



LC75813E, 75813T

1/3, 1/4 Duty General-Purpose LCD Driver



An ON Semiconductor Company

Overview

The LC75813E and LC75813T are 1/3 duty and 1/4 duty general-purpose LCD drivers that can be used for frequency display in electronic tuners under the control of a microcontroller. The LC75813E and LC75813T can drive an LCD with up to 344 segments directly. The LC75813E and LC75813T can also control up to 8 general-purpose output ports. Since the LC75813E and LC75813T use separate power supply systems for the LCD drive block and the logic block, the LCD driver block power-supply voltage can be set to any voltage in the range 2.7 to 6.0 volts, regardless of the logic block power-supply voltage.

Features

- Switching between 1/3 duty and 1/4 duty drive techniques under serial data control.
- Switching between 1/2 bias and 1/3 bias drive techniques under serial data control.
- Up to 261 segments for 1/3 duty drive and 344 segments for 1/4 duty drive can be displayed.
- Serial data input supports CCB format communication with the system controller.
- Serial data control of the power-saving mode based backup function and all the segments forced off function.
- Serial data control of switching between the segment output port and the general-purpose output port functions.

Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|----------------------|-----------------------------------|-------------------------|------------------|
| Maximum supply voltage | $V_{DD\text{ max}}$ | V_{DD} | -0.3 to +7.0 | V |
| | $V_{LCD\text{ max}}$ | V_{LCD} | -0.3 to +7.0 | |
| Input voltage | V_{IN1} | CE, CL, DI, INH | -0.3 to +7.0 | V |
| | V_{IN2} | OSC | -0.3 to $V_{DD} + 0.3$ | |
| | V_{IN3} | V_{LCD1} , V_{LCD2} | -0.3 to $V_{LCD} + 0.3$ | |
| Output voltage | V_{OUT1} | OSC | -0.3 to $V_{DD} + 0.3$ | V |
| | V_{OUT2} | S1 to S87, COM1 to COM4, P1 to P8 | -0.3 to $V_{LCD} + 0.3$ | |
| Output current | I_{OUT1} | S1 to S87 | 300 | μA |
| | I_{OUT2} | COM1 to COM4 | 3 | mA |
| | I_{OUT3} | P1 to P8 | 5 | |
| Allowable power dissipation | $P_d\text{ max}$ | $T_a = 85^\circ\text{C}$ | 200 | mW |
| Operating temperature | T_{opr} | | -40 to +85 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -55 to +125 | $^\circ\text{C}$ |

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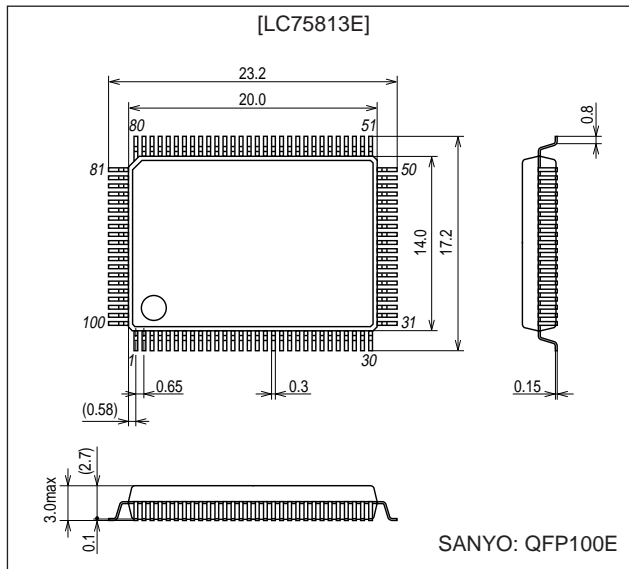
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- Serial data control of frame frequency for common and segment output waveforms.
- High generality, since display data is displayed directly without decoder intervention.
- Independent V_{LCD} for the LCD driver block (V_{LCD} can be set to any voltage in the range 2.7 to 6.0 volts, regardless of the logic block power-supply voltage.)
- The \overline{INH} pin can force the display to the off state.
- RC oscillator circuit

Package Dimensions

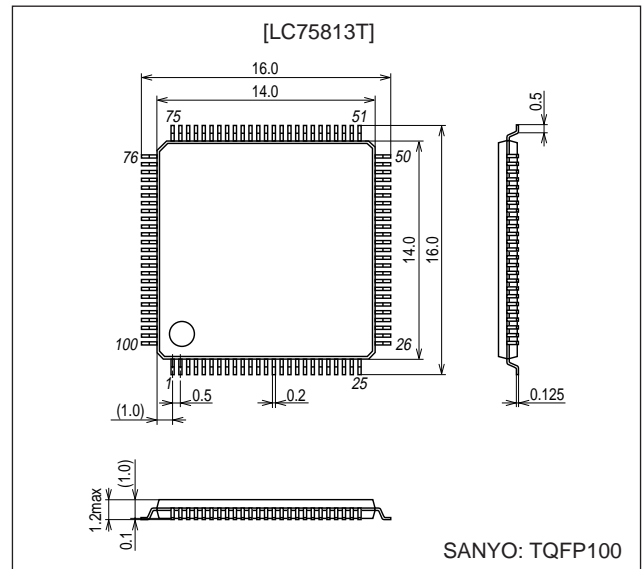
unit: mm

3151A-QFP100E



unit: mm

3274-TQFP100 (14×14)



Allowable Operating Ranges at $T_a = -40$ to $+85^\circ\text{C}$, $V_{SS} = 0$ V

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|----------------------------------|--------------|---------------------------------|--------------|---------------|--------------|---------------|
| | | | min | typ | max | |
| Supply voltage | V_{DD} | V_{DD} | 2.7 | | 6.0 | V |
| | V_{LCD} | V_{LCD} | 2.7 | | 6.0 | |
| Input voltage | V_{LCD1} | V_{LCD1} | | $2/3 V_{LCD}$ | V_{LCD} | V |
| | V_{LCD2} | V_{LCD2} | | $1/3 V_{LCD}$ | V_{LCD} | |
| Input high level voltage | V_{IH} | CE, CL, DI, \overline{INH} | $0.8 V_{DD}$ | | 6.0 | V |
| Input low level voltage | V_{IL} | CE, CL, DI, \overline{INH} | 0 | | $0.2 V_{DD}$ | V |
| Recommended external resistance | R_{OSC} | OSC | | 39 | | k Ω |
| Recommended external capacitance | C_{OSC} | OSC | | 1000 | | pF |
| Guaranteed oscillation range | f_{OSC} | OSC | 19 | 38 | 76 | kHz |
| Data setup time | t_{ds} | CL, DI: Figure 2 | 160 | | | ns |
| Data hold time | t_{dh} | CL, DI: Figure 2 | 160 | | | ns |
| CE wait time | t_{cp} | CE, CL: Figure 2 | 160 | | | ns |
| CE setup time | t_{cs} | CE, CL: Figure 2 | 160 | | | ns |
| CE hold time | t_{ch} | CE, CL: Figure 2 | 160 | | | ns |
| High level clock pulse width | $t_{\phi H}$ | CL: Figure 2 | 160 | | | ns |
| Low level clock pulse width | $t_{\phi L}$ | CL: Figure 2 | 160 | | | ns |
| Rise time | t_r | CE, CL, DI: Figure 2 | | 160 | | ns |
| Fall time | t_f | CE, CL, DI: Figure 2 | | 160 | | ns |
| \overline{INH} switching time | t_c | \overline{INH} , CE: Figure 3 | 10 | | | μs |

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Electrical Characteristics for the Allowable Operating Ranges

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|-------------------------------|------------|---|---------------------|--------------|---------------------|---------------|
| | | | min | typ | max | |
| Hysteresis | V_H | CE, CL, DI, $\overline{\text{INH}}$ | | $0.1 V_{DD}$ | | V |
| Input high level current | I_{IH} | CE, CL, DI, $\overline{\text{INH}}$: $V_I = 6.0 \text{ V}$ | | | 5.0 | μA |
| Input low level current | I_{IL} | CE, CL, DI, $\overline{\text{INH}}$: $V_I = 0 \text{ V}$ | -5.0 | | | μA |
| Output high level voltage | V_{OH1} | S1 to S87: $I_O = -20 \mu\text{A}$ | $V_{LCD} - 0.9$ | | | V |
| | V_{OH2} | COM1 to COM4: $I_O = -100 \mu\text{A}$ | $V_{LCD} - 0.9$ | | | |
| | V_{OH3} | P1 to P8: $I_O = -1 \text{ mA}$ | $V_{LCD} - 0.9$ | | | |
| Output low level voltage | V_{OL1} | S1 to S87: $I_O = 20 \mu\text{A}$ | | | 0.9 | V |
| | V_{OL2} | COM1 to COM4: $I_O = 100 \mu\text{A}$ | | | 0.9 | |
| | V_{OL3} | P1 to P8: $I_O = 1 \text{ mA}$ | | | 0.9 | |
| Output middle level voltage*1 | V_{MID1} | COM1 to COM4: 1/2 bias, $I_O = \pm 100 \mu\text{A}$ | $1/2 V_{LCD} - 0.9$ | | $1/2 V_{LCD} + 0.9$ | V |
| | V_{MID2} | S1 to S87: 1/3 bias, $I_O = \pm 20 \mu\text{A}$ | $2/3 V_{LCD} - 0.9$ | | $2/3 V_{LCD} + 0.9$ | |
| | V_{MID3} | S1 to S87: 1/3 bias, $I_O = \pm 20 \mu\text{A}$ | $1/3 V_{LCD} - 0.9$ | | $1/3 V_{LCD} + 0.9$ | |
| | V_{MID4} | COM1 to COM4: 1/3 bias, $I_O = \pm 100 \mu\text{A}$ | $2/3 V_{LCD} - 0.9$ | | $2/3 V_{LCD} + 0.9$ | |
| | V_{MID5} | COM1 to COM4: 1/3 bias, $I_O = \pm 100 \mu\text{A}$ | $1/3 V_{LCD} - 0.9$ | | $1/3 V_{LCD} + 0.9$ | |
| Oscillator frequency | f_{OSC} | OSC: $R_{OSC} = 39 \text{ k}\Omega$, $C_{OSC} = 1000 \text{ pF}$ | 30.4 | 38 | 45.6 | kHz |
| Current drain | I_{DD1} | V_{DD} : Power-saving mode | | | 5 | μA |
| | I_{DD2} | V_{DD} : $V_{DD} = 6.0 \text{ V}$, output open, $f_{OSC} = 38 \text{ kHz}$ | | 250 | 500 | |
| | I_{LCD1} | V_{LCD} : Power-saving mode | | | 5 | |
| | I_{LCD2} | V_{LCD} : $V_{LCD} = 6.0 \text{ V}$, output open, 1/2 bias, $f_{OSC} = 38 \text{ kHz}$ | | 200 | 400 | |
| | I_{LCD3} | V_{LCD} : $V_{LCD} = 6.0 \text{ V}$, output open, 1/3 bias, $f_{OSC} = 38 \text{ kHz}$ | | 120 | 240 | |

Note: *1 Excluding the bias voltage generation divider resistors built in the V_{LCD1} and V_{LCD2} . (See Figure 1.)

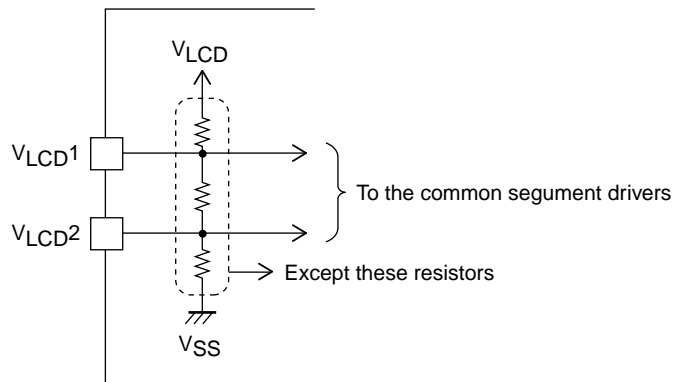
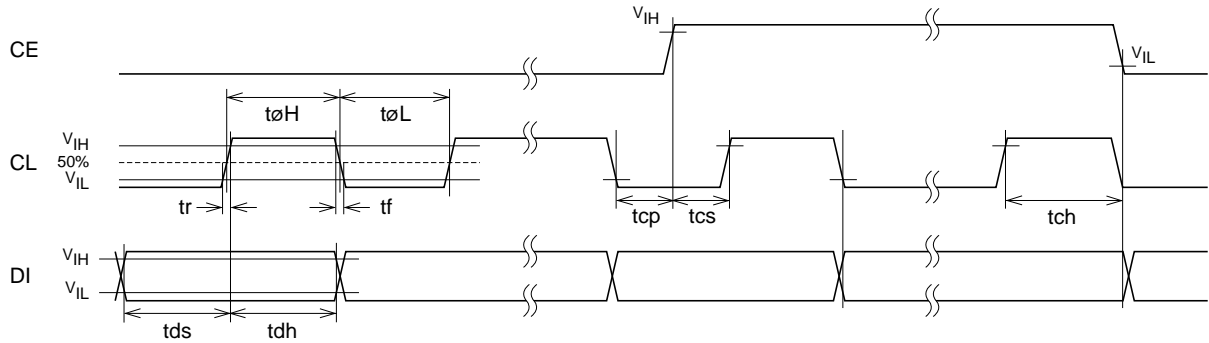


Figure 1

1. When CL is stopped at the low level



2. When CL is stopped at the high level

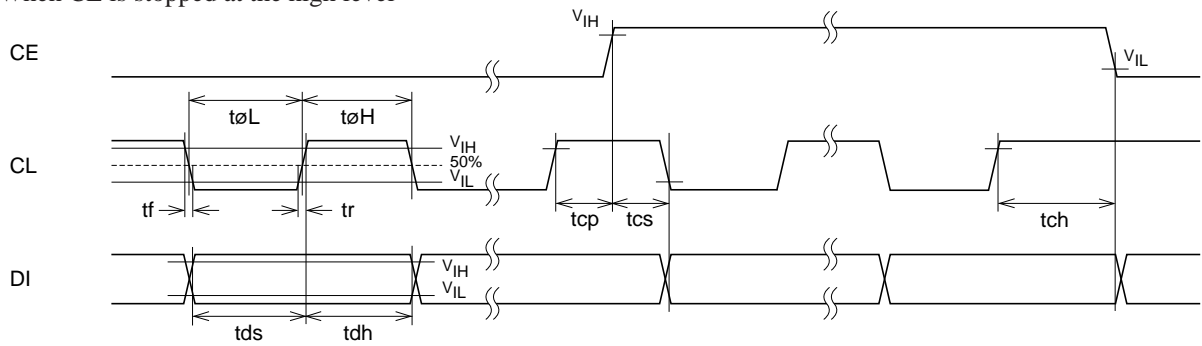
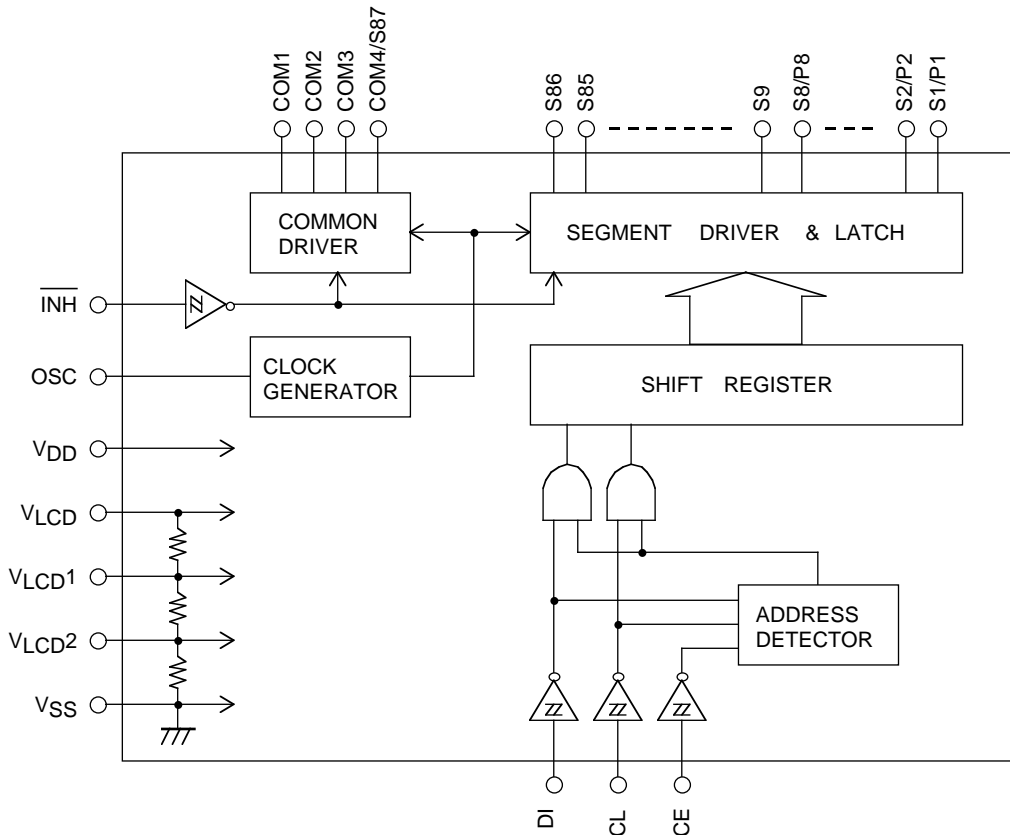


Figure 2

Block Diagram

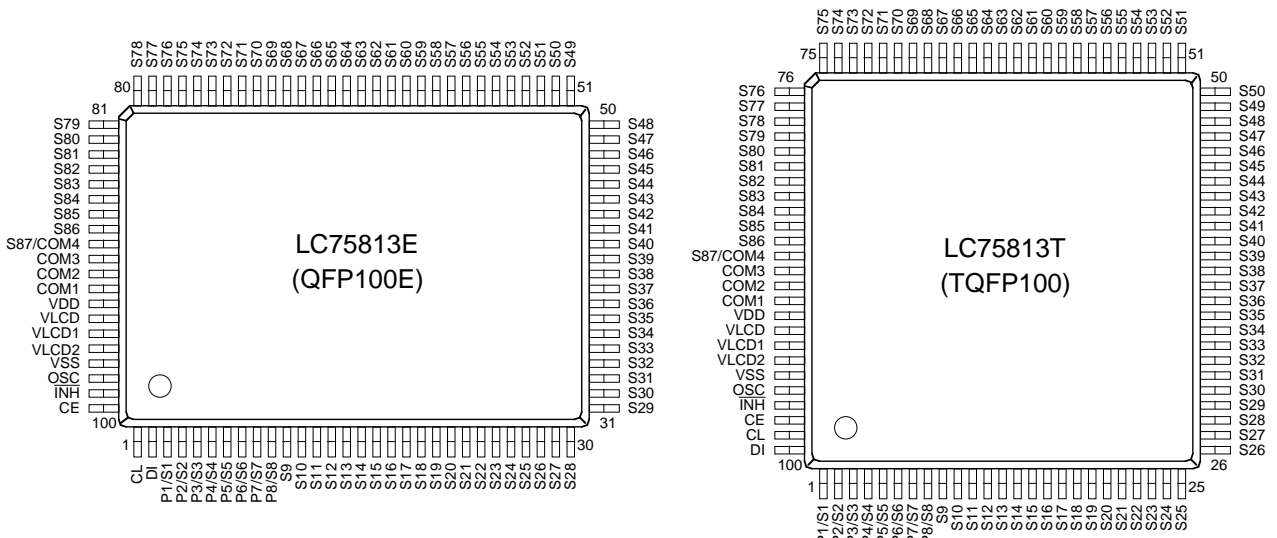


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Pin Functions

| Symbol | Pin No. | | Function | Active | I/O | Handling when unused |
|-----------------------------|---------------------|-------------------|--|-------------|-------------|----------------------|
| | LC75813E | LC75813T | | | | |
| S1/P1 to S8/P8 S9 to S86 | 3 to 10 11 to 88 | 1 to 8 9 to 86 | Segment outputs for displaying the display data transferred by serial data input. The pins S1/P1 to S8/P8 can be used as general-purpose output ports when so set up by the control data. | — | O | Open |
| COM1 to COM3 COM4/S87 | 92 to 90 89 | 90 to 88 87 | Common driver outputs. The frame frequency is f_0 Hz. The COM4/S87 pin can be used as a segment output in 1/3 duty. | — | O | Open |
| OSC | 98 | 96 | Oscillator connection. An oscillator circuit is formed by connecting an external resistor and capacitor to this pin. | — | I/O | V_{DD} |
| CE CL DI | 100 1 2 | 98 99 100 | Serial data transfer inputs. These pins are connected to the control microprocessor. CE: Chip enable CL: Synchronization clock DI: Transfer data | H — — | I I I | GND |
| $\overline{\text{INH}}$ | 99 | 97 | Display off control input • $\overline{\text{INH}} = \text{low } (V_{SS}) \dots \text{Off}$ S1/P1 to S8/P8 = low (V_{SS}) (These pins are forcibly set to the segment output port function and fixed at the V_{SS} level.) S9 to S86 = low (V_{SS}) COM1 to COM3 = low (V_{SS}) COM4/S87 = low (V_{SS}) • $\overline{\text{INH}} = \text{high } (V_{DD}) \dots \text{On}$ Note that serial data transfers can be performed when the display is forced off by this pin. | L | I | GND |
| V_{LCD1} | 95 | 93 | Used to apply the LCD drive 2/3 bias voltage externally. This pin must be connected to V_{LCD2} when 1/2 bias drive is used. | — | I | Open |
| V_{LCD2} | 96 | 94 | Used to apply the LCD drive 1/3 bias voltage externally. This pin must be connected to V_{LCD1} when 1/2 bias drive is used. | — | I | Open |
| V_{DD} | 93 | 91 | Logic block power supply. Provide a voltage in the range 2.7 to 6.0 V. | — | — | — |
| V_{LCD} | 94 | 92 | LCD driver block power supply. Provide a voltage in the range 2.7 to 6.0 V. | — | — | — |
| V_{SS} | 97 | 95 | Ground pin. Connect to ground. | — | — | — |

Pin Assignments

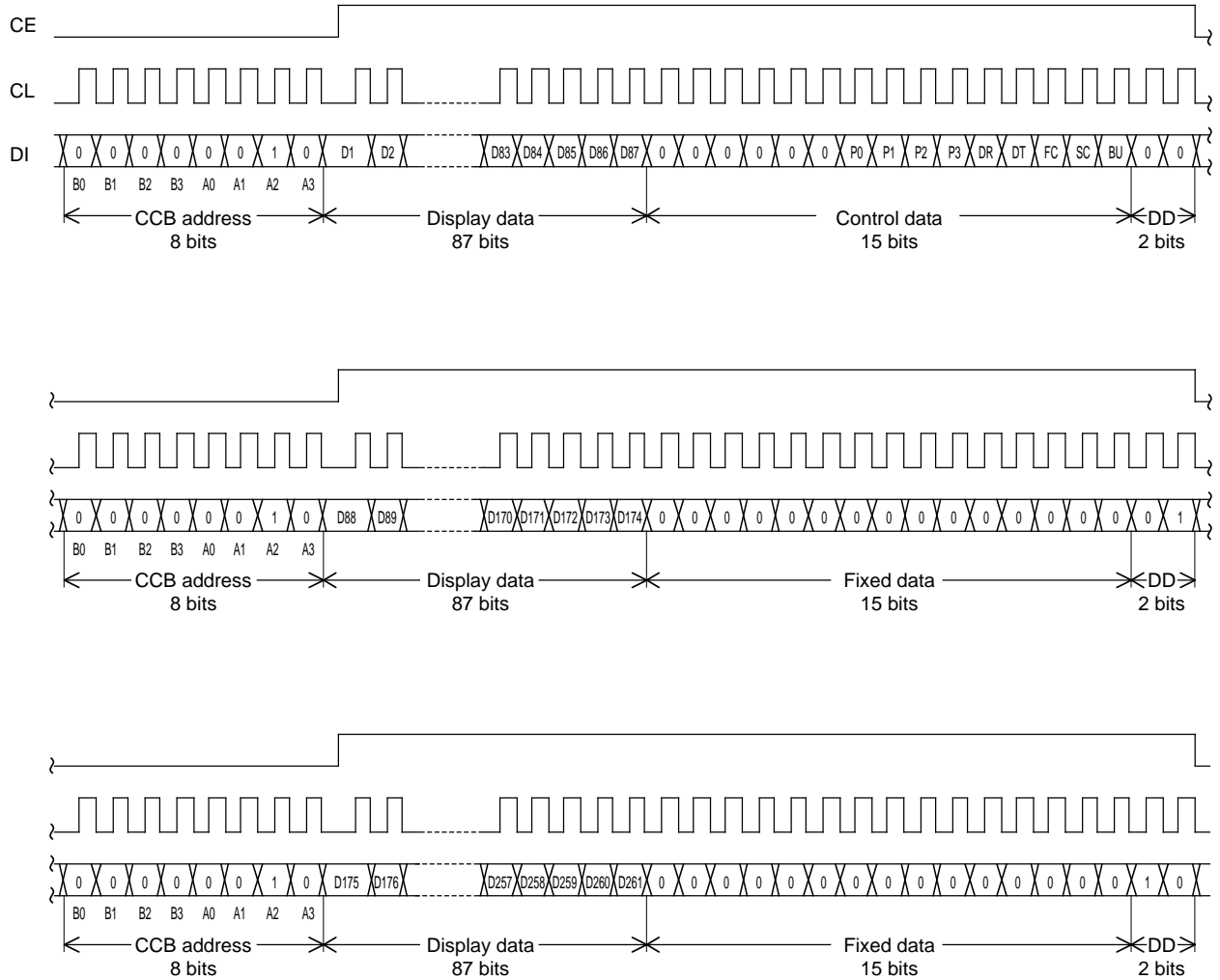


Top view

Serial Data Transfer Format

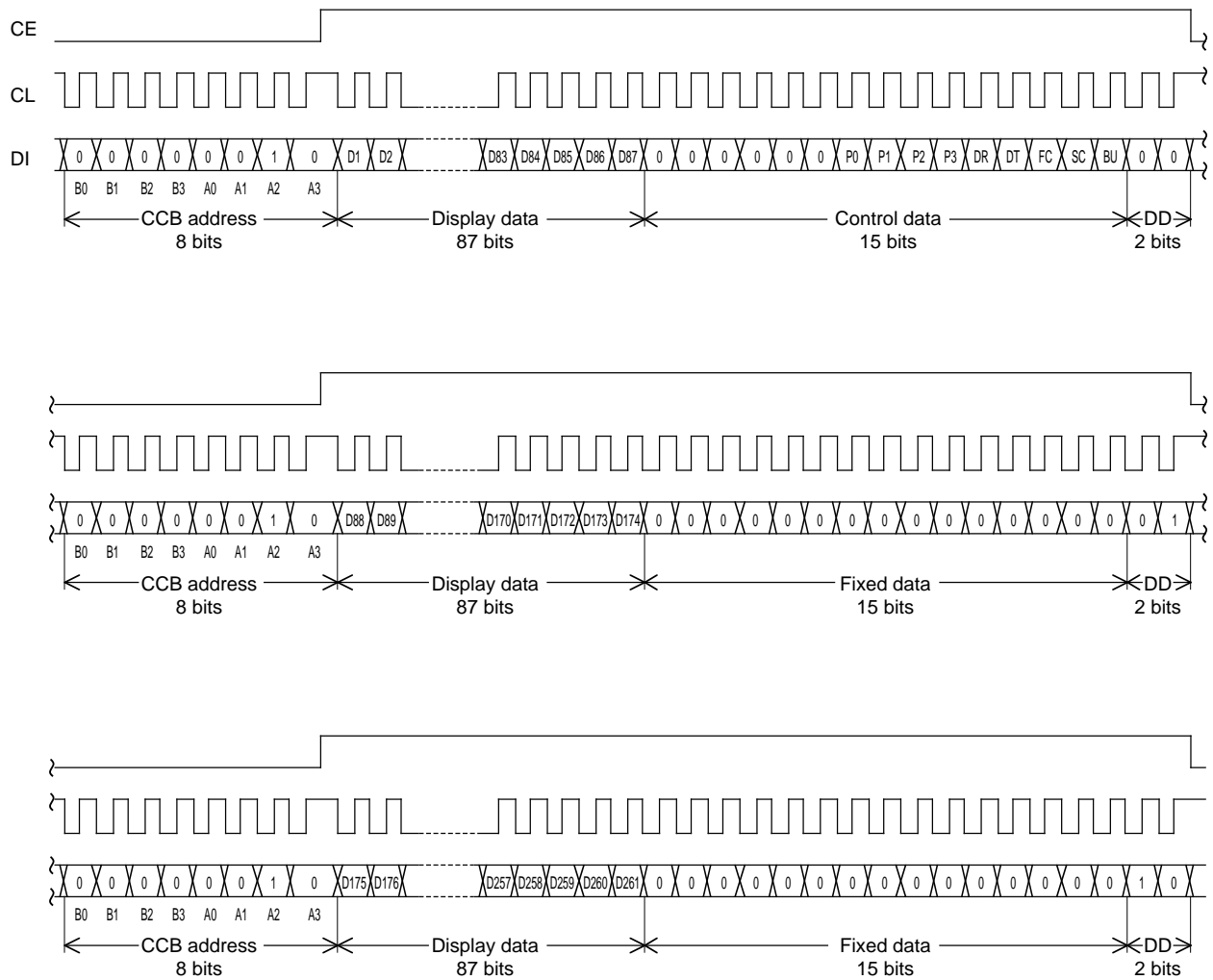
1. 1/3 duty

① When CL is stopped at the low level



Note: DD---Direction data.

② When CL is stopped at the high level



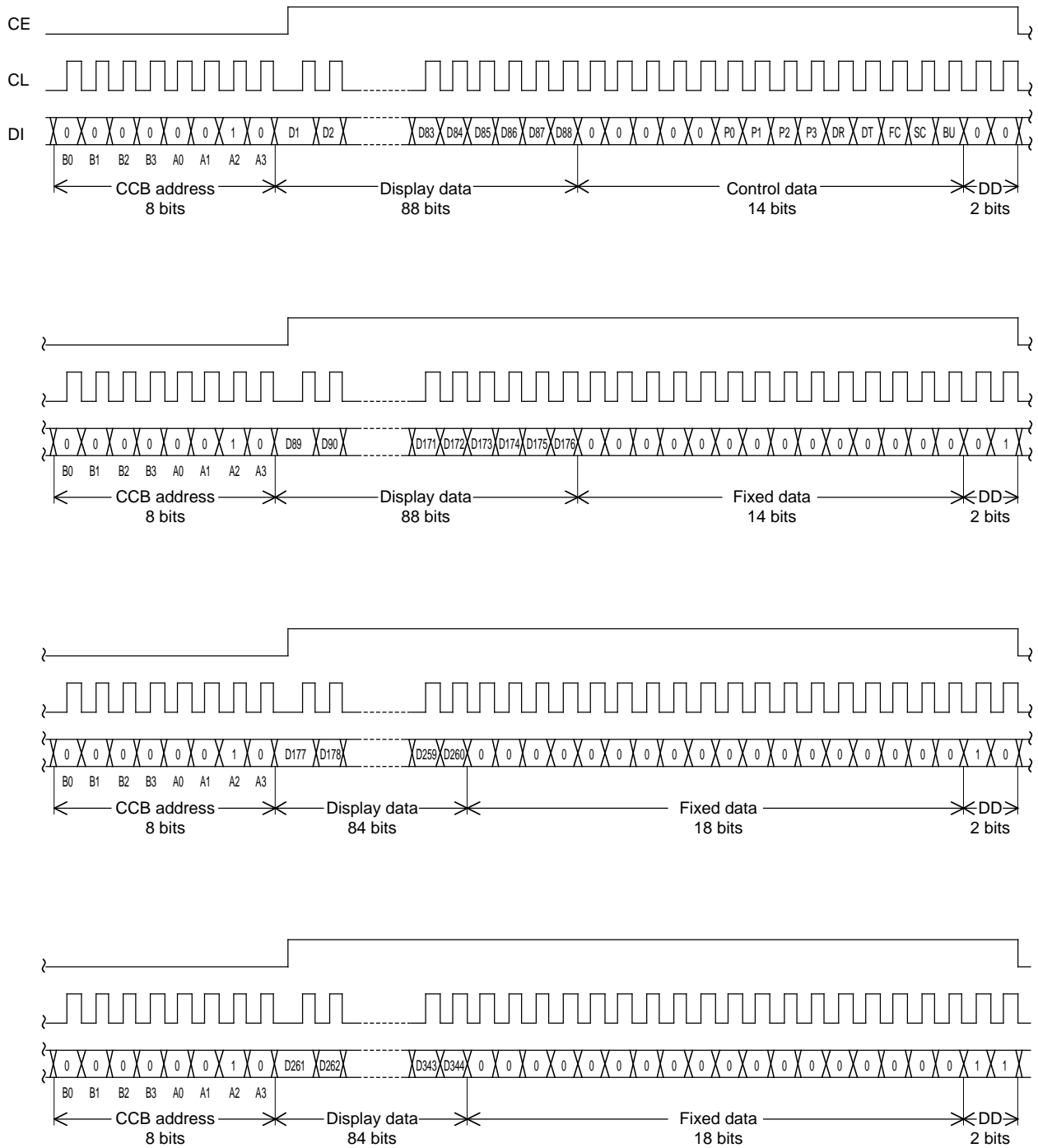
Note: DD...Direction data.

- CCB address.....40H
- D1 to D261.....Display data
- P0 to P3Segment output port/general-purpose output port switching control data
- DR1/2 bias drive or 1/3 bias drive switching control data
- DT1/3 duty drive or 1/4 duty drive switching control data
- FC.....Common and segment output waveforms frame frequency setting control data
- SC.....Segments on/off control data
- BUNormal mode/power-saving mode control data

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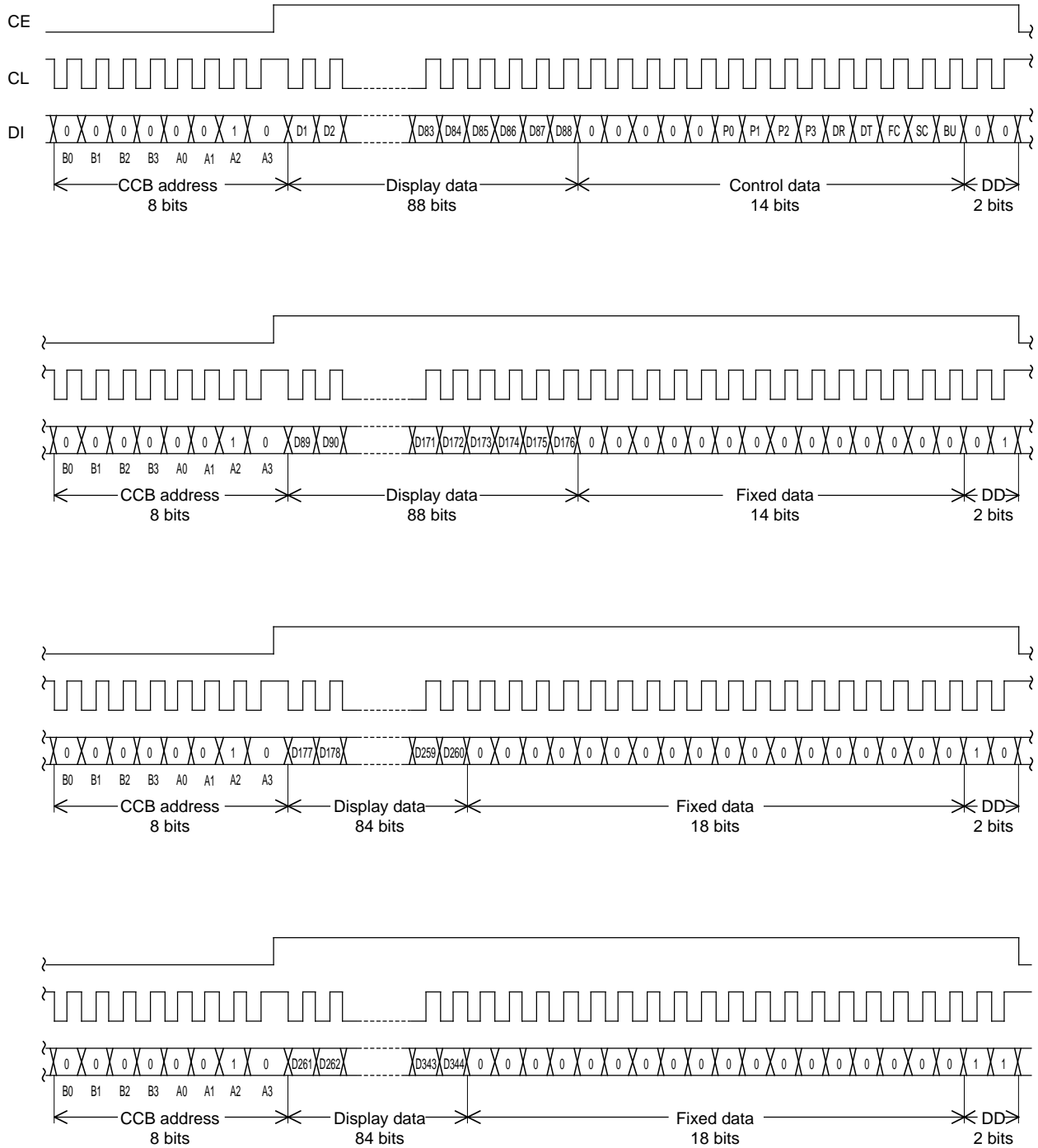
2. 1/4 duty

① When CL is stopped at the low level



Note: DD---Direction data.

② When CL is stopped at the high level



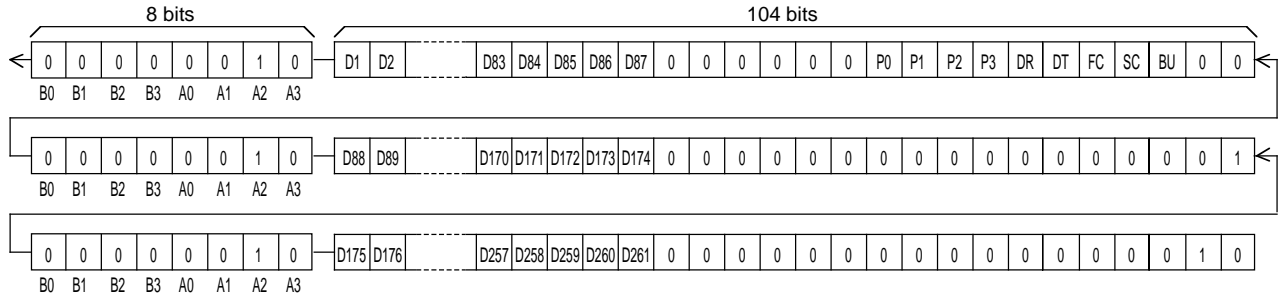
Note: DD...Direction data.

- CCB address.....40H
- D1 to D344.....Display data
- P0 to P3Segment output port/general-purpose output port switching control data
- DR1/2 bias drive or 1/3 bias drive switching control data
- DT1/3 duty drive or 1/4 duty drive switching control data
- FC.....Common and segment output waveforms frame frequency setting control data
- SC.....Segments on/off control data
- BUNormal mode/power-saving mode control data

Serial Data Transfer Example

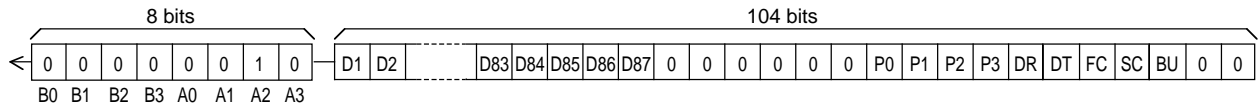
1. 1/3 duty

- ① When 175 or more segments are used
All 312 bits of serial data must be sent.



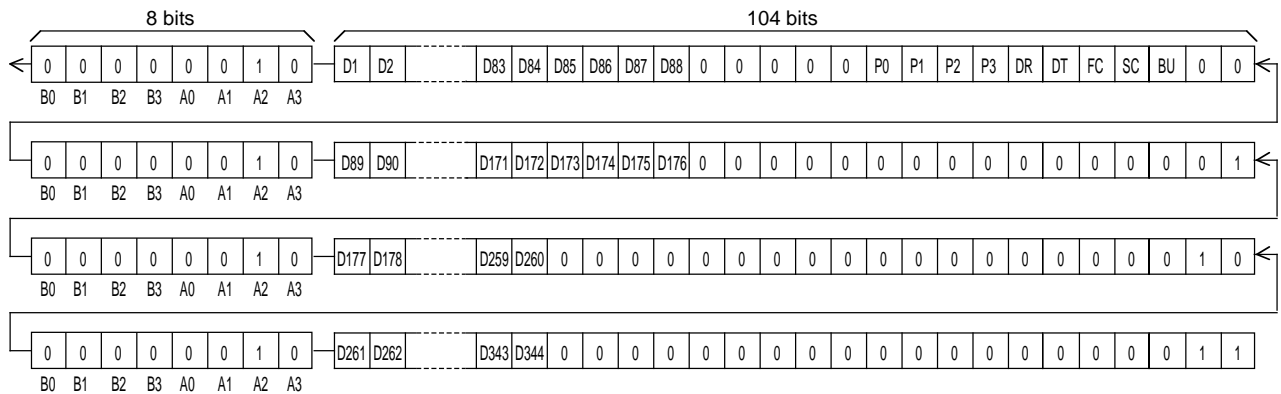
- ② When fewer than 175 segments are used

Either 104 or 208 bits of serial data may be sent, depending on the number of segments used. However, the serial data shown below (the D1 to D87 display data and the control data) must be sent.



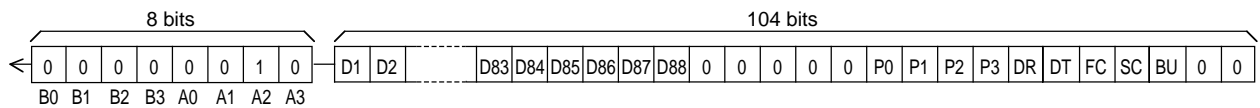
2. 1/4 duty

- ① When 261 or more segments are used
All 416 bits of serial data must be sent.



- ② When fewer than 261 segments are used

Either 104, 208 or 312 bits of serial data may be sent, depending on the number of segments used. However, the serial data shown below (the D1 to D88 display data and the control data) must be sent.



Control Data Functions

1. P0 to P3: Segment output port/general-purpose output port switching control data.

These control data bits switch the S1/P1 to S8/P8 output pins between their segment output port and general-purpose output port functions.

| Control data | | | | Output pin state | | | | | | | | |
|--------------|----|----|----|------------------|-------|-------|-------|-------|-------|-------|-------|--|
| P0 | P1 | P2 | P3 | S1/P1 | S2/P2 | S3/P3 | S4/P4 | S5/P5 | S6/P6 | S7/P7 | S8/P8 | |
| 0 | 0 | 0 | 0 | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | |
| 0 | 0 | 0 | 1 | P1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | |
| 0 | 0 | 1 | 0 | P1 | P2 | S3 | S4 | S5 | S6 | S7 | S8 | |
| 0 | 0 | 1 | 1 | P1 | P2 | P3 | S4 | S5 | S6 | S7 | S8 | |
| 0 | 1 | 0 | 0 | P1 | P2 | P3 | P4 | S5 | S6 | S7 | S8 | |
| 0 | 1 | 0 | 1 | P1 | P2 | P3 | P4 | P5 | S6 | S7 | S8 | |
| 0 | 1 | 1 | 0 | P1 | P2 | P3 | P4 | P5 | P6 | S7 | S8 | |
| 0 | 1 | 1 | 1 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | S8 | |
| 1 | 0 | 0 | 0 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | |

Note: Sn (n = 1 to 8): Segment output ports
Pn (n = 1 to 8): General-purpose output ports

Also note that when the general-purpose output port function is selected, the output pins and the display data will have the correspondences listed in the tables below.

| Output pin | Corresponding display data | |
|------------|----------------------------|----------|
| | 1/3 duty | 1/4 duty |
| S1/P1 | D1 | D1 |
| S2/P2 | D4 | D5 |
| S3/P3 | D7 | D9 |
| S4/P4 | D10 | D13 |
| S5/P5 | D13 | D17 |
| S6/P6 | D16 | D21 |
| S7/P7 | D19 | D25 |
| S8/P8 | D22 | D29 |

For example, when 1/4 duty drive scheme is used, if the general-purpose output port function is selected for the S4/P4 output pin, that output pin will output a high level (V_{LCD}) when the display data D13 is 1, and a low level (V_{SS}) when the D13 is 0.

2. DR: 1/2 bias drive or 1/3 bias drive switching control data

This control data bit selects either 1/2 bias drive or 1/3 bias drive.

| DR | Bias drive scheme |
|----|-------------------|
| 0 | 1/3 bias drive |
| 1 | 1/2 bias drive |

3. DT: 1/3 duty drive or 1/4 duty drive switching control data

This control data bit selects either 1/3 duty drive or 1/4 duty drive.

| DT | Duty drive scheme | Output pin state (COM4/S87) |
|----|-------------------|-----------------------------|
| 0 | 1/4 duty drive | COM4 |
| 1 | 1/3 duty drive | S87 |

Note: COM4: common output
S87: segment output

4. FC: Common and segment output waveforms frame frequency setting control data

This control data bit sets the frame frequency for common and segment output waveforms.

| FC | Frame frequency f0 [Hz] |
|----|-------------------------|
| 0 | $\frac{f_{osc}}{384}$ |
| 1 | $\frac{f_{osc}}{192}$ |

5. SC: Segments on/off control data

This control data bit controls the on/off state of the segments.

| SC | Display state |
|----|---------------|
| 0 | On |
| 1 | Off |

However, note that when the segments are turned off by setting SC to 1, the segments are turned off by outputting segment off waveforms from the segment output pins.

6. BU: Normal mode/power-saving mode control data

This control data bit selects either normal mode or power-saving mode.

| BU | Mode |
|----|--|
| 0 | Normal mode |
| 1 | Power saving mode (The OSC pin oscillator is stopped, and the common and segment output pins go to the V _{SS} level. However, the S1/P1 to S8/P8 output pins that are set to be general-purpose output ports by the control data P0 to P3 can be used as general-purpose output ports.) |

Display Data to Segment Output Pin Correspondence

1. 1/3 duty

| Segment Output pin | COM1 | COM2 | COM3 | Segment Output pin | COM1 | COM2 | COM3 | Segment Output pin | COM1 | COM2 | COM3 |
|--------------------|------|------|------|--------------------|------|------|------|--------------------|------|------|------|
| S1/P1 | D1 | D2 | D3 | S30 | D88 | D89 | D90 | S59 | D175 | D176 | D177 |
| S2/P2 | D4 | D5 | D6 | S31 | D91 | D92 | D93 | S60 | D178 | D179 | D180 |
| S3/P3 | D7 | D8 | D9 | S32 | D94 | D95 | D96 | S61 | D181 | D182 | D183 |
| S4/P4 | D10 | D11 | D12 | S33 | D97 | D98 | D99 | S62 | D184 | D185 | D186 |
| S5/P5 | D13 | D14 | D15 | S34 | D100 | D101 | D102 | S63 | D187 | D188 | D189 |
| S6/P6 | D16 | D17 | D18 | S35 | D103 | D104 | D105 | S64 | D190 | D191 | D192 |
| S7/P7 | D19 | D20 | D21 | S36 | D106 | D107 | D108 | S65 | D193 | D194 | D195 |
| S8/P8 | D22 | D23 | D24 | S37 | D109 | D110 | D111 | S66 | D196 | D197 | D198 |
| S9 | D25 | D26 | D27 | S38 | D112 | D113 | D114 | S67 | D199 | D200 | D201 |
| S10 | D28 | D29 | D30 | S39 | D115 | D116 | D117 | S68 | D202 | D203 | D204 |
| S11 | D31 | D32 | D33 | S40 | D118 | D119 | D120 | S69 | D205 | D206 | D207 |
| S12 | D34 | D35 | D36 | S41 | D121 | D122 | D123 | S70 | D208 | D209 | D210 |
| S13 | D37 | D38 | D39 | S42 | D124 | D125 | D126 | S71 | D211 | D212 | D213 |
| S14 | D40 | D41 | D42 | S43 | D127 | D128 | D129 | S72 | D214 | D215 | D216 |
| S15 | D43 | D44 | D45 | S44 | D130 | D131 | D132 | S73 | D217 | D218 | D219 |
| S16 | D46 | D47 | D48 | S45 | D133 | D134 | D135 | S74 | D220 | D221 | D222 |
| S17 | D49 | D50 | D51 | S46 | D136 | D137 | D138 | S75 | D223 | D224 | D225 |
| S18 | D52 | D53 | D54 | S47 | D139 | D140 | D141 | S76 | D226 | D227 | D228 |
| S19 | D55 | D56 | D57 | S48 | D142 | D143 | D144 | S77 | D229 | D230 | D231 |
| S20 | D58 | D59 | D60 | S49 | D145 | D146 | D147 | S78 | D232 | D233 | D234 |
| S21 | D61 | D62 | D63 | S50 | D148 | D149 | D150 | S79 | D235 | D236 | D237 |
| S22 | D64 | D65 | D66 | S51 | D151 | D152 | D153 | S80 | D238 | D239 | D240 |
| S23 | D67 | D68 | D69 | S52 | D154 | D155 | D156 | S81 | D241 | D242 | D243 |
| S24 | D70 | D71 | D72 | S53 | D157 | D158 | D159 | S82 | D244 | D245 | D246 |
| S25 | D73 | D74 | D75 | S54 | D160 | D161 | D162 | S83 | D247 | D248 | D249 |
| S26 | D76 | D77 | D78 | S55 | D163 | D164 | D165 | S84 | D250 | D251 | D252 |
| S27 | D79 | D80 | D81 | S56 | D166 | D167 | D168 | S85 | D253 | D254 | D255 |
| S28 | D82 | D83 | D84 | S57 | D169 | D170 | D171 | S86 | D256 | D257 | D258 |
| S29 | D85 | D86 | D87 | S58 | D172 | D173 | D174 | COM4/S87 | D259 | D260 | D261 |

Note: This applies to the case where the S1/P1 to S8/P8, and COM4/S87 output pins are set to be segment output ports.

For example, the table below lists the segment output states for the S11 output pin.

| Display data | | | Segment output pin (S11) state |
|--------------|-----|-----|---|
| D31 | D32 | D33 | |
| 0 | 0 | 0 | The LCD segments corresponding to COM1, COM2, and COM3 are off. |
| 0 | 0 | 1 | The LCD segment corresponding to COM3 is on. |
| 0 | 1 | 0 | The LCD segment corresponding to COM2 is on. |
| 0 | 1 | 1 | The LCD segments corresponding to COM2 and COM3 are on. |
| 1 | 0 | 0 | The LCD segment corresponding to COM1 is on. |
| 1 | 0 | 1 | The LCD segments corresponding to COM1 and COM3 are on. |
| 1 | 1 | 0 | The LCD segments corresponding to COM1 and COM2 are on. |
| 1 | 1 | 1 | The LCD segments corresponding to COM1, COM2, and COM3 are on. |

LC75813E, 75813T

2. 1/4 duty

| Segment Output pin | COM1 | COM2 | COM3 | COM4 | Segment Output pin | COM1 | COM2 | COM3 | COM4 |
|--------------------|------|------|------|------|--------------------|------|------|------|------|
| S1/P1 | D1 | D2 | D3 | D4 | S44 | D173 | D174 | D175 | D176 |
| S2/P2 | D5 | D6 | D7 | D8 | S45 | D177 | D178 | D179 | D180 |
| S3/P3 | D9 | D10 | D11 | D12 | S46 | D181 | D182 | D183 | D184 |
| S4/P4 | D13 | D14 | D15 | D16 | S47 | D185 | D186 | D187 | D188 |
| S5/P5 | D17 | D18 | D19 | D20 | S48 | D189 | D190 | D191 | D192 |
| S6/P6 | D21 | D22 | D23 | D24 | S49 | D193 | D194 | D195 | D196 |
| S7/P7 | D25 | D26 | D27 | D28 | S50 | D197 | D198 | D199 | D200 |
| S8/P8 | D29 | D30 | D31 | D32 | S51 | D201 | D202 | D203 | D204 |
| S9 | D33 | D34 | D35 | D36 | S52 | D205 | D206 | D207 | D208 |
| S10 | D37 | D38 | D39 | D40 | S53 | D209 | D210 | D211 | D212 |
| S11 | D41 | D42 | D43 | D44 | S54 | D213 | D214 | D215 | D216 |
| S12 | D45 | D46 | D47 | D48 | S55 | D217 | D218 | D219 | D220 |
| S13 | D49 | D50 | D51 | D52 | S56 | D221 | D222 | D223 | D224 |
| S14 | D53 | D54 | D55 | D56 | S57 | D225 | D226 | D227 | D228 |
| S15 | D57 | D58 | D59 | D60 | S58 | D229 | D230 | D231 | D232 |
| S16 | D61 | D62 | D63 | D64 | S59 | D233 | D234 | D235 | D236 |
| S17 | D65 | D66 | D67 | D68 | S60 | D237 | D238 | D239 | D240 |
| S18 | D69 | D70 | D71 | D72 | S61 | D241 | D242 | D243 | D244 |
| S19 | D73 | D74 | D75 | D76 | S62 | D245 | D246 | D247 | D248 |
| S20 | D77 | D78 | D79 | D80 | S63 | D249 | D250 | D251 | D252 |
| S21 | D81 | D82 | D83 | D84 | S64 | D253 | D254 | D255 | D256 |
| S22 | D85 | D86 | D87 | D88 | S65 | D257 | D258 | D259 | D260 |
| S23 | D89 | D90 | D91 | D92 | S66 | D261 | D262 | D263 | D264 |
| S24 | D93 | D94 | D95 | D96 | S67 | D265 | D266 | S267 | D268 |
| S25 | D97 | D98 | D99 | D100 | S68 | D269 | D270 | D271 | D272 |
| S26 | D101 | D102 | D103 | D104 | S69 | D273 | D274 | D275 | D276 |
| S27 | D105 | D106 | D107 | D108 | S70 | D277 | D278 | D279 | D280 |
| S28 | D109 | D110 | D111 | D112 | S71 | D281 | D282 | D283 | D284 |
| S29 | D113 | D114 | D115 | D116 | S72 | D285 | D286 | D287 | D288 |
| S30 | D117 | D118 | D119 | D120 | S73 | D289 | D290 | D291 | D292 |
| S31 | D121 | D122 | D123 | D124 | S74 | D293 | D294 | D295 | D296 |
| S32 | D125 | D126 | D127 | D128 | S75 | D297 | D298 | D299 | D300 |
| S33 | D129 | D130 | D131 | D132 | S76 | D301 | D302 | D303 | D304 |
| S34 | D133 | D134 | D135 | D136 | S77 | D305 | D306 | D307 | D308 |
| S35 | D137 | D138 | D139 | D140 | S78 | D309 | D310 | D311 | D312 |
| S36 | D141 | D142 | D143 | D144 | S79 | D313 | D314 | D315 | D316 |
| S37 | D145 | D146 | D147 | D148 | S80 | D317 | D318 | D319 | D320 |
| S38 | D149 | D150 | D151 | D152 | S81 | D321 | D322 | D323 | D324 |
| S39 | D153 | D154 | D155 | D156 | S82 | D325 | D326 | D327 | D328 |
| S40 | D157 | D158 | D159 | D160 | S83 | D329 | D330 | D331 | D332 |
| S41 | D161 | D162 | D163 | D164 | S84 | D333 | D334 | D335 | D336 |
| S42 | D165 | D166 | D167 | D168 | S85 | D337 | D338 | D339 | D340 |
| S43 | D169 | D170 | D171 | D172 | S86 | D341 | D342 | D343 | D344 |

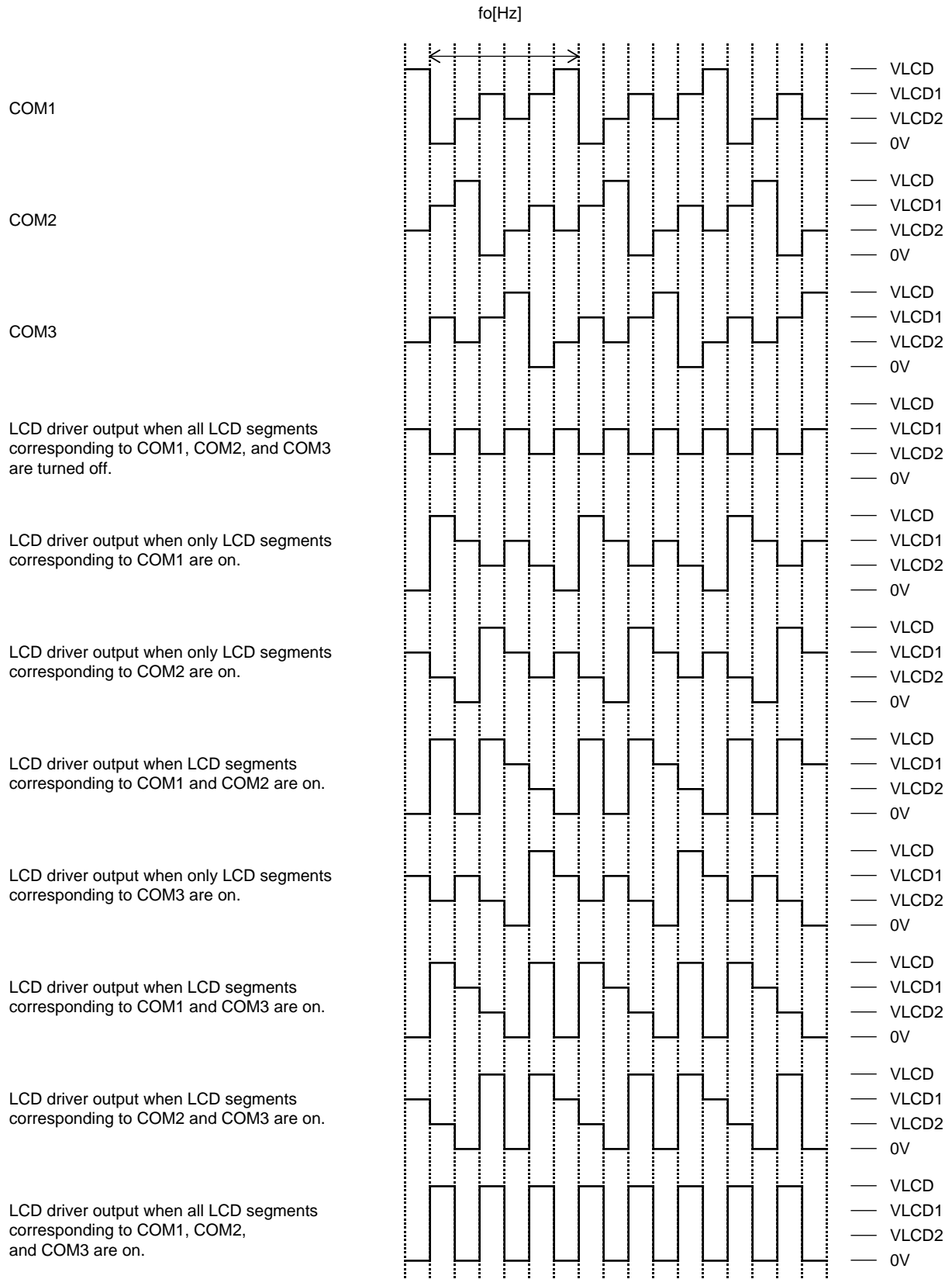
Note: This applies to the case where the S1/P1 to S8/P8 output pins are set to be segment output ports.

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For example, the table below lists the segment output states for the S11 output pin.

| Display data | | | | Segment output pin (S11) state |
|--------------|-----|-----|-----|---|
| D41 | D42 | D43 | D44 | |
| 0 | 0 | 0 | 0 | The LCD segments corresponding to COM1, COM2, COM3, and COM4 are off. |
| 0 | 0 | 0 | 1 | The LCD segment corresponding to COM4 is on. |
| 0 | 0 | 1 | 0 | The LCD segment corresponding to COM3 is on. |
| 0 | 0 | 1 | 1 | The LCD segments corresponding to COM3 and COM4 are on. |
| 0 | 1 | 0 | 0 | The LCD segment corresponding to COM2 is on. |
| 0 | 1 | 0 | 1 | The LCD segments corresponding to COM2 and COM4 are on. |
| 0 | 1 | 1 | 0 | The LCD segments corresponding to COM2 and COM3 are on. |
| 0 | 1 | 1 | 1 | The LCD segments corresponding to COM2, COM3, and COM4 are on. |
| 1 | 0 | 0 | 0 | The LCD segment corresponding to COM1 is on. |
| 1 | 0 | 0 | 1 | The LCD segments corresponding to COM1 and COM4 are on. |
| 1 | 0 | 1 | 0 | The LCD segments corresponding to COM1 and COM3 are on. |
| 1 | 0 | 1 | 1 | The LCD segments corresponding to COM1, COM3, and COM4 are on. |
| 1 | 1 | 0 | 0 | The LCD segments corresponding to COM1 and COM2 are on. |
| 1 | 1 | 0 | 1 | The LCD segments corresponding to COM1, COM2, and COM4 are on. |
| 1 | 1 | 1 | 0 | The LCD segments corresponding to COM1, COM2, and COM3 are on. |
| 1 | 1 | 1 | 1 | The LCD segments corresponding to COM1, COM2, COM3, and COM4 are on. |

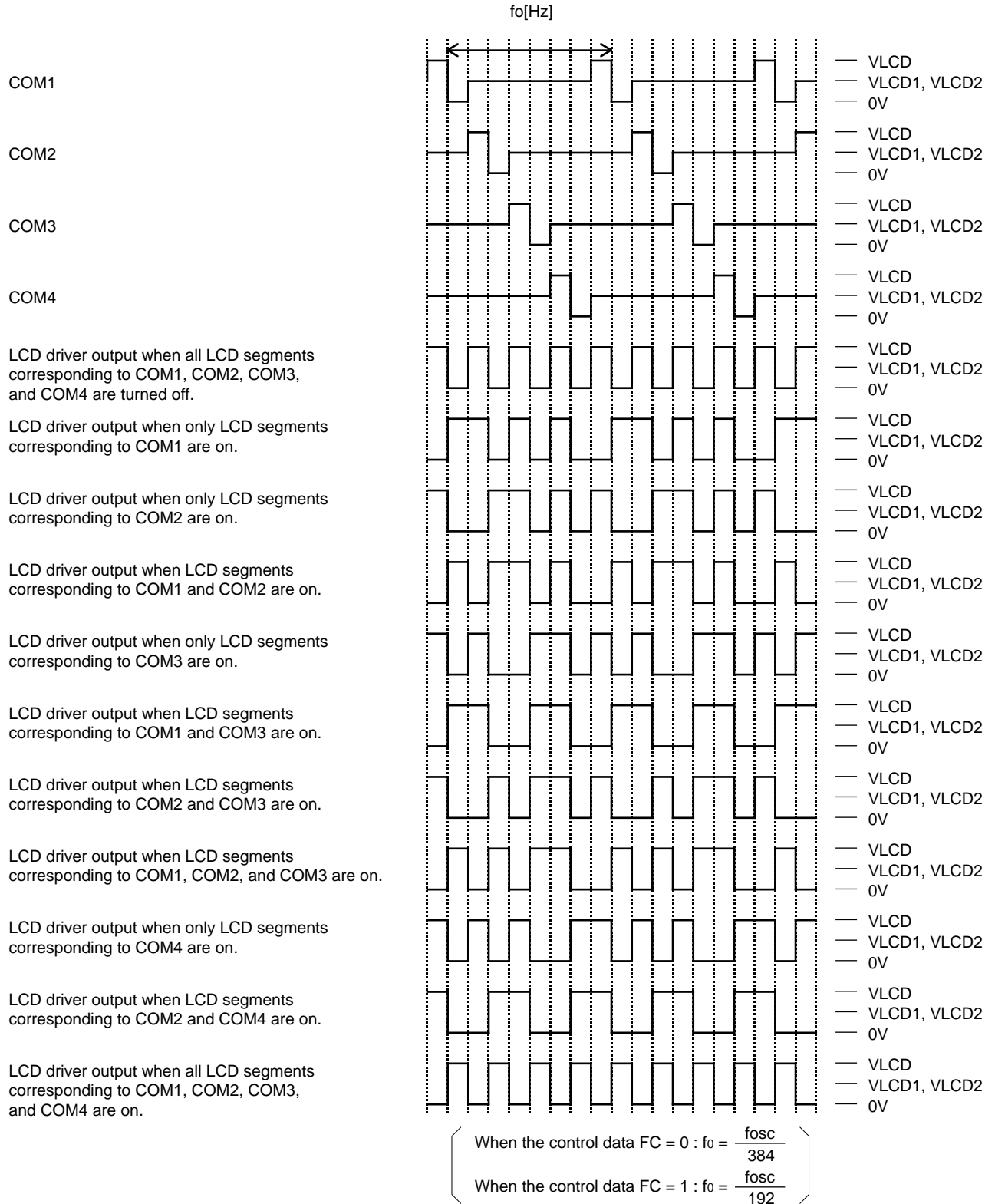
1/3 Duty, 1/3 Bias Drive Technique



$$\left(\begin{array}{l} \text{When the control data FC} = 0 : f_o = \frac{f_{osc}}{384} \\ \text{When the control data FC} = 1 : f_o = \frac{f_{osc}}{192} \end{array} \right)$$

1/3 Duty, 1/3 Bias Waveforms

1/4 Duty, 1/2 Bias Drive Technique



1/4 Duty, 1/2 Bias Waveforms

The $\overline{\text{INH}}$ pin and Display Control

Since the IC internal data (1/3 duty: the display data D1 to D261 and the control data, 1/4 duty: the display data D1 to D344 and the control data) is undefined when power is first applied, applications should set the $\overline{\text{INH}}$ pin low at the same time as power is applied to turn off the display (This sets the S1/P1 to S8/P8, S9 to S86, COM1 to COM3, and COM4/S87 to the V_{SS} level.) and during this period send serial data from the controller. The controller should then set the $\overline{\text{INH}}$ pin high after the data transfer has completed. This procedure prevents meaningless displays at power on. (See Figures 3 and 4.)

Notes on the Power On/Off Sequences

Applications should observe the following sequences when turning the LC75813E and LC75813T power on and off.

- At power on: Logic block power supply (V_{DD}) on \rightarrow LCD driver block power supply (V_{LCD}) on
- At power off: LCD driver block power supply (V_{LCD}) off \rightarrow Logic block power supply (V_{DD}) off

However, if the logic and LCD driver block use a shared power supply, then the power supplies can be turned on and off at the same time.

1. 1/3 duty

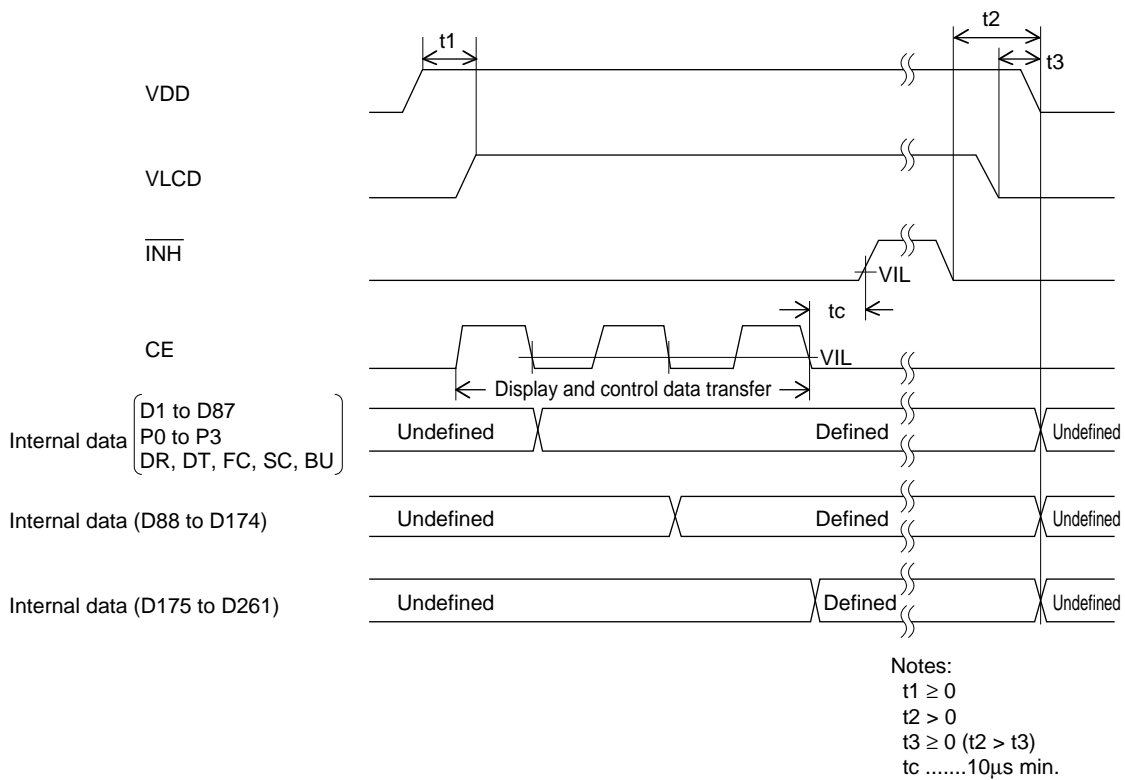


Figure 3

2. 1/4 duty

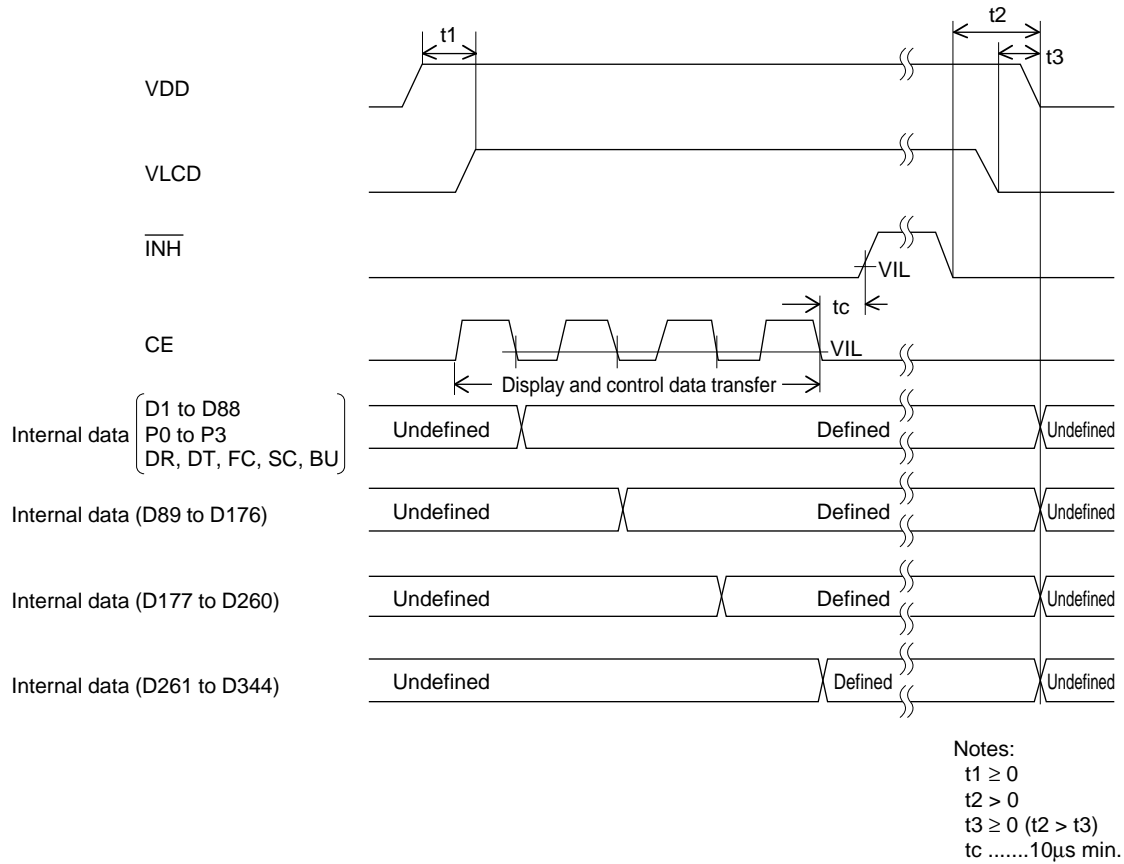


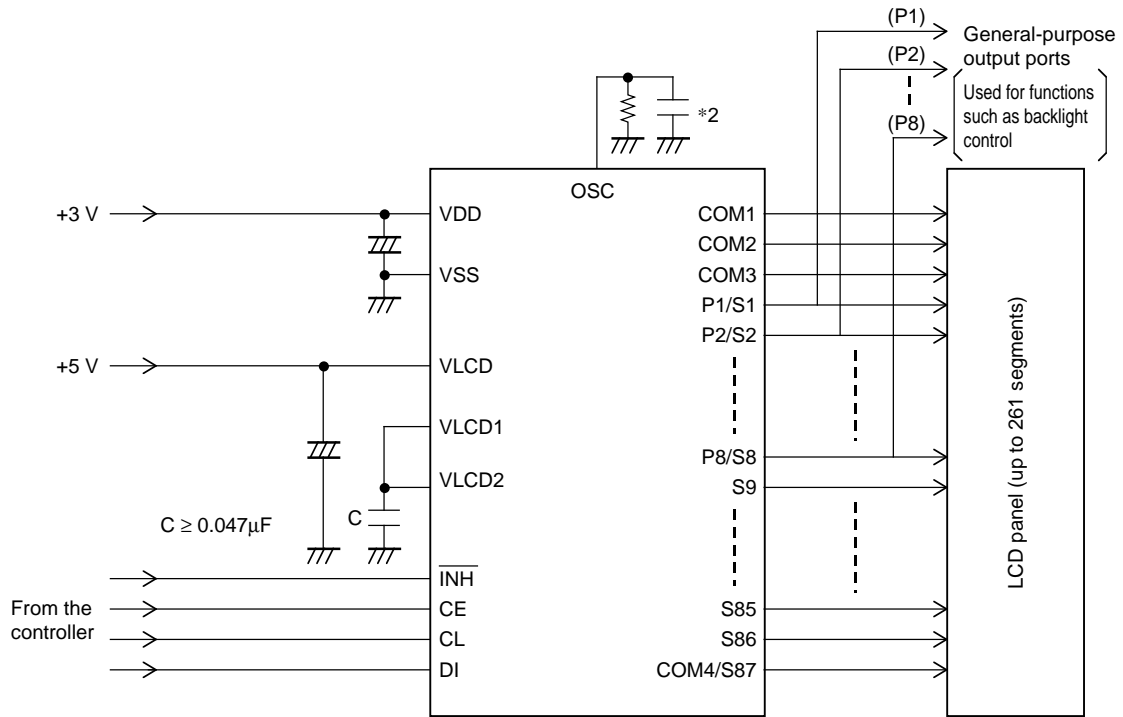
Figure 4

Notes on Controller Transfer of Display Data

Since the LC75813E and LC75813T accept the display data (D1 to D261) divided into three separate transfer operations when using 1/3 duty drive scheme and the data (D1 to D344) divided into four separate transfer operations when 1/4 duty drive, we recommend that applications transfer all of the display data within a period of less than 30 ms to prevent observable degradation of display quality.

Sample Application Circuit 1

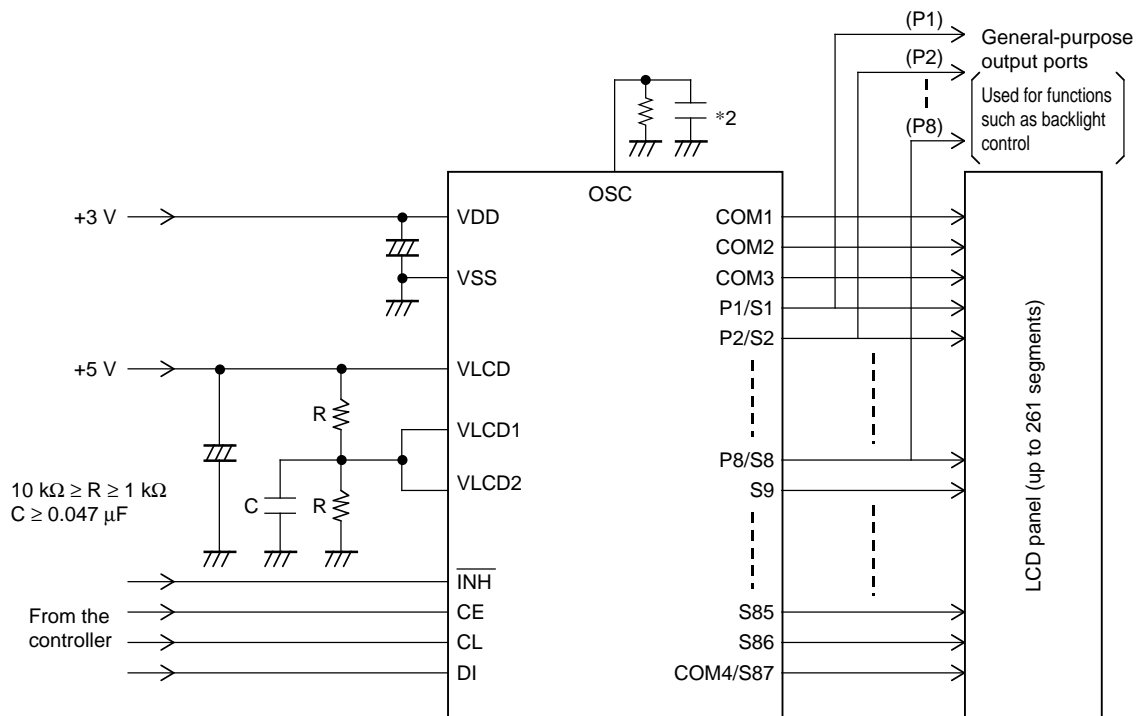
1/3 Duty, 1/2 Bias (for use with normal panels)



Note: $*2$ When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

Sample Application Circuit 2

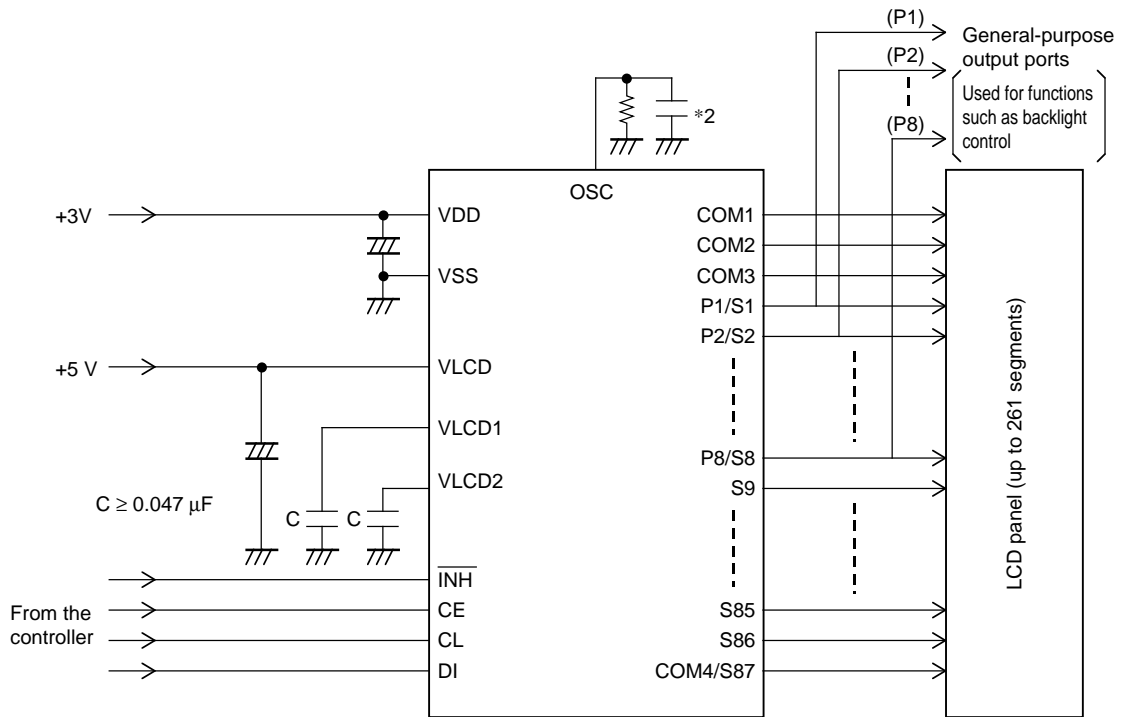
1/3 Duty, 1/2 Bias (for use with large panels)



Note: $*2$ When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

Sample Application Circuit 3

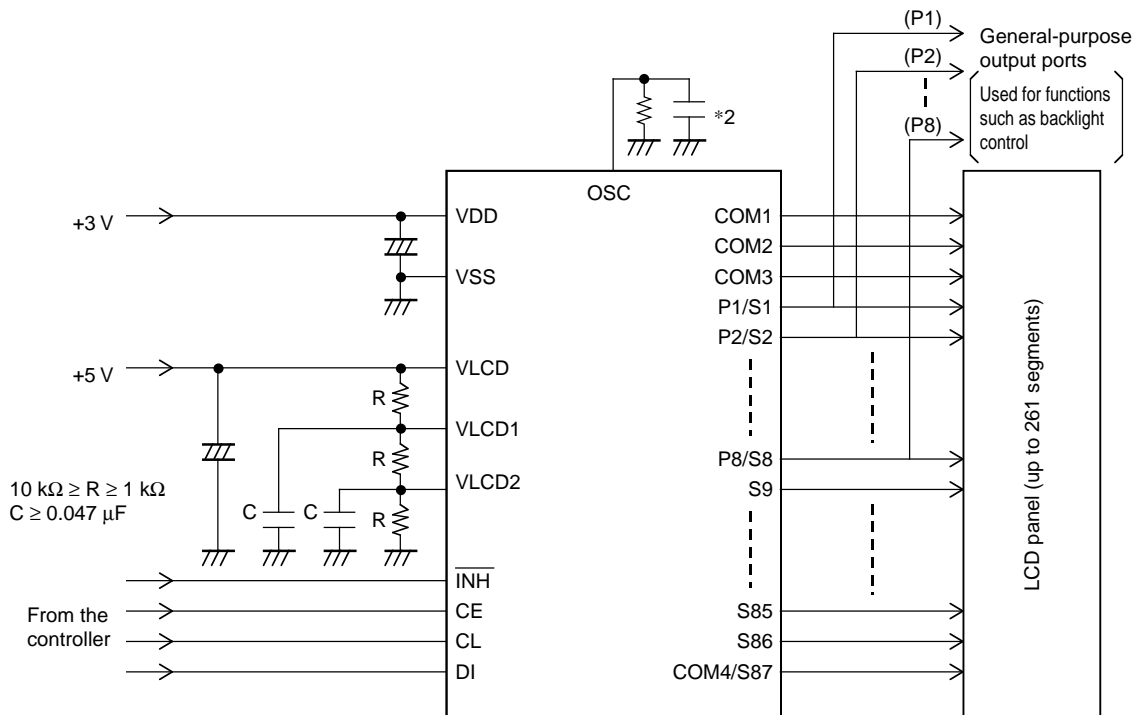
1/3 Duty, 1/3 Bias (for use with normal panels)



Note: *2 When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

Sample Application Circuit 4

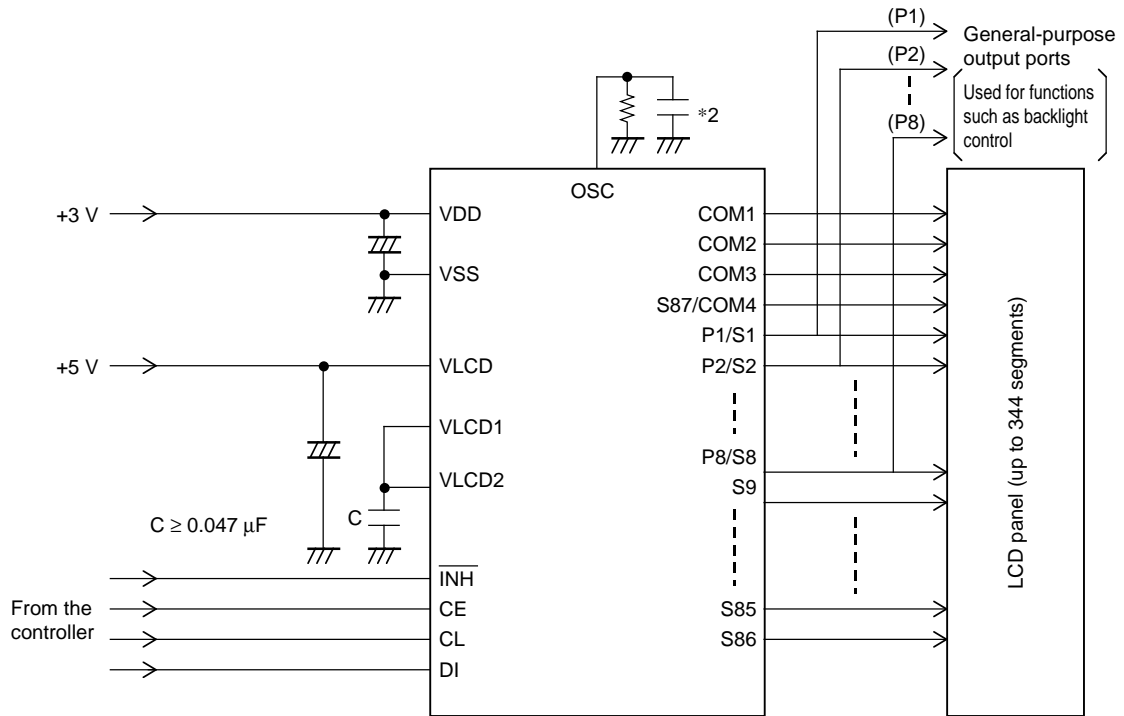
1/3 Duty, 1/3 Bias (for use with large panels)



Note: *2 When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

Sample Application Circuit 5

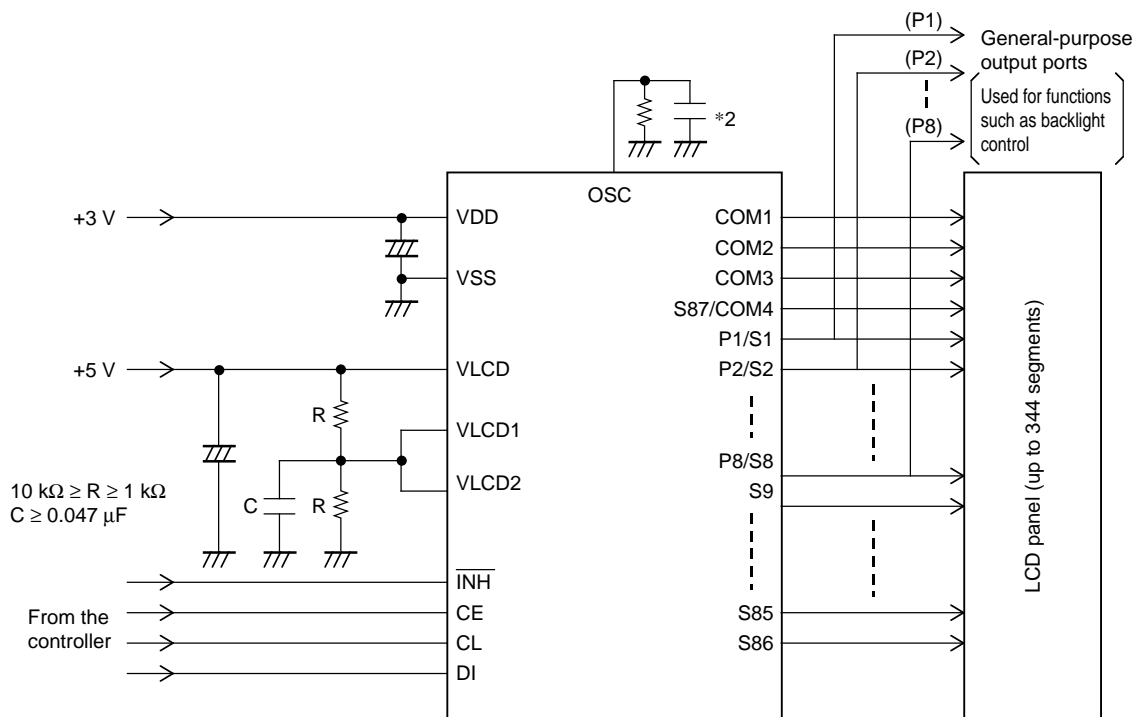
1/4 Duty, 1/2 Bias (for use with normal panels)



Note: *2 When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

Sample Application Circuit 6

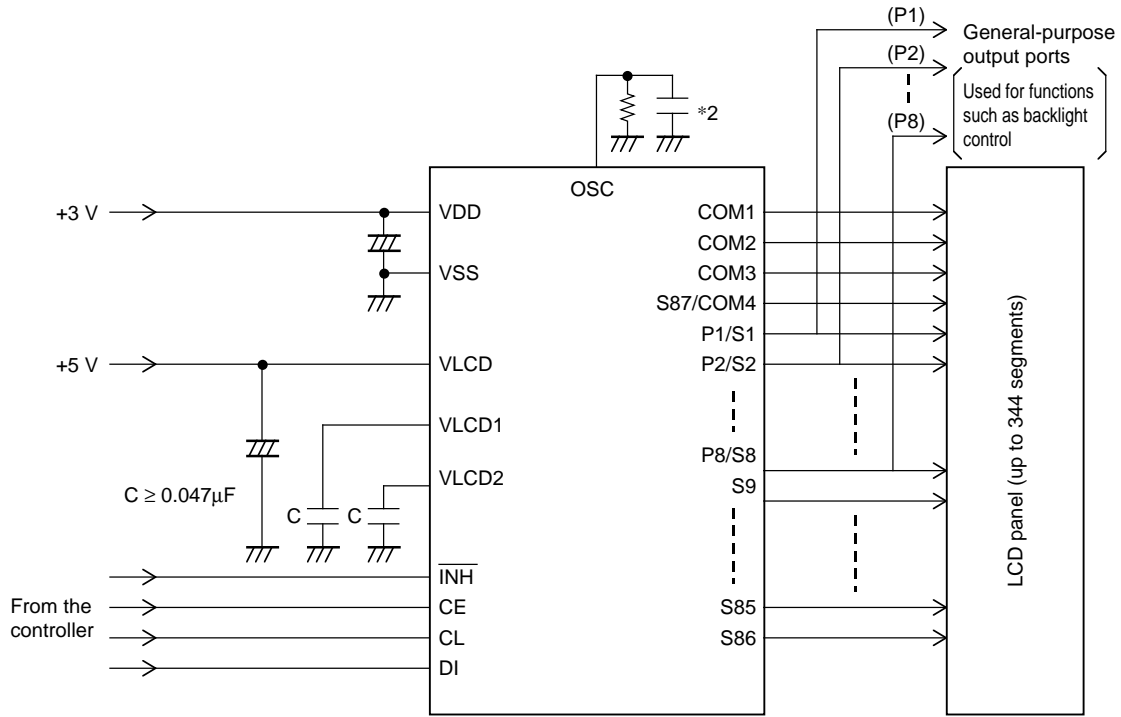
1/4 Duty, 1/2 Bias (for use with large panels)



Note: *2 When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

Sample Application Circuit 7

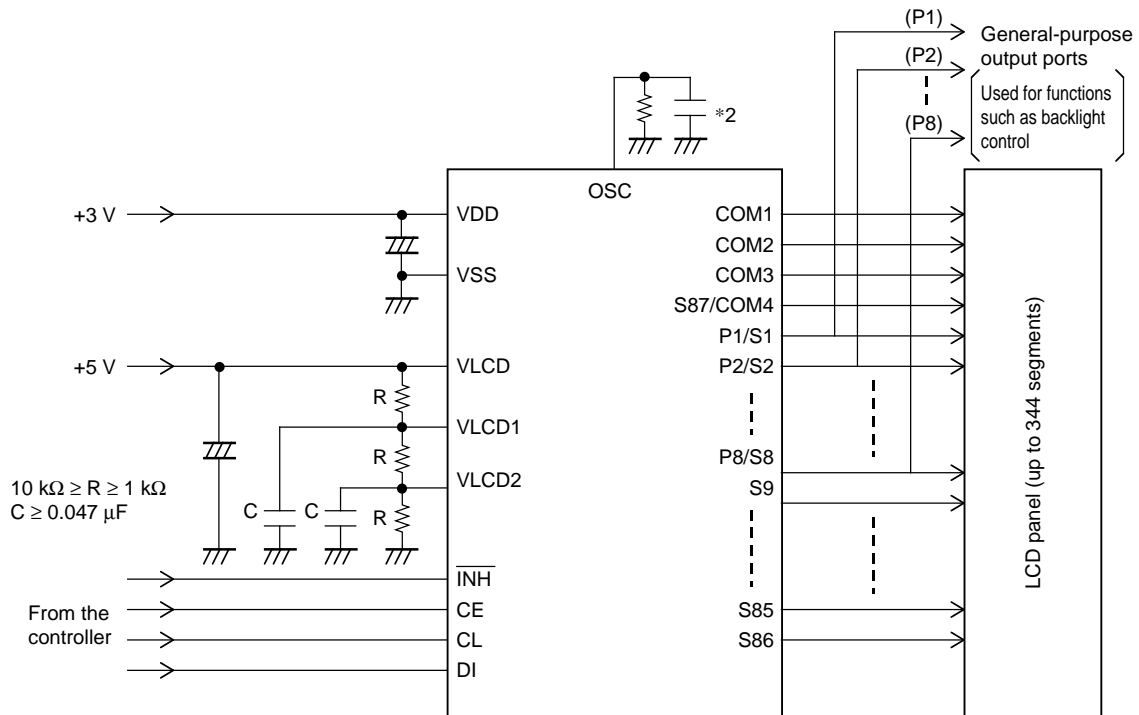
1/4 Duty, 1/3 Bias (for use with normal panels)



Note: *2 When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

Sample Application Circuit 8

1/4 Duty, 1/3 Bias (for use with large panels)



Note: *2 When a capacitor except the recommended external capacitance ($C_{osc} = 1000 \text{ pF}$) is connected the OSC pin, we recommend that applications connect the OSC pin with a capacitor in the range 220 to 2200 pF.

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