

## LCD Segment Drivers

# Multi-function Segment Drivers

BU97540KV-M

MAX335 Segment(67segx5COM)

### General Description

The BU97540KV-M is 1/5, 1/4, 1/3, or 1/1 duty general-purpose LCD driver that can be used for frequency display in electronic tuners under the control of a microcontroller. The BU97540KV-M can drive up to 335 LCD Segments directly. The BU97540KV-M can also control up to 9 general-purpose output ports.

These products also incorporate a key scan circuit that accepts input from up to 30 keys to reduce printed circuit board wiring

### Key Specifications

|                                |                               |
|--------------------------------|-------------------------------|
| ■ Supply Voltage Range:        | +2.7V to +6.0V                |
| ■ Operating Temperature Range: | -40°C to +85°C                |
| ■ Max Segments:                | 335 Segments                  |
| ■ Display Duty:                | 1/1, 1/3, 1/4, 1/5 Selectable |
| ■ Bias:                        | 1/1, 1/2, 1/3, 1/4 Selectable |
| ■ Interface:                   | 3Wire Serial Interface        |

### Features

- AEC-Q100 Qualified (Note1)
- Key input function for up to 30 keys (A key scan is performed only when a key is pressed.)
- Supports 1 chip(Master) mode and 2 chip(Master + Slave) mode
- Either 1/5, 1/4, 1/3 or 1/1 duty (static) can be selected with the serial control data.
  - 1 chip mode(only Master):
    - 1/5 duty drive: Up to 335 segments can be driven
    - 1/4 duty drive: Up to 272 segments can be driven
    - 1/3 duty drive: Up to 204 segments can be driven
    - 1/1 duty drive: Up to 68 segments can be driven
  - 2 chip mode(Master + Slave):
    - 1/5 duty drive: Up to 680 segments can be driven
    - 1/4 duty drive: Up to 548 segments can be driven
    - 1/3 duty drive: Up to 411 segments can be driven
    - 1/1 duty drive: Up to 137 segments can be driven
- Serial data control of frame frequency for common and segment output waveforms.
- Serial data control of switching between the segment output port, PWM output port and general-purpose output port functions.(Max 9 ports)
- Built-in OSC circuit
- Integrated Power-on Reset circuit
- No external component
- Low power consumption design
- Supports Line and Frame Inversion

(Note1) Grade 3

### Packages

VQFP80

W(Typ) × D(Typ) × H(Max)



### Applications

- Car audio, Home electrical appliance, Meter equipment etc.

## Typical Application Circuit

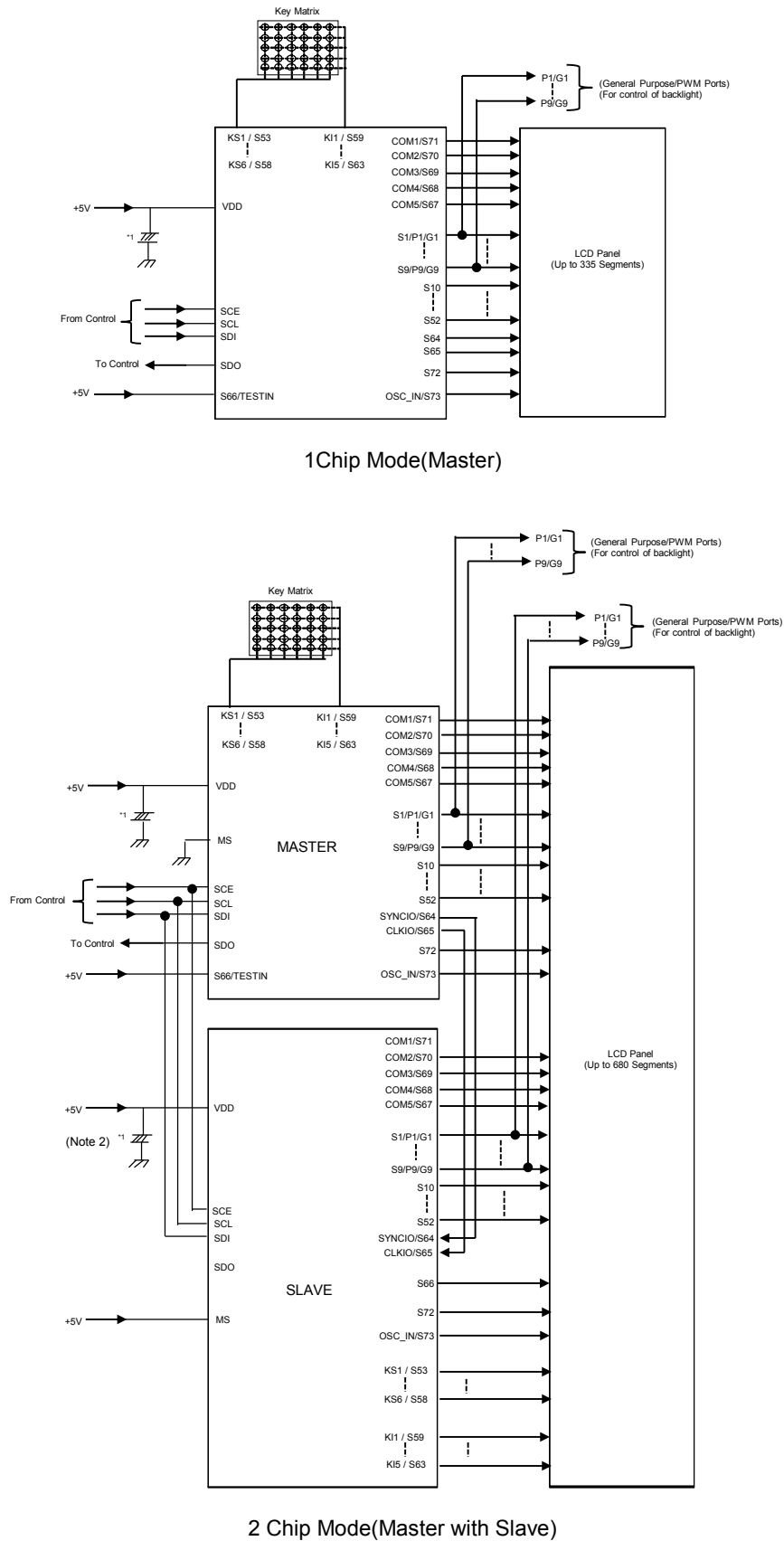


Figure 1. Typical Application Circuit

Block Diagram

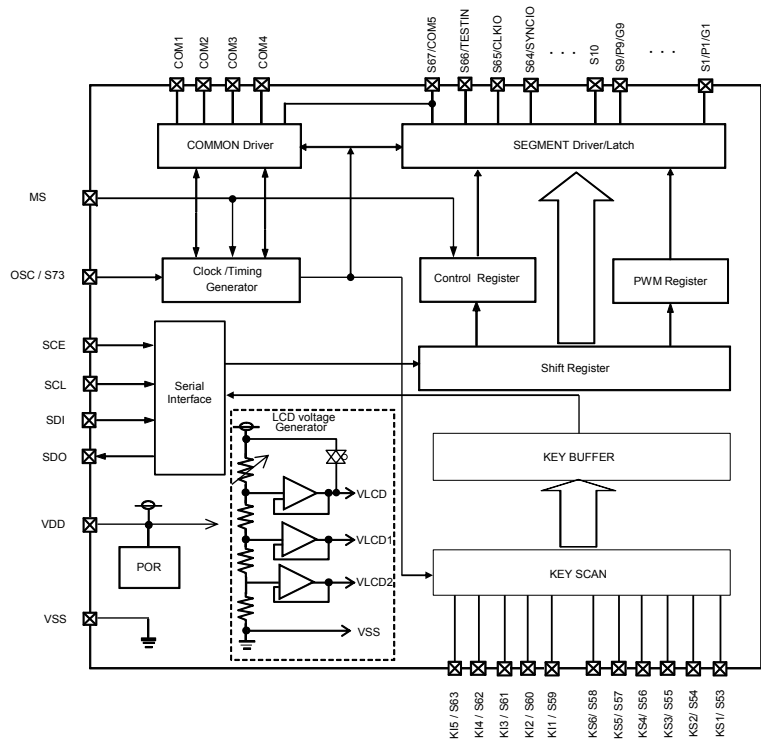


Figure 2. Block Diagram

Pin Arrangement

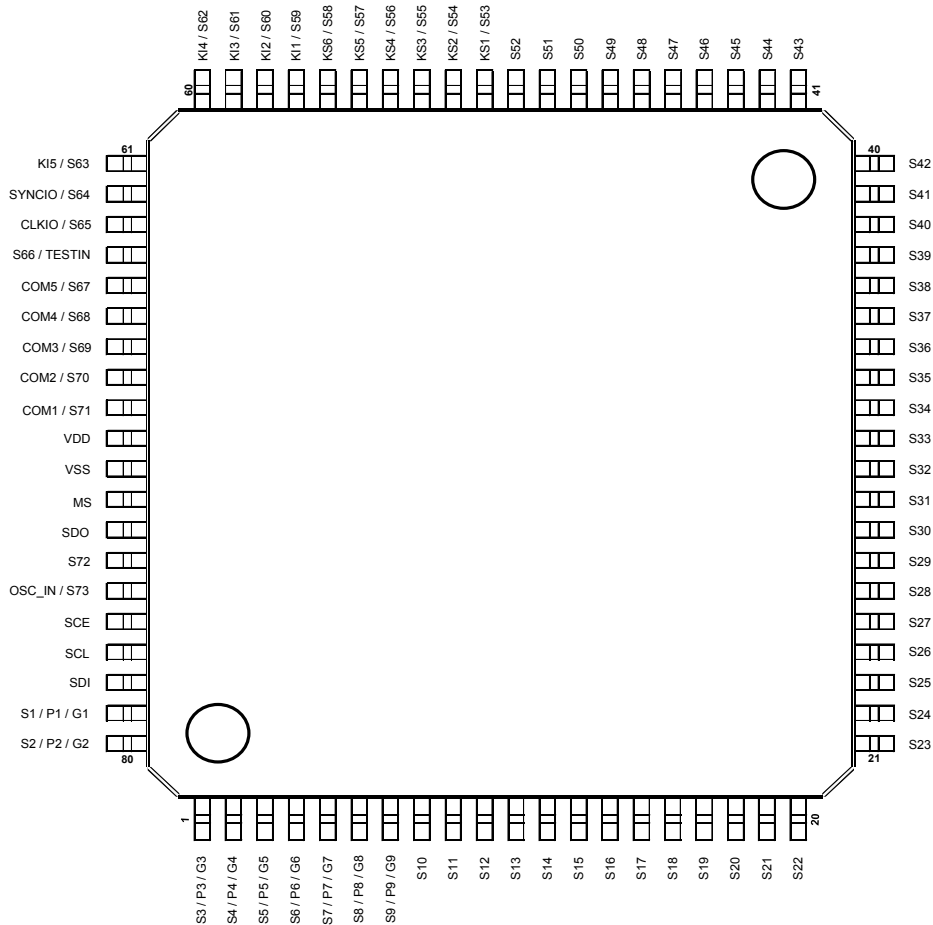


Figure 3. Pin Configuration (TOP VIEW)

**Absolute Maximum Ratings (Ta = 25°C, VSS = 0V)**

| Parameter              | Symbol  | Conditions    | Rating       | Unit |
|------------------------|---------|---------------|--------------|------|
| Maximum Supply Voltage | VDD max | VDD           | -0.3 to +7.0 | V    |
| Input Voltage          | VIN1    | SCE, SCL, SDI | -0.3 to +7.0 | V    |
|                        | VIN2    | KI1 to KI5    | -0.3 to +7.0 | V    |
| Allowable Loss         | Pd      |               | 1.2 (Note3)  | W    |
| Operating Temperature  | Topr    |               | -40 to +85   | °C   |
| Storage Temperature    | Tstg    |               | -55 to +125  | °C   |

(Note3) When use more than Ta=25°C, subtract 12mW per degree. (Using ROHM standard board)

(Board size: 70mm×70mm×1.6mm material: FR4 board copper foil: land pattern only)

**Caution:** Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

**Recommend Operating Conditions (Ta = -40°C to +85°C, VSS = 0V)**

| Parameter      | Symbol | Conditions | Rating |     |     | Unit |
|----------------|--------|------------|--------|-----|-----|------|
|                |        |            | Min    | Typ | Max |      |
| Supply Voltage | VDD    |            | 2.7    | 5.0 | 6.0 | V    |

**Electrical Characteristics for the Allowable Operating Ranges**

| Parameter                   | Symbol | Pin                                          | Conditions                            | Limit           |          |                 | Unit |
|-----------------------------|--------|----------------------------------------------|---------------------------------------|-----------------|----------|-----------------|------|
|                             |        |                                              |                                       | Min             | Typ      | Max             |      |
| Hysteresis                  | VH1    | SCE, SCL, SDI                                |                                       | -               | 0.03 VDD | -               | V    |
|                             | VH2    | KI1 to KI5                                   |                                       | -               | 0.1 VDD  | -               | V    |
| Power-on Detection Voltage  | VDET   | VDD                                          |                                       | 1.3             | 1.8      | 2.2             | V    |
| “H” Level Input Voltage     | VIH1   | SCE, SCL, SDI, SYNCIO, CLKIO                 | 4.5V ≤ VDD ≤ 6.0V                     | 0.4VDD          | -        | VDD             | V    |
|                             | VIH2   | SCE, SCL, SDI, SYNCIO, CLKIO                 | 2.7V ≤ VDD < 4.5V                     | 0.8VDD          | -        | VDD             |      |
|                             | VIH3   | KI1 to KI5                                   |                                       | 0.7VDD          | -        | VDD             |      |
| “L” Level Input Voltage     | VIL1   | SCE, SCL, SDI<br>KI1 to KI5<br>SYNCIO, CLKIO |                                       | 0               | -        | 0.2VDD          | V    |
| Input Floating Voltage      | VIF    | KI1 to KI5                                   |                                       | -               | -        | 0.05VDD         | V    |
| Pull-down Resistance        | RPD    | KI1 to KI5                                   | VDD=5.0V                              | 50              | 100      | 250             | KΩ   |
| Output Off Leakage Current  | IOFFH  | SDO                                          | VO=6.0V                               | -               | -        | 6.0             | μA   |
| “H” Level Input Current     | IIH1   | SCE, SCL, SDI<br>SYNCIO, CLKIO               | VI = 5.5V                             | -               | -        | 5.0             | μA   |
| “L” Level Input Current     | IIL1   | SCE, SCL, SDI<br>SYNCIO, CLKIO               | VI = 0V                               | -5.0            | -        | -               | μA   |
| “H” Level Output Voltage    | VOH1   | S1 to S73                                    | IO = -20μA,<br>VLCD=1.00*VDD          | VDD-0.9         | -        | -               | V    |
|                             | VOH2   | COM1 to COM5                                 | IO = -100μA,<br>VDD=1.00*VDD          | VDD-0.9         | -        | -               |      |
|                             | VOH3   | P1/G1 to P9/G9                               | IO = -1mA                             | VDD-0.9         | -        | -               |      |
|                             | VOH4   | KS1 to KS6                                   | IO = -500μA                           | VDD-1.0         | VDD-0.5  | VDD-0.2         |      |
|                             | VOH5   | SYNCIO, CLKIO                                | IO = -1mA                             | VDD-0.9         | -        | -               |      |
| “L” Level Output Voltage    | VOL1   | S1 to S70                                    | IO = 20μA                             | -               | -        | 0.9             | V    |
|                             | VOL2   | COM1 to COM5                                 | IO = 100μA                            | -               | -        | 0.9             |      |
|                             | VOL3   | P1/G1 to P9/G9                               | IO = 1mA                              | -               | -        | 0.9             |      |
|                             | VOL4   | KS1 to KS6                                   | IO = 25μA                             | 0.2             | 0.5      | 1.5             |      |
|                             | VOL5   | SDO                                          | IO = 1mA                              | -               | 0.1      | 0.5             |      |
|                             | VOL6   | SYNCIO, CLKIO                                | IO = 1mA                              | -               | -        | 0.9             |      |
| Middle Level Output Voltage | VMID1  | S1 to S73                                    | 1/2 bias IO = ±20μA<br>VLCD=1.00*VDD  | 1/2 VDD<br>-0.9 | -        | 1/2 VDD<br>+0.9 | V    |
|                             | VMID2  | COM1 to COM5                                 | 1/2 bias IO = ±100μA<br>VLCD=1.00*VDD | 1/2 VDD<br>-0.9 | -        | 1/2 VDD<br>+0.9 |      |
|                             | VMID3  | S1 to S73                                    | 1/3 bias IO = ±20μA<br>VLCD=1.00*VDD  | 2/3 VDD<br>-0.9 | -        | 2/3 VDD<br>+0.9 |      |
|                             | VMID4  | S1 to S73                                    | 1/3 bias IO = ±20μA<br>VLCD=1.00*VDD  | 1/3 VDD<br>-0.9 | -        | 1/3 VDD<br>+0.9 |      |
|                             | VMID5  | COM1 to COM5                                 | 1/3 bias IO = ±100μA<br>VLCD=1.00*VDD | 2/3 VDD<br>-0.9 | -        | 2/3 VDD<br>+0.9 |      |
|                             | VMID6  | COM1 to COM5                                 | 1/3 bias IO = ±100μA<br>VLCD=1.00*VDD | 1/3 VDD<br>-0.9 | -        | 1/3 VDD<br>+0.9 |      |

## Electrical Characteristics – continued

| Parameter           | Symbol | Pin | Conditions                                                                                          | Limit |     |     | Unit |
|---------------------|--------|-----|-----------------------------------------------------------------------------------------------------|-------|-----|-----|------|
|                     |        |     |                                                                                                     | Min   | Typ | Max |      |
| Current Consumption | IDD1   | VDD | Power-saving mode                                                                                   | -     | -   | 15  | μA   |
|                     | IDD2   | VDD | 1chip mode<br>VDD = 5.0V<br>Output open, 1/2 bias<br>Frame frequency=80Hz<br>VLCD=1.00*VDD          | -     | 105 | 220 | μA   |
|                     | IDD3   | VDD | 1chip mode<br>VDD = 5.0V<br>Output open, 1/3 bias<br>Frame frequency=80Hz<br>VLCD=1.00*VDD          | -     | 130 | 270 | μA   |
|                     | IDD4   | VDD | 2chip mode : Master<br>VDD = 5.0V<br>Output open, 1/3 bias<br>Frame frequency=80Hz<br>VLCD=1.00*VDD | -     | 195 | 370 | μA   |
|                     | IDD5   | VDD | 2chip mode : Slave<br>VDD = 5.0V<br>Output open, 1/3 bias<br>Frame frequency=80Hz<br>VLCD=1.00*VDD  | -     | 105 | 220 | μA   |

## Oscillation Characteristics (Ta = -40 to +85°C, VDD = 2.7V to 6.0V, VSS = 0.0V)

| Parameter                                   | Symbol | Pin        | Conditions                 | Limit |     |      | Unit |
|---------------------------------------------|--------|------------|----------------------------|-------|-----|------|------|
|                                             |        |            |                            | Min   | Typ | Max  |      |
| Oscillator Frequency 1                      | fosc1  | -          | VDD = 2.7V to 6.0V         | 300   | -   | 720  | kHz  |
| Oscillator Frequency 2                      | fosc2  | -          | VDD = 5.0V                 | 540   | 600 | 660  | kHz  |
| Oscillator Frequency 3                      | fosc3  | -          | VDD = 6.0V                 | 562   | 625 | 688  | kHz  |
| External Clock Frequency <sup>(Note4)</sup> | fosc4  | OSC_IN/S73 | External clock mode (OC=1) | 30    | -   | 1000 | kHz  |
| External Clock Duty                         | tdty   | OSC_IN/S73 | External clock mode (OC=1) | 30    | 50  | 70   | %    |

(Note4) Frame frequency is decided external frequency and dividing ratio of FC0 to FC3 setting.

## 【Reference Data】

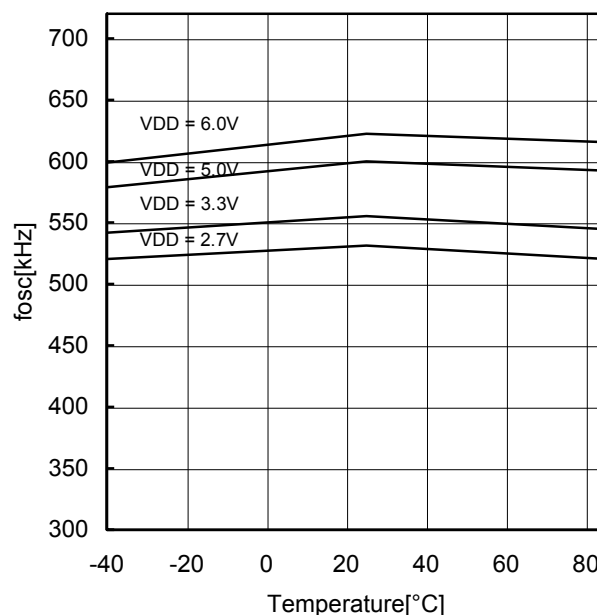


Figure 4. Typical Temperature Characteristics

## MPU Interface Characteristics (Ta=-40 to +85°C, VDD = 2.7V to 6.0V, VSS=0V)

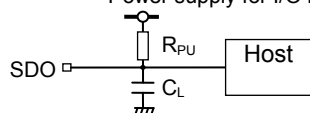
| Parameter                           | Symbol | Pin           | Conditions                              | Limit |     |     | Unit |
|-------------------------------------|--------|---------------|-----------------------------------------|-------|-----|-----|------|
|                                     |        |               |                                         | Min   | Typ | Max |      |
| Data Setup Time                     | tds    | SCL, SDI      |                                         | 120   | -   | -   | ns   |
| Data Hold Time                      | tdh    | SCL, SDI      |                                         | 120   | -   | -   | ns   |
| SCE Wait Time                       | tcp    | SCE, SCL      |                                         | 120   | -   | -   | ns   |
| SCE Setup Time                      | tcs    | SCE, SCL      |                                         | 120   | -   | -   | ns   |
| SCE Hold Time                       | tch    | SCE, SCL      |                                         | 120   | -   | -   | ns   |
| Clock Cycle Time                    | tccyc  | SCL           |                                         | 320   | -   | -   | ns   |
| High-level Clock Pulse Width        | tchw   | SCL           |                                         | 120   | -   | -   | ns   |
| Low-level Clock Pulse Width (Write) | tclww  | SCL           |                                         | 120   | -   | -   | ns   |
| Low-level Clock Pulse Width (Read)  | tclwr  | SCL           | RPU=4.7KΩ<br>CL=10pF <sup>(Note5)</sup> | 1.6   | -   | -   | us   |
| Rise Time                           | tr     | SCE, SCL, SDI |                                         | -     | 160 | -   | ns   |
| Fall Time                           | tf     | SCE, SCL, SDI |                                         | -     | 160 | -   | ns   |
| SDO Output Delay Time               | tdc    | SDO           | RPU=4.7KΩ<br>CL=10pF <sup>(Note5)</sup> | -     | -   | 1.5 | μs   |
| SDO Rise Time                       | Tdr    | SDO           | RPU=4.7KΩ<br>CL=10pF <sup>(Note5)</sup> | -     | -   | 1.5 | μs   |

(Note5) Since SDO is an open-drain output, "tdc" and "tdr" depend on the resistance of the pull-up resistor RPU and the load capacitance SCL.

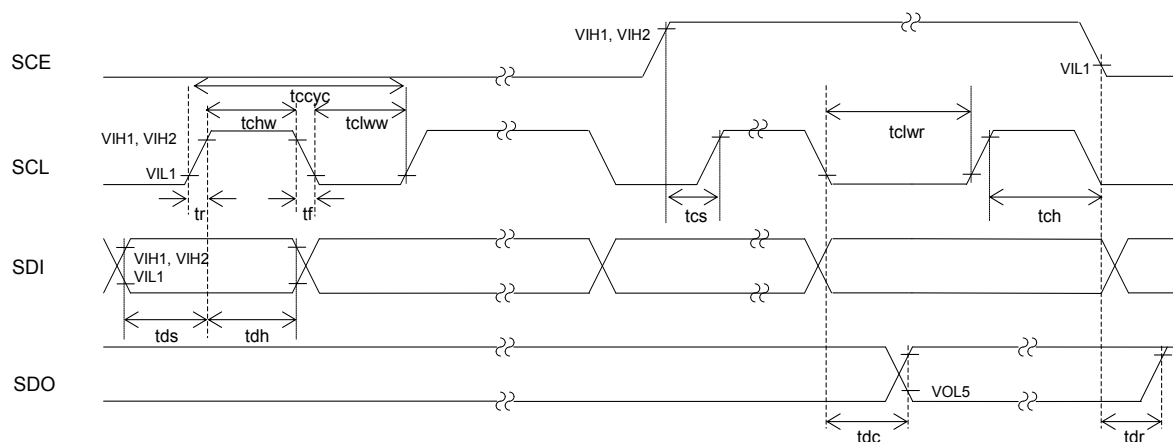
RPU: 1kΩ≤RPU≤10kΩ is recommended.

CL: A parasitic capacitance to VSS in an application circuit. Any component is not necessary to be attached.

Power supply for I/O level



### 1. When SCL is stopped at the low level



### 2. When SCL is stopped at the high level

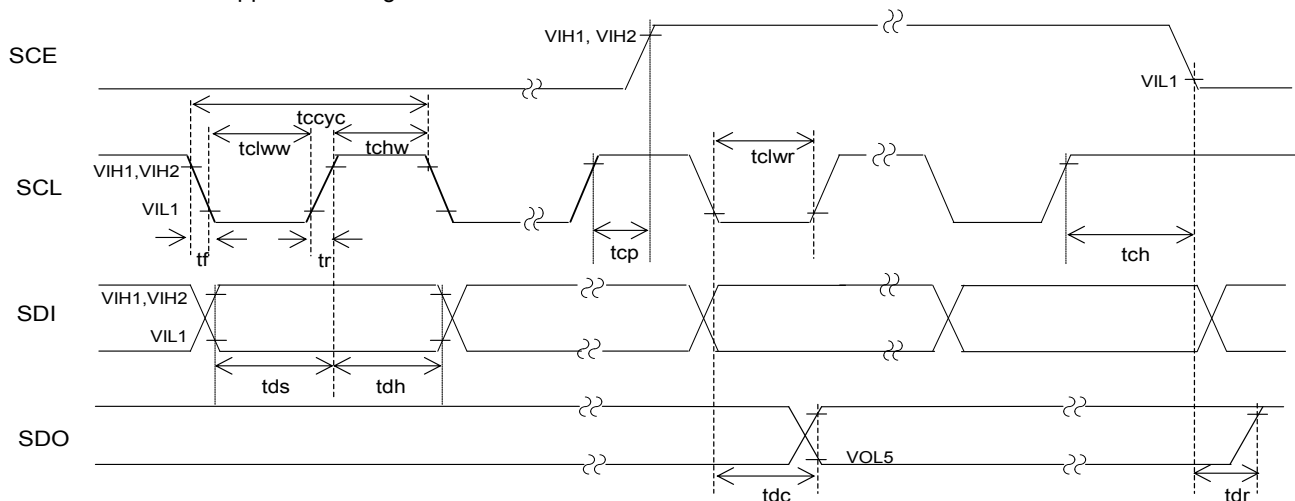


Figure 5. Serial Interface Timing

## Pin Description

| Symbol               | Pin No.        | Function                                                                                                                                                                                                                                                                                                                                                                                     | Active                                                                                          | I/O         | Handling when unused |
|----------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-------------|----------------------|
| S1/P1/G1 to S9/P9/G9 | 79,80, 1 to 7  | Segment output for displaying the display data transferred by serial data input. The S1/P1/G1 to S6/P6/G6 pins can also be used as General –purpose outputs when so set up by the control data.                                                                                                                                                                                              | -                                                                                               | O           | OPEN                 |
| S10 to S52, S72      | 8 to 50, 74    | Segment output for displaying the display data transferred by serial data input.                                                                                                                                                                                                                                                                                                             | -                                                                                               | O           | OPEN                 |
| KS1/S53 to KS6/S58   | 51 to 56       | Key scan outputs<br>Although normal key scan timing lines require diodes to be inserted in the timing lines to prevent shorts, since these outputs are unbalanced CMOS transistor outputs, these outputs will not be damaged by shorting when these outputs are used to form a key matrix. The KS1/S53 to KS6/S58 pins can be used as segment outputs when so specified by the control data. | -                                                                                               | O           | OPEN                 |
| KI1/S59 to KI5/S63   | 57 to 61       | Key scan inputs<br>These pins have built-in pull-down resistors. The KI1/S59 to KI5/S63 pins can be used as segment outputs when so specified by the control data.                                                                                                                                                                                                                           | -                                                                                               | I/O         | OPEN                 |
| SYNCIO/S64           | 62             | Segment Output for Master without Slave application.<br>SYNC output signal for Master with Slave application and SYNC input signal for Slave application.                                                                                                                                                                                                                                    | -<br>-<br>H                                                                                     | O<br>O<br>I | OPEN<br>-<br>-       |
| CLKIO/S65            | 63             | Segment Output for Master without Slave application.<br>CLK output signal for Master with Slave application and CLK input signal for Slave application.                                                                                                                                                                                                                                      | -<br>-<br>   | O<br>O<br>I | OPEN<br>-<br>-       |
| S66/TESTIN           | 64             | TESTIN Input for Master Application.<br>Segment Output for Slave Application.                                                                                                                                                                                                                                                                                                                | -<br>-                                                                                          | I<br>O      | VDD<br>OPEN          |
| COM5/S67             | 65             | COMMON / SEGMENT output for LCD driving<br>Assigned as COMMON output in 1/5 Duty mode and SEGMENT output in 1/1 Duty, 1/3 Duty and 1/4 Duty modes                                                                                                                                                                                                                                            | -                                                                                               | O           | OPEN                 |
| COM1 to COM4         | 69 to 66       | Common driver output pins. The frame frequency is fo[Hz].                                                                                                                                                                                                                                                                                                                                    | -                                                                                               | O           | -                    |
| MS                   | 72             | Master / Slave Control Switch<br>L : Master, H : Slave                                                                                                                                                                                                                                                                                                                                       | -                                                                                               | I           | -                    |
| OSC_IN/S73           | 75             | Segment output for displaying the display data transferred by serial data input.<br>The pin OSC_IN/S73 can be used as external frequency input pin when set up by the control data.                                                                                                                                                                                                          | -                                                                                               | I/O         | OPEN                 |
| SCE<br>SCL<br>SDI    | 76<br>77<br>78 | Serial data transfer inputs. Must be connected to the controller.<br>SCE: Chip enable<br>SCL: Synchronization clock<br>SDI: Transfer data                                                                                                                                                                                                                                                    | <br>-<br>- | I<br>I<br>I | -<br>-<br>-          |
| SDO                  | 73             | Output data                                                                                                                                                                                                                                                                                                                                                                                  | -                                                                                               | O           | OPEN                 |
| VDD                  | 70             | Power supply pin of the IC<br>A power voltage of 2.7V to 6.0V must be applied to this pin.                                                                                                                                                                                                                                                                                                   | -                                                                                               | -           | -                    |
| VSS                  | 71             | Power supply pin. Must be connected to ground.                                                                                                                                                                                                                                                                                                                                               | -                                                                                               | -           | -                    |

## IO Equivalence Circuit

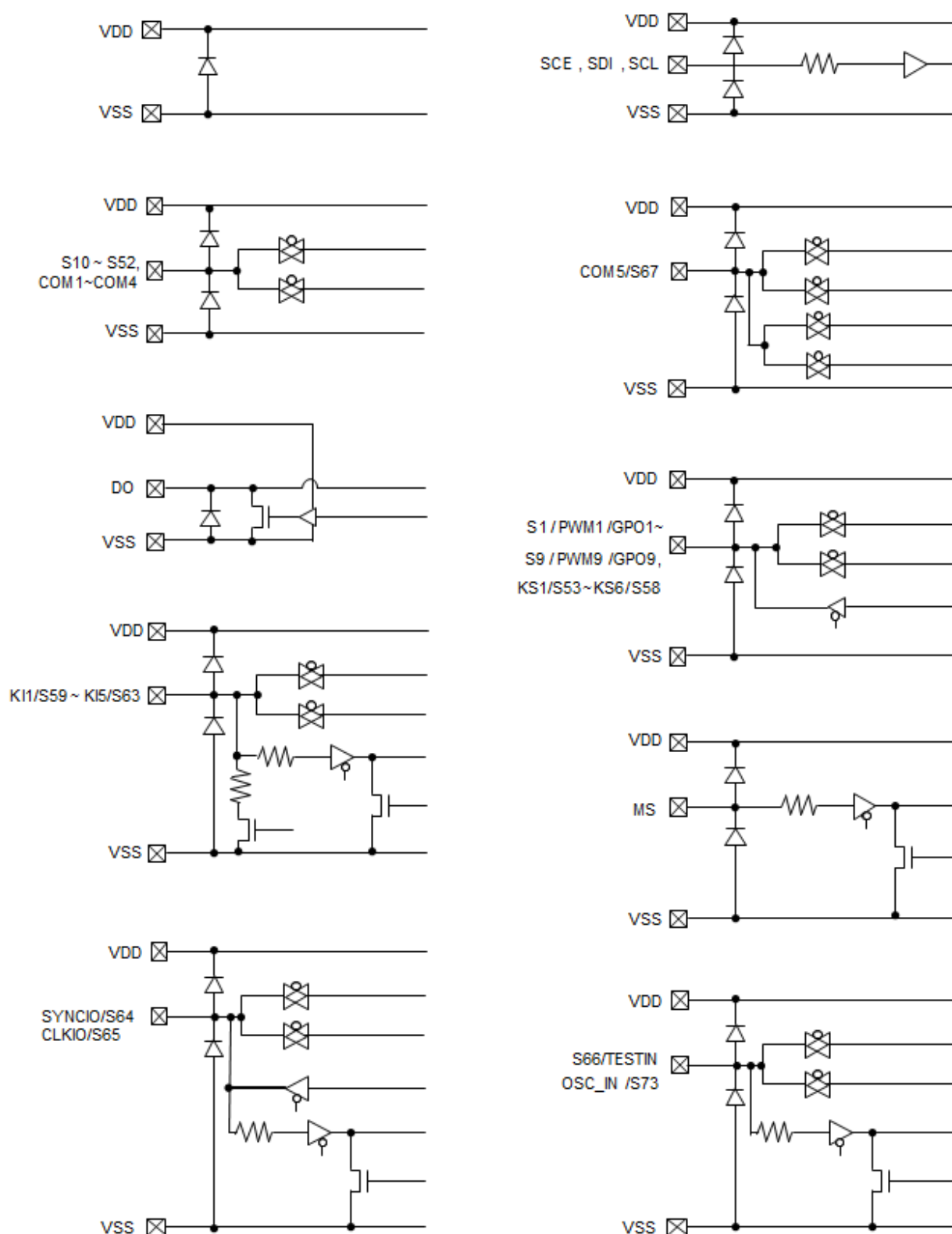


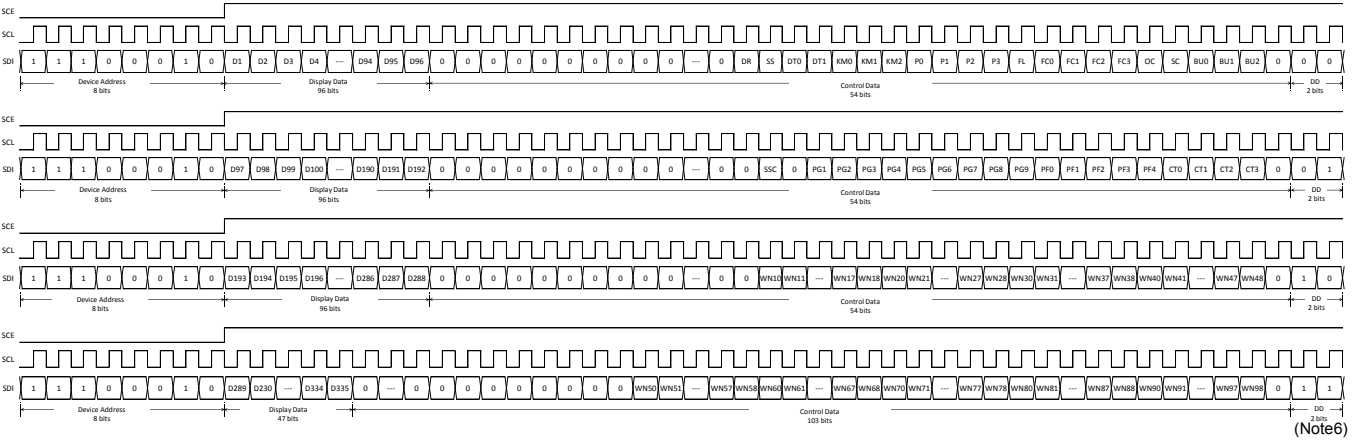
Figure 6. I/O Equivalent Circuit

Serial Data Transfer Formats

1. 1/5 Duty

(1) When SCL is stopped at the low level

(a) Master



(b) Slave

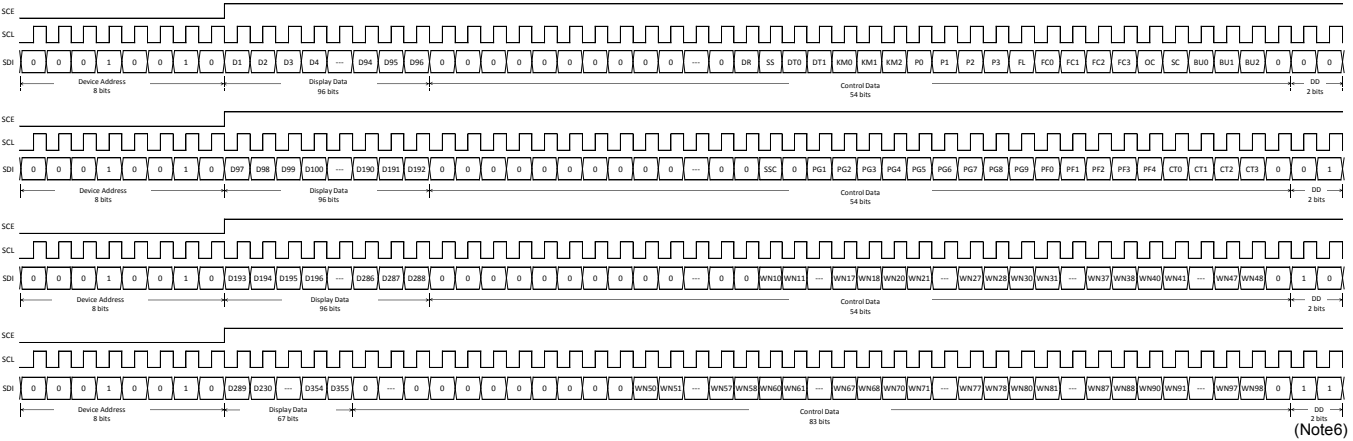
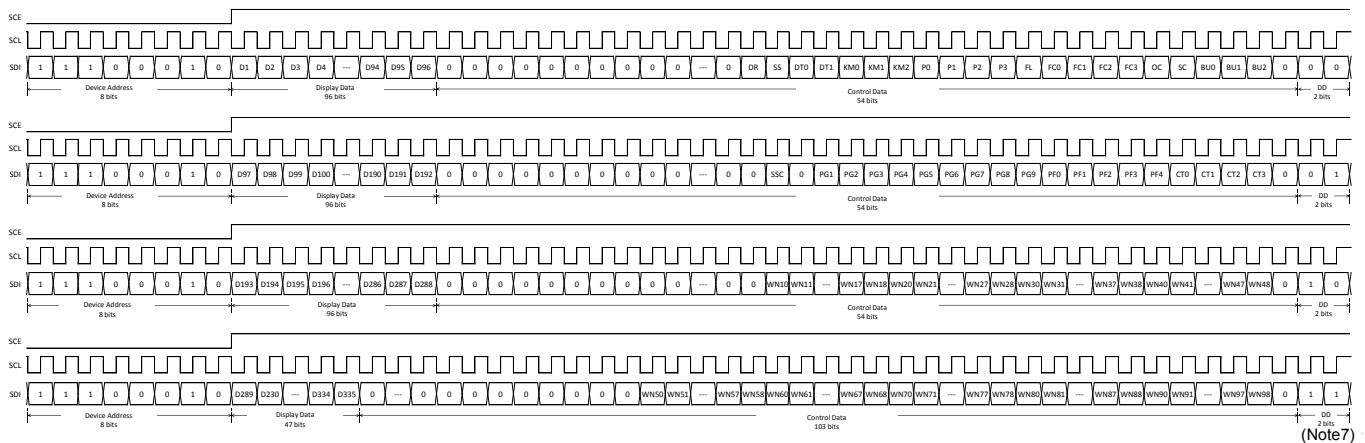


Figure 7. 3-SPI Data Transfer Format

(Note6) DD is direction data.

(2) When SCL is stopped at the high level

## (a) Master



## (b) Slave

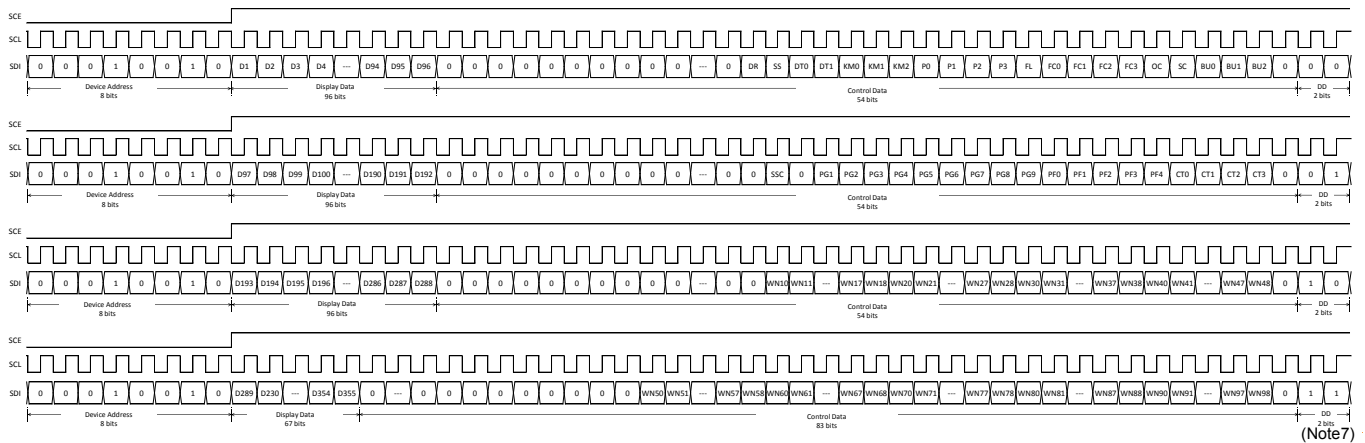


Figure 8. 3-SPI Data Transfer Format

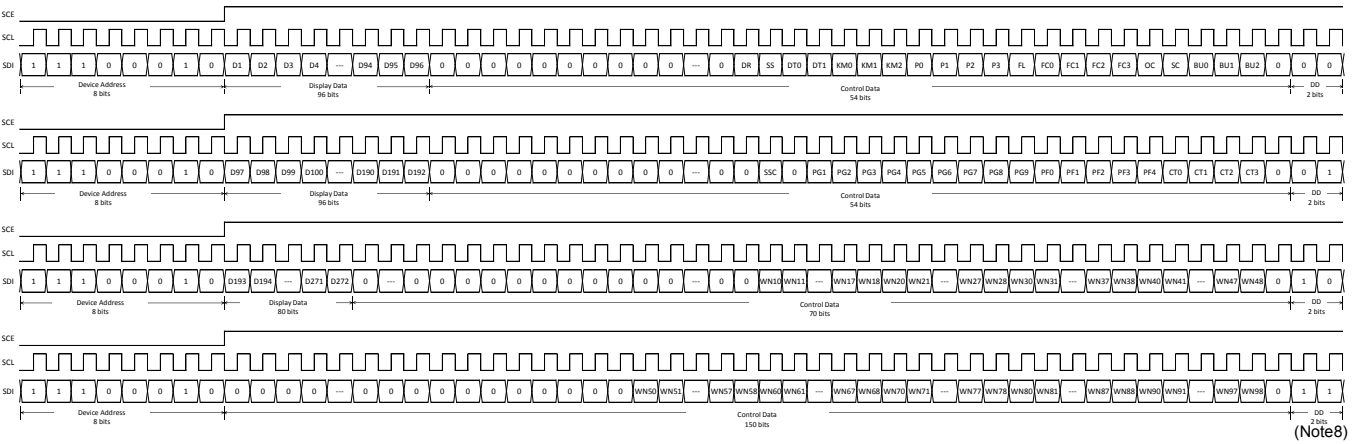
(Note7) DD is direction data.

- Device code....."47H" for Master , "48H" for Slave
- KM0 to KM2.....Key Scan output port/Segment output port switching control data
- D1 to D335.....Display data for Master
- D1 to D355.....Display data for Slave
- SS.....Master Clock and Sync output port/Segment output port switching control data
- SSC.....SEG/COM output port switching control data
- P0 to P3.....Segment output port/general-purpose output port switching control data
- FL.....Line Inversion or Frame Inversion switching control data
- DR.....1/3 bias driver or 1/2 bias driver switching control data
- DT0 to DT1.....1/5-duty drive, 1/4-duty drive, 1/3-duty drive or 1/1-duty(static) drive switching control data
- FC0 to FC3.....Common/segment output waveform frame frequency setting control data
- OC.....Internal oscillator operating mode/External clock operating mode switching control data
- SC.....Segment on/off control data
- BU0 to BU2.....Normal mode/power-saving mode control data
- PG1 to PG9.....PWM/General Purpose output select data
- PF0 to PF4.....PWM output waveform frame frequency setting control data.
- CT0 to CT3.....LCD bias voltage VLCD setting control data.
- W10 to W18, W20 to W28, W30 to W38, W40 to W48, W50 to W58, W60 to W68, W70 to W78, W80 to W88, W90 to W98  
.....PWM output duty setting control data

2. 1/4 Duty

(1) When SCL is stopped at the low level

(a) Master



(b) Slave

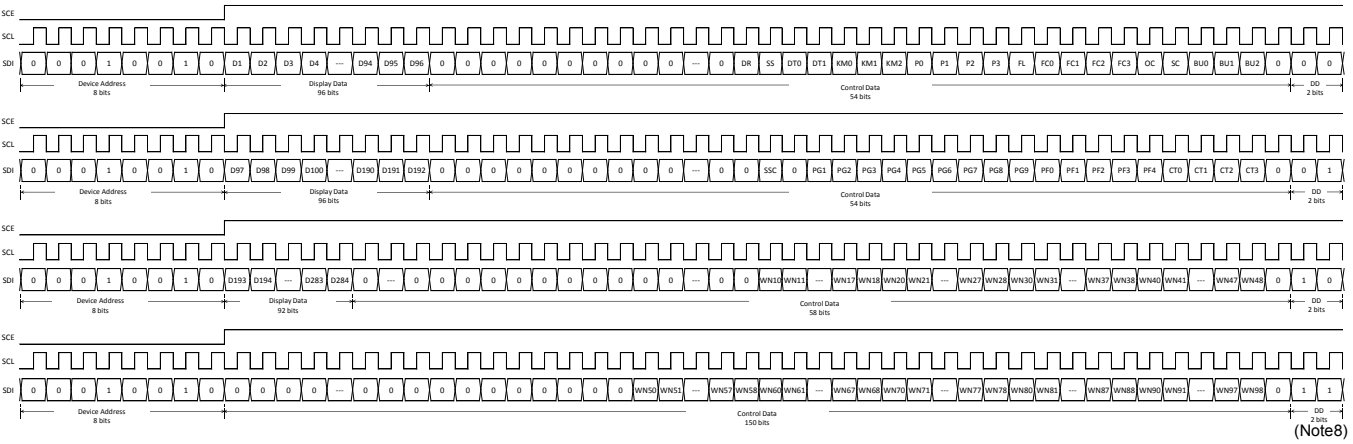
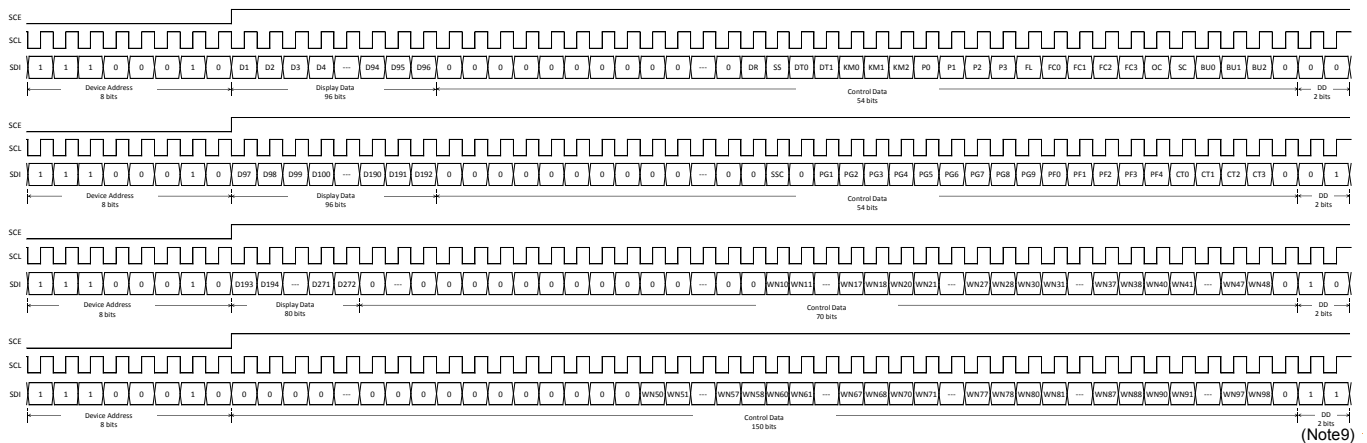


Figure 9. 3-SPI Data Transfer Format

(Note8) DD is direction data.

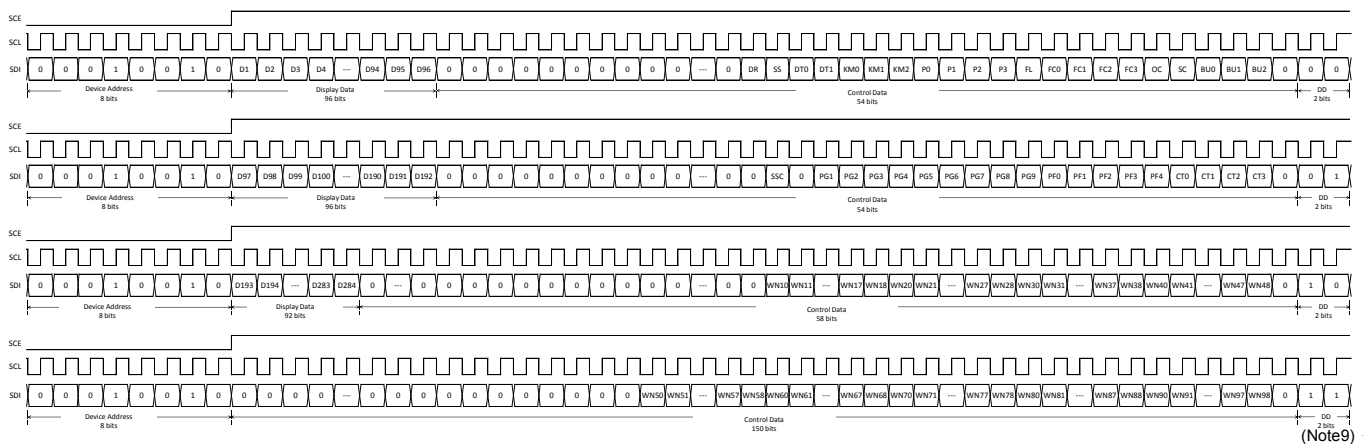
(2) When SCL is stopped at the high level

(a) Master



(Note9)

(b) Slave



(Note9)

Figure 10. 3-SPI Data Transfer Format

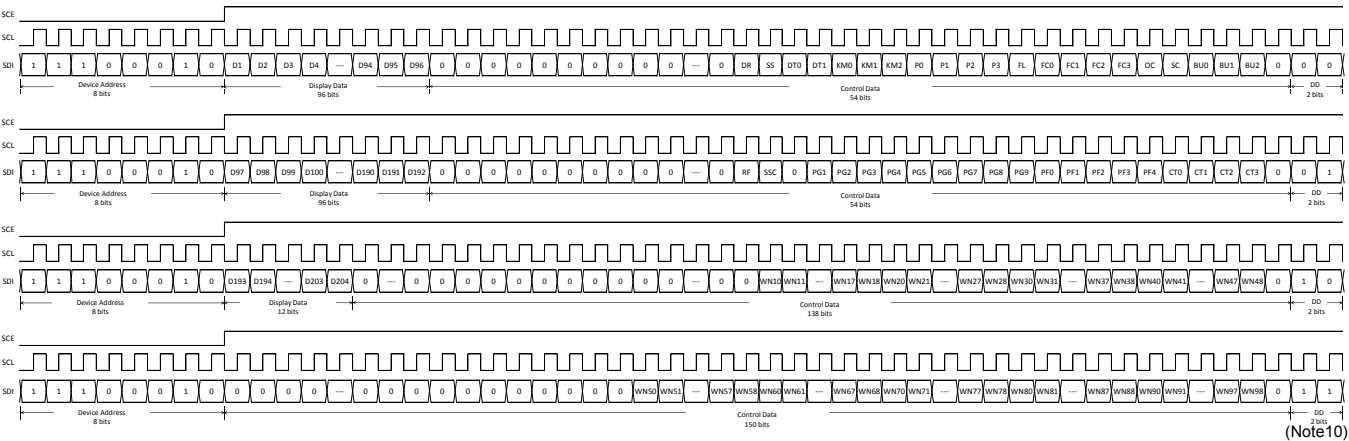
(Note9) DD is direction data.

- Device code....."47H" for Master , "48H" for Slave
- KM0 to KM2.....Key Scan output port/Segment output port switching control data
- D1 to D272.....Display data for Master
- D1 to D284.....Display data for Slave
- SS.....Master Clock and Sync output port/Segment output port switching control data
- SSC.....SEG/COM output port switching control data
- P0 to P3.....Segment output port/general-purpose output port switching control data
- FL.....Line Inversion or Frame Inversion switching control data
- DR.....1/3 bias driver or 1/2 bias driver switching control data
- DT0 to DT1.....1/5-duty drive, 1/4-duty drive, 1/3-duty drive or 1/1-duty(static) drive switching control data
- FC0 to FC3.....Common/segment output waveform frame frequency setting control data
- OC.....Internal oscillator operating mode/External clock operating mode switching control data
- SC.....Segment on/off control data
- BU0 to BU2.....Normal mode/power-saving mode control data
- PG1 to PG9.....PWM/General Purpose output select data
- PF0 to PF4.....PWM output waveform frame frequency setting control data.
- CT0 to CT3.....LCD bias voltage VLCD setting control data.
- W10 to W18, W20 to W28, W30 to W38, W40 to W48, W50 to W58, W60 to W68, W70 to W78, W80 to W88, W90 to W98.....PWM output duty setting control data

3. 1/3 Duty

(1) When SCL is stopped at the low level

(a) Master



(b) Slave

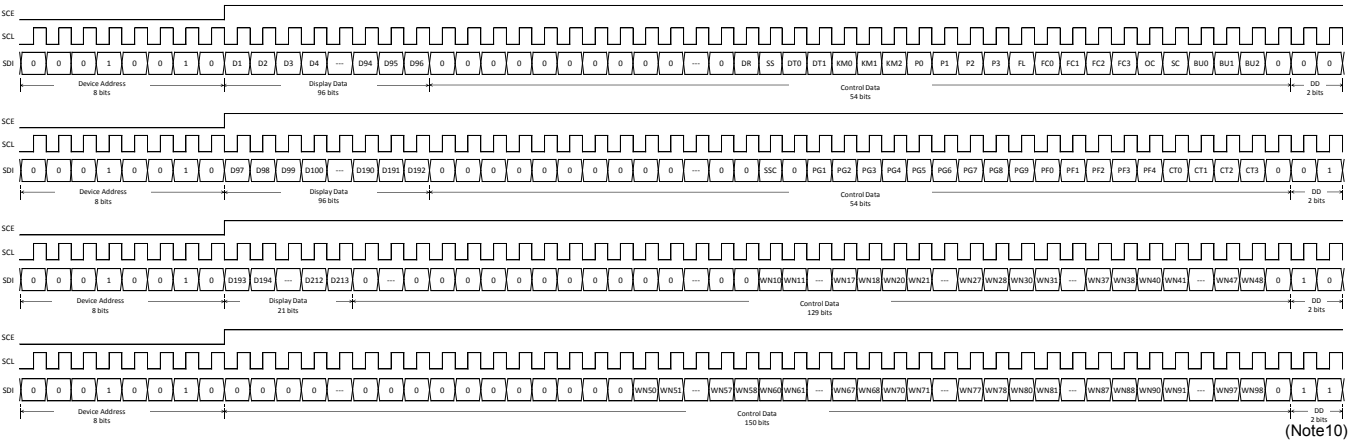
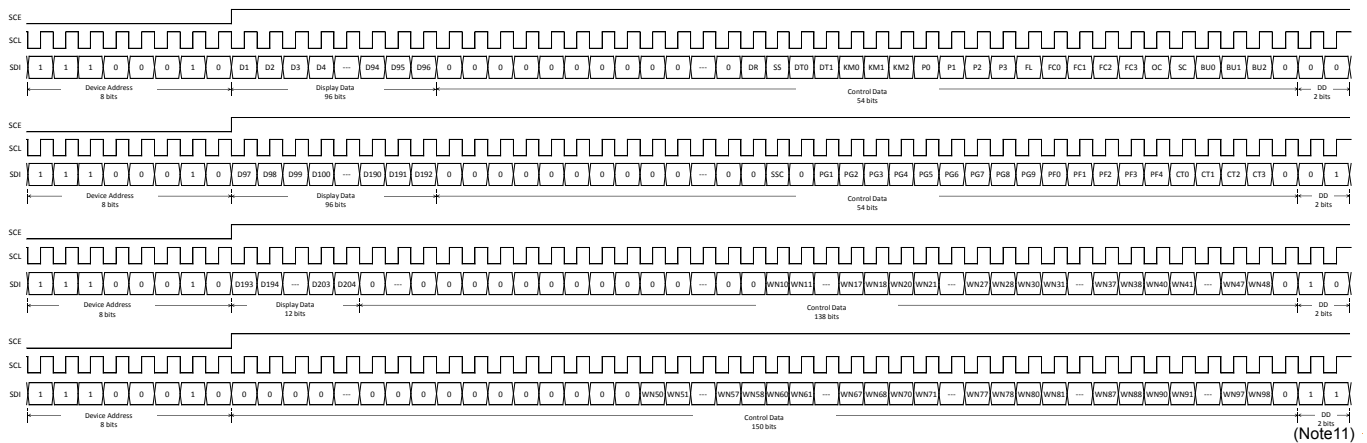


Figure 11. 3-SPI Data Transfer Format

(Note10) DD is direction data.

(2) When SCL is stopped at the high level

(a) Master



(b) Slave

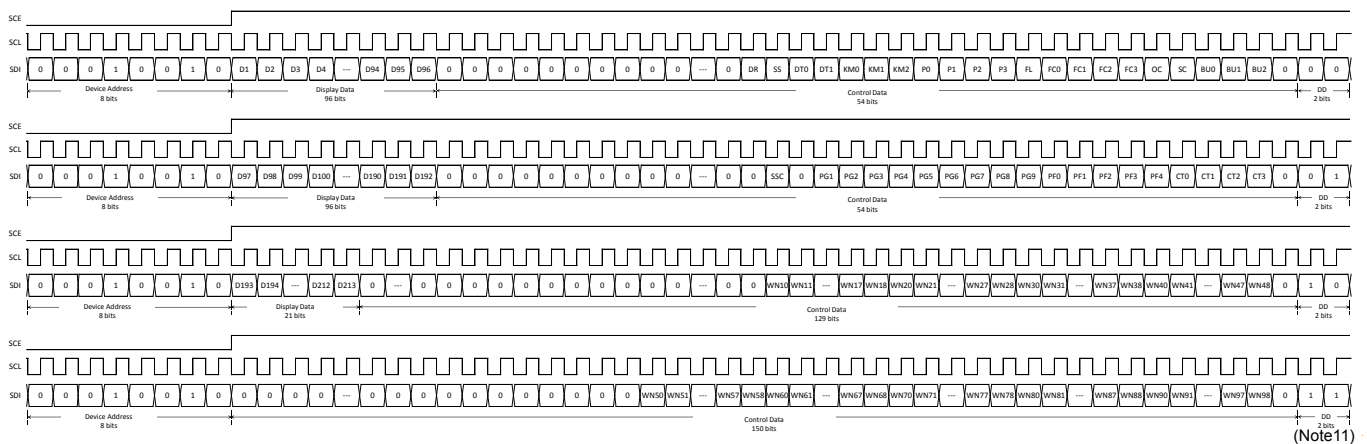


Figure 12. 3-SPI Data Transfer Format

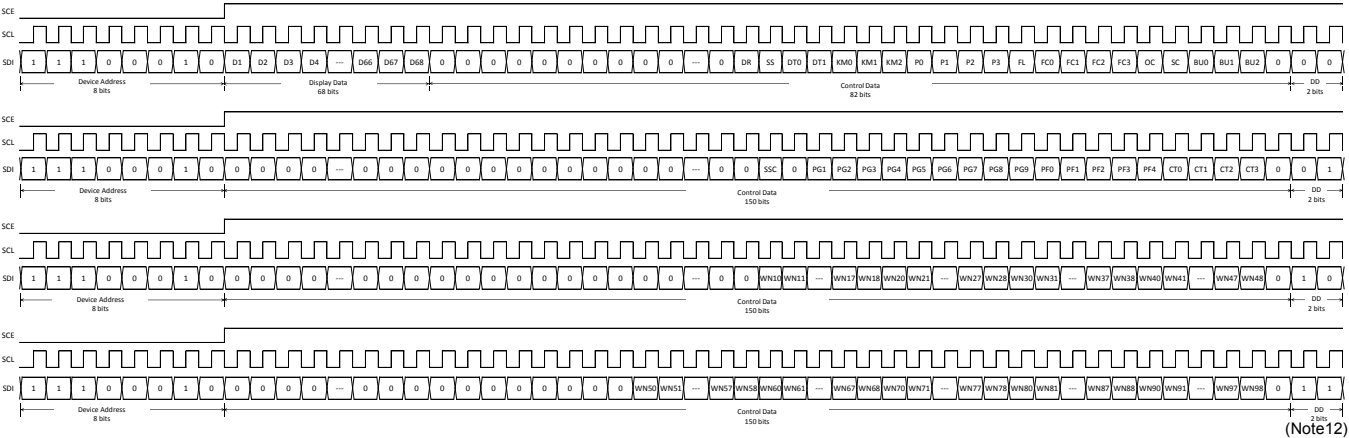
(Note11) DD is direction data.

- Device code....."47H" for Master , "48H" for Slave
- KM0 to KM2.....Key Scan output port/Segment output port switching control data
- D1 to D204.....Display data for Master
- D1 to D213.....Display data for Slave
- SS.....Master Clock and Sync output port/Segment output port switching control data
- SSC.....SEG/COM output port switching control data
- P0 to P3.....Segment output port/general-purpose output port switching control data
- FL.....Line Inversion or Frame Inversion switching control data
- DR.....1/3 bias driver or 1/2 bias driver switching control data
- DT0 to DT1.....1/5-duty drive, 1/4-duty drive, 1/3-duty drive or 1/1-duty(static) drive switching control data
- FC0 to FC3.....Common/segment output waveform frame frequency setting control data
- OC.....Internal oscillator operating mode/External clock operating mode switching control data
- SC.....Segment on/off control data
- BU0 to BU2.....Normal mode/power-saving mode control data
- PG1 to PG9.....PWM/General Purpose output select data
- PF0 to PF4.....PWM output waveform frame frequency setting control data.
- CT0 to CT3.....LCD bias voltage VLCD setting control data.
- W10 to W18, W20 to W28, W30 to W38, W40 to W48, W50 to W58, W60 to W68, W70 to W78, W80 to W88, W90 to W98.....PWM output duty setting control data

4. 1/1 Duty (Static)

(1) When SCL is stopped at the low level

(a) Master



(b) Slave

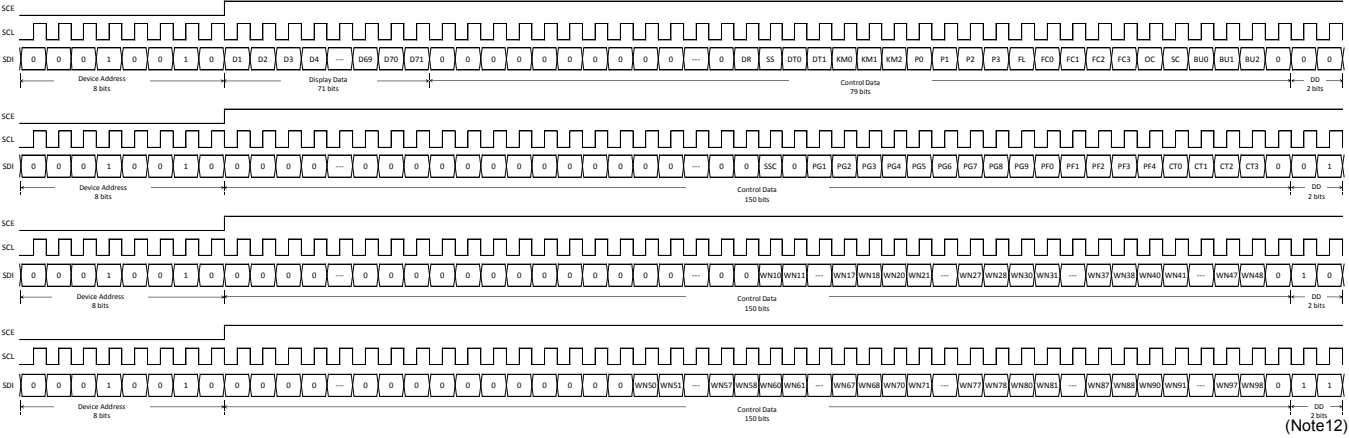
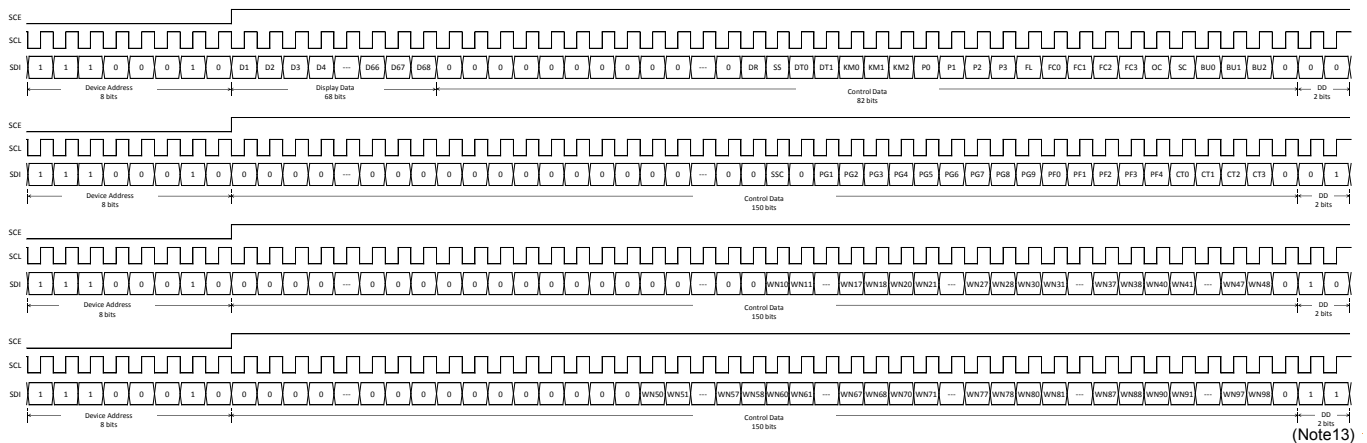


Figure 13. 3-SPI Data Transfer Format

(Note12) DD is direction data.

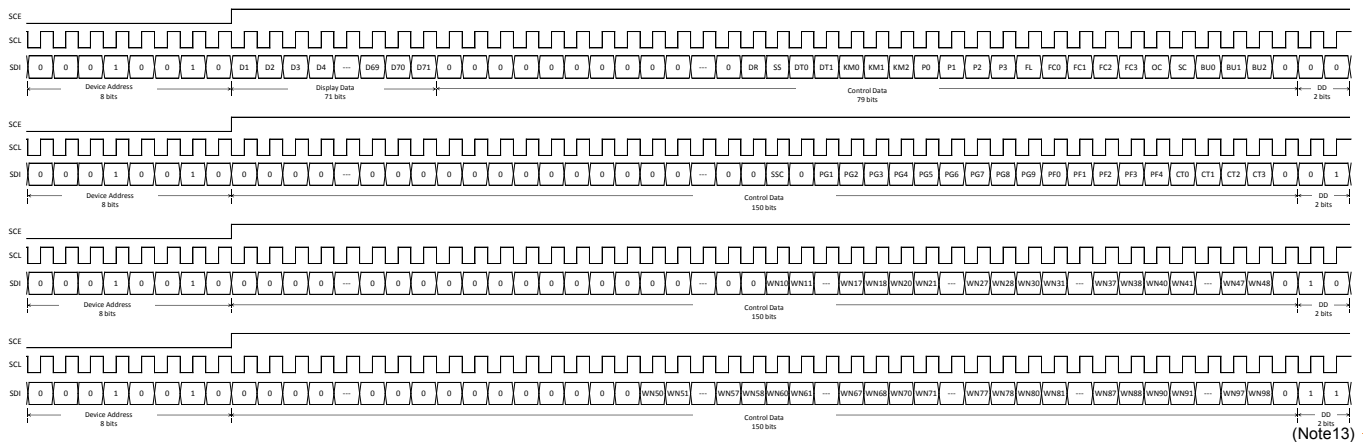
(2) When SCL is stopped at the high level

(a) Master



(Note13)

(b) Slave



(Note13)

Figure 14. 3-SPI Data Transfer Format

(Note13) DD is direction data.

- Device code....."47H" for Master , "48H" for Slave
- KM0 to KM2.....Key Scan output port/Segment output port switching control data
- D1 to D68.....Display data for Master
- D1 to D71.....Display data for Slave
- SS.....Master Clock and Sync output port/Segment output port switching control data
- SSC.....SEG/COM output port switching control data
- P0 to P3.....Segment output port/general-purpose output port switching control data
- FL.....Line Inversion or Frame Inversion switching control data
- DR.....1/3 bias driver or 1/2 bias driver switching control data
- DT0 to DT1.....1/5-duty drive, 1/4-duty drive, 1/3-duty drive or 1/1-duty(static) drive switching control data
- FC0 to FC3.....Common/segment output waveform frame frequency setting control data
- OC.....Internal oscillator operating mode/External clock operating mode switching control data
- SC.....Segment on/off control data
- BU0 to BU2.....Normal mode/power-saving mode control data
- PG1 to PG9.....PWM/General Purpose output select data
- PF0 to PF4.....PWM output waveform frame frequency setting control data.
- CT0 to CT3.....LCD bias voltage VLCD setting control data.
- W10 to W18, W20 to W28, W30 to W38, W40 to W48, W50 to W58, W60 to W68, W70 to W78, W80 to W88, W90 to W98  
.....PWM output duty setting control data

## Control Data Functions

### 1. KM0, KM1 and KM2 : Key Scan output port/Segment output port switching control data

These control data bits switch the functions of the KS1/S53 to KS6/S58 output pins between key scan output and segment output.

| KM0 | KM1 | KM2 | Output Pin State |         |         |         |         |         | Maximum Number of Input keys |
|-----|-----|-----|------------------|---------|---------|---------|---------|---------|------------------------------|
|     |     |     | KS1/S53          | KS2/S54 | KS3/S55 | KS4/S56 | KS5/S57 | KS6/S58 |                              |
| 0   | 0   | 0   | KS1              | KS2     | KS3     | KS4     | KS5     | KS6     | 30                           |
| 0   | 0   | 1   | S53              | KS2     | KS3     | KS4     | KS5     | KS6     | 25                           |
| 0   | 1   | 0   | S53              | S54     | KS3     | KS4     | KS5     | KS6     | 20                           |
| 0   | 1   | 1   | S53              | S54     | S55     | KS4     | KS5     | KS6     | 15                           |
| 1   | 0   | 0   | S53              | S54     | S55     | S56     | KS5     | KS6     | 10                           |
| 1   | 0   | 1   | S53              | S54     | S55     | S56     | S57     | KS6     | 5                            |
| 1   | 1   | 0   | S53              | S54     | S55     | S56     | S57     | S58     | 0                            |
| 1   | 1   | 1   | S53              | S54     | S55     | S56     | S57     | S58     | 0                            |

In Slave Mode, it is automatically set to all segment output and cannot be controlled by Serial Interface.

### 2. P0, P1, P2, and P3: Segment / PWM / General Purpose output port switching control data

These control bits are used to select the function of the S1/P1/G1 to S9/P9/G9 output pins (Segment Output Pins or PWM Output Pins or General Purpose Output Pins).

| P0 | P1 | P2 | P3 | S1/P1/G1 | S2/P2/G2 | S3/P3/G3 | S4/P4/G4 | S5/P5/G5 | S6/P6/G6 | S7/P7/G7 | S8/P8/G8 | S9/P9/G9 |
|----|----|----|----|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 0  | 0  | 0  | 0  | S1       | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 0  | 0  | 0  | 1  | P1/G1    | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 0  | 0  | 1  | 0  | P1/G1    | P2/G2    | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 0  | 0  | 1  | 1  | P1/G1    | P2/G2    | P3/G3    | S4       | S5       | S6       | S7       | S8       | S9       |
| 0  | 1  | 0  | 0  | P1/G1    | P2/G2    | P3/G3    | P4/G4    | S5       | S6       | S7       | S8       | S9       |
| 0  | 1  | 0  | 1  | P1/G1    | P2/G2    | P3/G3    | P4/G4    | P5/G5    | S6       | S7       | S8       | S9       |
| 0  | 1  | 1  | 0  | P1/G1    | P2/G2    | P3/G3    | P4/G4    | P5/G5    | P6/G6    | S7       | S8       | S9       |
| 0  | 1  | 1  | 1  | P1/G1    | P2/G2    | P3/G3    | P4/G4    | P5/G5    | P6/G6    | P7/G7    | S8       | S9       |
| 1  | 0  | 0  | 0  | P1/G1    | P2/G2    | P3/G3    | P4/G4    | P5/G5    | P6/G6    | P7/G7    | P8/G8    | S9       |
| 1  | 0  | 0  | 1  | P1/G1    | P2/G2    | P3/G3    | P4/G4    | P5/G5    | P6/G6    | P7/G7    | P8/G8    | P9/S9    |
| 1  | 0  | 1  | 0  | S1       | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 1  | 0  | 1  | 1  | S1       | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 1  | 1  | 0  | 0  | S1       | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 1  | 1  | 0  | 1  | S1       | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 1  | 1  | 1  | 0  | S1       | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |
| 1  | 1  | 1  | 1  | S1       | S2       | S3       | S4       | S5       | S6       | S7       | S8       | S9       |

PWM output or General Purpose output is selected by PGx(x=1 to 9) control data bit.

When the General Purpose Output Port Function is selected, the correspondence between the output pins and the respective display data is given in the table below.

| Output Pins | Corresponding Display Data |               |               |                        |
|-------------|----------------------------|---------------|---------------|------------------------|
|             | 1/5 Duty mode              | 1/4 Duty mode | 1/3 Duty mode | 1/1 Duty (static) mode |
| S1/P1/G1    | D1                         | D1            | D1            | D1                     |
| S2/P2/G2    | D6                         | D5            | D4            | D2                     |
| S3/P3/G3    | D11                        | D9            | D7            | D3                     |
| S4/P4/G4    | D16                        | D13           | D10           | D4                     |
| S5/P5/G5    | D21                        | D17           | D13           | D4                     |
| S6/P6/G6    | D26                        | D21           | D16           | D5                     |
| S7/P7/G7    | D31                        | D25           | D19           | D7                     |
| S8/P8/G8    | D36                        | D29           | D22           | D8                     |
| S9/P9/G9    | D41                        | D33           | D25           | D9                     |

When the General Purpose Output Port Function is selected, the respective output pin outputs a "HIGH" level when its corresponding display data is set to "1". Likewise, it will output a "LOW" level, if its corresponding display data is set to "0". For example, at 1/4 Duty mode, S4/P4/G4 is used as a General Purpose Output Port, if its corresponding display data D13 is set to "1", then S4/P4/G4 will output "HIGH" level. Likewise, if D13 is set to "0", then S4/P4/G4 will output "LOW" level.

### 3. FL: Line Inversion or Frame Inversion switching control data

This control data bit selects either line inversion mode or frame inversion mode.

| FL | Inversion mode  |
|----|-----------------|
| 0  | Line Inversion  |
| 1  | Frame Inversion |

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

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

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

## 5. SS: Master Clock and Sync output port/Segment output port switching control data

This control data bit switches the functions of the CLKIO/S64 and SYNCIO/S65 output pins between master/slave output and segment output.

| SS | Output Pin State |            |
|----|------------------|------------|
|    | CLKIO/S64        | SYNCIO/S65 |
| 0  | S64              | S65        |
| 1  | CLKIO            | SYNCIO     |

In Slave Mode, it is automatically set to all segment output and cannot be controlled by Serial Interface.

## 6. DT: 1/5 duty drive, 1/4 duty drive, 1/3 duty drive or 1/1 duty switching control data

These control data bits select either 1/5 duty drive, 1/4 duty drive, 1/3 duty drive or 1/1 duty (static)

| DT0 | DT1 | Duty drive scheme       |
|-----|-----|-------------------------|
| 0   | 0   | 1/1 duty (static) drive |
| 0   | 0   | 1/3 duty drive          |
| 0   | 1   | 1/4 duty drive          |
| 1   | 1   | 1/5 duty drive          |

## 7. FC0, FC1, FC2 and FC3: Common/segment output waveform frame frequency setting control data

These control data bits set the frame frequency for common and segment output waveforms.

| FC0 | FC1 | FC2 | FC3 | Frame Frequency fo(Hz)       |
|-----|-----|-----|-----|------------------------------|
| 0   | 0   | 0   | 0   | $f_{osc}^{(Note14)} / 12288$ |
| 0   | 0   | 0   | 1   | $f_{osc} / 10752$            |
| 0   | 0   | 1   | 0   | $f_{osc} / 9216$             |
| 0   | 0   | 1   | 1   | $f_{osc} / 7680$             |
| 0   | 1   | 0   | 0   | $f_{osc} / 6144$             |
| 0   | 1   | 0   | 1   | $f_{osc} / 4608$             |
| 0   | 1   | 1   | 0   | $f_{osc} / 3840$             |
| 0   | 1   | 1   | 1   | $f_{osc} / 3072$             |
| 1   | 0   | 0   | 0   | $f_{osc} / 2880$             |
| 1   | 0   | 0   | 1   | $f_{osc} / 2688$             |
| 1   | 0   | 1   | 0   | $f_{osc} / 2496$             |
| 1   | 0   | 1   | 1   | $f_{osc} / 2304$             |
| 1   | 1   | 0   | 0   | $f_{osc} / 2112$             |
| 1   | 1   | 0   | 1   | $f_{osc} / 1920$             |
| 1   | 1   | 1   | 0   | $f_{osc} / 1728$             |
| 1   | 1   | 1   | 1   | $f_{osc} / 1536$             |

(Note14)fosc: Internal Oscillation Frequency (600 [kHz] Typ)

## 8. OC: Internal oscillator operating mode/External clock operating mode switching control data

| OC | Operating mode      | In/Out pin(OSC_IN/S73) status |
|----|---------------------|-------------------------------|
| 0  | Internal oscillator | S73 (segment output)          |
| 1  | External Clock      | OSC_IN (clock input)          |

## 9. SC: Segment on/off control data

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

| SC | Display state |
|----|---------------|
| 0  | ON            |
| 1  | OFF           |

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.

10. BU0, BU1 and BU2 : Normal mode/power-saving mode control data  
These control data bits select either normal mode or power-saving mode.

| BU0 | BU1 | BU2 | Mode         | OSC Oscillator | Segment outputs<br>Common outputs | Output Pin States During Key Scan Standby |     |     |     |     |     |
|-----|-----|-----|--------------|----------------|-----------------------------------|-------------------------------------------|-----|-----|-----|-----|-----|
|     |     |     |              |                |                                   | KS1                                       | KS2 | KS3 | KS4 | KS5 | KS6 |
| 0   | 0   | 0   | Normal       | Operating      | Operating                         | H                                         | H   | H   | H   | H   | H   |
| 0   | 0   | 1   | Power-saving | Stopped        | Low(VSS)                          | L                                         | L   | L   | L   | L   | H   |
| 0   | 1   | 0   |              |                |                                   | L                                         | L   | L   | L   | H   | H   |
| 0   | 1   | 1   |              |                |                                   | L                                         | L   | L   | H   | H   | H   |
| 1   | 0   | 0   |              |                |                                   | L                                         | L   | H   | H   | H   | H   |
| 1   | 0   | 1   |              |                |                                   | L                                         | H   | H   | H   | H   | H   |
| 1   | 1   | 0   |              |                |                                   | H                                         | H   | H   | H   | H   | H   |
| 1   | 1   | 1   |              |                |                                   | H                                         | H   | H   | H   | H   | H   |

Power-saving mode status: S1/P1/G1 to S9/P9/G9 = active only General Purpose output

S10 to OSC\_IN/S73 = low (VSS)

COM1 to COM5 = low (VSS)

Shut off current to the LCD drive bias voltage generation circuit

Stop the Internal oscillation circuit

However, serial data transfer is possible when at Power-saving mode.

11. SSC: SEG/COM output port switching control data

This control data bit selects SEG or COM output for Slave.

| SSC | Output Pin State |          |          |          |          |
|-----|------------------|----------|----------|----------|----------|
|     | COM5/S67         | COM4/S68 | COM3/S69 | COM2/S70 | COM1/S71 |
| 0   | S67              | S68      | S69      | S70      | S71      |
| 1   | COM5             | COM4     | COM3     | COM2     | COM1     |

This option is not available in Master mode.

12. PG1, PG2, PG3, PG4, PG5, PG6, PG7, PG8 and PG9: PWM/General Purpose output control data

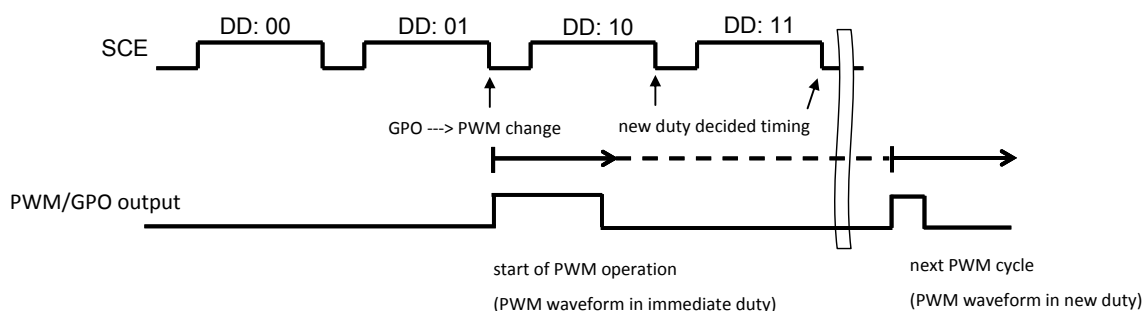
This control data bit select either PWM output or General Purpose output of Sx/Px/Gx pins. (x=1 to 9)

| PGx(x=1 to 9) | Mode                   |
|---------------|------------------------|
| 0             | PWM Output             |
| 1             | General Purpose Output |

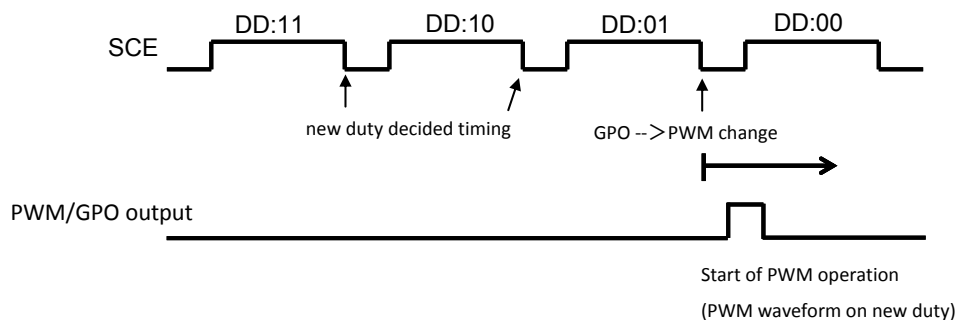
<PWM->GPO Changing function>

Normal behavior of changing GPO to PWM is below.

- PWM operation is started by command import timing of DD: 01 during GPO → PWM change.
- Please take care of reflect timing of new duty setting of DD: 10 and DD: 11 are from the next PWM.



In order to avoid this operation, please input commands in reverse as below.



## 13. PF0, PF1, PF2, PF3 and PF4: PWM output waveform frame frequency setting control data

These control data bits set the frame frequency for pwm output waveforms.

| PF0   | PF1   | PF2   | PF3   | PF4   | PWM output Frame Frequency fp(Hz) |
|-------|-------|-------|-------|-------|-----------------------------------|
| 0     | 0     | 0     | 0     | 0     | fosc / 4096                       |
| 0     | 0     | 0     | 0     | 1     | fosc / 3840                       |
| 0     | 0     | 0     | 1     | 0     | fosc / 3584                       |
| 0     | 0     | 0     | 1     | 1     | fosc / 3328                       |
| 0     | 0     | 1     | 0     | 0     | fosc / 3072                       |
| 0     | 0     | 1     | 0     | 1     | fosc / 2816                       |
| 0     | 0     | 1     | 1     | 0     | fosc / 2560                       |
| 0     | 0     | 1     | 1     | 1     | fosc / 2304                       |
| 0     | 1     | 0     | 0     | 0     | fosc / 2048                       |
| 0     | 1     | 0     | 0     | 1     | fosc / 1792                       |
| 0     | 1     | 0     | 1     | 0     | fosc / 1536                       |
| 0     | 1     | 0     | 1     | 1     | fosc / 1280                       |
| 0     | 1     | 1     | 0     | 0     | fosc / 1024                       |
| 0     | 1     | 1     | 0     | 1     | fosc / 768                        |
| 0     | 1     | 1     | 1     | 0     | fosc / 512                        |
| 0     | 1     | 1     | 1     | 1     | fosc / 256                        |
| 1     | 0     | 0     | 0     | 0     | fosc / 128                        |
| . . . | . . . | . . . | . . . | . . . | . . .                             |
| 1     | 1     | 1     | 1     | 1     | fosc / 128                        |

## 14. CT0, CT1, CT2 and CT3: Display Contrast setting control data

These control data bits set display contrast

| CT0 | CT1 | CT2 | CT3 | LCD Drive bias voltage for VLCD Level |
|-----|-----|-----|-----|---------------------------------------|
| 0   | 0   | 0   | 0   | 1.000*VDD                             |
| 0   | 0   | 0   | 1   | 0.975*VDD                             |
| 0   | 0   | 1   | 0   | 0.950*VDD                             |
| 0   | 0   | 1   | 1   | 0.925*VDD                             |
| 0   | 1   | 0   | 0   | 0.900*VDD                             |
| 0   | 1   | 0   | 1   | 0.875*VDD                             |
| 0   | 1   | 1   | 0   | 0.850*VDD                             |
| 0   | 1   | 1   | 1   | 0.825*VDD                             |
| 1   | 0   | 0   | 0   | 0.800*VDD                             |
| 1   | 0   | 0   | 1   | 0.775*VDD                             |
| 1   | 0   | 1   | 0   | 0.750*VDD                             |
| 1   | 0   | 1   | 1   | 0.725*VDD                             |
| 1   | 1   | 0   | 0   | 0.700*VDD                             |
| 1   | 1   | 0   | 1   | 0.675*VDD                             |
| 1   | 1   | 1   | 0   | 0.650*VDD                             |
| 1   | 1   | 1   | 1   | 0.625*VDD                             |

15. W10 to W18<sup>(Note15)</sup>, W20 to W28, W30 to W38, W40 to W48, W50 to W58, W60 to W68, W70 to W78, W80 to W88 and W90 to W98: PWM output waveform duty setting control data. These control data bits set the high level pulse width (duty) for pwm output waveforms.

Table below shows PWM high level pulse width when PF0 to PF3 command setting is [PF0,PF1,PF2,PF3]=[0,x,x,x]

n = 1 to 9 , Tp = 1/fp

| Wn0   | Wn1   | Wn2   | Wn3   | Wn4   | Wn5   | Wn6   | Wn7   | Wn8   | PWM duty       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|----------------|
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | (0/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | (1/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | (2/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | (3/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | 0     | (4/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | 1     | (5/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | 0     | (6/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | (7/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 0     | 0     | (8/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 0     | 1     | (9/256) x Tp   |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 1     | 0     | (10/256) x Tp  |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 1     | 1     | (11/256) x Tp  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 0     | 0     | (12/256) x Tp  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 0     | 1     | (13/256) x Tp  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | 0     | (14/256) x Tp  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | 1     | (15/256) x Tp  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 0     | 0     | (16/256) x Tp  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 0     | 1     | (17/256) x Tp  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 1     | 0     | (18/256) x Tp  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 1     | 1     | (19/256) x Tp  |
| 0     | 0     | 0     | 0     | 1     | 0     | 1     | 0     | 0     | (20/256) x Tp  |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . .          |
| 0     | 1     | 1     | 1     | 0     | 1     | 0     | 1     | 1     | (235/256) x Tp |
| 0     | 1     | 1     | 1     | 0     | 1     | 1     | 0     | 0     | (236/256) x Tp |
| 0     | 1     | 1     | 1     | 0     | 1     | 1     | 0     | 1     | (237/256) x Tp |
| 0     | 1     | 1     | 1     | 0     | 1     | 1     | 1     | 0     | (238/256) x Tp |
| 0     | 1     | 1     | 1     | 0     | 1     | 1     | 1     | 1     | (239/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 0     | 0     | 0     | (240/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 0     | 0     | 1     | (241/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 0     | 1     | 0     | (242/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 0     | 1     | 1     | (243/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 1     | 0     | 0     | (244/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 1     | 0     | 1     | (245/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 1     | 1     | 0     | (246/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 0     | 1     | 1     | 1     | (247/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 0     | 0     | 0     | (248/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 0     | 0     | 1     | (249/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 0     | 1     | 0     | (250/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 0     | 1     | 1     | (251/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 0     | (252/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 1     | (253/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | (254/256) x Tp |
| 0     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | (255/256) x Tp |
| 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | (256/256) x Tp |
| 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | (256/256) x Tp |
| 1     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | (256/256) x Tp |
| 1     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | (256/256) x Tp |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . .          |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 0     | (256/256) x Tp |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 1     | (256/256) x Tp |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | (256/256) x Tp |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | (256/256) x Tp |

(Note15) W10 to W18:S1/P1/G1 pwm duty data  
W20 to W28:S2/P2/G2 pwm duty data  
W30 to W38:S3/P3/G3 pwm duty data  
W40 to W48:S4/P4/G4 pwm duty data  
W50 to W58:S5/P5/G5 pwm duty data  
W60 to W68:S6/P6/G6 pwm duty data  
W70 to W78:S7/P7/G7 pwm duty data  
W80 to W88:S8/P8/G8 pwm duty data  
W90 to W98:S9/P9/G9 pwm duty data

Table below shows PWM high level pulse width when PF0 to PF3 command setting is [PF0,PF1,PF2,PF3]=[1,x,x,x]

n = 1 to 9 ,  $T_p = 1/f_p$

| Wn0   | Wn1   | Wn2   | Wn3   | Wn4   | Wn5   | Wn6   | Wn7   | Wn8   | PWM duty          |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------------|
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | (0/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | (1/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | (2/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | (3/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | 0     | (4/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | 1     | (5/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | 0     | (6/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | (7/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 0     | 0     | (8/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 0     | 1     | (9/128) x $T_p$   |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 1     | 0     | (10/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 0     | 1     | 0     | 1     | 1     | (11/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 0     | 0     | (12/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 0     | 1     | (13/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | 0     | (14/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 0     | 1     | 1     | 1     | 1     | (15/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 0     | 0     | (16/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 0     | 1     | (17/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 1     | 0     | (18/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 1     | 0     | 0     | 1     | 1     | (19/128) x $T_p$  |
| 0     | 0     | 0     | 0     | 1     | 0     | 1     | 0     | 0     | (20/128) x $T_p$  |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . .             |
| 0     | 0     | 1     | 1     | 0     | 1     | 0     | 1     | 1     | (107/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 0     | 1     | 1     | 0     | 0     | (108/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 0     | 1     | 1     | 0     | 1     | (109/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 0     | 1     | 1     | 1     | 0     | (110/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 0     | 1     | 1     | 1     | 1     | (111/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 0     | 0     | 0     | (112/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 0     | 0     | 1     | (113/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 0     | 1     | 0     | (114/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 0     | 1     | 1     | (115/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 1     | 0     | 0     | (116/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 1     | 0     | 1     | (117/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 1     | 1     | 0     | (118/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 0     | 1     | 1     | 1     | (119/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 0     | 0     | 0     | (120/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 0     | 0     | 1     | (121/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 0     | 1     | 0     | (122/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 0     | 1     | 1     | (123/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 1     | 0     | 0     | (124/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 1     | 0     | 1     | (125/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | (126/128) x $T_p$ |
| 0     | 0     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | (127/128) x $T_p$ |
| 0     | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 0     | (128/128) x $T_p$ |
| 0     | 1     | 0     | 0     | 0     | 0     | 0     | 0     | 1     | (128/128) x $T_p$ |
| 0     | 1     | 0     | 0     | 0     | 0     | 0     | 1     | 0     | (128/128) x $T_p$ |
| 0     | 1     | 0     | 0     | 0     | 0     | 0     | 1     | 1     | (128/128) x $T_p$ |
| . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . .             |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 0     | (128/128) x $T_p$ |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | 1     | (128/128) x $T_p$ |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 0     | (128/128) x $T_p$ |
| 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | (128/128) x $T_p$ |

(Note15) W10 to W18:S1/P1/G1 pwm duty data  
W20 to W28:S2/P2/G2 pwm duty data  
W30 to W38:S3/P3/G3 pwm duty data  
W40 to W48:S4/P4/G4 pwm duty data  
W50 to W58:S5/P5/G5 pwm duty data  
W60 to W68:S6/P6/G6 pwm duty data  
W70 to W78:S7/P7/G7 pwm duty data  
W80 to W88:S8/P8/G8 pwm duty data  
W90 to W98:S9/P9/G9 pwm duty data

## Display Data and Output Pin Correspondence

1.1/5 duty Master

| Output Pin <sup>(Note16)</sup> | COM1 | COM2 | COM3 | COM4 | COM5 |
|--------------------------------|------|------|------|------|------|
| S1/P1/G1                       | D1   | D2   | D3   | D4   | D5   |
| S2/P2/G2                       | D6   | D7   | D8   | D9   | D10  |
| S3/P3/G3                       | D11  | D12  | D13  | D14  | D15  |
| S4/P4/G4                       | D16  | D17  | D18  | D19  | D20  |
| S5/P5/G5                       | D21  | D22  | D23  | D24  | D25  |
| S6/P6/G6                       | D26  | D27  | D28  | D29  | D30  |
| S7/P7/G7                       | D31  | D32  | D33  | D34  | D35  |
| S8/P8/G8                       | D36  | D37  | D38  | D39  | D40  |
| S9/P9/G9                       | D41  | D42  | D43  | D44  | D45  |
| S10                            | D46  | D47  | D48  | D49  | D50  |
| S11                            | D51  | D52  | D53  | D54  | D55  |
| S12                            | D56  | D57  | D58  | D59  | D60  |
| S13                            | D61  | D62  | D63  | D64  | D65  |
| S14                            | D66  | D67  | D68  | D69  | D70  |
| S15                            | D71  | D72  | D73  | D74  | D75  |
| S16                            | D76  | D77  | D78  | D79  | D80  |
| S17                            | D81  | D82  | D83  | D84  | D85  |
| S18                            | D86  | D87  | D88  | D89  | D90  |
| S19                            | D91  | D92  | D93  | D94  | D95  |
| S20                            | D96  | D97  | D98  | D99  | D100 |
| S21                            | D101 | D102 | D103 | D104 | D105 |
| S22                            | D106 | D107 | D108 | D109 | D110 |
| S23                            | D111 | D112 | D113 | D114 | D115 |
| S24                            | D116 | D117 | D118 | D119 | D120 |
| S25                            | D121 | D122 | D123 | D124 | D125 |
| S26                            | D126 | D127 | D128 | D129 | D130 |
| S27                            | D131 | D132 | D133 | D134 | D135 |
| S28                            | D136 | D137 | D138 | D139 | D140 |
| S29                            | D141 | D142 | D143 | D144 | D145 |
| S30                            | D146 | D147 | D148 | D149 | D150 |
| S31                            | D151 | D152 | D153 | D154 | D155 |
| S32                            | D156 | D157 | D158 | D159 | D160 |
| S33                            | D161 | D162 | D163 | D164 | D165 |
| S34                            | D166 | D167 | D168 | D169 | D170 |
| S35                            | D171 | D172 | D173 | D174 | D175 |
| S36                            | D176 | D177 | D178 | D179 | D180 |
| S37                            | D181 | D182 | D183 | D184 | D185 |
| S38                            | D186 | D187 | D188 | D189 | D190 |
| S39                            | D191 | D192 | D193 | D194 | D195 |
| S40                            | D196 | D197 | D198 | D199 | D200 |
| S41                            | D201 | D202 | D203 | D204 | D205 |
| S42                            | D206 | D207 | D208 | D209 | D210 |
| S43                            | D211 | D212 | D213 | D214 | D215 |
| S44                            | D216 | D217 | D218 | D219 | D220 |
| S45                            | D221 | D222 | D223 | D224 | D225 |
| S46                            | D226 | D227 | D228 | D229 | D230 |
| S47                            | D231 | D232 | D233 | D234 | D235 |
| S48                            | D236 | D237 | D238 | D239 | D240 |
| S49                            | D241 | D242 | D243 | D244 | D245 |
| S50                            | D246 | D247 | D248 | D249 | D250 |
| S51                            | D251 | D252 | D253 | D254 | D255 |
| S52                            | D256 | D257 | D258 | D259 | D260 |
| KS1/S53                        | D261 | D262 | D263 | D264 | D265 |
| KS2/S54                        | D266 | D267 | D268 | D269 | D270 |
| KS3/S55                        | D271 | D272 | D273 | D274 | D275 |
| KS4/S56                        | D276 | D277 | D278 | D279 | D280 |
| KS5/S57                        | D281 | D282 | D283 | D284 | D285 |
| KS6/S58                        | D286 | D287 | D288 | D289 | D290 |
| KI1/S59                        | D291 | D292 | D293 | D294 | D295 |
| KI2/S60                        | D296 | D297 | D298 | D299 | D300 |
| KI3/S61                        | D301 | D302 | D303 | D304 | D305 |
| KI4/S62                        | D306 | D307 | D308 | D309 | D310 |
| KI5/S63                        | D311 | D312 | D313 | D314 | D315 |

| Output Pin <sup>(Note16)</sup> | COM1 | COM2 | COM3 | COM4 | COM5 |
|--------------------------------|------|------|------|------|------|
| CLKIO/S64                      | D316 | D317 | D318 | D319 | D320 |
| SYNCIO/S65                     | D321 | D322 | D323 | D324 | D325 |
| S66/TESTIN                     |      |      |      |      |      |
| COM5/S67                       |      |      |      |      |      |
| COM4/S68                       |      |      |      |      |      |
| COM3/S69                       |      |      |      |      |      |
| COM2/S70                       |      |      |      |      |      |
| COM1/S71                       |      |      |      |      |      |
| S72                            | D326 | D327 | D328 | D329 | D330 |
| OSC_IN/S73                     | D331 | D332 | D333 | D334 | D335 |

(Note 16) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, KS1/S53 to KS6/S58, K11/S59 to K15/S63, OSC\_IN/S73. Also, COM5/S67 pin is used as Common output.

During 1 chip mode, S66/TESTIN functions as TESTIN input.

During 2 chip mode(Master with Slave), CLKIO/S64 and SYNCIO/S65 function as CLK and SYNC outputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display data |      |      |      |      | State of S21 Output Pin                                              |
|--------------|------|------|------|------|----------------------------------------------------------------------|
| D101         | D102 | D103 | D104 | D105 |                                                                      |
| 0            | 0    | 0    | 0    | 0    | LCD Segments corresponding to COM1 to COM5 are OFF.                  |
| 0            | 0    | 0    | 0    | 1    | LCD Segment corresponding to COM5 is ON.                             |
| 0            | 0    | 0    | 1    | 0    | LCD Segment corresponding to COM4 is ON.                             |
| 0            | 0    | 0    | 1    | 1    | LCD Segments corresponding to COM4 and COM5 are ON.                  |
| 0            | 0    | 1    | 0    | 0    | LCD Segment corresponding to COM3 is ON.                             |
| 0            | 0    | 1    | 0    | 1    | LCD Segments corresponding to COM3 and COM5 are ON.                  |
| 0            | 0    | 1    | 1    | 0    | LCD Segments corresponding to COM3 and COM4 are ON.                  |
| 0            | 0    | 1    | 1    | 1    | LCD Segments corresponding to COM3, COM4 and COM5 are ON.            |
| 0            | 1    | 0    | 0    | 0    | LCD Segment corresponding to COM2 is ON.                             |
| 0            | 1    | 0    | 0    | 1    | LCD Segments corresponding to COM2 and COM5 are ON.                  |
| 0            | 1    | 0    | 1    | 0    | LCD Segments corresponding to COM2 and COM4 are ON.                  |
| 0            | 1    | 0    | 1    | 1    | LCD Segments corresponding to COM2, COM4 and COM5 are ON.            |
| 0            | 1    | 1    | 0    | 0    | LCD Segments corresponding to COM2 and COM3 are ON.                  |
| 0            | 1    | 1    | 0    | 1    | LCD Segments corresponding to COM2, COM3, and COM5 are ON.           |
| 0            | 1    | 1    | 1    | 0    | LCD Segments corresponding to COM2, COM3, and COM4 are ON.           |
| 0            | 1    | 1    | 1    | 1    | LCD Segments corresponding to COM2, COM3, COM4 and COM5 are ON.      |
| 1            | 0    | 0    | 0    | 0    | LCD Segment corresponding to COM1 is ON.                             |
| 1            | 0    | 0    | 0    | 1    | LCD Segment corresponding to COM1 and COM5 are ON.                   |
| 1            | 0    | 0    | 1    | 0    | LCD Segment corresponding to COM1 and COM4 are ON.                   |
| 1            | 0    | 0    | 1    | 1    | LCD Segment corresponding to COM1, COM4 and COM5 are ON.             |
| 1            | 0    | 1    | 0    | 0    | LCD Segment corresponding to COM1 and COM3 are ON.                   |
| 1            | 0    | 1    | 0    | 1    | LCD Segment corresponding to COM1, COM3 and COM5 are ON.             |
| 1            | 0    | 1    | 1    | 0    | LCD Segment corresponding to COM1, COM3 and COM4 are ON.             |
| 1            | 0    | 1    | 1    | 1    | LCD Segment corresponding to COM1, COM3, COM4 and COM5 are ON.       |
| 1            | 1    | 0    | 0    | 0    | LCD Segment corresponding to COM1 and COM2 are ON.                   |
| 1            | 1    | 0    | 0    | 1    | LCD Segment corresponding to COM1, COM2 and COM5 are ON.             |
| 1            | 1    | 0    | 1    | 0    | LCD Segment corresponding to COM1, COM2 and COM4 are ON.             |
| 1            | 1    | 0    | 1    | 1    | LCD Segment corresponding to COM1, COM2, COM4 and COM5 are ON.       |
| 1            | 1    | 1    | 0    | 0    | LCD Segment corresponding to COM1, COM2 and COM3 are ON.             |
| 1            | 1    | 1    | 0    | 1    | LCD Segment corresponding to COM1, COM2, COM3 and COM5 are ON.       |
| 1            | 1    | 1    | 1    | 0    | LCD Segment corresponding to COM1, COM2, COM3 and COM4 are ON.       |
| 1            | 1    | 1    | 1    | 1    | LCD Segment corresponding to COM1, COM2, COM3, COM4 and COM5 are ON. |

## 2.1/5 duty Slave

| Output Pin <sup>(Note 17)</sup> | COM1 | COM2 | COM3 | COM4 | COM5 |
|---------------------------------|------|------|------|------|------|
| S1/P1/G1                        | D1   | D2   | D3   | D4   | D5   |
| S2/P2/G2                        | D6   | D7   | D8   | D9   | D10  |
| S3/P3/G3                        | D11  | D12  | D13  | D14  | D15  |
| S4/P4/G4                        | D16  | D17  | D18  | D19  | D20  |
| S5/P5/G5                        | D21  | D22  | D23  | D24  | D25  |
| S6/P6/G6                        | D26  | D27  | D28  | D29  | D30  |
| S7/P7/G7                        | D31  | D32  | D33  | D34  | D35  |
| S8/P8/G8                        | D36  | D37  | D38  | D39  | D40  |
| S9/P9/G9                        | D41  | D42  | D43  | D44  | D45  |
| S10                             | D46  | D47  | D48  | D49  | D50  |
| S11                             | D51  | D52  | D53  | D54  | D55  |
| S12                             | D56  | D57  | D58  | D59  | D60  |
| S13                             | D61  | D62  | D63  | D64  | D65  |
| S14                             | D66  | D67  | D68  | D69  | D70  |
| S15                             | D71  | D72  | D73  | D74  | D75  |
| S16                             | D76  | D77  | D78  | D79  | D80  |
| S17                             | D81  | D82  | D83  | D84  | D85  |
| S18                             | D86  | D87  | D88  | D89  | D90  |
| S19                             | D91  | D92  | D93  | D94  | D95  |
| S20                             | D96  | D97  | D98  | D99  | D100 |
| S21                             | D101 | D102 | D103 | D104 | D105 |
| S22                             | D106 | D107 | D108 | D109 | D110 |
| S23                             | D111 | D112 | D113 | D114 | D115 |
| S24                             | D116 | D117 | D118 | D119 | D120 |
| S25                             | D121 | D122 | D123 | D124 | D125 |
| S26                             | D126 | D127 | D128 | D129 | D130 |
| S27                             | D131 | D132 | D133 | D134 | D135 |
| S28                             | D136 | D137 | D138 | D139 | D140 |
| S29                             | D141 | D142 | D143 | D144 | D145 |
| S30                             | D146 | D147 | D148 | D149 | D150 |
| S31                             | D151 | D152 | D153 | D154 | D155 |
| S32                             | D156 | D157 | D158 | D159 | D160 |
| S33                             | D161 | D162 | D163 | D164 | D165 |
| S34                             | D166 | D167 | D168 | D169 | D170 |
| S35                             | D171 | D172 | D173 | D174 | D175 |
| S36                             | D176 | D177 | D178 | D179 | D180 |
| S37                             | D181 | D182 | D183 | D184 | D185 |
| S38                             | D186 | D187 | D188 | D189 | D190 |
| S39                             | D191 | D192 | D193 | D194 | D195 |
| S40                             | D196 | D197 | D198 | D199 | D200 |
| S41                             | D201 | D202 | D203 | D204 | D205 |
| S42                             | D206 | D207 | D208 | D209 | D210 |
| S43                             | D211 | D212 | D213 | D214 | D215 |
| S44                             | D216 | D217 | D218 | D219 | D220 |
| S45                             | D221 | D222 | D223 | D224 | D225 |
| S46                             | D226 | D227 | D228 | D229 | D230 |
| S47                             | D231 | D232 | D233 | D234 | D235 |
| S48                             | D236 | D237 | D238 | D239 | D240 |
| S49                             | D241 | D242 | D243 | D244 | D245 |
| S50                             | D246 | D247 | D248 | D249 | D250 |
| S51                             | D251 | D252 | D253 | D254 | D255 |
| S52                             | D256 | D257 | D258 | D259 | D260 |
| S53                             | D261 | D262 | D263 | D264 | D265 |
| S54                             | D266 | D267 | D268 | D269 | D270 |
| S55                             | D271 | D272 | D273 | D274 | D275 |
| S56                             | D276 | D277 | D278 | D279 | D280 |
| S57                             | D281 | D282 | D283 | D284 | D285 |
| S58                             | D286 | D287 | D288 | D289 | D290 |
| S59                             | D291 | D292 | D293 | D294 | D295 |
| S60                             | D296 | D297 | D298 | D299 | D300 |
| S61                             | D301 | D302 | D303 | D304 | D305 |
| S62                             | D306 | D307 | D308 | D309 | D310 |
| S63                             | D311 | D312 | D313 | D314 | D315 |

| Output Pin <sup>(Note17)</sup> | COM1 | COM2 | COM3 | COM4 | COM5 |
|--------------------------------|------|------|------|------|------|
| CLKIO/S64                      |      |      |      |      |      |
| SYNCIO/S65                     |      |      |      |      |      |
| S66/TESTIN                     | D316 | D317 | D318 | D319 | D320 |
| COM5/S67                       | D321 | D322 | D323 | D324 | D325 |
| COM4/S68                       | D326 | D327 | D328 | D329 | D330 |
| COM3/S69                       | D331 | D332 | D333 | D334 | D335 |
| COM2/S70                       | D336 | D337 | D338 | D339 | D340 |
| COM1/S71                       | D341 | D342 | D343 | D344 | D345 |
| S72                            | D346 | D347 | D348 | D349 | D350 |
| OSC_IN/S73                     | D351 | D352 | D353 | D354 | D355 |

(Note 17) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9.

Also, CLKIO/S64 and SYNCIO/S65 pins are used as SYNC and CLK inputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display data |      |      |      |      | State of S21 Output Pin                                              |
|--------------|------|------|------|------|----------------------------------------------------------------------|
| D101         | D102 | D103 | D104 | D105 |                                                                      |
| 0            | 0    | 0    | 0    | 0    | LCD Segments corresponding to COM1 to COM5 are OFF.                  |
| 0            | 0    | 0    | 0    | 1    | LCD Segment corresponding to COM5 is ON.                             |
| 0            | 0    | 0    | 1    | 0    | LCD Segment corresponding to COM4 is ON.                             |
| 0            | 0    | 0    | 1    | 1    | LCD Segments corresponding to COM4 and COM5 are ON.                  |
| 0            | 0    | 1    | 0    | 0    | LCD Segment corresponding to COM3 is ON.                             |
| 0            | 0    | 1    | 0    | 1    | LCD Segments corresponding to COM3 and COM5 are ON.                  |
| 0            | 0    | 1    | 1    | 0    | LCD Segments corresponding to COM3 and COM4 are ON.                  |
| 0            | 0    | 1    | 1    | 1    | LCD Segments corresponding to COM3, COM4 and COM5 are ON.            |
| 0            | 1    | 0    | 0    | 0    | LCD Segment corresponding to COM2 is ON.                             |
| 0            | 1    | 0    | 0    | 1    | LCD Segments corresponding to COM2 and COM5 are ON.                  |
| 0            | 1    | 0    | 1    | 0    | LCD Segments corresponding to COM2 and COM4 are ON.                  |
| 0            | 1    | 0    | 1    | 1    | LCD Segments corresponding to COM2, COM4 and COM5 are ON.            |
| 0            | 1    | 1    | 0    | 0    | LCD Segments corresponding to COM2 and COM3 are ON.                  |
| 0            | 1    | 1    | 0    | 1    | LCD Segments corresponding to COM2, COM3, and COM5 are ON.           |
| 0            | 1    | 1    | 1    | 0    | LCD Segments corresponding to COM2, COM3, and COM4 are ON.           |
| 0            | 1    | 1    | 1    | 1    | LCD Segments corresponding to COM2, COM3, COM4 and COM5 are ON.      |
| 1            | 0    | 0    | 0    | 0    | LCD Segment corresponding to COM1 is ON.                             |
| 1            | 0    | 0    | 0    | 1    | LCD Segment corresponding to COM1 and COM5 are ON.                   |
| 1            | 0    | 0    | 1    | 0    | LCD Segment corresponding to COM1 and COM4 are ON.                   |
| 1            | 0    | 0    | 1    | 1    | LCD Segment corresponding to COM1, COM4 and COM5 are ON.             |
| 1            | 0    | 1    | 0    | 0    | LCD Segment corresponding to COM1 and COM3 are ON.                   |
| 1            | 0    | 1    | 0    | 1    | LCD Segment corresponding to COM1, COM3 and COM5 are ON.             |
| 1            | 0    | 1    | 1    | 0    | LCD Segment corresponding to COM1, COM3 and COM4 are ON.             |
| 1            | 0    | 1    | 1    | 1    | LCD Segment corresponding to COM1, COM3, COM4 and COM5 are ON.       |
| 1            | 1    | 0    | 0    | 0    | LCD Segment corresponding to COM1 and COM2 are ON.                   |
| 1            | 1    | 0    | 0    | 1    | LCD Segment corresponding to COM1, COM2 and COM5 are ON.             |
| 1            | 1    | 0    | 1    | 0    | LCD Segment corresponding to COM1, COM2 and COM4 are ON.             |
| 1            | 1    | 0    | 1    | 1    | LCD Segment corresponding to COM1, COM2, COM4 and COM5 are ON.       |
| 1            | 1    | 1    | 0    | 0    | LCD Segment corresponding to COM1, COM2 and COM3 are ON.             |
| 1            | 1    | 1    | 0    | 1    | LCD Segment corresponding to COM1, COM2, COM3 and COM5 are ON.       |
| 1            | 1    | 1    | 1    | 0    | LCD Segment corresponding to COM1, COM2, COM3 and COM4 are ON.       |
| 1            | 1    | 1    | 1    | 1    | LCD Segment corresponding to COM1, COM2, COM3, COM4 and COM5 are ON. |

## 3.1/4 duty Master

| Output Pin <sup>(Note18)</sup> | COM1 | COM2 | COM3 | COM4 |
|--------------------------------|------|------|------|------|
| S1/P1/G1                       | D1   | D2   | D3   | D4   |
| S2/P2/G2                       | D5   | D6   | D7   | D8   |
| S3/P3/G3                       | D9   | D10  | D11  | D12  |
| S4/P4/G4                       | D13  | D14  | D15  | D16  |
| S5/P5/G5                       | D17  | D18  | D19  | D20  |
| S6/P6/G6                       | D21  | D22  | D23  | D24  |
| S7/P7/G7                       | D25  | D26  | D27  | D28  |
| S8/P8/G8                       | D29  | D30  | D31  | D32  |
| S9/P9/G9                       | D33  | D34  | D35  | D36  |
| S10                            | D37  | D38  | D39  | D40  |
| S11                            | D41  | D42  | D43  | D44  |
| S12                            | D45  | D46  | D47  | D48  |
| S13                            | D49  | D50  | D51  | D52  |
| S14                            | D53  | D54  | D55  | D56  |
| S15                            | D57  | D58  | D59  | D60  |
| S16                            | D61  | D62  | D63  | D64  |
| S17                            | D65  | D66  | D67  | D68  |
| S18                            | D69  | D70  | D71  | D72  |
| S19                            | D73  | D74  | D75  | D76  |
| S20                            | D77  | D78  | D79  | D80  |
| S21                            | D81  | D82  | D83  | D84  |
| S22                            | D85  | D86  | D87  | D88  |
| S23                            | D89  | D90  | D91  | D92  |
| S24                            | D93  | D94  | D95  | D96  |
| S25                            | D97  | D98  | D99  | D100 |
| S26                            | D101 | D102 | D103 | D104 |
| S27                            | D105 | D106 | D107 | D108 |
| S28                            | D109 | D110 | D111 | D112 |
| S29                            | D113 | D114 | D115 | D116 |
| S30                            | D117 | D118 | D119 | D120 |
| S31                            | D121 | D122 | D123 | D124 |
| S32                            | D125 | D126 | D127 | D128 |
| S33                            | D129 | D130 | D131 | D132 |
| S34                            | D133 | D134 | D135 | D136 |
| S35                            | D137 | D138 | D139 | D140 |
| S36                            | D141 | D142 | D143 | D144 |
| S37                            | D145 | D146 | D147 | D148 |
| S38                            | D149 | D150 | D151 | D152 |
| S39                            | D153 | D154 | D155 | D156 |
| S40                            | D157 | D158 | D159 | D160 |
| S41                            | D161 | D162 | D163 | D164 |
| S42                            | D165 | D166 | D167 | D168 |
| S43                            | D169 | D170 | D171 | D172 |
| S44                            | D173 | D174 | D175 | D176 |
| S45                            | D177 | D178 | D179 | D180 |
| S46                            | D181 | D182 | D183 | D184 |
| S47                            | D185 | D186 | D187 | D188 |
| S48                            | D189 | D190 | D191 | D192 |
| S49                            | D193 | D194 | D195 | D196 |
| S50                            | D197 | D198 | D199 | D200 |
| S51                            | D201 | D202 | D203 | D204 |
| S52                            | D205 | D206 | D207 | D208 |
| KS1/S53                        | D209 | D210 | D211 | D212 |
| KS2/S54                        | D213 | D214 | D215 | D216 |
| KS3/S55                        | D217 | D218 | D219 | D220 |
| KS4/S56                        | D221 | D222 | D223 | D224 |
| KS5/S57                        | D225 | D226 | D227 | D228 |
| KS6/S58                        | D229 | D230 | D231 | D232 |
| KI1/S59                        | D233 | D234 | D235 | D236 |
| KI2/S60                        | D237 | D238 | D239 | D240 |
| KI3/S61                        | D241 | D242 | D243 | D244 |
| KI4/S62                        | D245 | D246 | D247 | D248 |
| KI5/S63                        | D249 | D250 | D251 | D252 |

| Output Pin <sup>(Note18)</sup> | COM1 | COM2 | COM3 | COM4 |
|--------------------------------|------|------|------|------|
| CLKIO/S64                      | D253 | D254 | D255 | D256 |
| SYNCIO/S65                     | D257 | D258 | D259 | D260 |
| S66/TESTIN                     |      |      |      |      |
| COM5/S67                       | D261 | D262 | D263 | D264 |
| COM4/S68                       |      |      |      |      |
| COM3/S69                       |      |      |      |      |
| COM2/S70                       |      |      |      |      |
| COM1/S71                       |      |      |      |      |
| S72                            | D265 | D266 | D267 | D268 |
| OSC_IN/S73                     | D269 | D270 | D271 | D272 |

(Note 18) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, KS1/S53 to KS6/S58, KI1/S59 to KI5/S63, OSC\_IN/S73.

During 1 chip mode, S66/TESTIN functions as TESTIN input.

During 2 chip mode(Master with Slave), CLKIO/S64 and SYNCIO/S65 function as CLK and SYNC outputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display data |     |     |     | State of S21 Output Pin                                         |
|--------------|-----|-----|-----|-----------------------------------------------------------------|
| D81          | D82 | D83 | D84 |                                                                 |
| 0            | 0   | 0   | 0   | LCD Segments corresponding to COM1 to COM4 are OFF.             |
| 0            | 0   | 0   | 1   | LCD Segment corresponding to COM4 is ON.                        |
| 0            | 0   | 1   | 0   | LCD Segment corresponding to COM3 is ON.                        |
| 0            | 0   | 1   | 1   | LCD Segments corresponding to COM3 and COM4 are ON.             |
| 0            | 1   | 0   | 0   | LCD Segment corresponding to COM2 is ON.                        |
| 0            | 1   | 0   | 1   | LCD Segments corresponding to COM2 and COM4 are ON.             |
| 0            | 1   | 1   | 0   | LCD Segments corresponding to COM2 and COM3 are ON.             |
| 0            | 1   | 1   | 1   | LCD Segments corresponding to COM2, COM3 and COM4 are ON.       |
| 1            | 0   | 0   | 0   | LCD Segment corresponding to COM1 is ON.                        |
| 1            | 0   | 0   | 1   | LCD Segments corresponding to COM1 and COM4 are ON.             |
| 1            | 0   | 1   | 0   | LCD Segments corresponding to COM1 and COM3 are ON.             |
| 1            | 0   | 1   | 1   | LCD Segments corresponding to COM1, COM3 and COM4 are ON.       |
| 1            | 1   | 0   | 0   | LCD Segments corresponding to COM1 and COM2 are ON.             |
| 1            | 1   | 0   | 1   | LCD Segments corresponding to COM1, COM2, and COM4 are ON.      |
| 1            | 1   | 1   | 0   | LCD Segments corresponding to COM1, COM2, and COM3 are ON.      |
| 1            | 1   | 1   | 1   | LCD Segments corresponding to COM1, COM2, COM3 and COM4 are ON. |

## 4. 1/4 duty Slave

| Output Pin <sup>(Note19)</sup> | COM1 | COM2 | COM3 | COM4 |
|--------------------------------|------|------|------|------|
| S1/P1/G1                       | D1   | D2   | D3   | D4   |
| S2/P2/G2                       | D5   | D6   | D7   | D8   |
| S3/P3/G3                       | D9   | D10  | D11  | D12  |
| S4/P4/G4                       | D13  | D14  | D15  | D16  |
| S5/P5/G5                       | D17  | D18  | D19  | D20  |
| S6/P6/G6                       | D21  | D22  | D23  | D24  |
| S7/P7/G7                       | D25  | D26  | D27  | D28  |
| S8/P8/G8                       | D29  | D30  | D31  | D32  |
| S9/P9/G9                       | D33  | D34  | D35  | D36  |
| S10                            | D37  | D38  | D39  | D40  |
| S11                            | D41  | D42  | D43  | D44  |
| S12                            | D45  | D46  | D47  | D48  |
| S13                            | D49  | D50  | D51  | D52  |
| S14                            | D53  | D54  | D55  | D56  |
| S15                            | D57  | D58  | D59  | D60  |
| S16                            | D61  | D62  | D63  | D64  |
| S17                            | D65  | D66  | D67  | D68  |
| S18                            | D69  | D70  | D71  | D72  |
| S19                            | D73  | D74  | D75  | D76  |
| S20                            | D77  | D78  | D79  | D80  |
| S21                            | D81  | D82  | D83  | D84  |
| S22                            | D85  | D86  | D87  | D88  |
| S23                            | D89  | D90  | D91  | D92  |
| S24                            | D93  | D94  | D95  | D96  |
| S25                            | D97  | D98  | D99  | D100 |
| S26                            | D101 | D102 | D103 | D104 |
| S27                            | D105 | D106 | D107 | D108 |
| S28                            | D109 | D110 | D111 | D112 |
| S29                            | D113 | D114 | D115 | D116 |
| S30                            | D117 | D118 | D119 | D120 |
| S31                            | D121 | D122 | D123 | D124 |
| S32                            | D125 | D126 | D127 | D128 |
| S33                            | D129 | D130 | D131 | D132 |
| S34                            | D133 | D134 | D135 | D136 |
| S35                            | D137 | D138 | D139 | D140 |
| S36                            | D141 | D142 | D143 | D144 |
| S37                            | D145 | D146 | D147 | D148 |
| S38                            | D149 | D150 | D151 | D152 |
| S39                            | D153 | D154 | D155 | D156 |
| S40                            | D157 | D158 | D159 | D160 |
| S41                            | D161 | D162 | D163 | D164 |
| S42                            | D165 | D166 | D167 | D168 |
| S43                            | D169 | D170 | D171 | D172 |
| S44                            | D173 | D174 | D175 | D176 |
| S45                            | D177 | D178 | D179 | D180 |
| S46                            | D181 | D182 | D183 | D184 |
| S47                            | D185 | D186 | D187 | D188 |
| S48                            | D189 | D190 | D191 | D192 |
| S49                            | D193 | D194 | D195 | D196 |
| S50                            | D197 | D198 | D199 | D200 |
| S51                            | D201 | D202 | D203 | D204 |
| S52                            | D205 | D206 | D207 | D208 |
| S53                            | D209 | D210 | D211 | D212 |
| S54                            | D213 | D214 | D215 | D216 |
| S55                            | D217 | D218 | D219 | D220 |
| S56                            | D221 | D222 | D223 | D224 |
| S57                            | D225 | D226 | D227 | D228 |
| S58                            | D229 | D230 | D231 | D232 |
| S59                            | D233 | D234 | D235 | D236 |
| S60                            | D237 | D238 | D239 | D240 |
| S61                            | D241 | D242 | D243 | D244 |
| S62                            | D245 | D246 | D247 | D248 |
| S63                            | D249 | D250 | D251 | D252 |

| Output Pin <sup>(Note19)</sup> | COM1 | COM2 | COM3 | COM4 |
|--------------------------------|------|------|------|------|
| CLKIO/S64                      |      |      |      |      |
| SYNCIO/S65                     |      |      |      |      |
| S66/TESTIN                     | D253 | D254 | D255 | D256 |
| COM5/S67                       | D257 | D258 | D259 | D260 |
| COM4/S68                       | D261 | D262 | D263 | D264 |
| COM3/S69                       | D265 | D266 | D267 | D268 |
| COM2/S70                       | D269 | D270 | D271 | D272 |
| COM1/S71                       | D273 | D274 | D275 | D276 |
| S72                            | D277 | D278 | D279 | D280 |
| OSC_IN/S73                     | D281 | D282 | D283 | D284 |

(Note 19) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9.

Also, CLKIO/S64 and SYNCIO/S65 pins are used as SYNC and CLK inputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display data |     |     |     | State of S21 Output Pin                                         |
|--------------|-----|-----|-----|-----------------------------------------------------------------|
| D81          | D82 | D83 | D84 |                                                                 |
| 0            | 0   | 0   | 0   | LCD Segments corresponding to COM1 to COM4 are OFF.             |
| 0            | 0   | 0   | 1   | LCD Segment corresponding to COM4 is ON.                        |
| 0            | 0   | 1   | 0   | LCD Segment corresponding to COM3 is ON.                        |
| 0            | 0   | 1   | 1   | LCD Segments corresponding to COM3 and COM4 are ON.             |
| 0            | 1   | 0   | 0   | LCD Segment corresponding to COM2 is ON.                        |
| 0            | 1   | 0   | 1   | LCD Segments corresponding to COM2 and COM4 are ON.             |
| 0            | 1   | 1   | 0   | LCD Segments corresponding to COM2 and COM3 are ON.             |
| 0            | 1   | 1   | 1   | LCD Segments corresponding to COM2, COM3 and COM4 are ON.       |
| 1            | 0   | 0   | 0   | LCD Segment corresponding to COM1 is ON.                        |
| 1            | 0   | 0   | 1   | LCD Segments corresponding to COM1 and COM4 are ON.             |
| 1            | 0   | 1   | 0   | LCD Segments corresponding to COM1 and COM3 are ON.             |
| 1            | 0   | 1   | 1   | LCD Segments corresponding to COM1, COM3 and COM4 are ON.       |
| 1            | 1   | 0   | 0   | LCD Segments corresponding to COM1 and COM2 are ON.             |
| 1            | 1   | 0   | 1   | LCD Segments corresponding to COM1, COM2, and COM4 are ON.      |
| 1            | 1   | 1   | 0   | LCD Segments corresponding to COM1, COM2, and COM3 are ON.      |
| 1            | 1   | 1   | 1   | LCD Segments corresponding to COM1, COM2, COM3 and COM4 are ON. |

## 5. 1/3 duty Master

| Output Pin <sup>(Note2)</sup> | COM1 | COM2 | COM3 |
|-------------------------------|------|------|------|
| S1/P1/G1                      | D1   | D2   | D3   |
| S2/P2/G2                      | D4   | D5   | D6   |
| S3/P3/G3                      | D7   | D8   | D9   |
| S4/P4/G4                      | D10  | D11  | D12  |
| S5/P5/G5                      | D13  | D14  | D15  |
| S6/P6/G6                      | D16  | D17  | D18  |
| S7/P7/G7                      | D19  | D20  | D21  |
| S8/P8/G8                      | D22  | D23  | D24  |
| S9/P9/G9                      | D25  | D26  | D27  |
| S10                           | D28  | D29  | D30  |
| S11                           | D31  | D32  | D33  |
| S12                           | D34  | D35  | D36  |
| S13                           | D37  | D38  | D39  |
| S14                           | D40  | D41  | D42  |
| S15                           | D43  | D44  | D45  |
| S16                           | D46  | D47  | D48  |
| S17                           | D49  | D50  | D51  |
| S18                           | D52  | D53  | D54  |
| S19                           | D55  | D56  | D57  |
| S20                           | D58  | D59  | D60  |
| S21                           | D61  | D62  | D63  |
| S22                           | D64  | D65  | D66  |
| S23                           | D67  | D68  | D69  |
| S24                           | D70  | D71  | D72  |
| S25                           | D73  | D74  | D75  |
| S26                           | D76  | D77  | D78  |
| S27                           | D79  | D80  | D81  |
| S28                           | D82  | D83  | D84  |
| S29                           | D85  | D85  | D87  |
| S30                           | D88  | D89  | D90  |
| S31                           | D91  | D92  | D93  |
| S32                           | D94  | D95  | D96  |
| S33                           | D97  | D98  | D99  |
| S34                           | D100 | D101 | D102 |
| S35                           | D103 | D104 | D105 |
| S36                           | D106 | D107 | D108 |
| S37                           | D109 | D110 | D111 |
| S38                           | D112 | D113 | D114 |
| S39                           | D115 | D116 | D117 |
| S40                           | D118 | D119 | D120 |
| S41                           | D121 | D122 | D123 |
| S42                           | D124 | D125 | D126 |
| S43                           | D127 | D128 | D129 |
| S44                           | D130 | D131 | D132 |
| S45                           | D133 | D134 | D135 |
| S46                           | D136 | D137 | D138 |
| S47                           | D139 | D140 | D141 |
| S48                           | D142 | D143 | D144 |
| S49                           | D145 | D146 | D147 |
| S50                           | D148 | D149 | D150 |
| S51                           | D151 | D152 | D153 |
| S52                           | D154 | D155 | D156 |
| KS1/S53                       | D157 | D158 | D159 |
| KS2/S54                       | D160 | D161 | D162 |
| KS3/S55                       | D163 | D164 | D165 |
| KS4/S56                       | D166 | D167 | D168 |
| KS5/S57                       | D169 | D170 | D171 |
| KS6/S58                       | D172 | D173 | D174 |
| KI1/S59                       | D175 | D176 | D177 |
| KI2/S60                       | D178 | D179 | D180 |
| KI3/S61                       | D181 | D182 | D183 |
| KI4/S62                       | D184 | D185 | D186 |
| KI5/S63                       | D187 | D188 | D189 |

| Output Pin <sup>(Note20)</sup> | COM1 | COM2 | COM3 |
|--------------------------------|------|------|------|
| CLKIO/S64                      | D190 | D191 | D192 |
| SYNCIO/S65                     | D193 | D194 | D195 |
| S66/TESTIN                     |      |      |      |
| COM5/S67                       | D196 | D197 | D198 |
| COM4/S68                       |      |      |      |
| COM3/S69                       |      |      |      |
| COM2/S70                       |      |      |      |
| COM1/S71                       |      |      |      |
| S72                            | D199 | D200 | D201 |
| OSC_IN/S73                     | D202 | D203 | D204 |

(Note 20) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, KS1/S53 to KS6/S58, KI1/S59 to KI5/S63, OSC\_IN/S73.

During 1 chip mode, S66/TESTIN functions as TESTIN input.

During 2 chip mode(Master with Slave), CLKIO/S64 and SYNCIO/S65 function as CLK and SYNC outputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display data |     |     | State of S21 Output Pin                                   |
|--------------|-----|-----|-----------------------------------------------------------|
| D61          | D62 | D63 |                                                           |
| 0            | 0   | 0   | LCD Segments corresponding to COM1 to COM3 are OFF.       |
| 0            | 0   | 1   | LCD Segment corresponding to COM3 is ON.                  |
| 0            | 1   | 0   | LCD Segment corresponding to COM2 is ON.                  |
| 0            | 1   | 1   | LCD Segments corresponding to COM2 and COM3 are ON.       |
| 1            | 0   | 0   | LCD Segment corresponding to COM1 is ON.                  |
| 1            | 0   | 1   | LCD Segments corresponding to COM1 and COM3 are ON.       |
| 1            | 1   | 0   | LCD Segments corresponding to COM1 and COM2 are ON.       |
| 1            | 1   | 1   | LCD Segments corresponding to COM1, COM2 and COM3 are ON. |

## 6. 1/3 duty Slave

| Output Pin <sup>(Note2)</sup> | COM1 | COM2 | COM3 |
|-------------------------------|------|------|------|
| S1/P1/G1                      | D1   | D2   | D3   |
| S2/P2/G2                      | D4   | D5   | D6   |
| S3/P3/G3                      | D7   | D8   | D9   |
| S4/P4/G4                      | D10  | D11  | D12  |
| S5/P5/G5                      | D13  | D14  | D15  |
| S6/P6/G6                      | D16  | D17  | D18  |
| S7/P7/G7                      | D19  | D20  | D21  |
| S8/P8/G8                      | D22  | D23  | D24  |
| S9/P9/G9                      | D25  | D26  | D27  |
| S10                           | D28  | D29  | D30  |
| S11                           | D31  | D32  | D33  |
| S12                           | D34  | D35  | D36  |
| S13                           | D37  | D38  | D39  |
| S14                           | D40  | D41  | D42  |
| S15                           | D43  | D44  | D45  |
| S16                           | D46  | D47  | D48  |
| S17                           | D49  | D50  | D51  |
| S18                           | D52  | D53  | D54  |
| S19                           | D55  | D56  | D57  |
| S20                           | D58  | D59  | D60  |
| S21                           | D61  | D62  | D63  |
| S22                           | D64  | D65  | D66  |
| S23                           | D67  | D68  | D69  |
| S24                           | D70  | D71  | D72  |
| S25                           | D73  | D74  | D75  |
| S26                           | D76  | D77  | D78  |
| S27                           | D79  | D80  | D81  |
| S28                           | D82  | D83  | D84  |
| S29                           | D85  | D85  | D87  |
| S30                           | D88  | D89  | D90  |
| S31                           | D91  | D92  | D93  |
| S32                           | D94  | D95  | D96  |
| S33                           | D97  | D98  | D99  |
| S34                           | D100 | D101 | D102 |
| S35                           | D103 | D104 | D105 |
| S36                           | D106 | D107 | D108 |
| S37                           | D109 | D110 | D111 |
| S38                           | D112 | D113 | D114 |
| S39                           | D115 | D116 | D117 |
| S40                           | D118 | D119 | D120 |
| S41                           | D121 | D122 | D123 |
| S42                           | D124 | D125 | D126 |
| S43                           | D127 | D128 | D129 |
| S44                           | D130 | D131 | D132 |
| S45                           | D133 | D134 | D135 |
| S46                           | D136 | D137 | D138 |
| S47                           | D139 | D140 | D141 |
| S48                           | D142 | D143 | D144 |
| S49                           | D145 | D146 | D147 |
| S50                           | D148 | D149 | D150 |
| S51                           | D151 | D152 | D153 |
| S52                           | D154 | D155 | D156 |
| S53                           | D157 | D158 | D159 |
| S54                           | D160 | D161 | D162 |
| S55                           | D163 | D164 | D165 |
| S56                           | D166 | D167 | D168 |
| S57                           | D169 | D170 | D171 |
| S58                           | D172 | D173 | D174 |
| S59                           | D175 | D176 | D177 |
| S60                           | D178 | D179 | D180 |
| S61                           | D181 | D182 | D183 |
| S62                           | D184 | D185 | D186 |
| S63                           | D187 | D188 | D189 |

| Output Pin <sup>(Note21)</sup> | COM1 | COM2 | COM3 |
|--------------------------------|------|------|------|
| CLKIO/S64                      |      |      |      |
| SYNCIO/S65                     |      |      |      |
| S66/TESTIN                     | D190 | D191 | D192 |
| COM5/S67                       | D193 | D194 | D195 |
| COM4/S68                       | D196 | D197 | D198 |
| COM3/S69                       | D199 | D200 | D201 |
| COM2/S70                       | D202 | D203 | D204 |
| COM1/S71                       | D205 | D206 | D207 |
| S72                            | D208 | D209 | D210 |
| OSC/S73                        | D211 | D212 | D213 |

(Note 21) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9. Also, CLKIO/S64 and SYNCIO/S65 pins are used as SYNC and CLK inputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display data |     |     | State of S21 Output Pin                                   |
|--------------|-----|-----|-----------------------------------------------------------|
| D61          | D62 | D63 |                                                           |
| 0            | 0   | 0   | LCD Segments corresponding to COM1 to COM3 are OFF.       |
| 0            | 0   | 1   | LCD Segment corresponding to COM3 is ON.                  |
| 0            | 1   | 0   | LCD Segment corresponding to COM2 is ON.                  |
| 0            | 1   | 1   | LCD Segments corresponding to COM2 and COM3 are ON.       |
| 1            | 0   | 0   | LCD Segment corresponding to COM1 is ON.                  |
| 1            | 0   | 1   | LCD Segments corresponding to COM1 and COM3 are ON.       |
| 1            | 1   | 0   | LCD Segments corresponding to COM1 and COM2 are ON.       |
| 1            | 1   | 1   | LCD Segments corresponding to COM1, COM2 and COM3 are ON. |

## 7. 1/1 duty (Static) Master

| Output Pin <sup>(Note22)</sup> | COM1 |
|--------------------------------|------|
| S1/P1/G1                       | D1   |
| S2/P2/G2                       | D2   |
| S3/P3/G3                       | D3   |
| S4/P4/G4                       | D4   |
| S5/P5/G5                       | D5   |
| S6/P6/G6                       | D6   |
| S7/P7/G7                       | D7   |
| S8/P8/G8                       | D8   |
| S9/P9/G9                       | D9   |
| S10                            | D10  |
| S11                            | D11  |
| S12                            | D12  |
| S13                            | D13  |
| S14                            | D14  |
| S15                            | D15  |
| S16                            | D16  |
| S17                            | D17  |
| S18                            | D18  |
| S19                            | D19  |
| S20                            | D20  |
| S21                            | D21  |
| S22                            | D22  |
| S23                            | D23  |
| S24                            | D24  |
| S25                            | D25  |
| S26                            | D26  |
| S27                            | D27  |
| S28                            | D28  |
| S29                            | D29  |
| S30                            | D30  |
| S31                            | D31  |
| S32                            | D32  |
| S33                            | D33  |
| S34                            | D34  |
| S35                            | D35  |
| S36                            | D36  |
| S37                            | D37  |
| S38                            | D38  |
| S39                            | D39  |
| S40                            | D40  |
| S41                            | D41  |
| S42                            | D42  |
| S43                            | D43  |
| S44                            | D44  |
| S45                            | D45  |
| S46                            | D46  |
| S47                            | D47  |
| S48                            | D48  |
| S49                            | D49  |
| S50                            | D50  |
| S51                            | D51  |
| S52                            | D52  |
| KS1/S53                        | D53  |
| KS2/S54                        | D54  |
| KS3/S55                        | D55  |
| KS4/S56                        | D56  |
| KS5/S57                        | D57  |
| KS6/S58                        | D58  |
| KI1/S59                        | D59  |
| KI2/S60                        | D60  |
| KI3/S61                        | D61  |
| KI4/S62                        | D62  |
| KI5/S63                        | D63  |

| Output Pin <sup>(Note22)</sup> | COM1 |
|--------------------------------|------|
| CLKIO/S64                      | D64  |
| SYNCIO/S65                     | D65  |
| S66/TESTIN                     |      |
| COM5/S67                       | D66  |
| COM4/S68                       |      |
| COM3/S69                       |      |
| COM2/S70                       |      |
| COM1/S71                       |      |
| S72                            | D67  |
| OSC_IN/S73                     | D68  |

(Note 22) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, KS1/S53 to KS6/S58, KI1/S59 to KI5/S63, OSC\_IN/S73.

During 1chip mode, S66/TESTIN functions as TESTIN input.

During 2 chip mode(Master with Slave), CLKIO/S64 and SYNCIO/S65 function as CLK and SYNC outputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display Data | State of S21Output Pin                    |
|--------------|-------------------------------------------|
| D21          |                                           |
| 0            | LCD Segment corresponding to COM1 is OFF. |
| 1            | LCD Segment corresponding to COM1 is ON.  |

## 8. 1/1 duty (Static) Slave

| Output Pin <sup>(Note3)</sup> | COM1 |
|-------------------------------|------|
| S1/P1/G1                      | D1   |
| S2/P2/G2                      | D2   |
| S3/P3/G3                      | D3   |
| S4/P4/G4                      | D4   |
| S5/P5/G5                      | D5   |
| S6/P6/G6                      | D6   |
| S7/P7/G7                      | D7   |
| S8/P8/G8                      | D8   |
| S9/P9/G9                      | D9   |
| S10                           | D10  |
| S11                           | D11  |
| S12                           | D12  |
| S13                           | D13  |
| S14                           | D14  |
| S15                           | D15  |
| S16                           | D16  |
| S17                           | D17  |
| S18                           | D18  |
| S19                           | D19  |
| S20                           | D20  |
| S21                           | D21  |
| S22                           | D22  |
| S23                           | D23  |
| S24                           | D24  |
| S25                           | D25  |
| S26                           | D26  |
| S27                           | D27  |
| S28                           | D28  |
| S29                           | D29  |
| S30                           | D30  |
| S31                           | D31  |
| S32                           | D32  |
| S33                           | D33  |
| S34                           | D34  |
| S35                           | D35  |
| S36                           | D36  |
| S37                           | D37  |
| S38                           | D38  |
| S39                           | D39  |
| S40                           | D40  |
| S41                           | D41  |
| S42                           | D42  |
| S43                           | D43  |
| S44                           | D44  |
| S45                           | D45  |
| S46                           | D46  |
| S47                           | D47  |
| S48                           | D48  |
| S49                           | D49  |
| S50                           | D50  |
| S51                           | D51  |
| S52                           | D52  |
| S53                           | D53  |
| S54                           | D54  |
| S55                           | D55  |
| S56                           | D56  |
| S57                           | D57  |
| S58                           | D58  |
| S59                           | D59  |
| S60                           | D60  |
| S61                           | D61  |
| S62                           | D62  |
| S63                           | D63  |

| Output Pin <sup>(Note23)</sup> | COM1 |
|--------------------------------|------|
| CLKIO/S64                      |      |
| SYNCIO/S65                     |      |
| S66/TESTIN                     | D64  |
| COM5/S67                       | D65  |
| COM4/S68                       | D66  |
| COM3/S69                       | D67  |
| COM2/S70                       | D68  |
| COM1/S71                       | D69  |
| S72                            | D70  |
| OSC IN/S73                     | D71  |

(Note 23) The Segment Output Port function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9.  
Also, CLKIO/S64 and SYNCIO/S65 pins are used as SYNC and CLK inputs.

To illustrate further, the states of the S21 output pin is given in the table below.

| Display Data<br>D21 | State of S21Output Pin                    |
|---------------------|-------------------------------------------|
| 0                   | LCD Segment corresponding to COM1 is OFF. |
| 1                   | LCD Segment corresponding to COM1 is ON.  |

## Serial Data Output

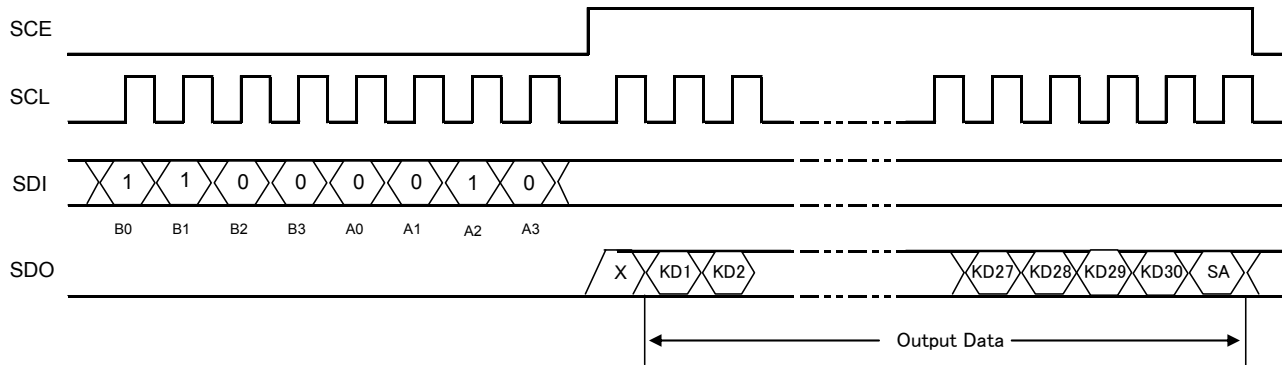
1. When SCL is stopped at the low level<sup>(Note24)</sup>

Figure 15. Serial Data Output Format

(Note24)

1. X=Don't care
2. B0 to B3, A0 to A3: Serial Interface address

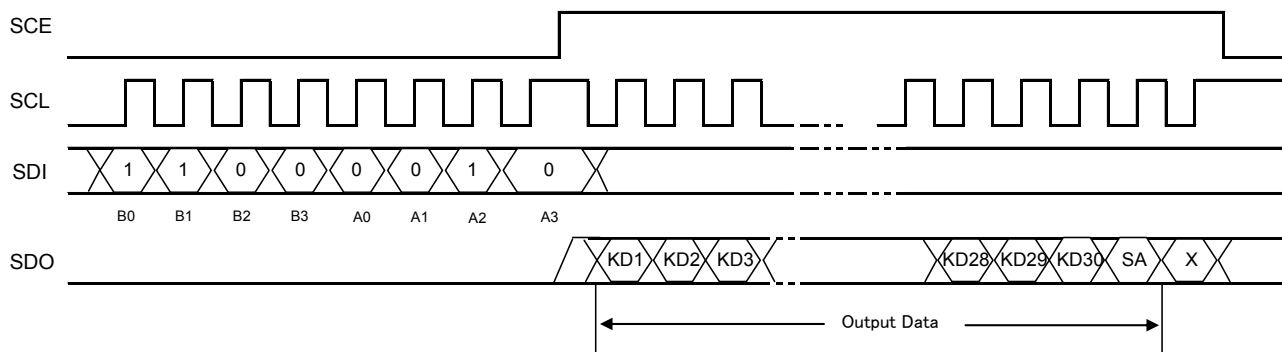
2. When SCL is stopped at the high level<sup>(Note25)</sup>

Figure 16. Serial Data Output Format

(Note25)

1. X=Don't care
2. B0 to B3, A0 to A3: Serial Interface address
3. Serial Interface address: 43H
4. KD1 to KD30: Key data
5. SA: Sleep acknowledge data
6. If a key data read operation is executed when SDO is high, the read key data (KD1 to KD30) and sleep acknowledge data (SA) will be invalid.

## Output Data

### 1.KD1 TO KD30: KEY DATA

When a key matrix of up to 30 keys is formed from the KS1 to KS6 output pins and the KI1 to KI5 input pins and one of those keys are pressed, the key output data corresponding to that key will be set to 1. The table shows the relationship between those pins and the key data bits.

| Item | KI1  | KI2  | KI3  | KI4  | KI5  |
|------|------|------|------|------|------|
| KS1  | KD1  | KD2  | KD3  | KD4  | KD5  |
| KS2  | KD6  | KD7  | KD8  | KD9  | KD10 |
| KS3  | KD11 | KD12 | KD13 | KD14 | KD15 |
| KS4  | KD16 | KD17 | KD18 | KD19 | KD20 |
| KS5  | KD21 | KD22 | KD23 | KD24 | KD25 |
| KS6  | KD26 | KD27 | KD28 | KD29 | KD30 |

### 2.SA: Sleep Acknowledge Data

This output data is set to the state when the key is pressed. In that case SDO will go to the low level. If serial data is input during this period and the mode is set (normal mode or sleep mode), the IC will be set to that mode. SA is set to 1 in the sleep mode and to 0 in the normal mode.

## Sleep Mode

Sleep mode is set up by setting the BU0 to BU2 in the control data to 1. The segment outputs will all go low and the common outputs will also go low, and the oscillator on the OSC pin will stop (it will be started by a key press). This reduces power dissipation. This mode is cleared by sending control data with all the BU0 to BU2 set to 0. However, note that the S1/P1/G1 to S9/P9/G9 outputs can be used as general-purpose output ports according to the state of the P0 to P3 control data bits, even in sleep mode. (See Control Data Functions.)

## Key Scan Operation Functions

### 1.Key Scan Timing

The key scan period is 4608T(s). To reliably determine the on/off state of the keys, the BU97540KV-M scans the keys twice and determines that a key has been pressed when the key data agrees. It outputs a key data read request (a low level on SDO) 9840T(s) after starting a key scan. If the key data does not agree and a key was pressed at that point, it scans the keys again. Thus the BU97540KV-M cannot detect a key press shorter than 9840T(s).

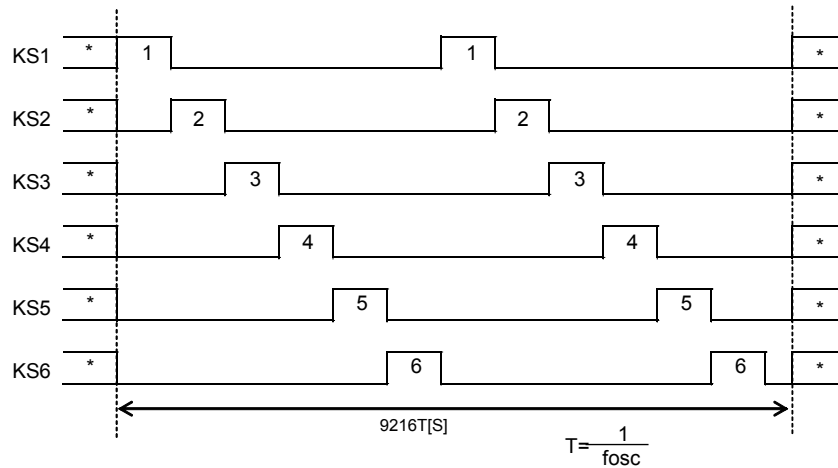


Figure 17. Key Scan Timing<sup>(Note26)</sup>

(Note26) In sleep mode, the high/low state of these pins is determined by the BU0 to BU2 bits in the control data. Key scan output signals are not output from pins that are set "L".

### 2.In Normal Mode

The pins KS1 to KS6 are set "H".

When a key is pressed a key scan is started and the keys are scanned until all keys are released. Multiple key presses are recognized by determining whether multiple key data bits are set.

If a key is pressed for longer than 9840T(s) (Where  $T=1/f_{osc}$ ) the BU97540KV-M outputs a key data read request (a low level on SDO) to the controller. The controller acknowledges this request and reads the key data. However, if SCE is high during a serial data transfer, SDO will be set high.

After the controller reads the key data, the key data read request is cleared (SDO is set high) and the BU97540KV-M performs another key scan. Also note that SDO, being an open-drain output, requires a pull-up resistor (between 1 and 10KΩ).

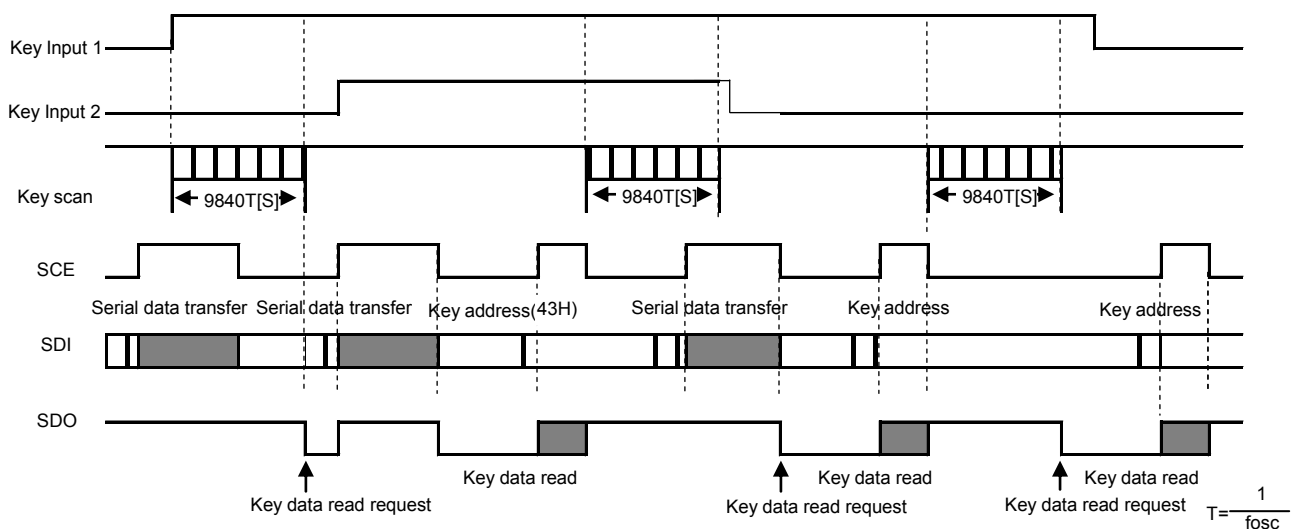


Figure 18. Key scan operation in normal mode

### 3. In Sleep Mode

The pins KS1 to KS6 are set to high or low by the BU0 to BU2 bits in the control data. (See the control data description for details.)

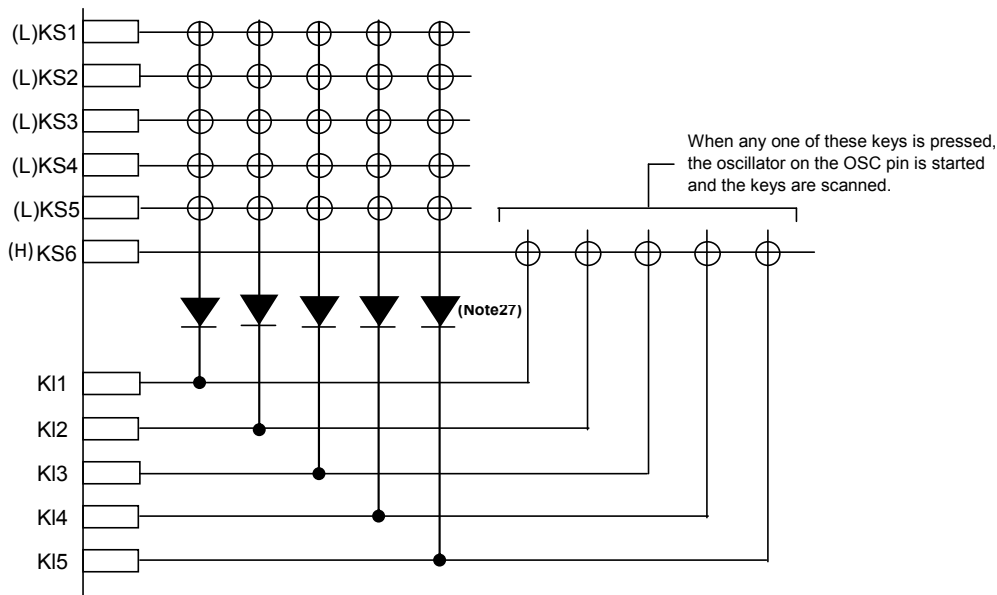
If a key on one of the lines corresponding to a KS1 to KS6 pin which is set high is pressed, the oscillator on the OSC pin is started and a key scan is performed. Keys are scanned until all keys are released. Multiple key presses are recognized by determining whether multiple key data bits are set.

If a key is pressed for longer than  $9840T(s)$  (Where  $T=1/f_{osc}$ ) the BU97540KV-M outputs a key data read request (a low level on SDO) to the controller. The controller acknowledges this request and reads the key data. However, if SCE is high during a serial data transfer, SDO will be set high.

After the controller reads the key data, the key data read request is cleared (SDO is set high) and the BU97540KV-M performs another key scan. However, this does not clear sleep mode. Also note that SDO, being an open-drain output, requires a pull-up resistor (between 1 and 10K $\Omega$ ).

Sleep mode key scan example

Example: BU0=0, BU1=0, BU2=1 (sleep with only KS6 high)



(Note 27)

These diodes are required to reliably recognize multiple key presses on the KS6 line when sleep mode state with only KS6 high, as in the above example. That is, these diodes prevent incorrect operations due to sneak currents in the KS6 key scan output signal when keys on the KS1 to KS5 lines are pressed at the same time.

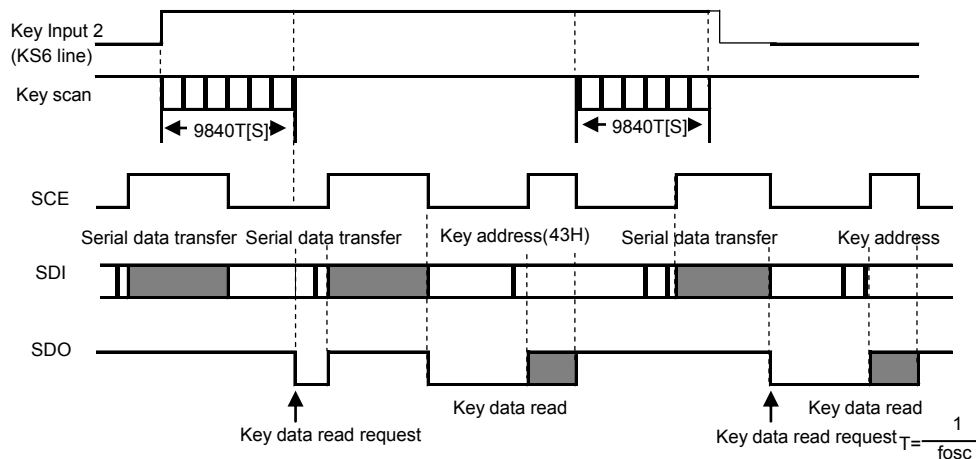


Figure 19. Key scan operation in sleep mode

### Multiple Key Presses

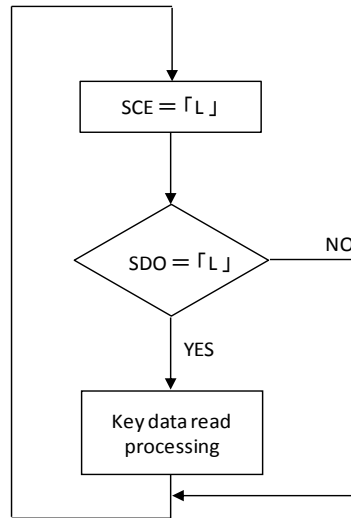
Although the BU97540KV-M is capable of key scanning without inserting diodes for dual key presses, triple key presses on the KI1 to KI5 input pin lines, or multiple key presses on the KS1 to KS6 output pin lines, multiple presses other than these cases may result in keys that were not pressed recognized as having been pressed. Therefore, a diode must be inserted in series with each key. Applications that do not recognize multiple key presses of three or more keys should check the key data for three or more 1 bit and ignore such data.

### Controller Key Data Read Techniques

When the controller receives a key data read request from BU97540KV-M, it performs a key data read acquisition operation using either the Timer Based Key Data Acquisition or the Interrupt Based Key Data Acquisition.

#### Timer Based Key Data Acquisition Technique

Under the Timer Based Key Data Acquisition Technique, the controller uses a timer to determine the states of the keys (ON or OFF) and read the key data. Please refer to the flowchart below.



Key data read processing: Refer to “Serial Data Output”

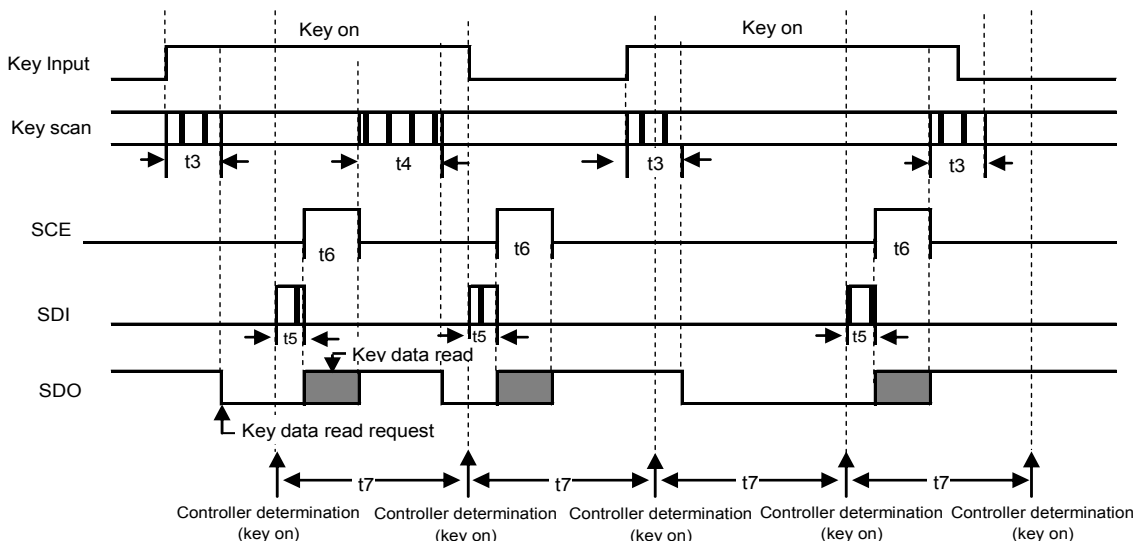
Figure 20. Flowchart

In this technique, the controller uses a timer to determine key on/off states and read the key data. The controller must check the SDO state when SCE is low every  $t_7$  period without fail. If SDO is low, the controller recognizes that a key has been pressed and executes the key data read operation.

The period  $t_7$  in this technique must satisfy the following condition.

$$T_7 > t_4 + t_5 + t_6$$

If a key data read operation is executed when SDO is high, the read key data (KD1 to KD20) and sleep acknowledge data (SA) will be invalid.



$t_3$ : Key scan execution time when the key data agreed for two key scans. (9904T(s))

$t_4$ : Key scan execution time when the key data did not agree for two key scans and the key scan was executed again.

(19808T(s))  $T = 1 / f_{osc}$

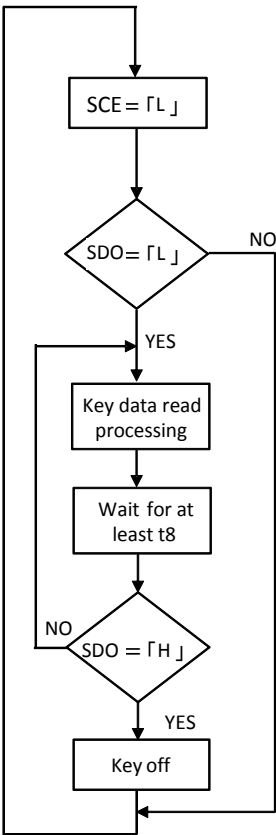
$t_5$ : Key address (43H) transfer time

$t_6$ : Key data read time

Figure 21. Timer based key data read operation

Interrupt Based Key Data Acquisition Technique

Under the Interrupt Based Key Data Acquisition Technique, the controller uses interrupts to determine the state of the keys (ON or OFF) and read the key data. Please refer to the flow chart diagram below.

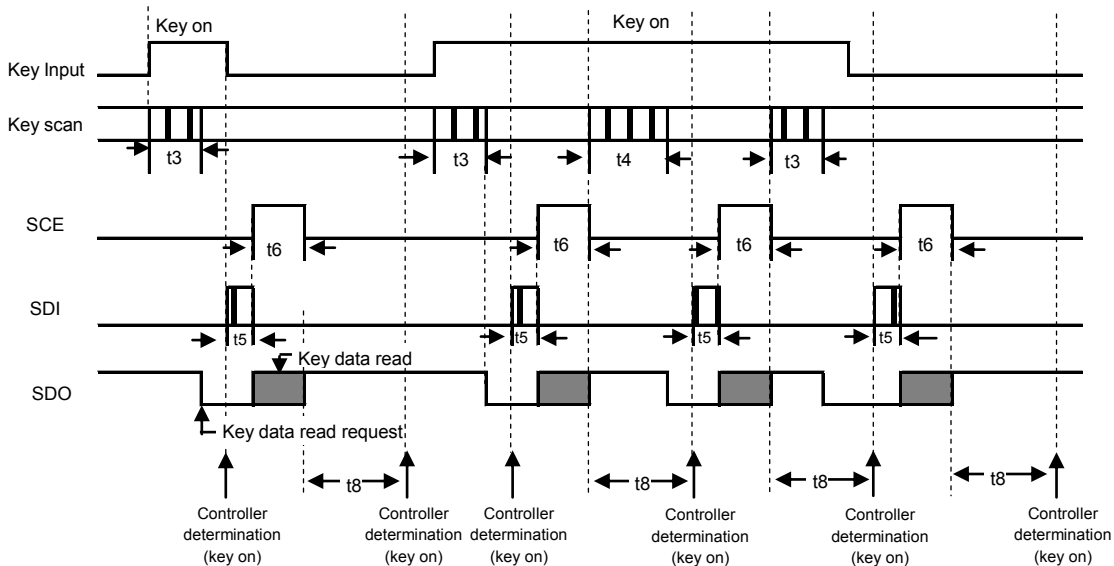


Key data read processing: Refer to “Serial Data Output”

Figure 22. Flowchart

In this technique, the controller uses interrupts to determine key on/off states and read the key data. The controller must check the SDO state when SCE is low. If SDO is low, the controller recognizes that a key has been pressed and executes the key data read operation. After that the next key on/off determination is performed after the time  $t_8$  has elapsed by checking the SDO state when SCE is low and reading the key data. The period  $t_8$  in this technique must satisfy  $t_8 > t_4$ .

If a key data read operation is executed when SDO is high, the read key data (KD1 to KD20) and sleep acknowledge data (SA) will be invalid.



$t_3$ : Key scan execution time when the key data agreed for two key scans. (9904T(s))

$t_4$ : Key scan execution time when the key data did not agree for two key scans and the key scan was executed again. (19808T(s))  $T = 1 / f_{osc}$

$t_5$ : Key address (43H) transfer time

$t_6$ : Key data read time

Figure 23. Interrupt Based Key Data Read Operation

## LCD Driving Waveforms

## 1. Line Inversion 1/5-Duty 1/3-Bias Drive Scheme

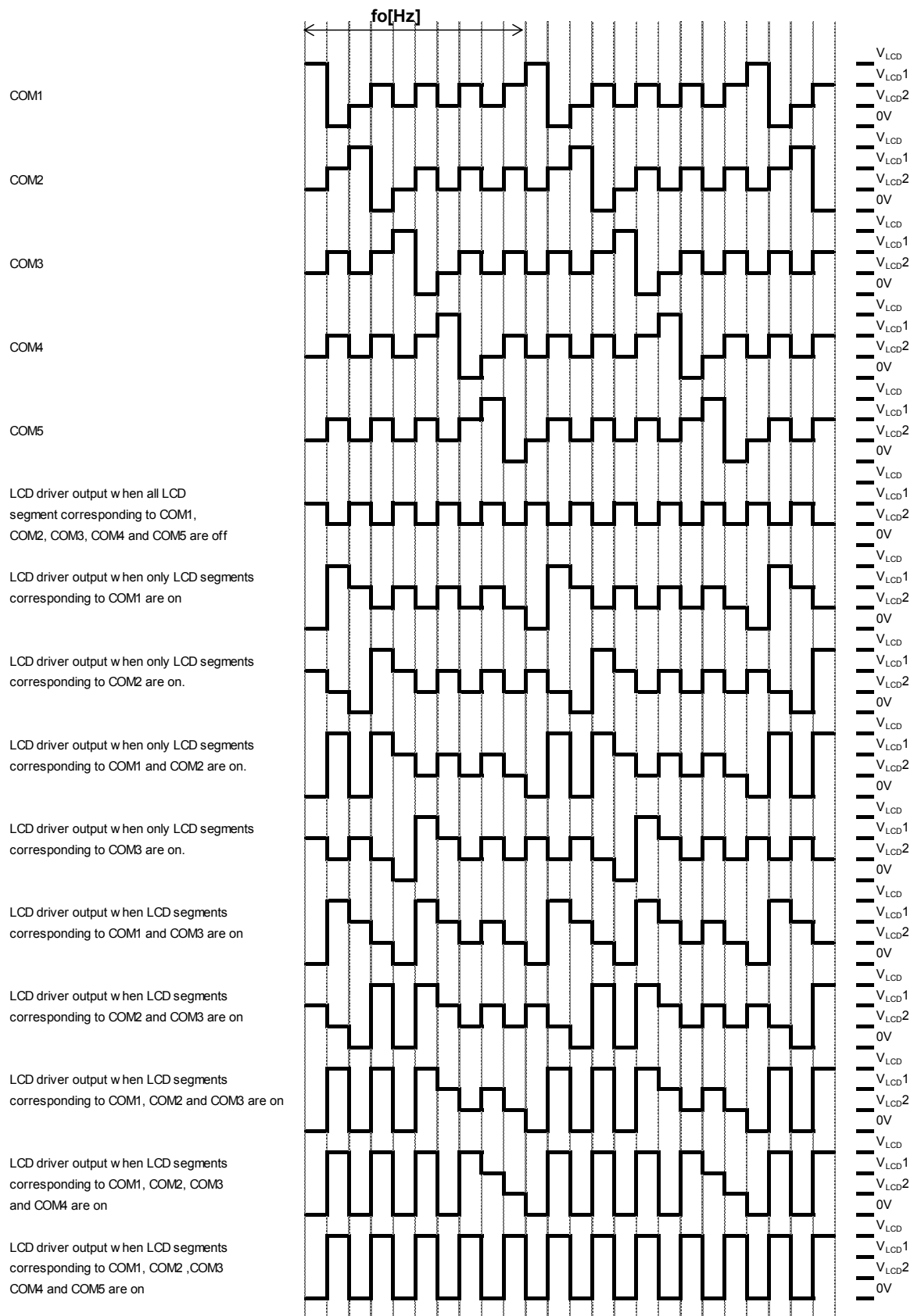


Figure 24. LCD Waveform (Line Inversion, 1/5 DUTY, 1/3 BIAS)

## 2. Line Inversion 1/5-Duty 1/2-Bias Drive Scheme

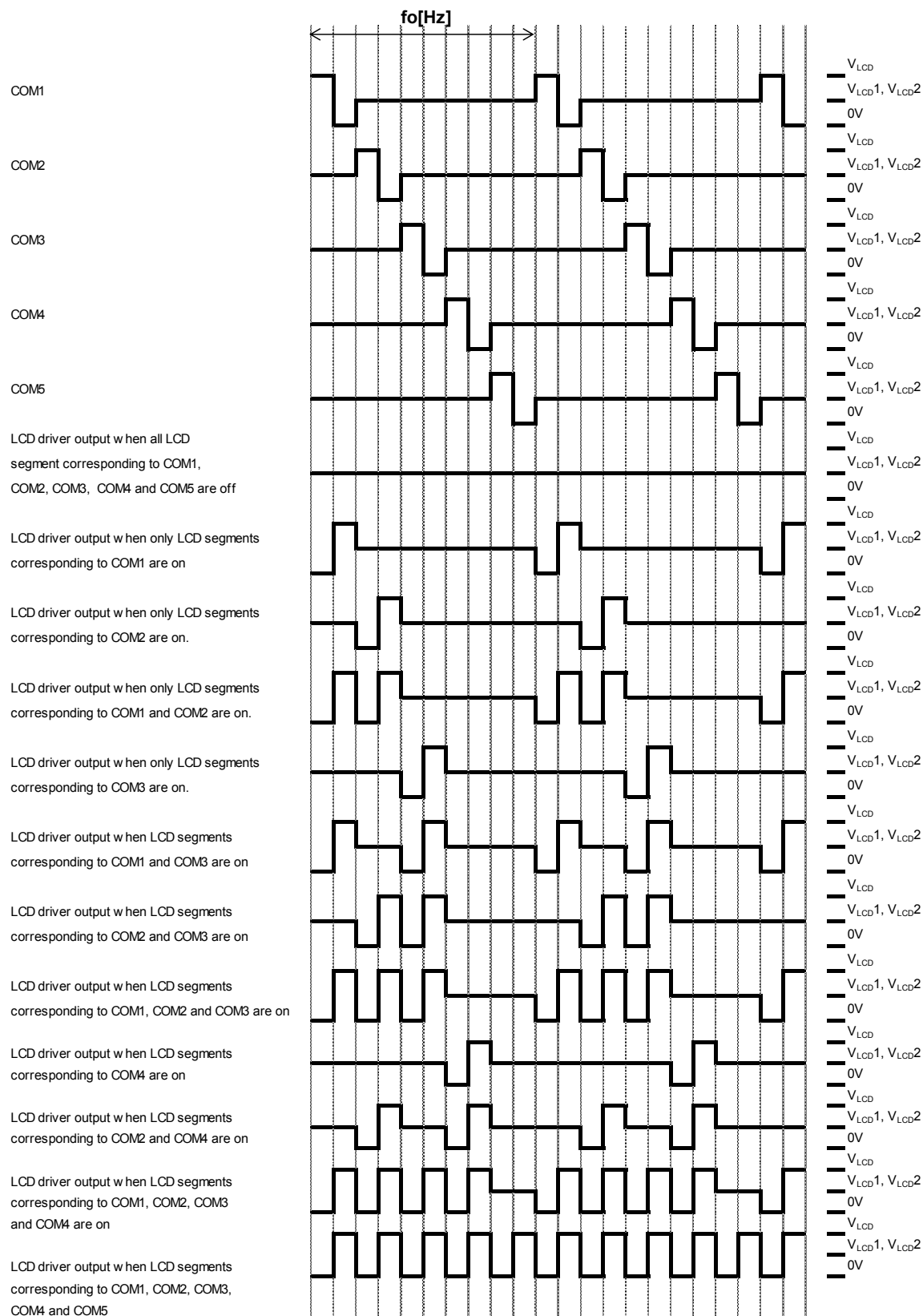


Figure 25. LCD Waveform (Line Inversion, 1/5 DUTY, 1/2 BIAS)

3. Line Inversion 1/4-Duty 1/3-Bias Drive Scheme

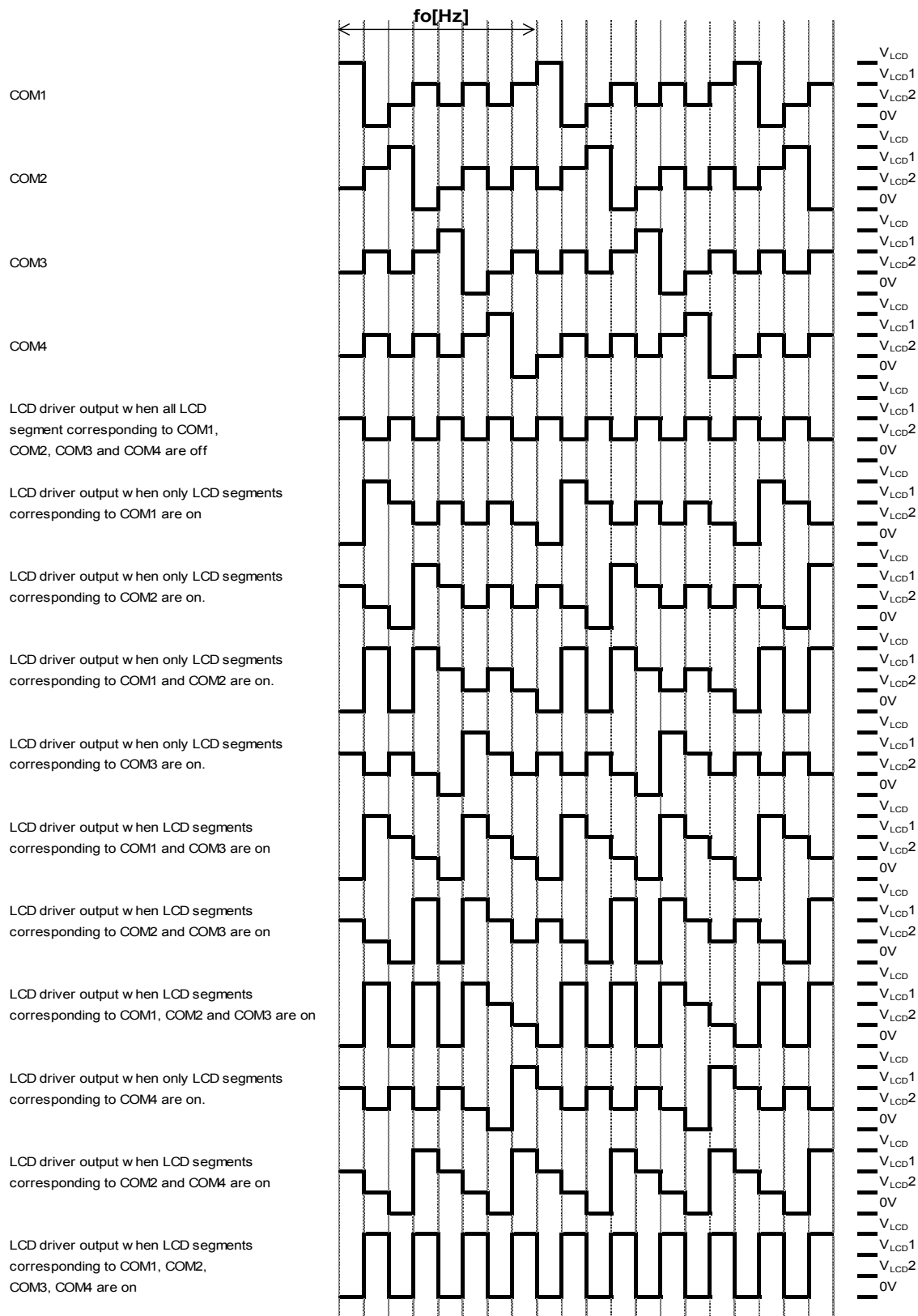


Figure 26. LCD Waveform (Line Inversion, 1/4 DUTY, 1/3 BIAS)

#### 4. Line Inversion 1/4-Duty 1/2-Bias Drive Scheme

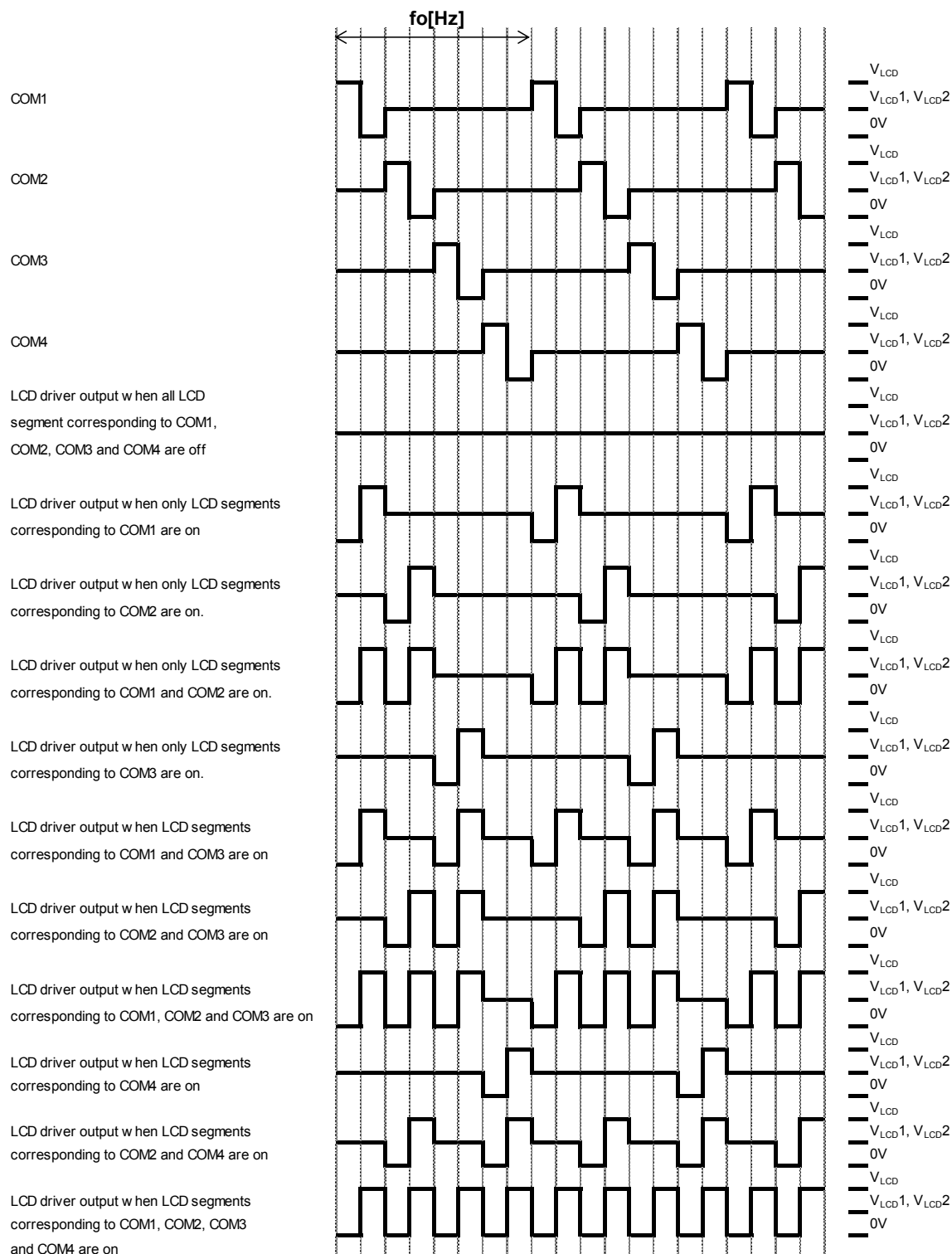


Figure 27. LCD Waveform (Line Inversion, 1/4 DUTY, 1/2 BIAS)

5. Line Inversion 1/3-Duty 1/3-Bias Drive Scheme

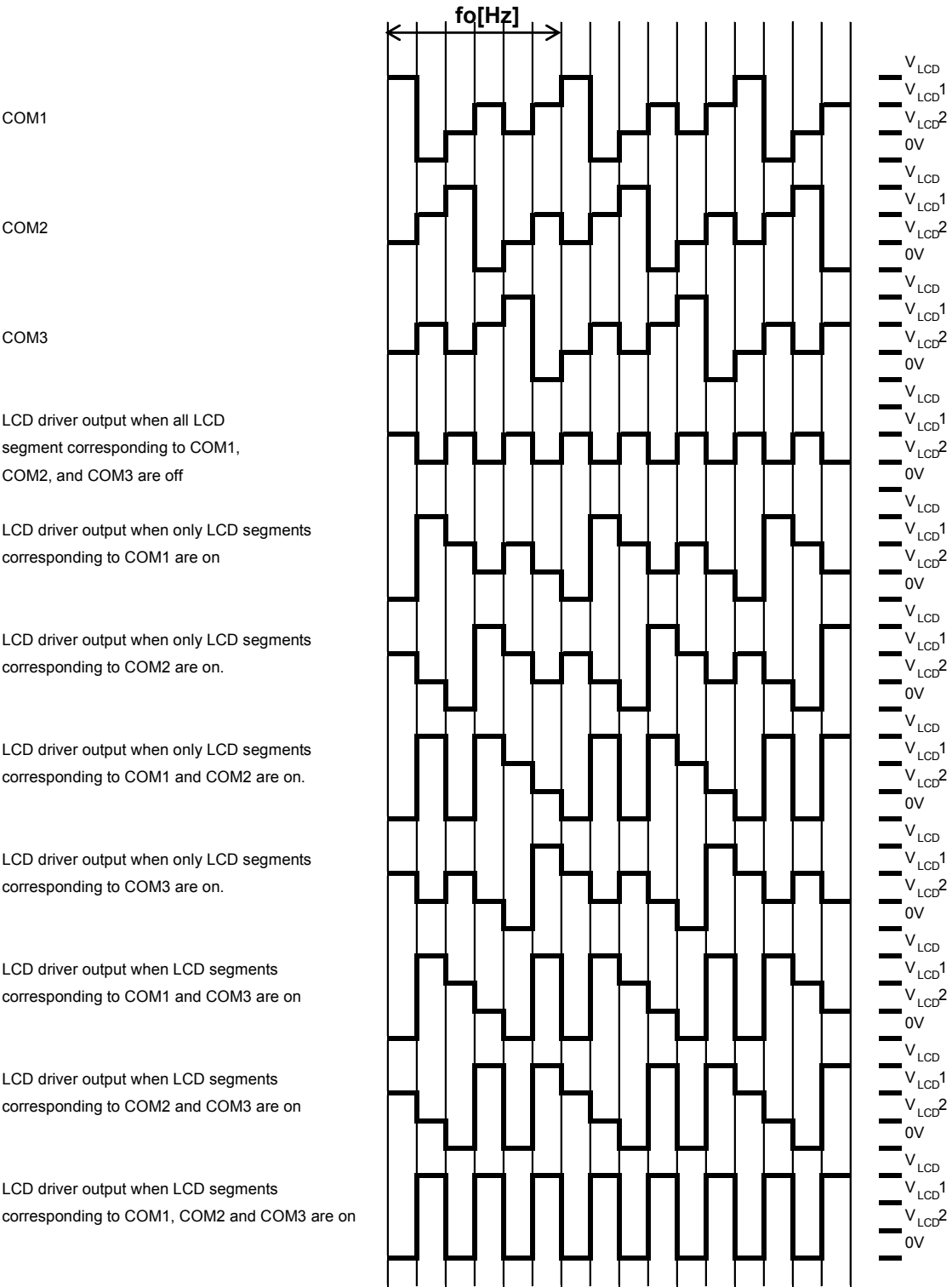


Figure 28. LCD Waveform (Line Inversion, 1/3 DUTY, 1/3 BIAS) (Note28)

(Note28) COM4 function is same as COM1 at 1/3 duty.

6. Line Inversion 1/3-Duty 1/2-Bias Drive Scheme

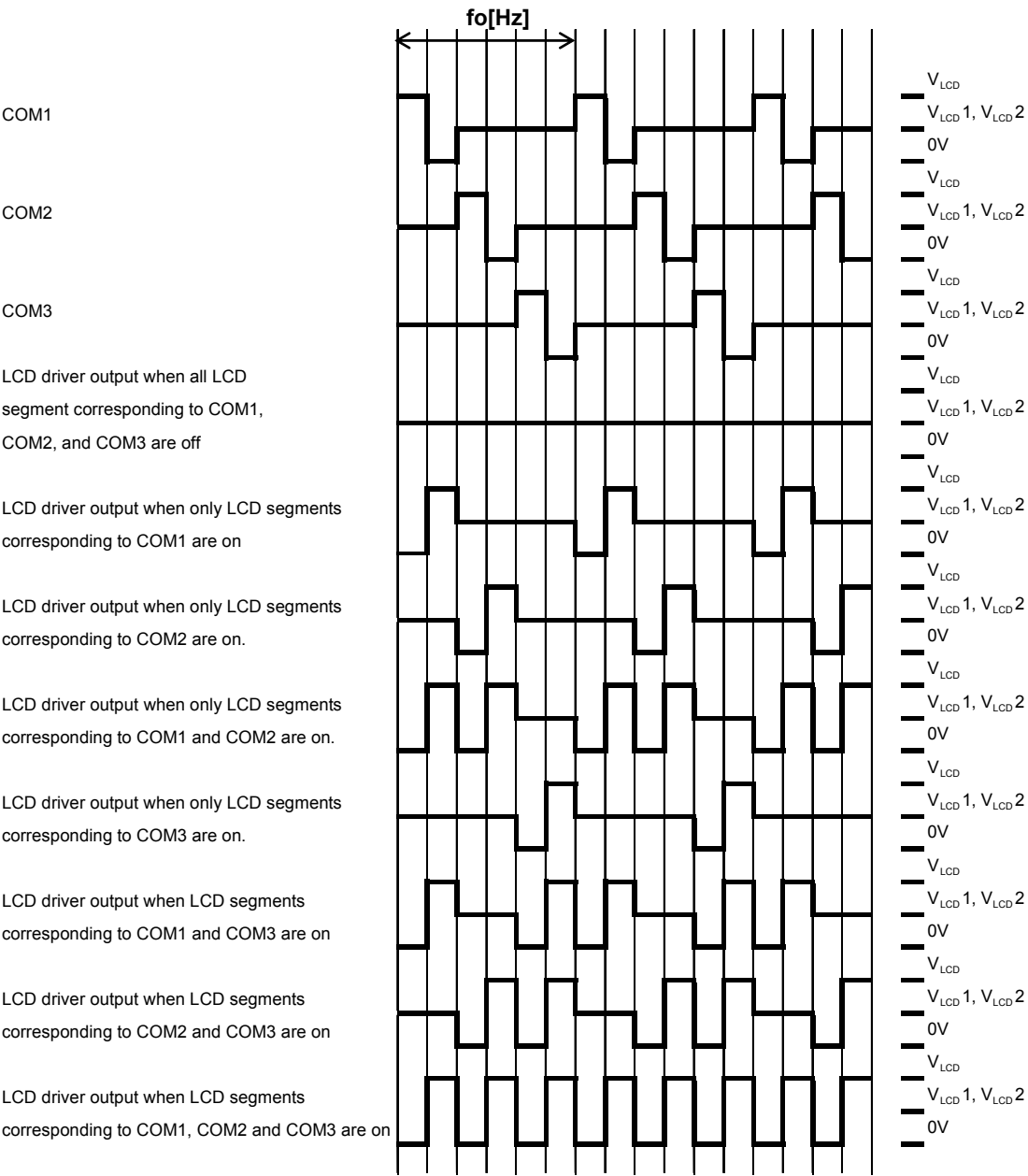


Figure 29. LCD Waveform (Line Inversion, 1/3 DUTY, 1/2 BIAS) <sup>(Note29)</sup>

(Note29) COM4 function is same as COM1 at 1/3 duty.

7. Line Inversion 1/1-Duty [Static] Drive Scheme

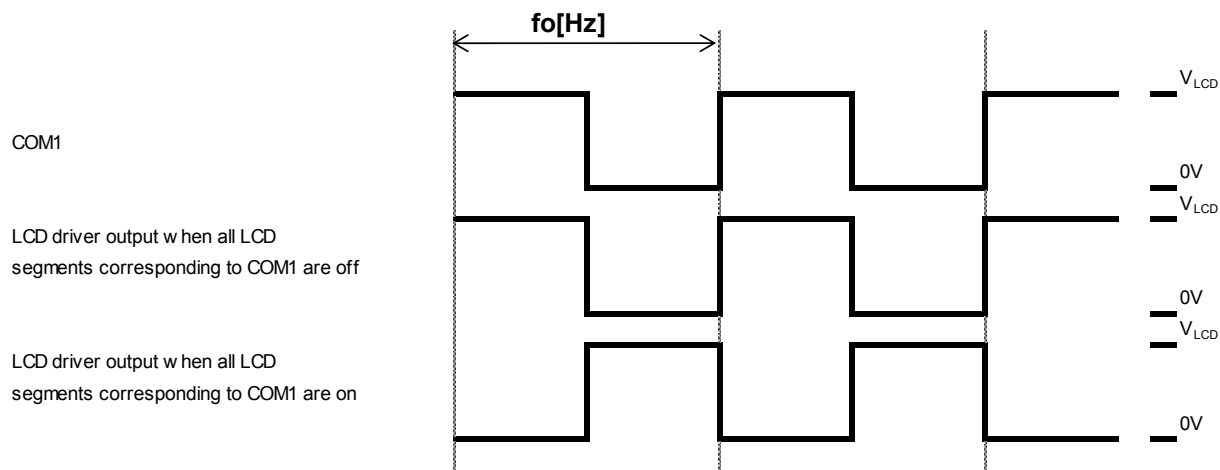


Figure 30. LCD Waveform (Line Inversion, 1/1 DUTY) (Note30)

(Note30) COM2, COM3 and COM4 function are same as COM1 at 1/1 duty.

8. Frame Inversion 1/5-Duty 1/3-Bias Drive Scheme

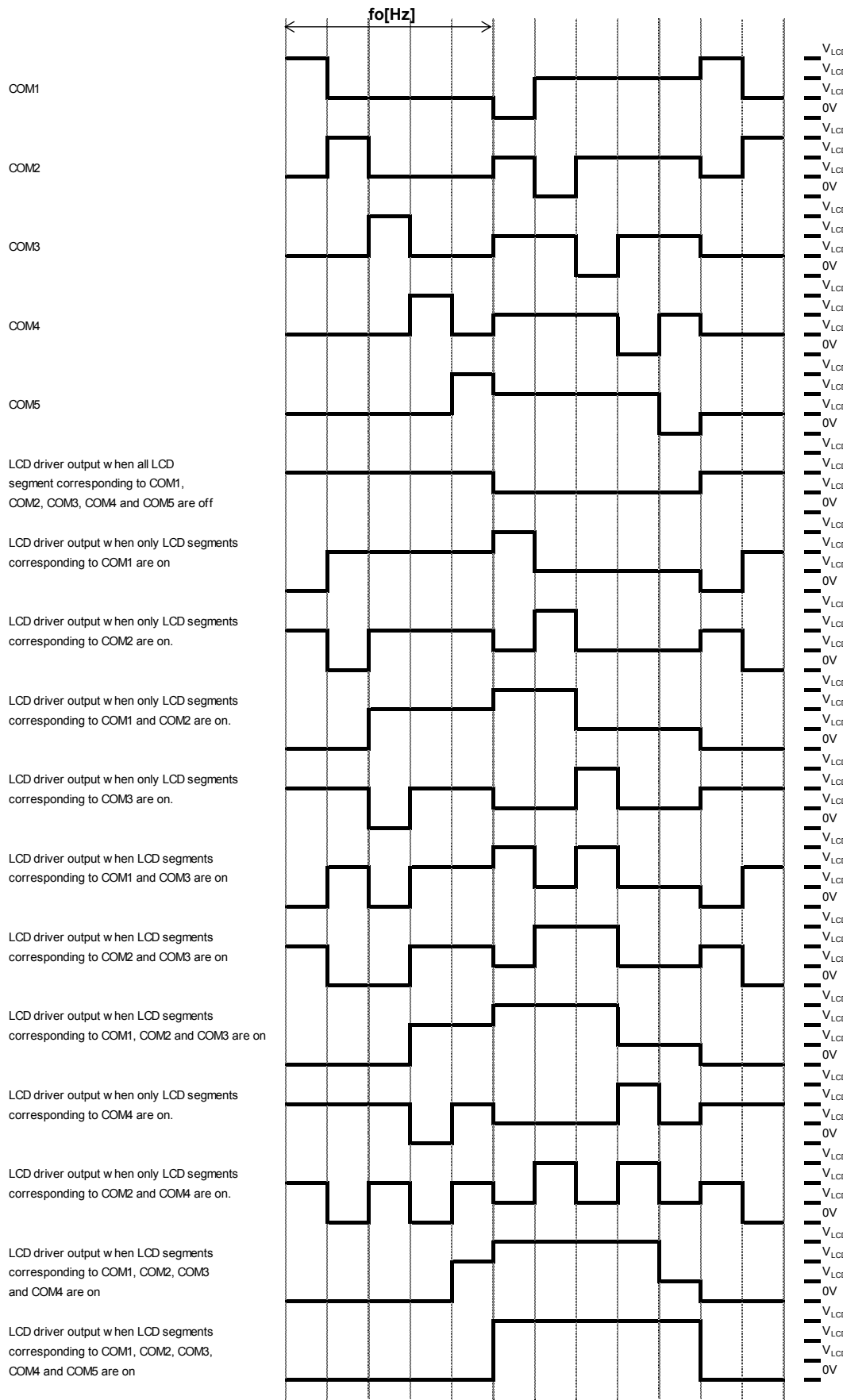


Figure 31. LCD Waveform (Frame Inversion, 1/5 DUTY, 1/3BIAS)

## 9. Frame Inversion 1/5-Duty 1/2-Bias Drive Scheme

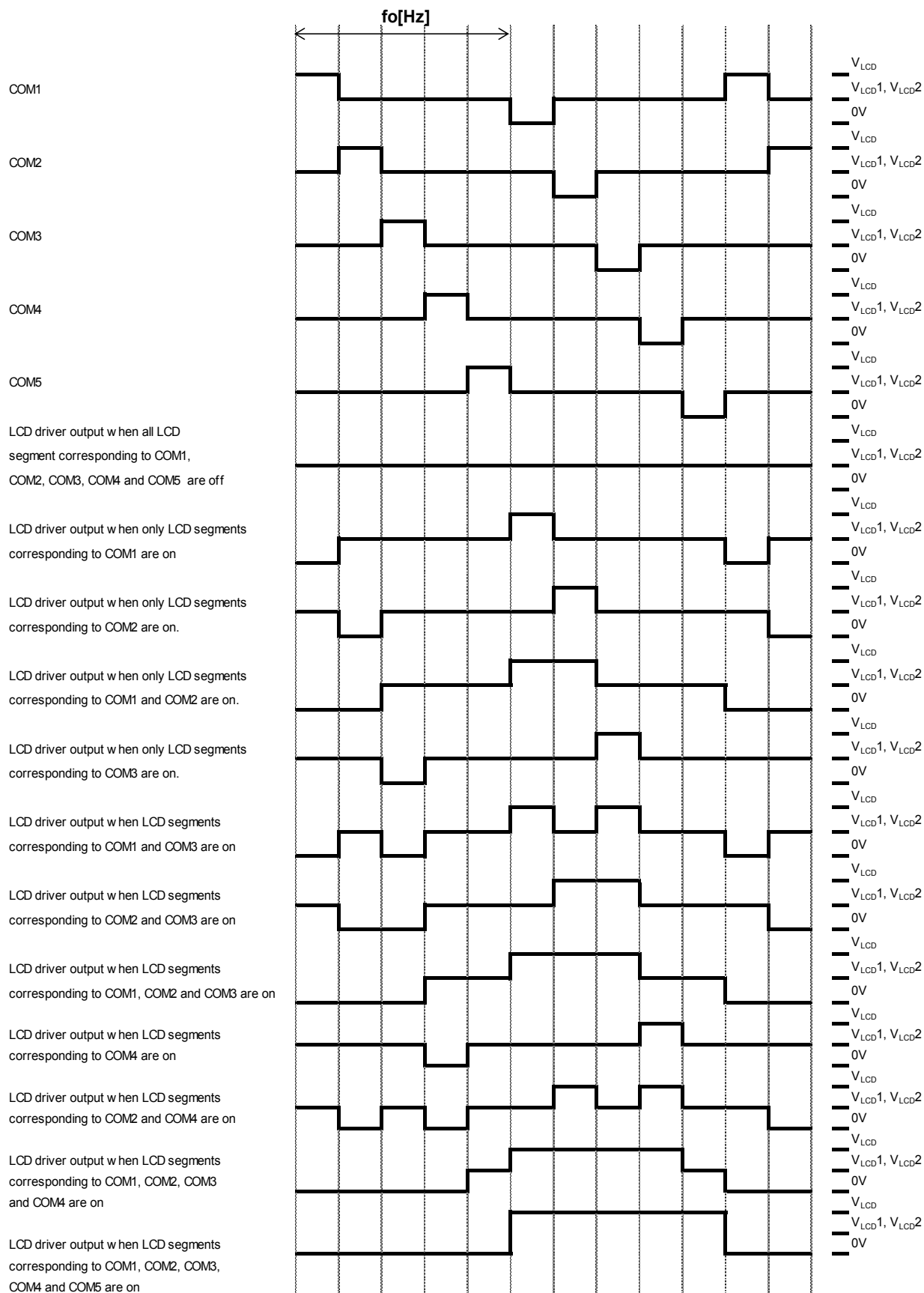


Figure 32. LCD Waveform (Frame Inversion, 1/5 DUTY, 1/2BIAS)

10. Frame Inversion 1/4-Duty 1/3-Bias Drive Scheme

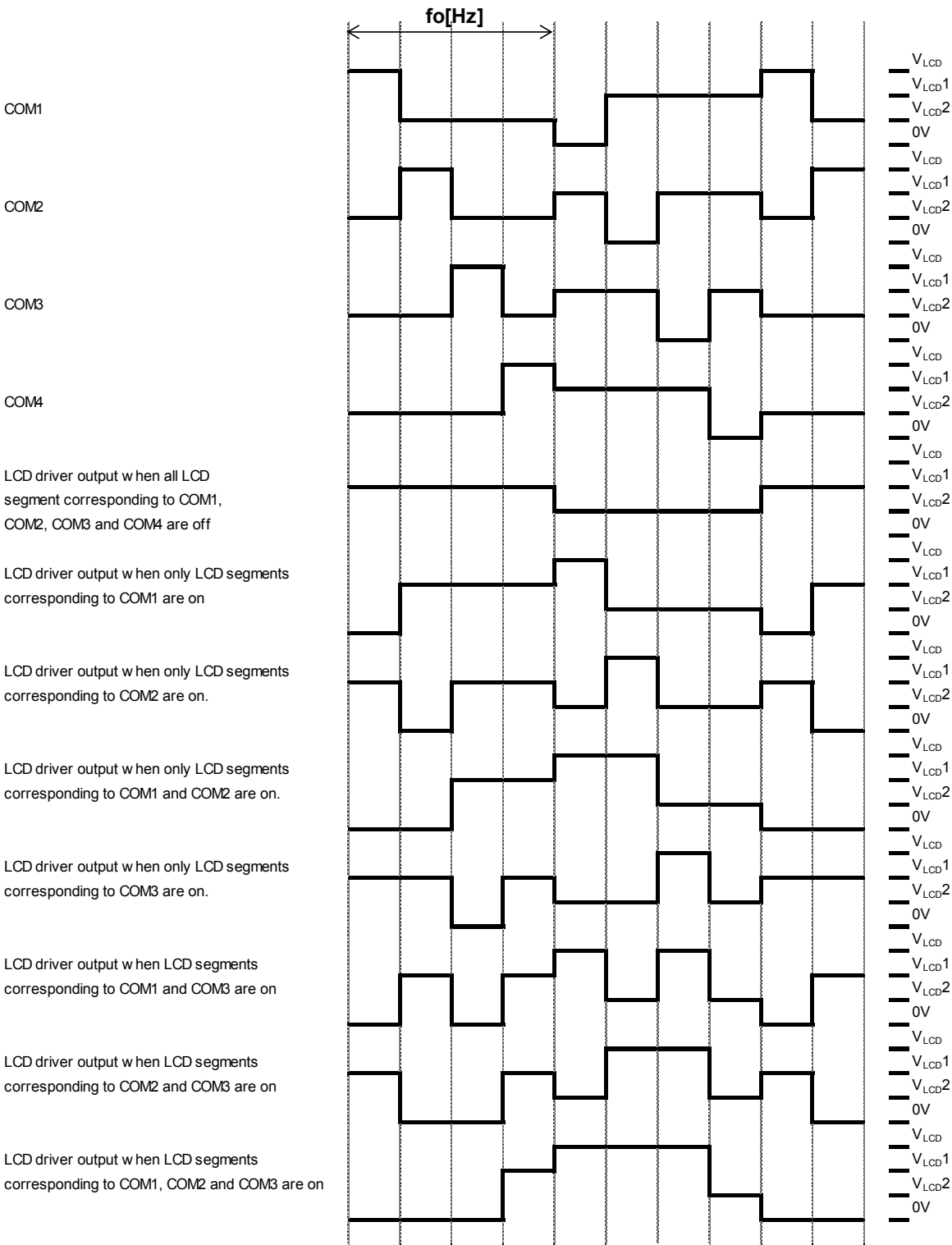


Figure 33. LCD Waveform (Frame Inversion, 1/4 DUTY, 1/3BIAS)

11. Frame Inversion 1/4-Duty 1/2-Bias Drive Scheme

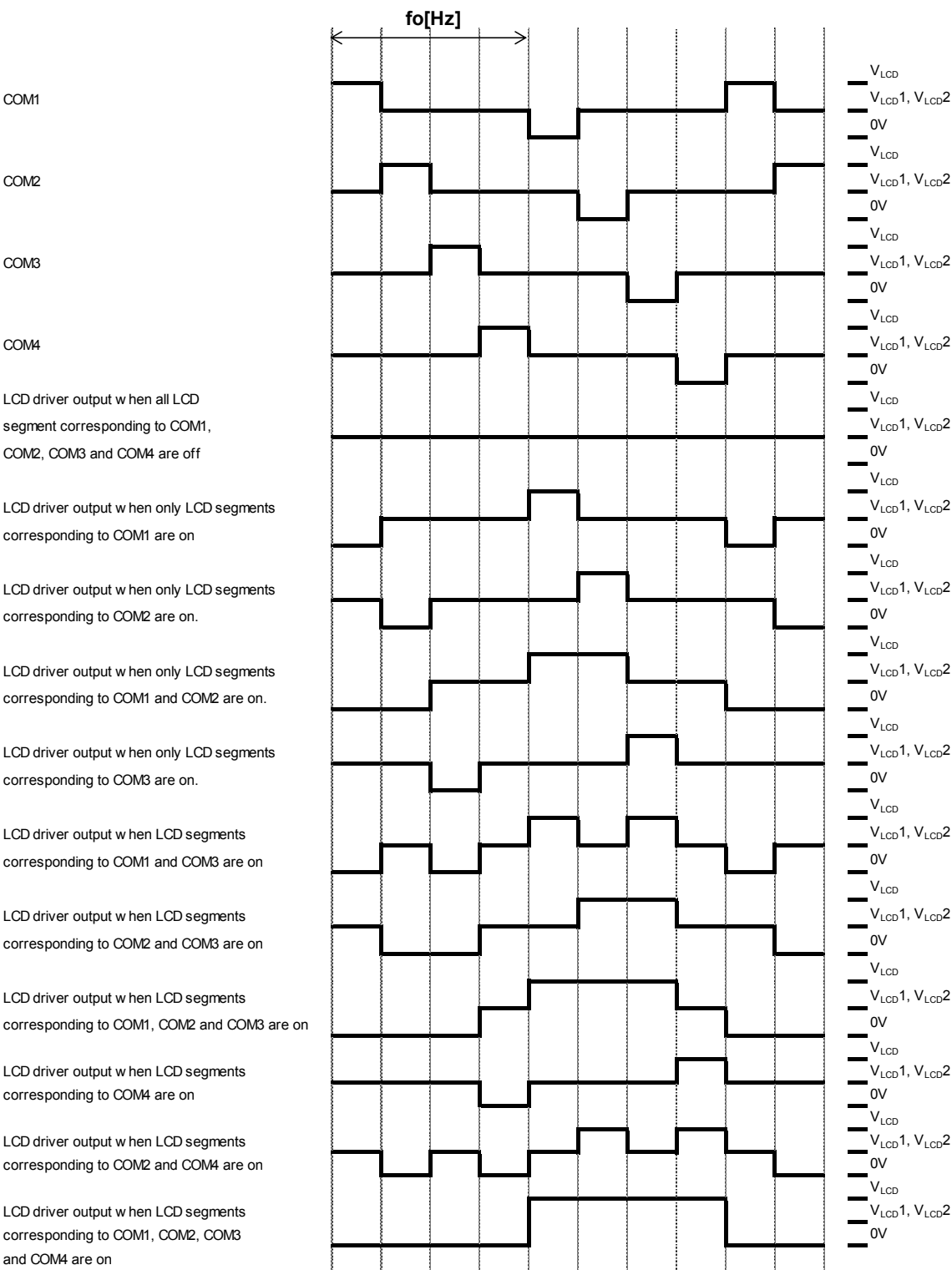


Figure 34. LCD Waveform (Frame Inversion, 1/4 DUTY, 1/2BIAS)

12. Frame Inversion 1/3-Duty 1/3-Bias Drive Scheme

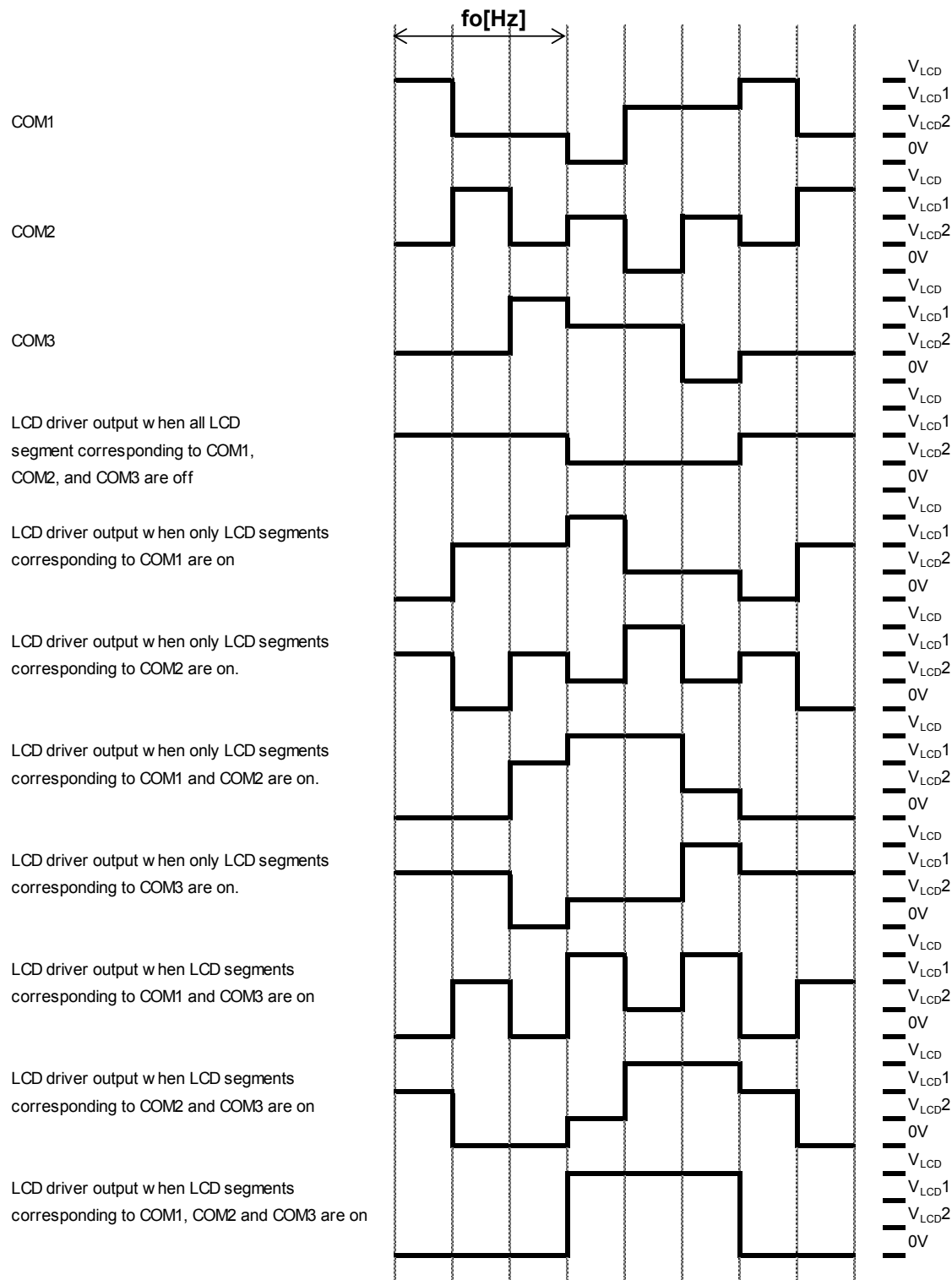


Figure 35. LCD Waveform (Frame Inversion, 1/3 DUTY, 1/3BIAS) (Note31)

(Note31) COM4 function is same as COM1 at 1/3 duty.

13. Frame Inversion 1/3-Duty 1/2-Bias Drive Scheme

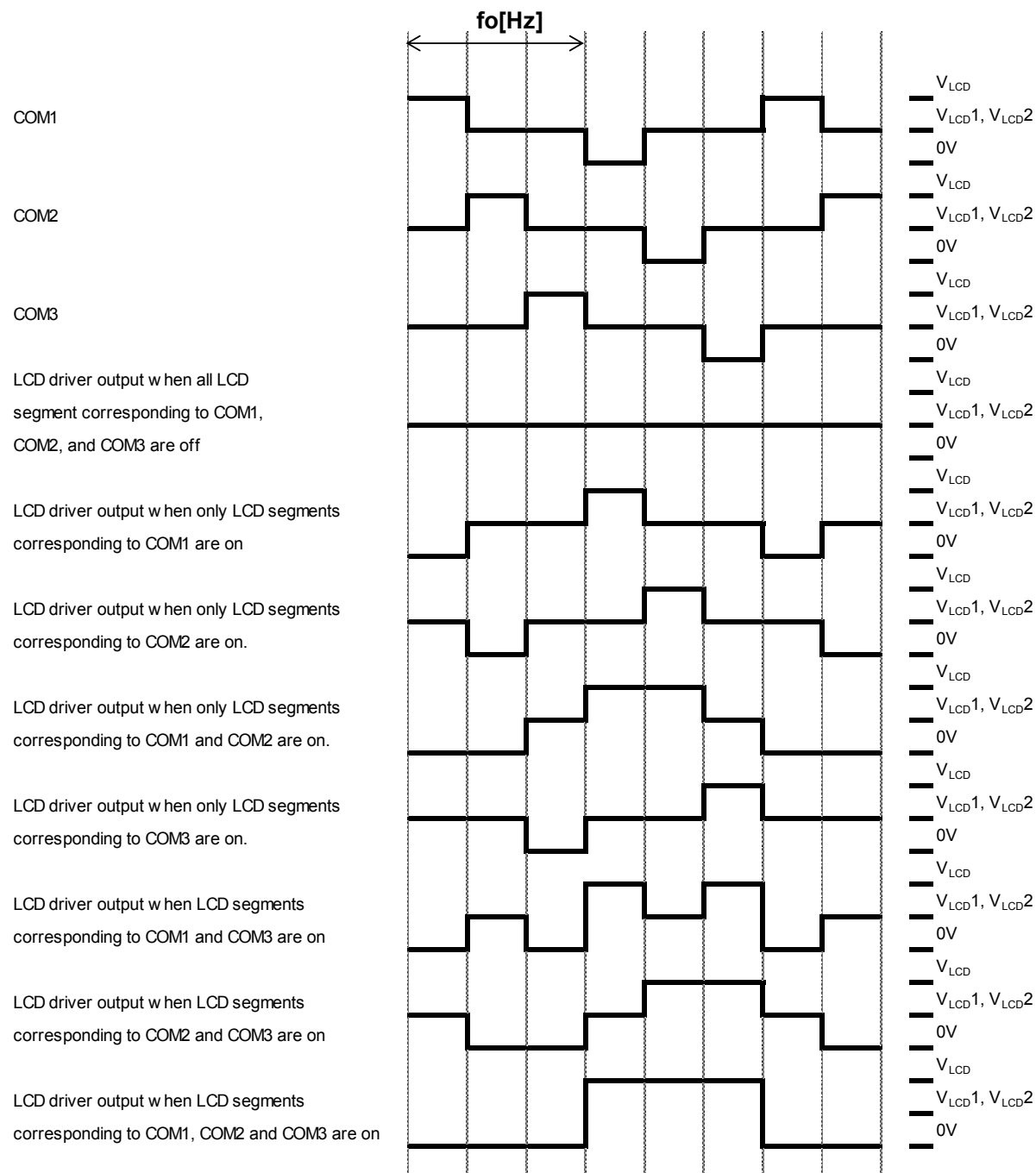


Figure 36. LCD Waveform (Frame Inversion, 1/3 DUTY, 1/2 BIAS) <sup>(Note32)</sup>

(Note32) COM4 function is same as COM1 at 1/3 duty.

14. Frame Inversion 1/1-Duty [Static] Drive Scheme)

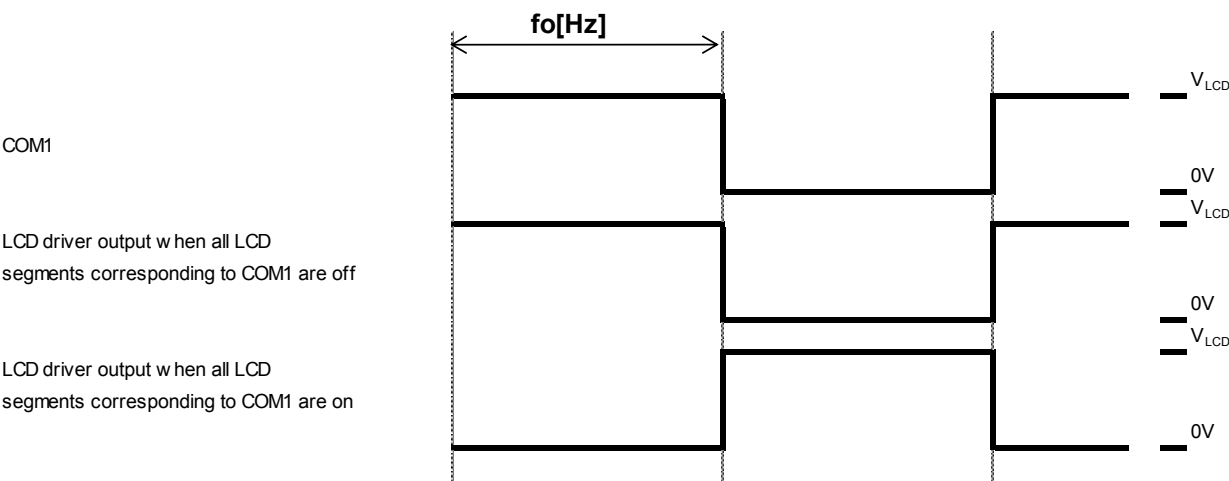


Figure 37. LCD Waveform (Frame Inversion, 1/1 DUTY) <sup>(Note33)</sup>

(Note33) COM2, COM3 and COM4 function are same as COM1 at 1/1 duty.

Oscillation Stabilization Time of the Internal Oscillation Circuit

It must be noted that the oscillation of the internal oscillation circuit is unstable for a maximum of 100μs (oscillation stabilization time) after oscillation has started.

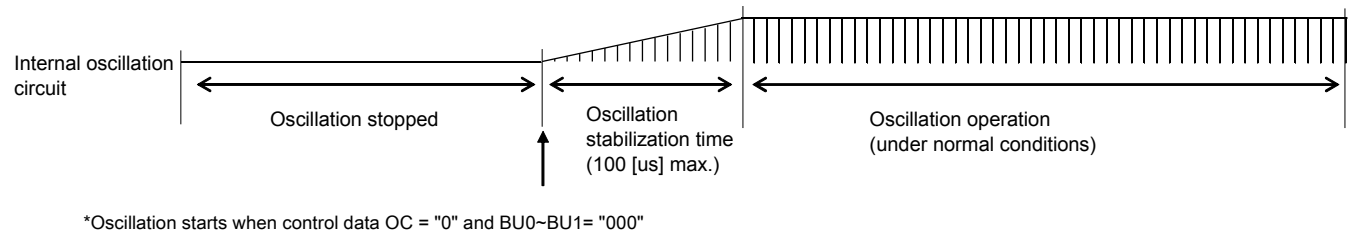


Figure 38. Oscillation Stabilization Time

### Voltage Detection Type Reset Circuit (VDET)

The Voltage Detection Type Reset Circuit generates an output signal that resets the system when power is applied for the first time and when the power supply voltage drops (that is, for example, the power supply voltage is less than or equal to the power down detection voltage (VDET = 1.8V typ.). To ensure that this reset function works properly, it is recommended that a capacitor be connected to the power supply line so that both the power supply voltage (VDD) rise time when power is first applied and the power supply voltage (VDD) fall time when the voltage drops are at least 1ms.

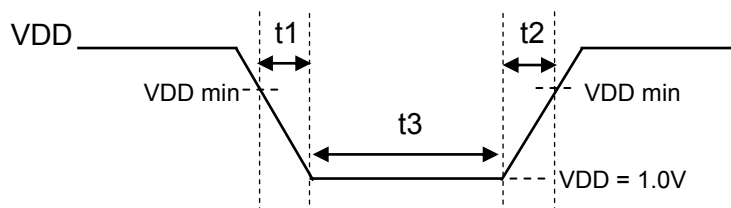


Figure 39. VDET Detection Timing

Power supply voltage VDD fall time:  $t1 > 1\text{ms}$   
 Power supply voltage VDD rise time:  $t2 > 1\text{ms}$   
 Internal reset power supply retain time:  $t3 > 1\text{ms}$

### Reset Condition

When BU97540KV-M is initialized, the internal status after power supply has been reset as the following table.

| Control Data Reset Condition |                                                            |
|------------------------------|------------------------------------------------------------|
| Instruction                  | At Reset Condition                                         |
| Key Scan Mode                | [KM0,KM1,KM2]=[1,1,1]:Keyscan no use                       |
| S1/P1/G1 to S9/P9/G9 Pin     | [P0,P1,P2,P3]=[0,0,0,0]:all segment output                 |
| Inversion Mode               | FL=0:Line Inversion                                        |
| LCD Bias                     | DR=0:1/3 bias                                              |
| LCD Duty                     | [DT0,DT1]=[0,1]:1/4 duty                                   |
| DISPLAY Frequency            | [FC0,FC1,FC2,FC3]=[0,0,0,0]:fosc/12288                     |
| Display Clock Mode           | OC=0:Internal oscillator                                   |
| LCD Display                  | SC=1:OFF                                                   |
| Power Mode                   | [BU0, BU1, BU2]=[1,1,1]:Power saving mode                  |
| PWM/GPO Output               | PGx=0:PWM output(x=1~9)                                    |
| PWM Frequency                | [PF0,PF1,PF2,PF3]=[0,0,0,0]: fosc /4096                    |
| PWM Duty                     | [Wn0~Wn8]=[0,0,0,0,0,0,0,0,0]:0/256)xTp<br>(n=1~9,Tp=1/fp) |
| Display Contrast Setting     | [CT0,CT1,CT2,CT3]=[0,0,0,0]:VLCD Level is 1.00*VDD         |

## Operational Notes

### 1. Reverse Connection of Power Supply

Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

### 2. Power Supply Lines

Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

### 3. Ground Voltage

Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

### 4. Ground Wiring Pattern

When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

### 5. Thermal Consideration

Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

### 6. Recommended Operating Conditions

These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

### 7. Inrush Current

When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

### 8. Operation Under Strong Electromagnetic Field

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

### 9. Testing on Application Boards

When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

### 10. Inter-pin Short and Mounting Errors

Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

**Operational Notes – continued****11. Unused Input Pins**

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

**12. Regarding the Input Pin of the IC**

In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements to operate, such as applying a voltage to an input pin lower than the ground voltage should be avoided. Furthermore, do not apply a voltage to the input pins when no power supply voltage is applied to the IC. Even if the power supply voltage is applied, make sure that the input pins have voltages within the values specified in the electrical characteristics of this IC.

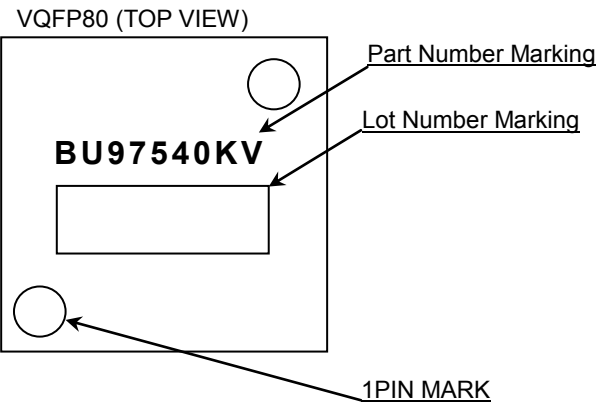
**13. Data transmission**

To refrain from data transmission is strongly recommended while power supply is rising up or falling down to prevent from the occurrence of disturbances on transmission and reception.

Ordering Information

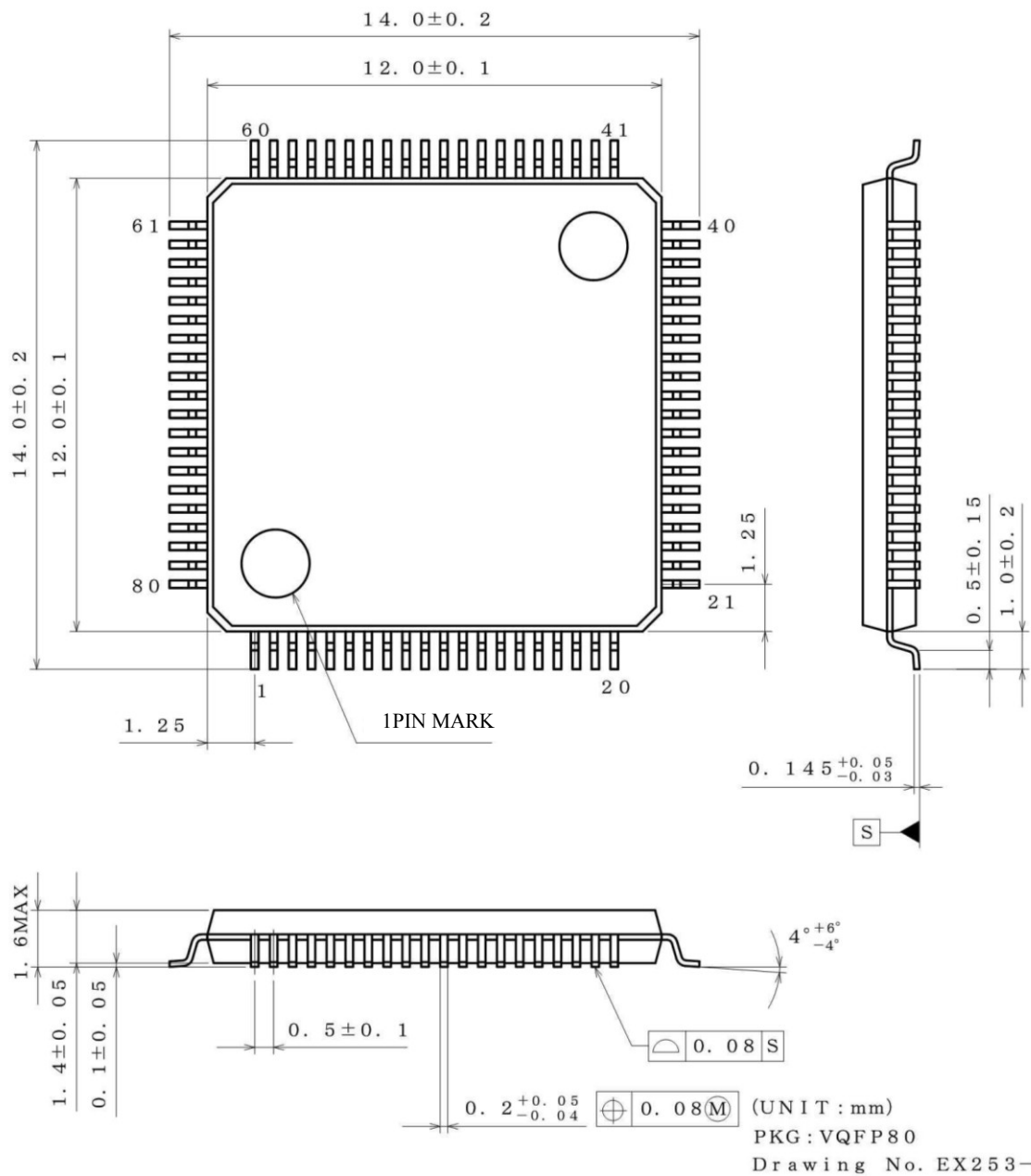
|                   |  |  |  |  |  |  |  |  |  |             |       |  |                            |  |  |
|-------------------|--|--|--|--|--|--|--|--|--|-------------|-------|--|----------------------------|--|--|
| B U 9 7 5 4 0 K V |  |  |  |  |  |  |  |  |  | -           | M E 2 |  |                            |  |  |
| Part Number       |  |  |  |  |  |  |  |  |  | Package     |       |  | Product Rank               |  |  |
|                   |  |  |  |  |  |  |  |  |  | KV : VQFP80 |       |  | M: for Automotive          |  |  |
|                   |  |  |  |  |  |  |  |  |  |             |       |  | Packaging Specification    |  |  |
|                   |  |  |  |  |  |  |  |  |  |             |       |  | E2: Embossed tape and reel |  |  |
|                   |  |  |  |  |  |  |  |  |  |             |       |  | (VQFP80)                   |  |  |

Marking Diagram



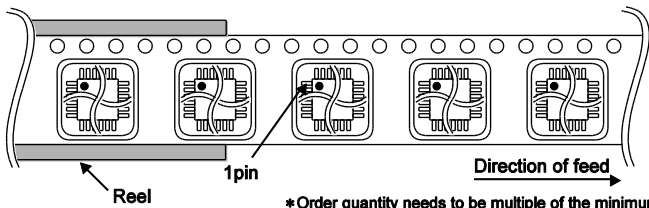
Physical Dimension, Tape and Reel Information

|              |        |
|--------------|--------|
| Package Name | VQFP80 |
|--------------|--------|



<Tape and Reel information>

|                   |                                                                                                                                                     |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Tape              | Embossed carrier tape (with dry pack)                                                                                                               |
| Quantity          | 1000pcs                                                                                                                                             |
| Direction of feed | E2<br>( The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand ) |



\* Order quantity needs to be multiple of the minimum quantity.

## Revision History

| Date        | Revision | Changes                                                                                                                                                             |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 02.Jun.2015 | 001      | New Release                                                                                                                                                         |
| 29.Jun.2015 | 002      | Modified Typical Application Circuit in Page2.<br>Modified S66/TESTIN Pin description(Handling when unused) in Page 7.<br>Modified comment of figure.39 in Page 61. |

# Notice

## Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment <sup>(Note 1)</sup>, aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

| JAPAN     | USA       | EU         | CHINA     |
|-----------|-----------|------------|-----------|
| CLASS III | CLASS III | CLASS II b | CLASS III |
| CLASS IV  |           | CLASS III  |           |

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
  - [a] Installation of protection circuits or other protective devices to improve system safety
  - [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure
3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
  - [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
  - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - [f] Sealing or coating our Products with resin or other coating materials
  - [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - [h] Use of the Products in places subject to dew condensation
4. The Products are not subject to radiation-proof design.
5. Please verify and confirm characteristics of the final or mounted products in using the Products.
6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
8. Confirm that operation temperature is within the specified range described in the product specification.
9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

## Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

## Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of ionizer, friction prevention and temperature / humidity control).

## Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
  - [a] the Products are exposed to sea winds or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [b] the temperature or humidity exceeds those recommended by ROHM
  - [c] the Products are exposed to direct sunshine or condensation
  - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

## Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

## Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

## Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

## Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.
2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).
3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

## Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.
2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.
3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.
4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

### General Precaution

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.
2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.
3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.