



SANYO Semiconductors DATA SHEET

LC7940KD LC7941KDR

CMOS IC
Dot-Matrix LCD Drivers

Overview

The LC7940KD and LC7941KDR 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 LC7940KD and LC7941KDR feature mirror-image pin assignments, allowing them to be used together to increase component density. They are designed to be used with the LC7942KD (QIP80D) 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 voltage can be supplied externally
- Operating supply voltage and ambient temperature
 - V_{DD} (logic block): 2.7 to 5.5V/-20 to +85°C
 - V_{DD}-V_{EE} (LCD block): 8 to 20V/-20 to +85°C
- CMOS process
- Package: QIP100D(LC7940KD)/QIP100DR(LC7941KDR)

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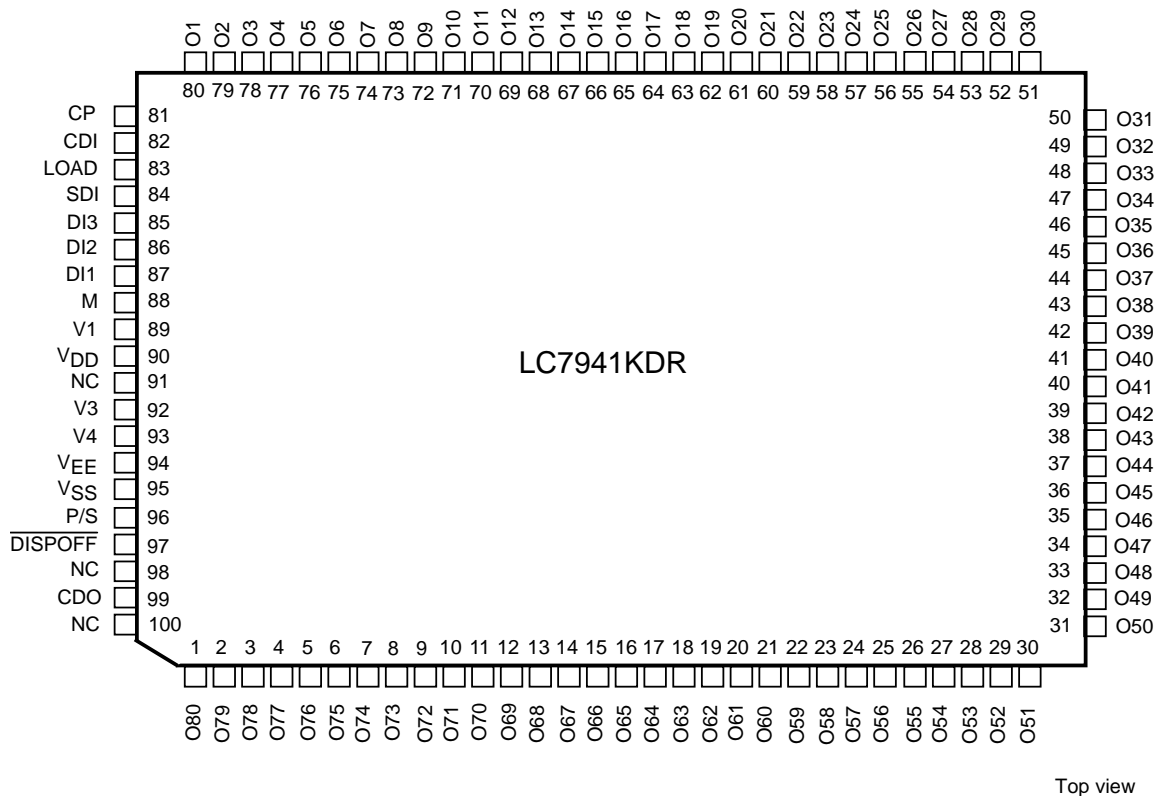
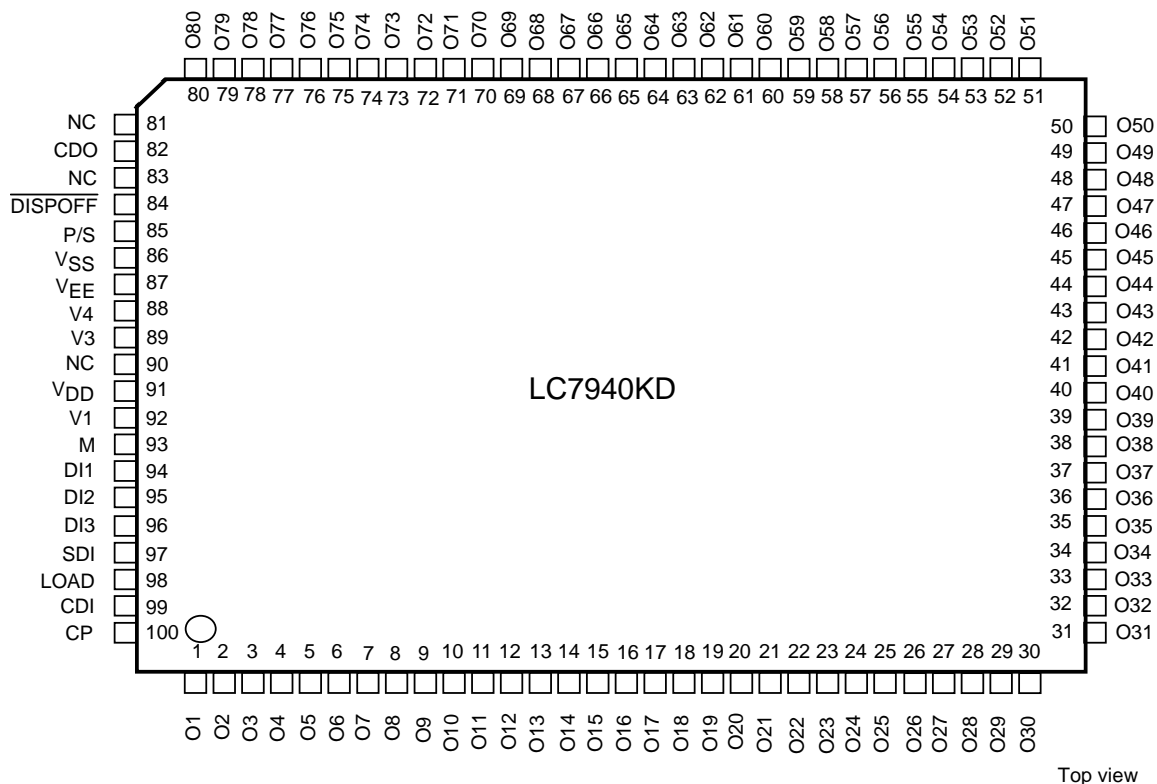
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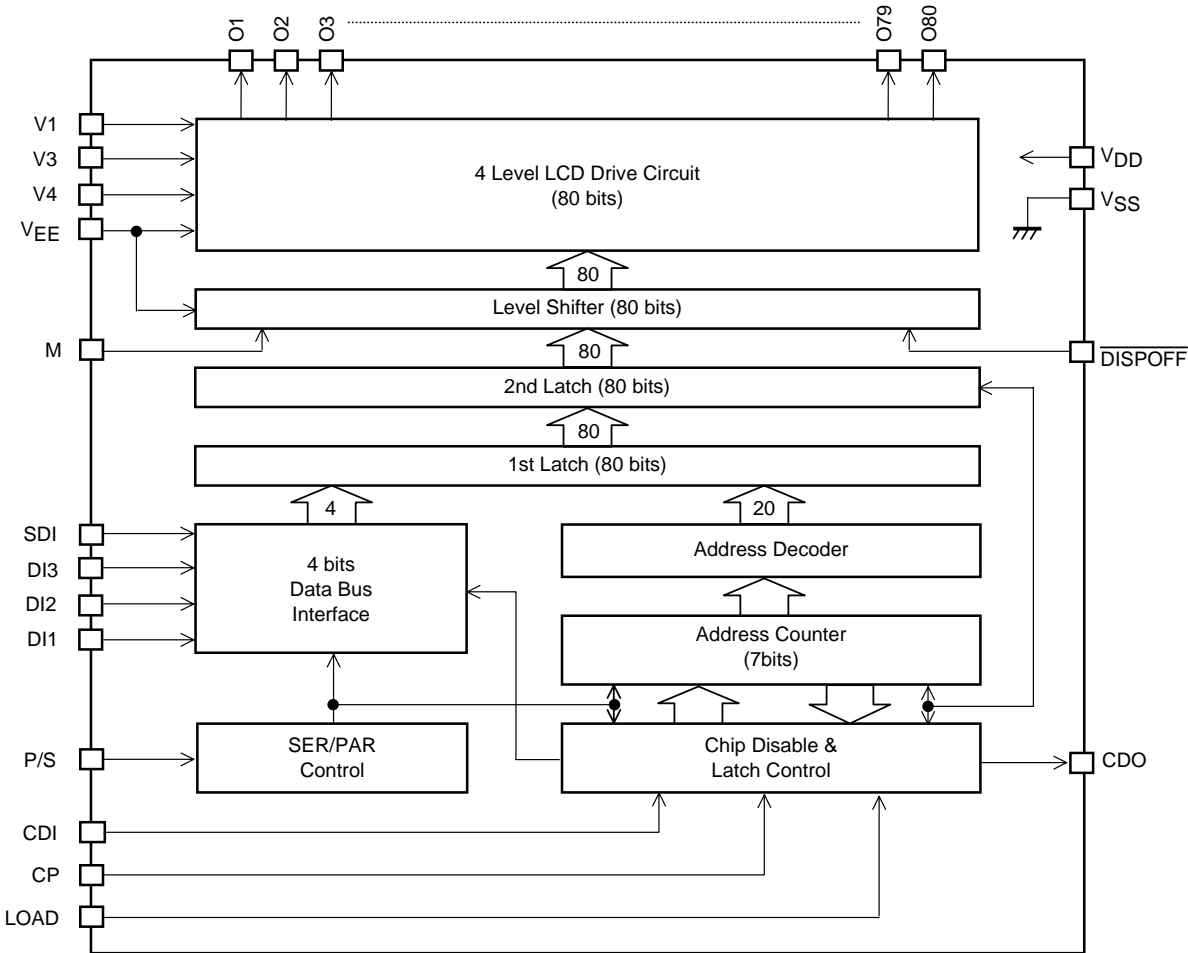
LC7940KD / LC7941KDR

Pin Assignment



LC7940KD / LC7941KDR

Block Diagram



LC7940KD / LC7941KDR

Pin Function

Pin No		Symbol	I/O	Function																								
LC7940KD	LC7941KDR																											
91	90	V _{DD}	Supply	LCD panel drive voltage supplies V _{DD} -V _{SS} is the logic supply. V _{DD} -V _{EE} is the LCD supply.																								
86	95	V _{SS}																										
87	94	V _{EE}																										
92	89	V1	Supply	LCD panel drive voltage supplies V1 and V _{EE} are selected levels. V3 and V4 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.																								
96	85	DI3	I	4-bit parallel data input pins. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Data input</th> <th colspan="3">LCD driver output</th> </tr> </thead> <tbody> <tr> <td>SDI</td> <td>O4</td> <td>O8</td> <td rowspan="4" style="text-align: center; vertical-align: middle;">→</td> </tr> <tr> <td>DI3</td> <td>O3</td> <td>O7</td> </tr> <tr> <td>DI2</td> <td>O2</td> <td>O6</td> </tr> <tr> <td>DI1</td> <td>O1</td> <td>O5</td> </tr> </tbody> </table>	Data input	LCD driver output			SDI	O4	O8	→	DI3	O3	O7	DI2	O2	O6	DI1	O1	O5							
Data input	LCD driver output																											
SDI	O4	O8			→																							
DI3	O3	O7																										
DI2	O2	O6																										
DI1	O1	O5																										
95	86	DI2																										
94	87	DI1																										
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 $\overline{\text{DISPOFF}}$ input as shown below. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>M</th> <th>Q</th> <th>$\overline{\text{DISPOFF}}$</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>L</td> <td>L</td> <td>H</td> <td>V3</td> </tr> <tr> <td>L</td> <td>H</td> <td>H</td> <td>V1</td> </tr> <tr> <td>H</td> <td>L</td> <td>H</td> <td>V4</td> </tr> <tr> <td>H</td> <td>H</td> <td>H</td> <td>V_{EE}</td> </tr> <tr> <td>*</td> <td>*</td> <td>L</td> <td>V1</td> </tr> </tbody> </table>	M	Q	$\overline{\text{DISPOFF}}$	Output	L	L	H	V3	L	H	H	V1	H	L	H	V4	H	H	H	V _{EE}	*	*	L	V1
M	Q	$\overline{\text{DISPOFF}}$	Output																									
L	L	H	V3																									
L	H	H	V1																									
H	L	H	V4																									
H	H	H	V _{EE}																									
*	*	L	V1																									
84	97	$\overline{\text{DISPOFF}}$	I	O1 to O80 output control input pin. When LOW, V1 is output on the O1 to O80 outputs. See the truth table.																								
81	91	NC	-	No connection.																								
83	98	NC																										
90	100	NC																										

LC7940KD / LC7941KDR

Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage (logic)	V_{DD} max	-	-0.3 to +7.0	V
Maximum supply voltage (LCD)	$V_{DD}-V_{EE}$ max	*1	0 to 22	V
Maximum 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_{stg}	-	-40 to +125	$^\circ\text{C}$

Note *1 The following relations between elements should be maintained:

$$V_{DD} \geq V_1 > V_3 > V_4 > V_{EE}, V_{DD} - V_3 \leq 7\text{V}, V_4 - V_{EE} \leq 7\text{V}$$

Allowable Operating Ranges at $T_a = -20$ to 85°C , $V_{SS} = 0\text{V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage (logic)	V_{DD}	-	2.7	-	5.5	V
Supply voltage (LCD)	$V_{DD}-V_{EE}$	*2, 3	8	-	20	V
Input high level voltage	V_{IH}	CP, CDI, DI1 to DI3, M, SDI, P/S, DISPOFF, and LOAD	$0.8V_{DD}$	-	-	V
Input low level voltage	V_{IL}	CP, CDI, DI1 to DI3, M, SDI, P/S, DISPOFF, and LOAD	-	-	$0.2V_{DD}$	V
CP Shift clock frequency	f_{CP}	CP	-	-	3.3	MHz
CP pulse width	t_{WC}	CP	100	-	-	ns
LOAD pulse width	t_{WL}	LOAD	100	-	-	ns
DIn and SDI to CP setup time	t_{SETUP}	DIn and SDI to CP	80	-	-	ns
DIn and SDI to CP hold time	t_{HOLD}	DIn and SDI to CP	80	-	-	ns
CP to LOAD time	t_{CL1}	CP to LOAD	0	-	-	ns
	t_{CL2}	CP to LOAD	100	-	-	ns
LOAD to CP time	t_{LC}	LOAD to CP	100	-	-	ns
CP rise time	t_R	CP	-	-	50	ns
CP fall time	t_F	CP	-	-	50	ns
LOAD rise time	t_{RL}	LOAD	-	-	50	ns
LOAD fall time	t_{FL}	LOAD	-	-	50	ns

Note *2 The following relations between elements should be maintained:

$$V_{DD} \geq V_1 > V_3 > V_4 > V_{EE}, V_{DD} - V_3 \leq 7\text{V}, V_4 - V_{EE} \leq 7\text{V}$$

*3 When the power is turned on, either the logic system power must be turned on before the LCD drive system power or else they must both be turned on at the same time. When the power is turned off, either the LCD drive system power must be turned off before the logic system power, or else both must be turned off at the same time.

LC7940KD / LC7941KDR

Electrical Characteristics at $T_a = 25 \pm 2^\circ\text{C}$, $V_{DD} = 2.7$ to 5.5V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Input high level current	I_{IH}	$V_{IN} = V_{DD}$: LOAD, CP, CDI, P/S, DI1 to DI3, SDI, M, and DISPOFF	-	-	1	μA
Input low level current	I_{IL}	$V_{IN} = V_{SS}$: LOAD, CP, CDI, P/S, DI1 to DI3, SDI, M, and DISPOFF	-1	-	-	μA
Output high level voltage	V_{OH}	$I_{OH} = -400\mu\text{A}$: CDO	$V_{DD}-0.4$	-	-	V
Output low level voltage	V_{OL}	$I_{OL} = 400\mu\text{A}$: CDO	-	-	0.4	V
Driver on resistance	R_{ON}	$V_{DD}-V_{EE} = 18\text{V}$, $ V_{DE}-V_O = 0.25\text{V}$ *4	-	0.7	2	$\text{k}\Omega$
Standby current drain	I_{ST}	CDI = V_{DD} , $V_{DD}-V_{EE} = 18\text{V}$, CP = 3.3MHz, Output unloaded: V_{SS}	-	-	200	μA
Operating current drain	I_{SS} *5	$V_{DD}-V_{EE} = 18\text{V}$, CP = 3.3MHz, LOAD = 5.156kHz M = 52Hz: V_{SS}	-	-	1.0	mA
	I_{EE} *6	$V_{DD}-V_{EE} = 18\text{V}$, CP = 3.3MHz, LOAD = 5.156kHz M = 52Hz: V_{EE}	-	-	0.1	mA

Note *4 V_{DE} = one of V_1, V_3, V_4 or V_{EE} . $V_1 = V_{DD}$, $V_3 = 9/11(V_{DD}-V_{EE})$, $V_4 = 2/11(V_{DD}-V_{EE})$

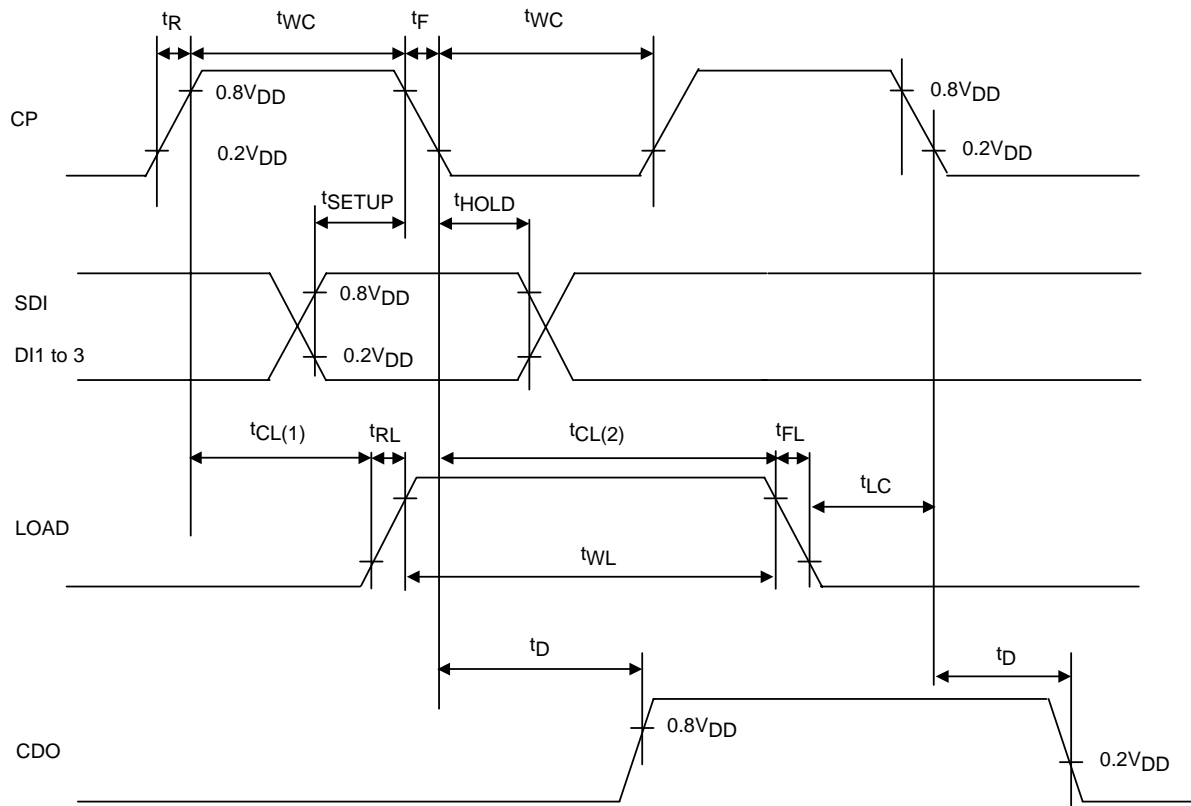
*5 I_{SS} is the current flowing from $V_{DD}-V_{SS}$.

*6 I_{EE} is the current flowing from $V_{DD}-V_{EE}$

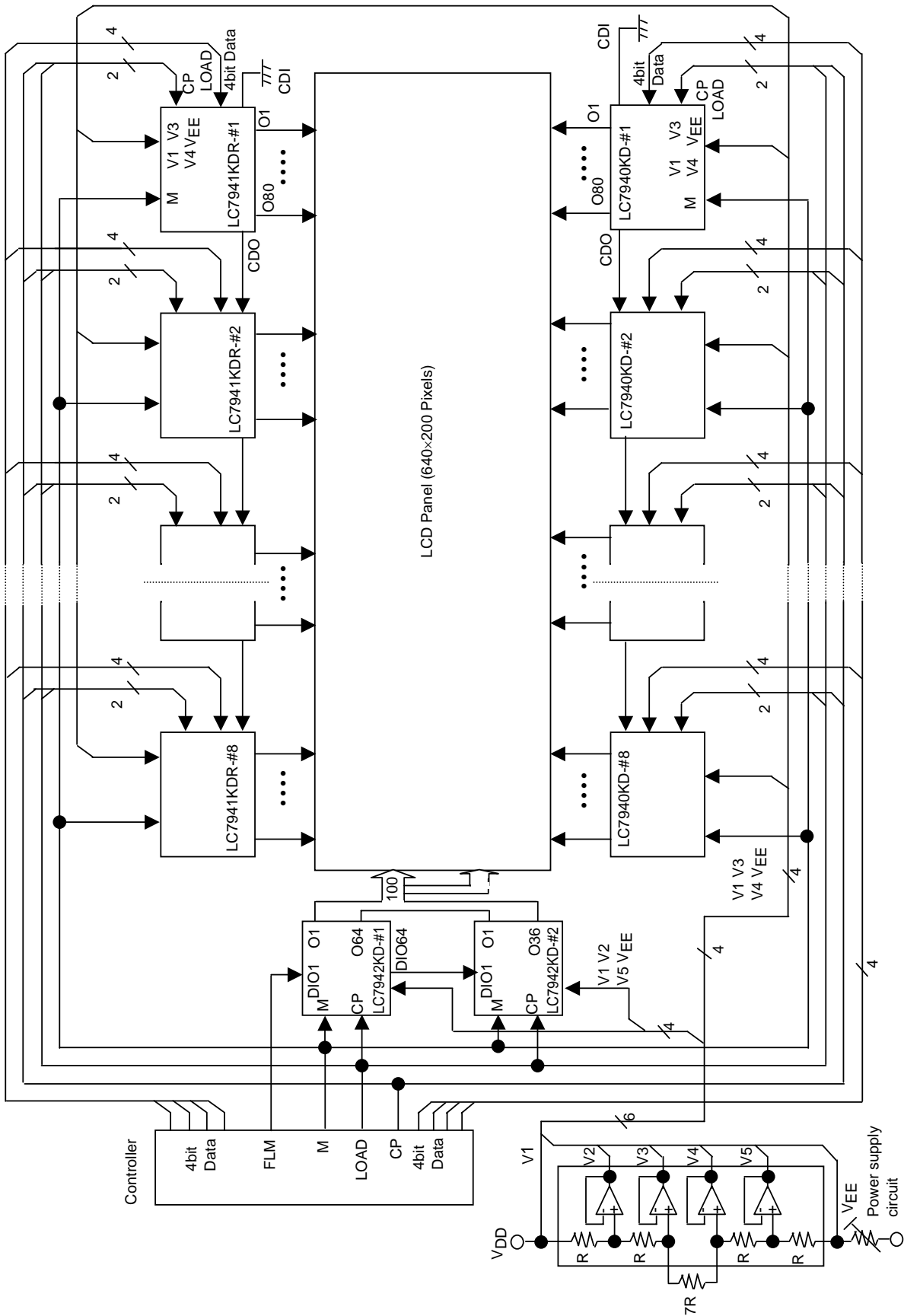
Switching Characteristics at $T_a = 25 \pm 2^\circ\text{C}$, $V_{SS} = 0\text{V}$, $V_{DD} = 2.7$ to 5.5V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Output delay time	t_D	CL=30pF: CDO	-	-	200	ns

Switching Characteristics Diagram



Application Notes LCD Panel2

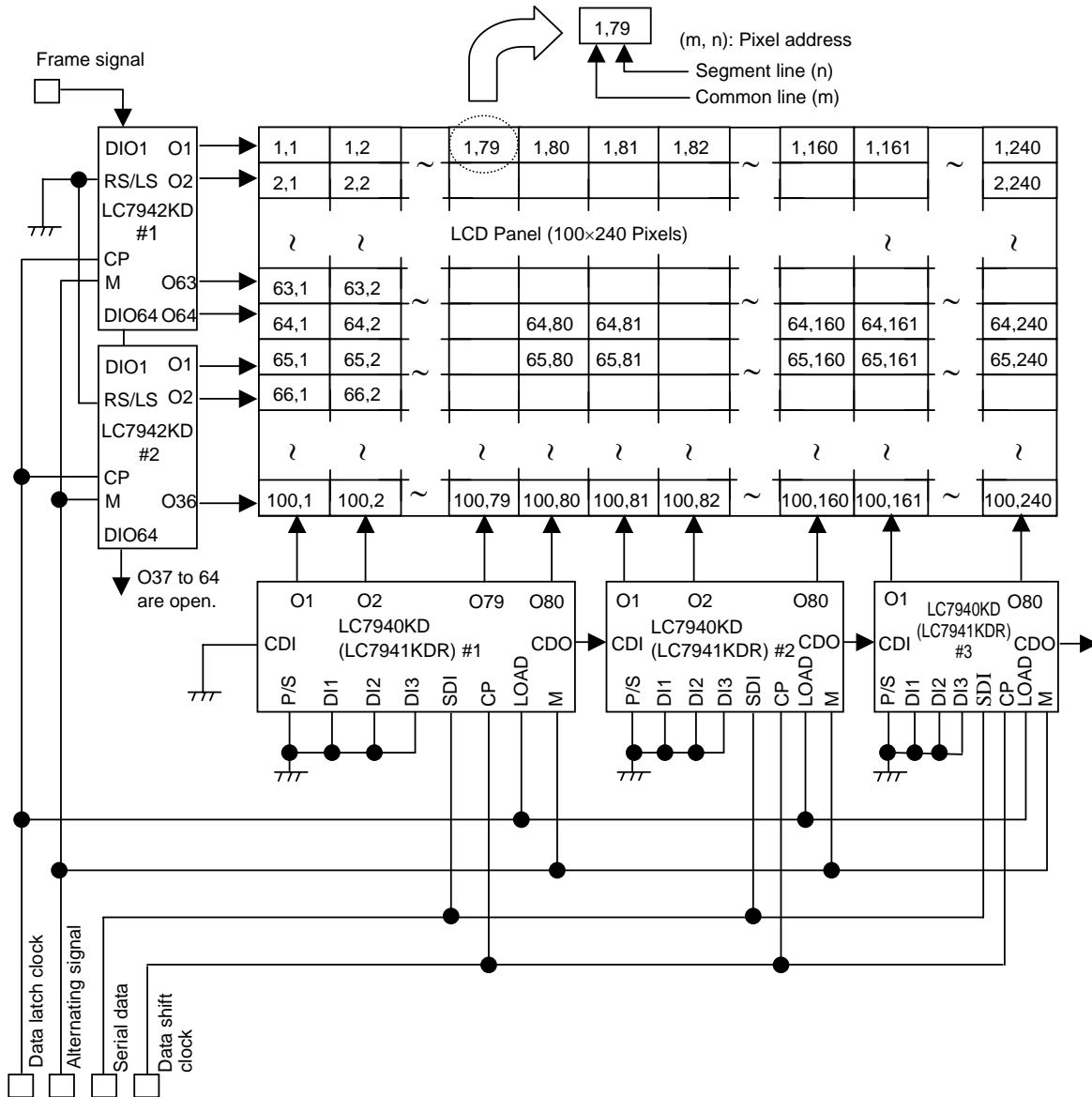


100×240-Pixel LCD Panel Application

A 100×240-Pixel LCD Panel requires the following drivers.

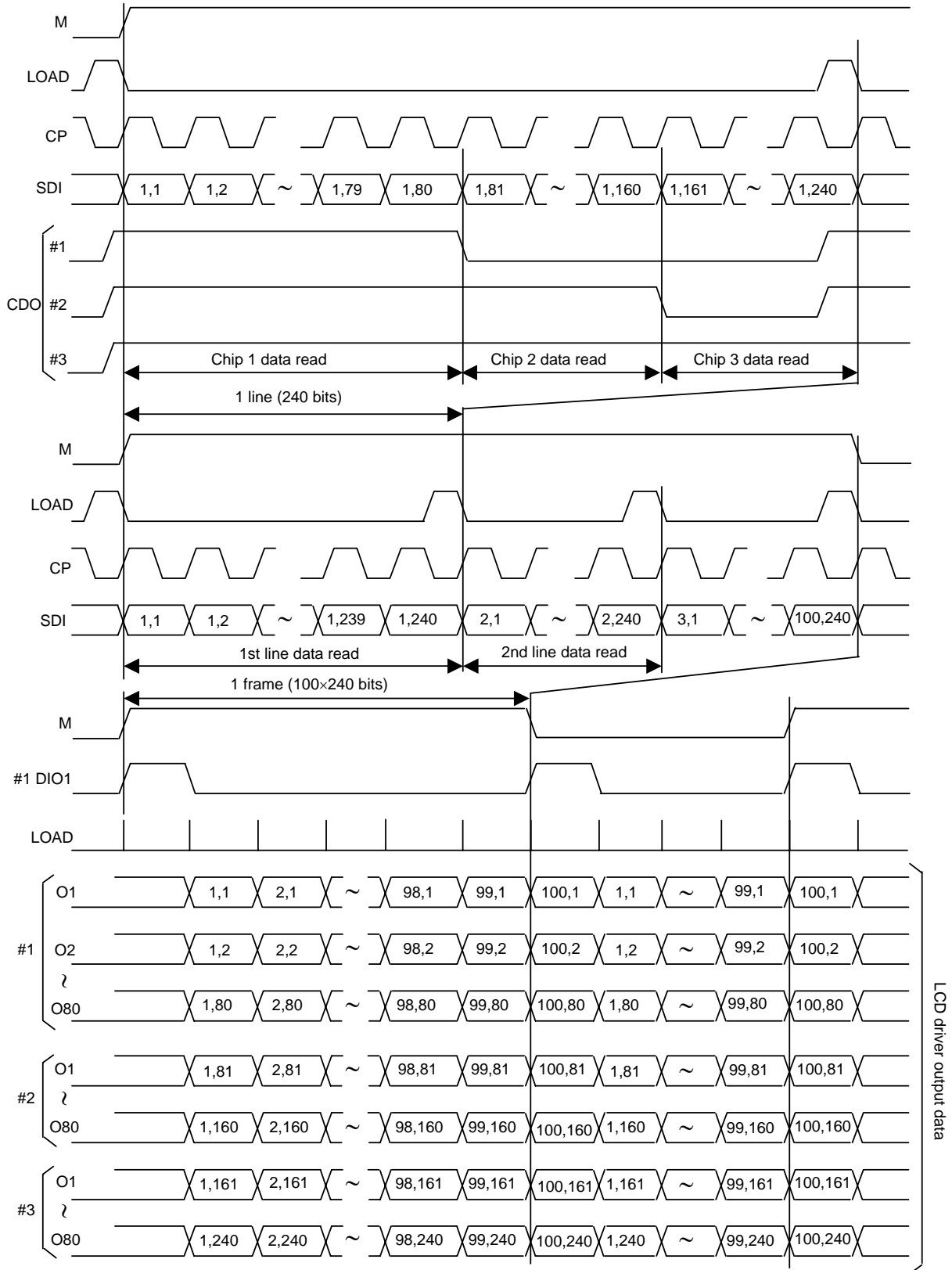
- 3×LC7940KD (or LC7941KDR) drivers
- 2×LC7942KD drivers

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



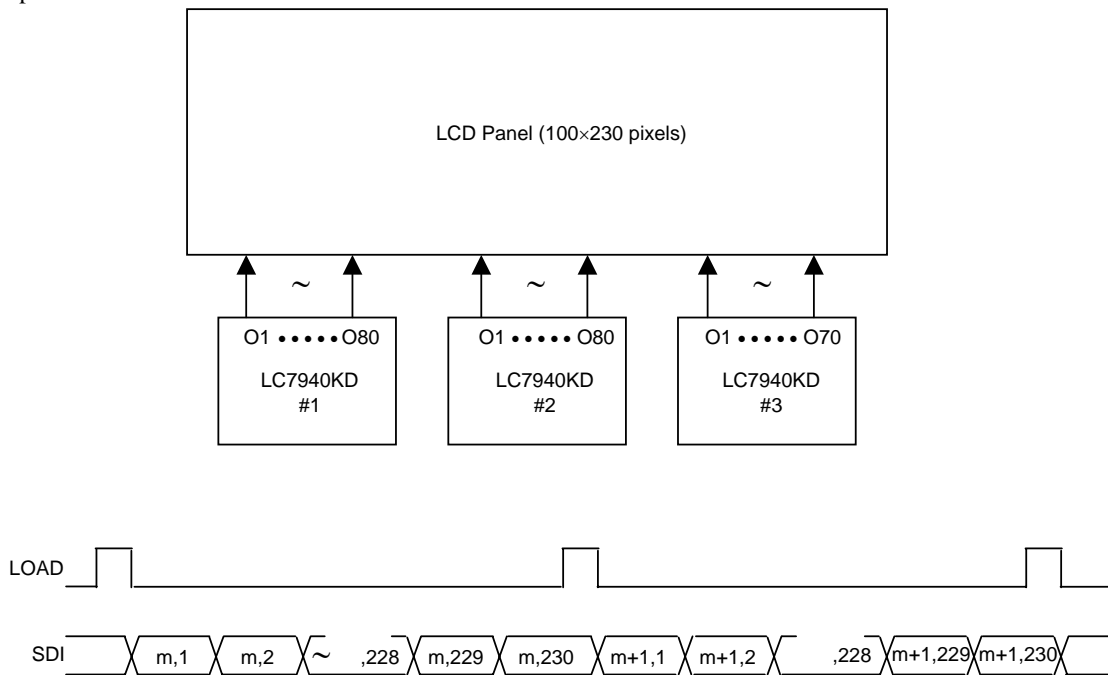
- (1) The LC7942KD chips are cascaded by connecting DIO64 on chip 1 to DIO1 on chip 2. For a 100-bit shift register, O37 to O64 on chip 2 are left open.
- (2) The LC7940KD (or LC7941KDR) chips are cascaded by connecting CDO on chip 1 to CDI on chip 2, and CDO on chip 2 to CDI on chip 3. CDI on chip 1 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



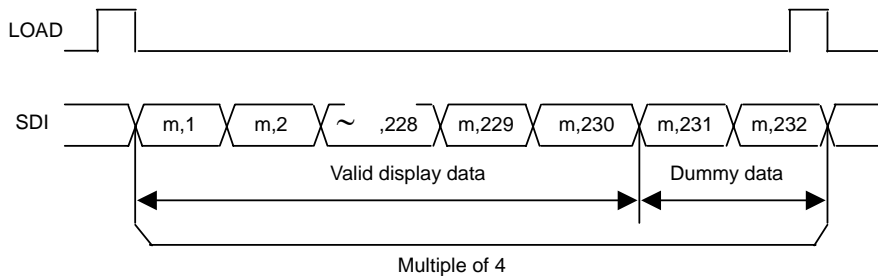
Segment Data Not Multiples of 4

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 LC7940KD (or LC7941KDR) converts serial/parallel data in 4-bit units, which also decrease 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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