-level output voltage	V_{OL}	I_{OL} = 400 μA	–	–	0.4	V
O1 to O80 driver ON resistance	R_{ON}	V_{DD} – V_{EE} = 18 V, $\lvert V_{DE} - V_O \rvert$ = 0.25 V. See note.	–	2	4	kΩ

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 V, f_{CP} = 3.3 MHz, no output load ; V_{SS}	–	–	200	μA
V_{DD} to V_{SS} operating supply current	I_{SS}	$V_{DD} - V_{EE}$ = 18 V, f_{CP} = 3.3 MHz, f_{LOAD} = 5.156 kHz, f_M = 52 Hz ; V_{SS}	–	–	1.0	mA
V_{DD} to V_{EE} operating supply current	I_{EE}	$V_{DD} - V_{EE}$ = 18 V, f_{CP} = 3.3 MHz, f_{LOAD} = 5.156 kHz, f_M = 52 Hz ; V_{EE}	–	–	0.1	mA
CP input capacitance	C_I	f_{CP} = 3.3 MHz ; CP	–	5	–	pF

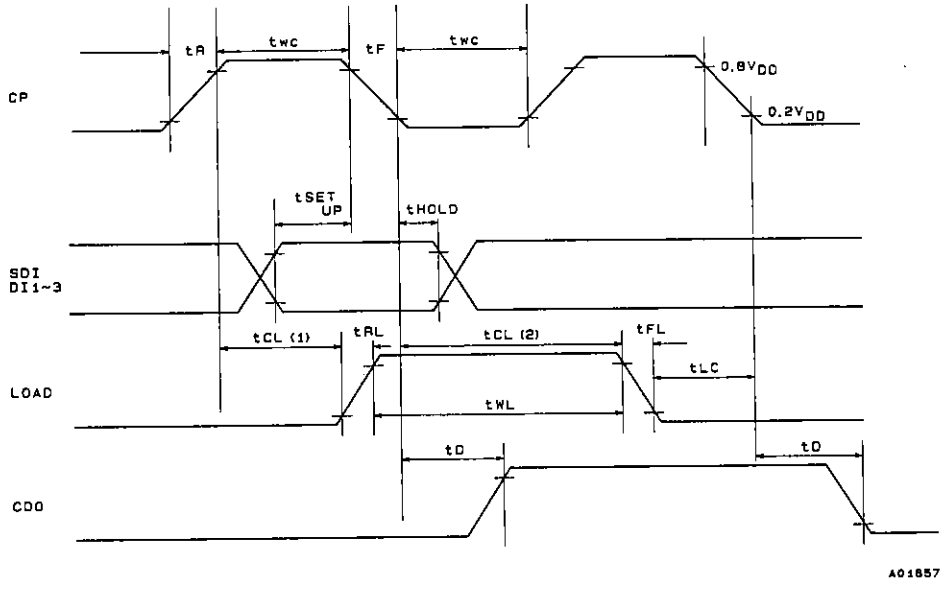
Note

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

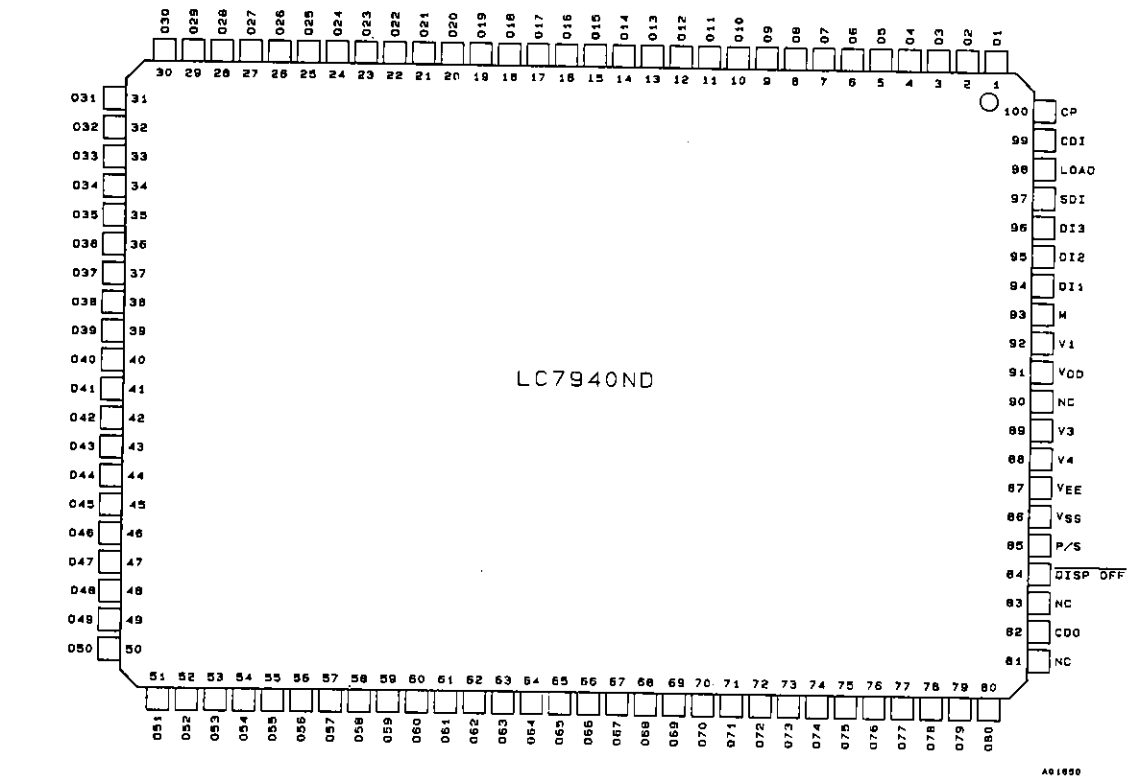
Switching Characteristics at Ta = 25 ± 2°C, V_{SS} = 0V, V_{DD} = 5V ± 10%

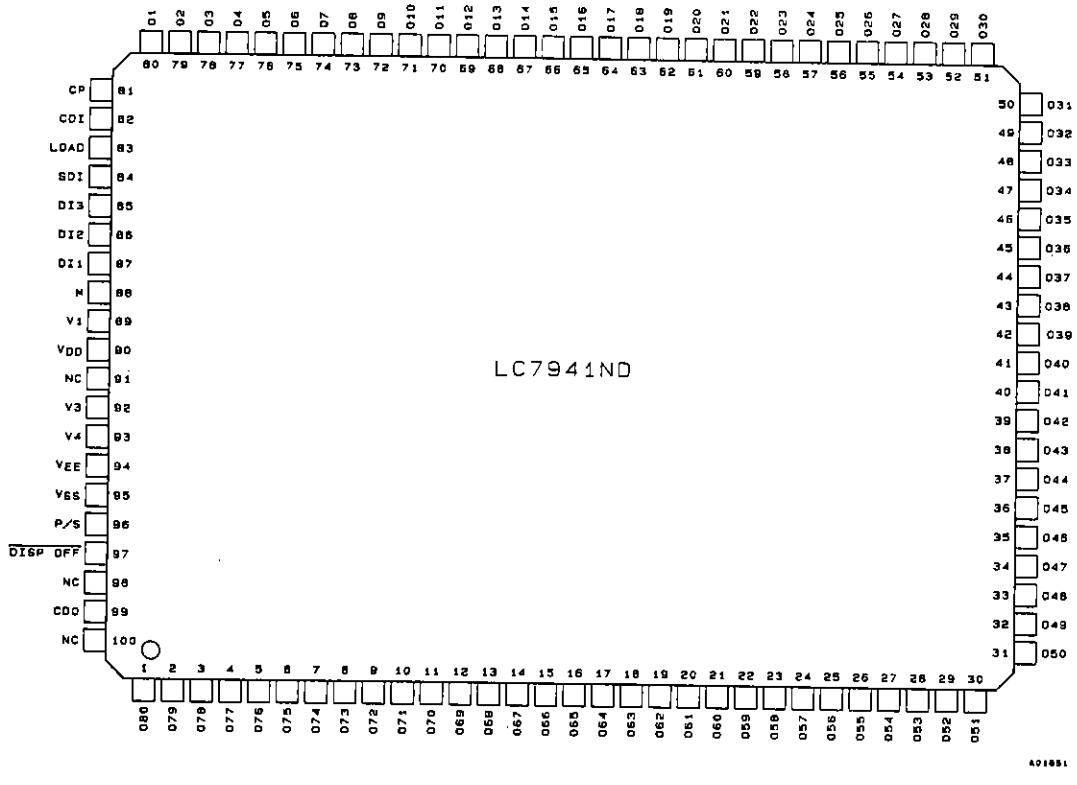
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
CDO output delay time	t_D	C_L = 30 pF	–	–	200	ns

Switching Characteristics Waveform



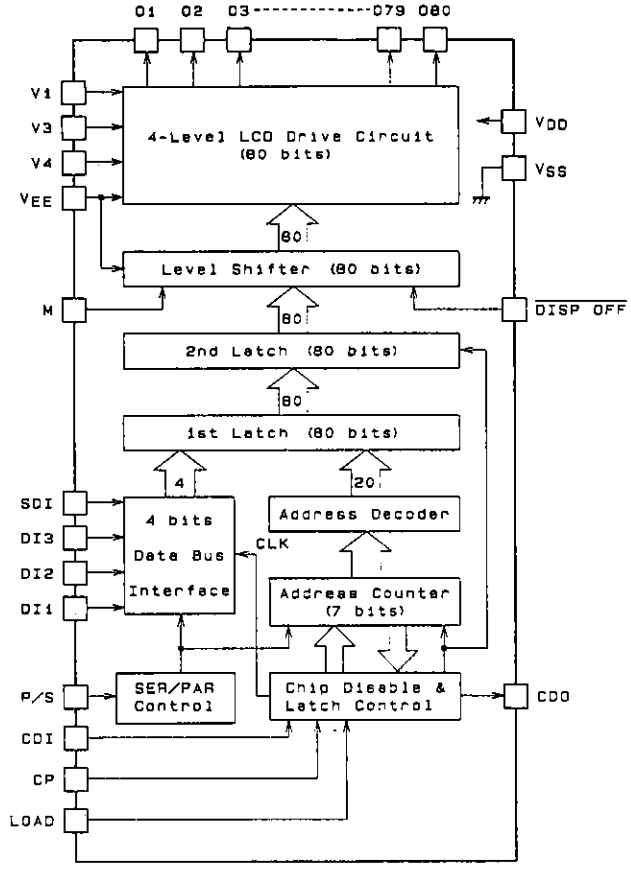
Pin Assignments





Top view

Block Diagram



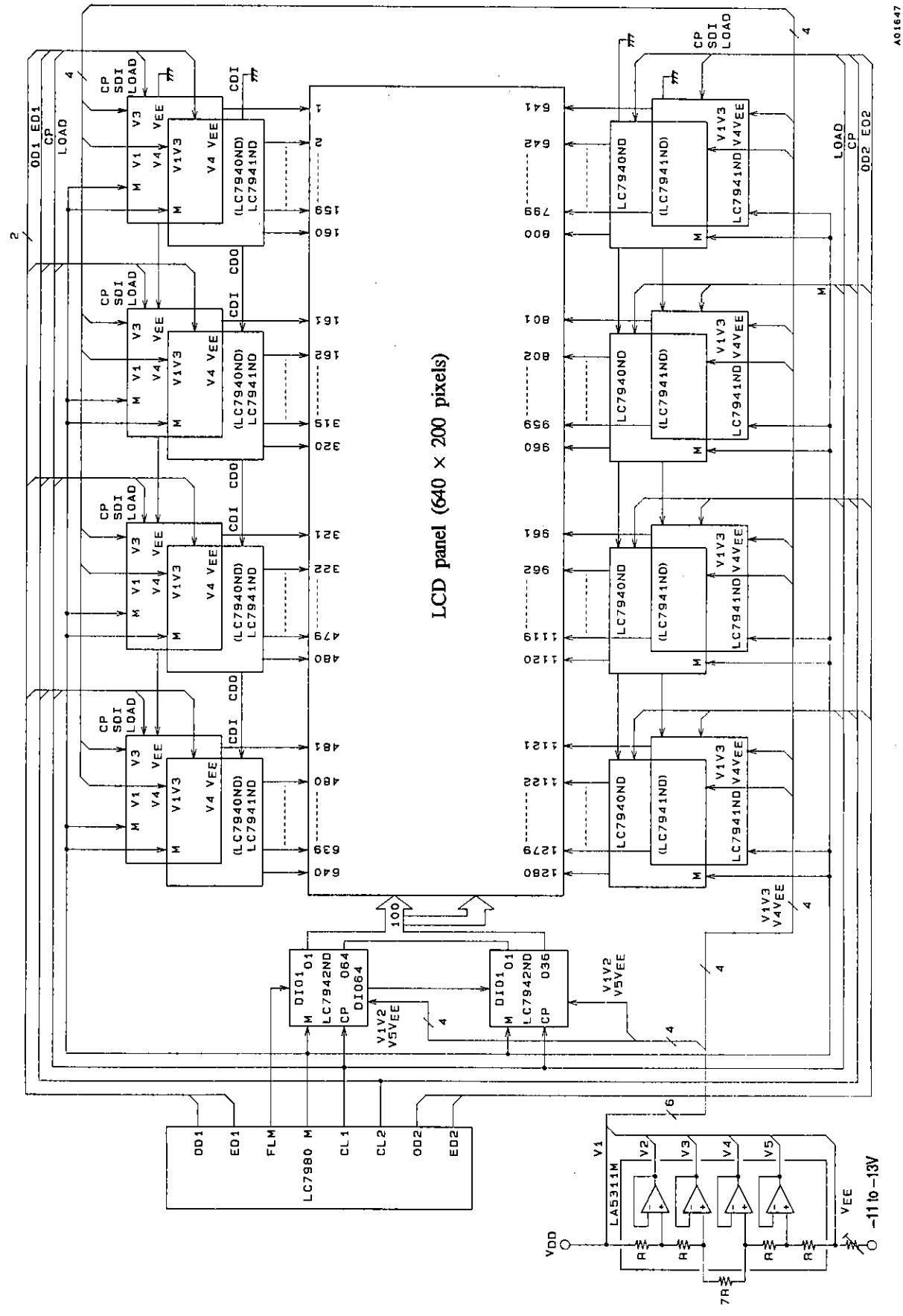
Pin Functions

Pin No.		Symbol	I/O	Function
LC7940ND	LC7941ND			
91	90	VDD	Supply	V_{DD} – V_{SS} is the logic supply. V_{DD} – V_{EE} is the LCD supply.
86	95	VSS		
87	94	VEE		
92	89	V1	Supply	LCD panel drive voltage supplies V_1 and V_{EE} are selected levels. V_3 and V_4 are not-selected levels.
89	92	V3		
88	93	V4		
100	81	CP	I	Display data input clock (falling-edge trigger).
99	82	CDI	I	Chip disable. Data is read in when LOW, and not read in when HIGH.
98	83	LOAD	I	Display data latch clock (falling-edge trigger). On the falling edge, the LCD drive signals set by the display data are output.
97	84	SDI	I	Serial data input.

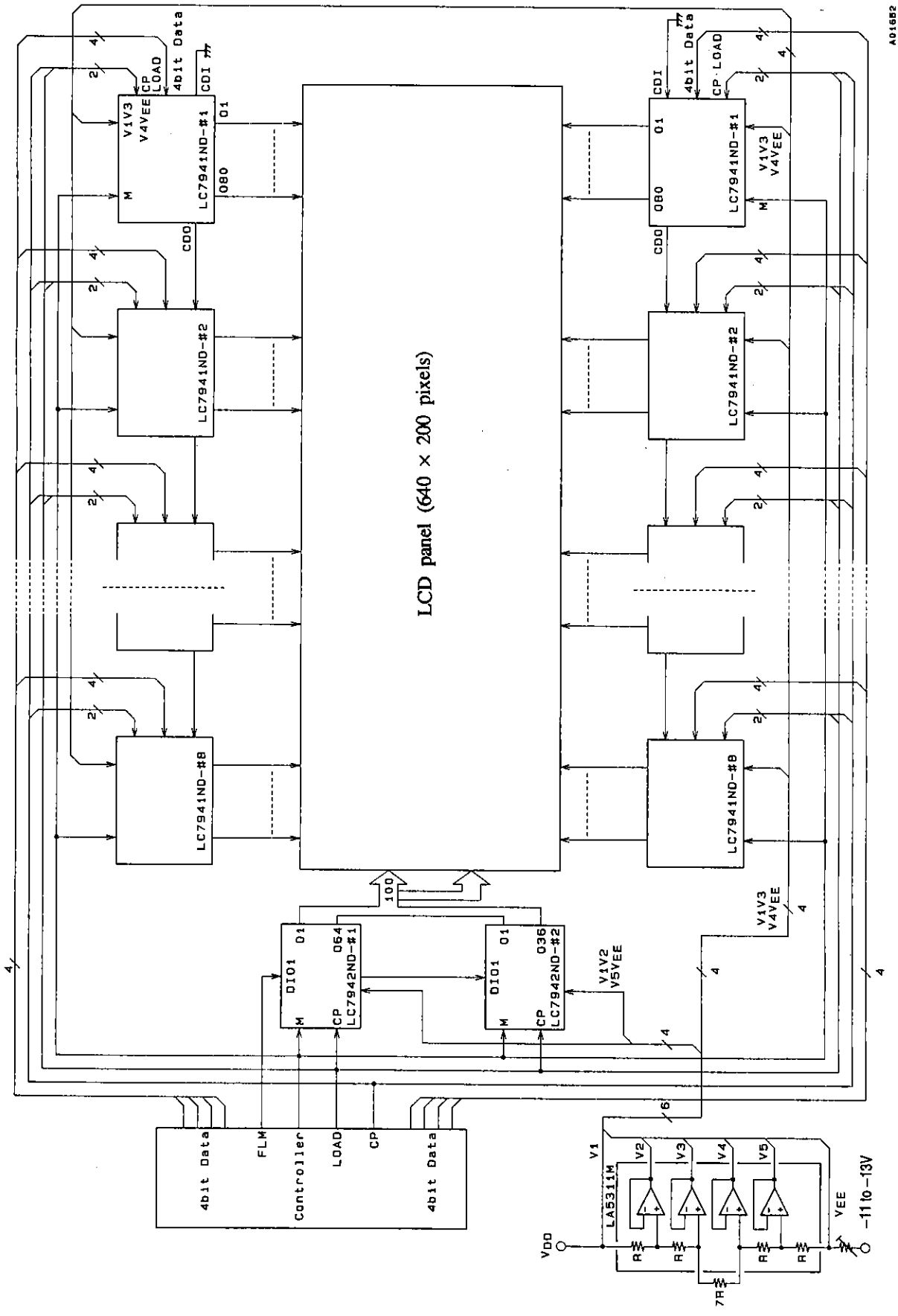
<table>
<tr><th colspan="2">Pin No.</th><th rowspan="2">Symbol</th><th rowspan="2">I/O</th><th rowspan="2">Function</th></tr>
<tr><th>LC7940ND</th><th>LC7941ND</th></tr>
<tr><td>96</td><td>85</td><td>DI3</td><td rowspan="3">I</td><td rowspan="3">4-bit parallel data input pins.
<table><tr><th>Data input</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>In serial data input mode, DI1 to DI3 should all be tied HIGH or LOW.</td></tr>
<tr><td>95</td><td>86</td><td>DI2</td></tr>
<tr><td>94</td><td>87</td><td>DI1</td></tr>
<tr><td>93</td><td>88</td><td>M</td><td>I</td><td>LCD panel drive voltage output alternation control signal.</td></tr>
<tr><td>85</td><td>96</td><td>P/S</td><td>I</td><td>Data input mode select. 4-bit parallel input when HIGH, and serial input when LOW.</td></tr>
<tr><td>82</td><td>99</td><td>CDO</td><td>O</td><td>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.</td></tr>
<tr><td>1 to 80</td><td>80 to 1</td><td>O1 to O80</td><td>O</td><td>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>$\overline{\text{DISP OFF}}$</th><th>Output</th></tr><tr><td>LOW</td><td>LOW</td><td>HIGH</td><td>V_3</td></tr><tr><td>LOW</td><td>HIGH</td><td>HIGH</td><td>V_1</td></tr><tr><td>HIGH</td><td>LOW</td><td>HIGH</td><td>V_4</td></tr><tr><td>HIGH</td><td>HIGH</td><td>HIGH</td><td>V_{EE}</td></tr><tr><td>×</td><td>×</td><td>LOW</td><td>V_1</td></tr></table>Note
× = don't care (tied HIGH or LOW)</td></tr>
<tr><td>84</td><td>97</td><td>$\overline{\text{DISP OFF}}$</td><td>I</td><td>O1 to O80 output control input pin.
When LOW, V_1 is output on the O1 to O80 outputs. See the truth table.</td></tr>
<tr><td>81</td><td>91</td><td>NC</td><td rowspan="3">–</td><td rowspan="3">No connection.</td></tr>
<tr><td>83</td><td>98</td><td>NC</td></tr>
<tr><td>90</td><td>100</td><td>NC</td></tr>
</table>

Application Notes

LCD Panel 1



LCD Panel 2

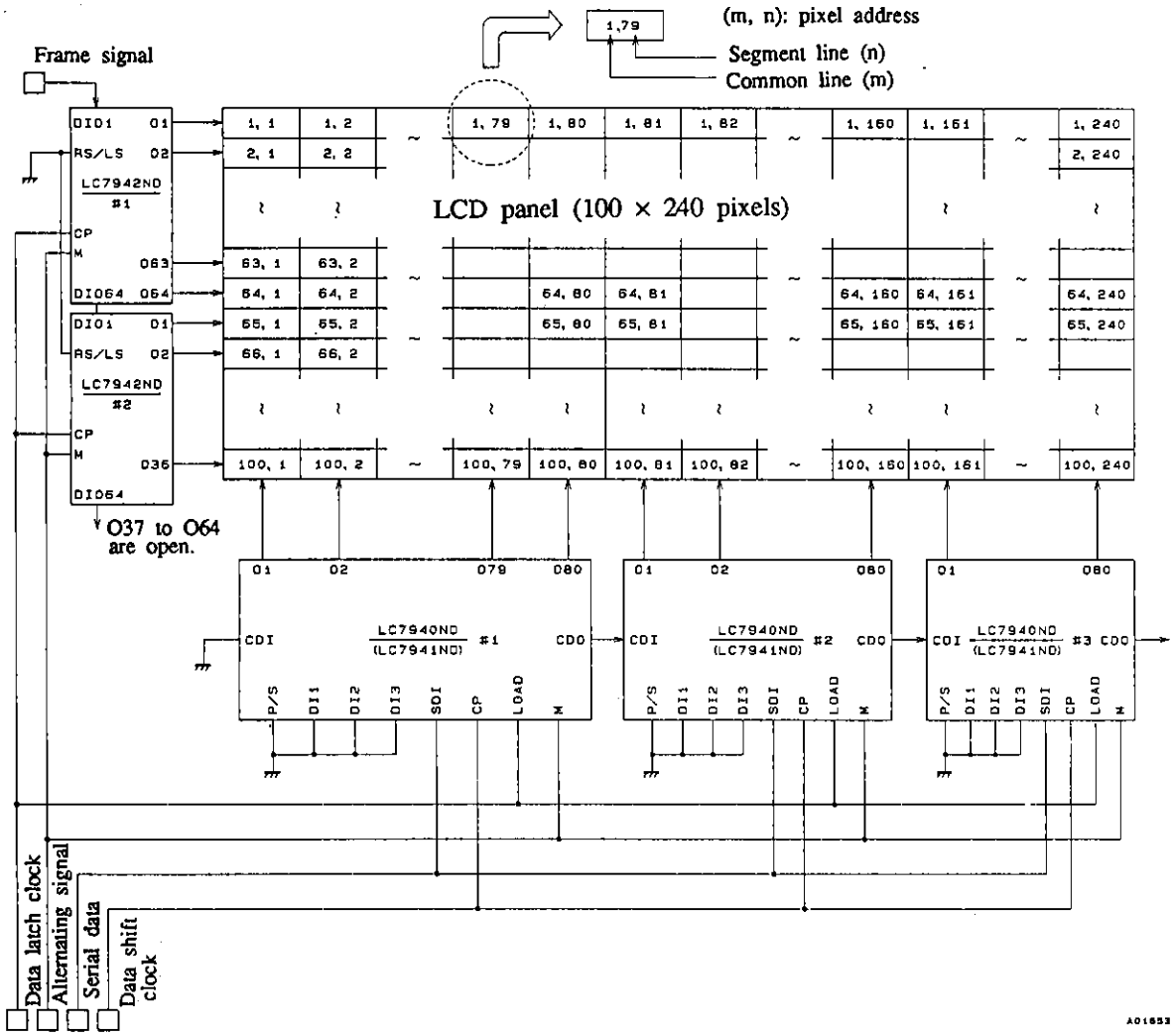

LCD panel (640 × 200 pixels)
LC7941ND-#1
LC7941ND-#2
LC7941ND-#8
LC7942ND-#1
LC7942ND-#2
4bit Data
CP
LOAD
CDI
CDO
V1V3
V4VEE
V1V2
V5VEE
FLM
Controller
LA5311M
V1
V2
V3
V4
V5
VEE
VDD
R
7R
-11 to -13V
A01682

100 × 240-pixel LCD Panel Application

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

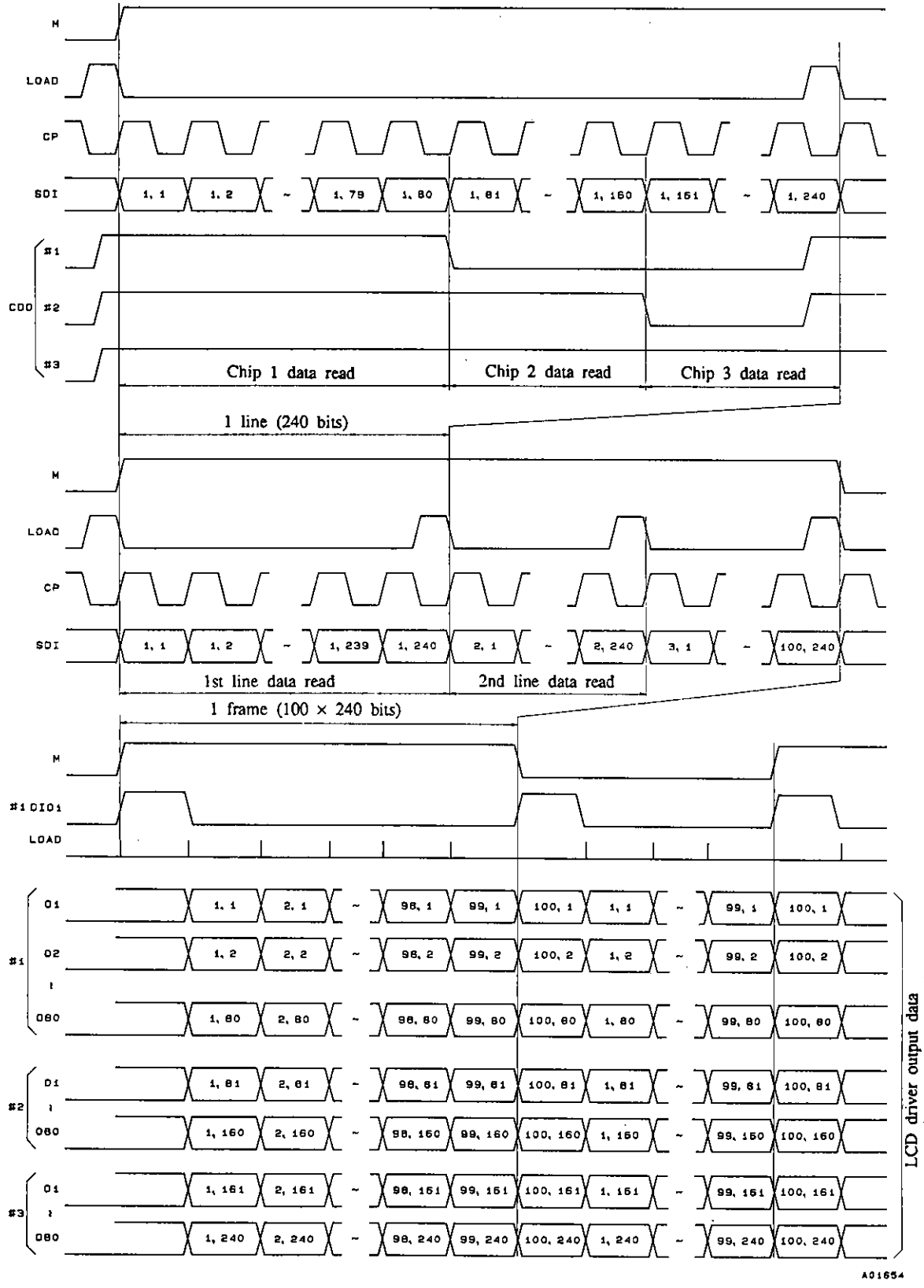
- 3 × LC7940ND (or LC7941ND) drivers
- 2 × LC7942ND drivers

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



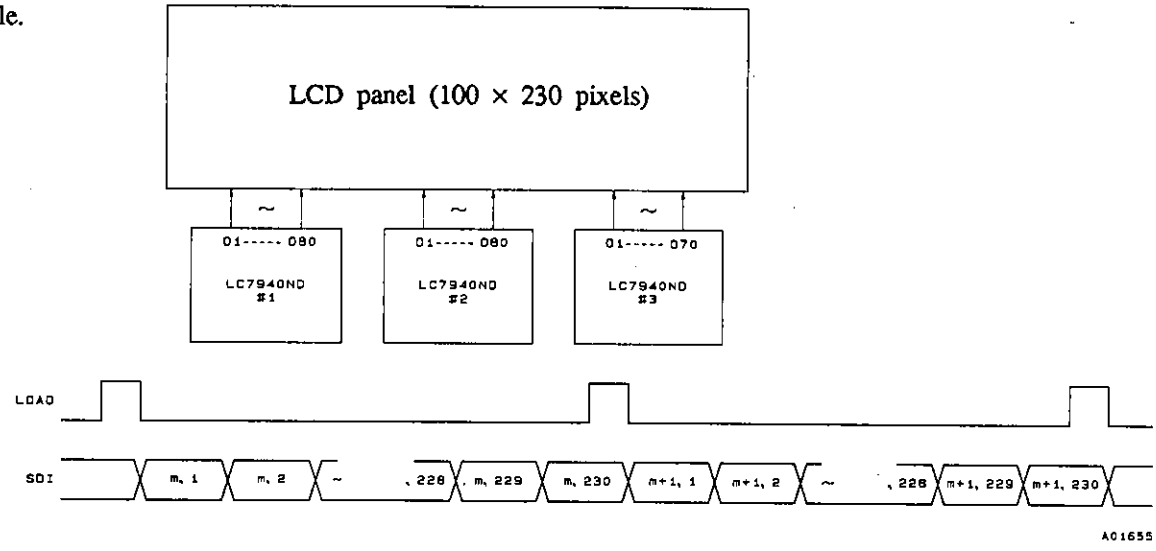
1. The LC7942ND chips are cascaded by connecting DIO64 on chip 1 to DIO1 on chip 2. For a 100-bit shift register, O37 to O64 on chip 2 are left open.
2. The LC7940ND (or LC7941ND) chips are cascaded by connecting CDO on chip 1 to CDI on chip 2, and CDO on chip 2 to CDI on chip 3. CDI on chip 1 is tied 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

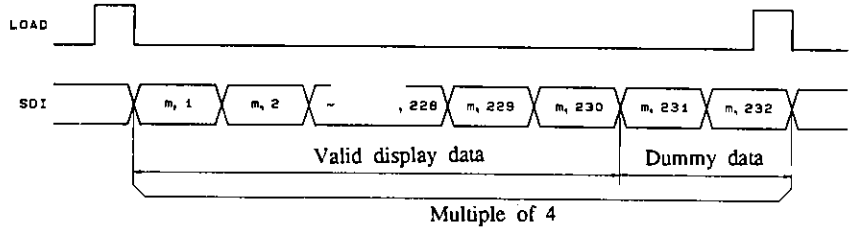


Segment Data Not Multiples of 4

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.