

LCD Segment Drivers

Multi-function LCD Segment Drivers

BU97530KVT-M

MAX 445 Segment(89SEGx5COM)

General Description

The BU97530KVT-M is 1/5, 1/4, 1/3 duty or Static General-purpose LCD driver. The BU97530KVT-M can drive up to 445 LCD Segments directly. The BU97530KVT-M can also control up to 9 General-purpose output pins / 9 PWM output pins. 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: 445 Segments
- Display Duty Static, 1/3, 1/4, 1/5 Selectable
- Bias: 1/2, 1/3 Selectable
- Interface: 3wire Serial Interface

Features

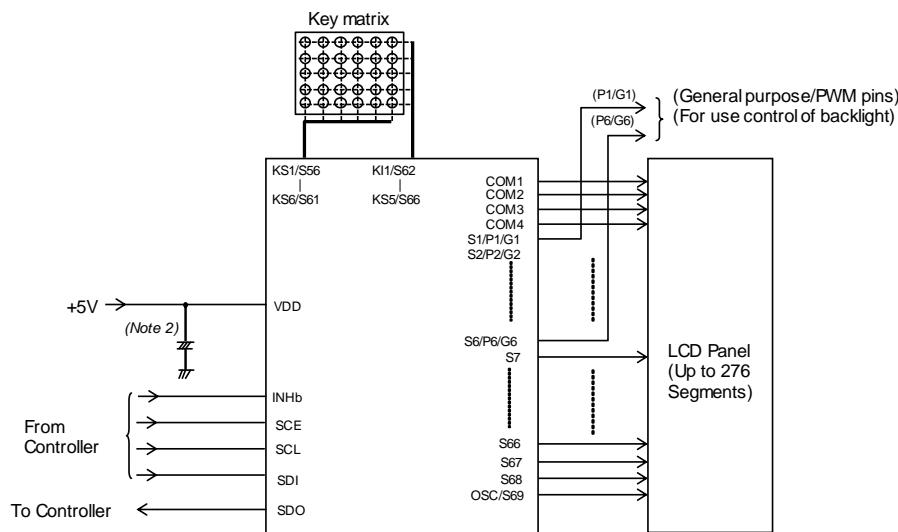
- AEC-Q100 Qualified (Note 1)
- Key Input Function for up to 30 Keys (A key scan is performed only when a key is pressed.)
- Either 1/5, 1/4, 1/3 Duty or Static Can be Selected with the Serial Control Data.
 - 1/5 Duty Drive: Up to 445 Segments can be Driven
 - 1/4 Duty Drive: Up to 360 Segments can be Driven
 - 1/3 Duty Drive: Up to 270 Segments can be Driven
 - Static Drive: Up to 90 Segments can be Driven
- Selectable Display Frame Frequency for Common and Segment Output Waveforms.
- Configurable Output Pin to Segment Output / PWM Output / General-purpose Output.(Max 9 Pins)
- Built-in OSC Circuit
- Integrated Voltage Detection Type Reset Circuit (VDET)
- No External Component
- Low Power Consumption Design
- Supports Line and Frame Inversion

(Note 1) Grade 3

Applications

- Car Audio, Home Electrical Appliance, Meter Equipment etc.

Typical Application Circuit

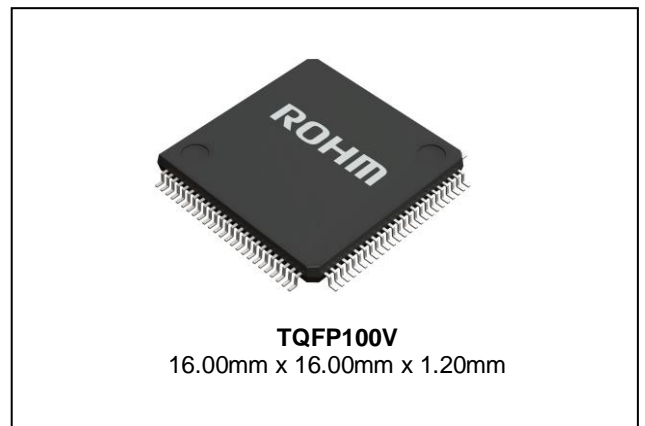


(Note 2) Insert capacitors between VDD and VSS C ≥ 0.1μF

Figure 1. Typical Application Circuit

Package

W (Typ) x D (Typ) x H (Max)



○Product structure : Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays.

Block Diagram

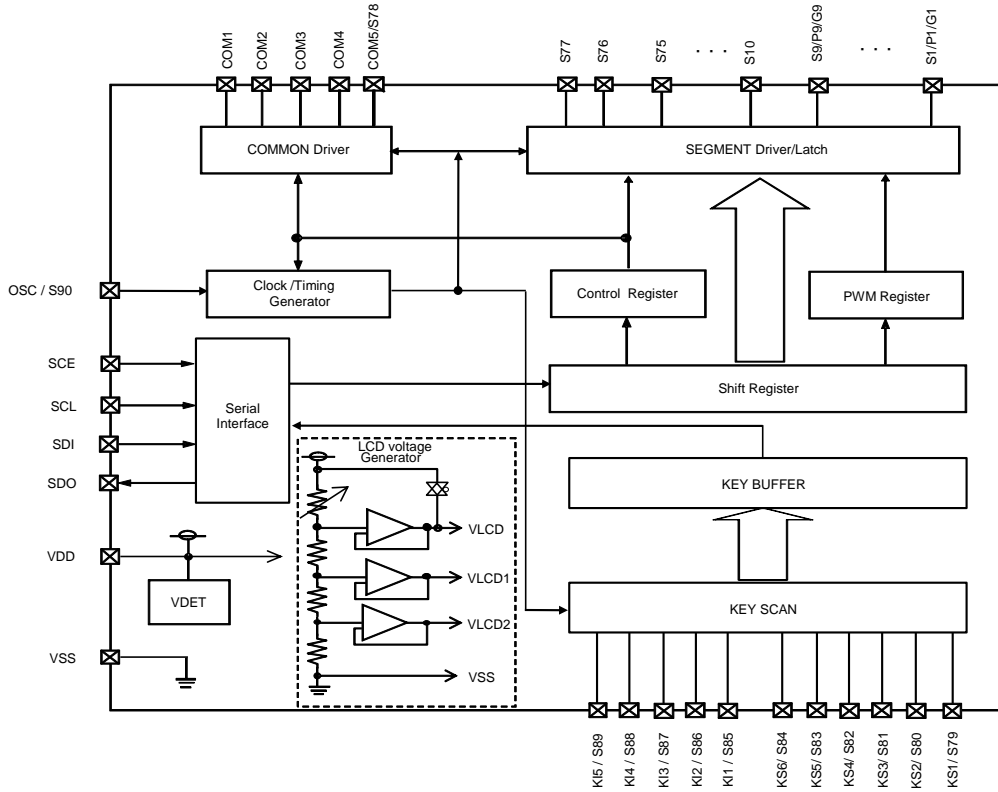


Figure 2. Block Diagram

Pin Arrangement

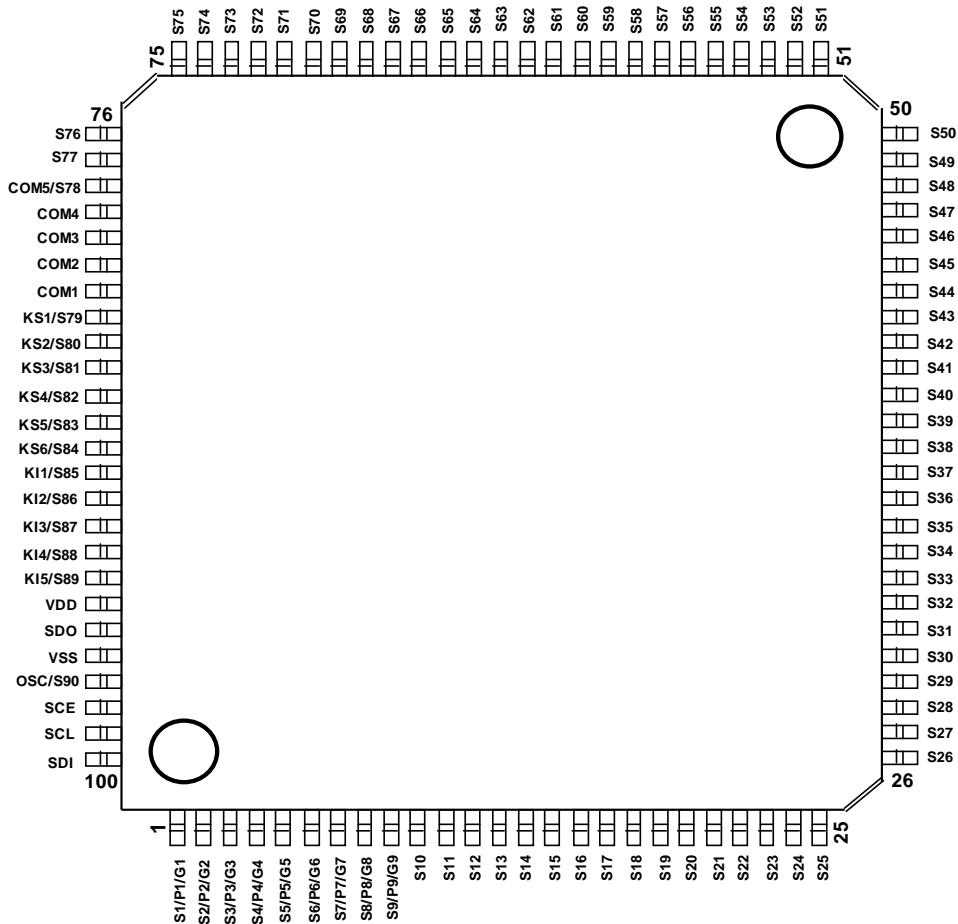


Figure 3. Pin Configuration(TOP VIEW)

Absolute Maximum Ratings(VSS = 0.0V)

| Parameter | Symbol | Pin / Conditions | Ratings | Unit |
|------------------------|------------------|--------------------|------------------------|------|
| Maximum Supply Voltage | VDD | VDD | -0.3 to +7.0 | V |
| Input Voltage | V _{IN1} | SCE, SCL, SDI, OSC | -0.3 to +7.0 | V |
| | V _{IN2} | KI1 to KI5 | -0.3 to +7.0 | V |
| Allowable Loss | Pd | - | 1.49 ^(Note) | W |
| Operating Temperature | Topr | - | -40 to +85 | °C |
| Storage Temperature | Tstg | - | -55 to +125 | °C |

(Note) Derate by 1.49mW/°C when operating above Ta=25°C (when mounted in ROHM's standard board).

(Board size: 70mmx70mmx1.6mm material: FR4 board copper foil: land pattern only)

Caution 1: 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.

Caution 2: Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB boards with power dissipation taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.

Recommended Operating Conditions (Ta = -40°C to +85°C, VSS = 0.0V)

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

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

| Parameter | Symbol | Pin | Conditions | Limit | | | Unit |
|-----------------------------|-------------------|----------------------------------|---|----------------|---------|----------------|------|
| | | | | Min | Typ | Max | |
| Hysteresis | V _{H1} | SCE, SCL, SDI, OSC | - | - | 0.03VDD | - | V |
| | V _{H2} | KI1 to KI5 | - | - | 0.1VDD | - | V |
| Power-on Detection Voltage | V _{DET} | VDD | - | 1.4 | 1.8 | 2.2 | V |
| "H" Level Input Voltage | V _{IH1} | SCE, SCL, SDI, OSC | 4.0V ≤ VDD ≤ 6.0V | 0.4VDD | - | VDD | V |
| | V _{IH2} | SCE, SCL, SDI, OSC | 2.7V ≤ VDD < 4.0V | 0.8VDD | - | VDD | V |
| | V _{IH3} | KI1 to KI5 | - | 0.7VDD | - | VDD | V |
| "L" Level Input Voltage | V _{IL1} | SCE, SCL, SDI, OSC KI1 to KI5 | - | 0 | - | 0.2VDD | V |
| Input Floating Voltage | V _{IF} | KI1 to KI5 | - | - | - | 0.05VDD | V |
| Pull-down Resistance | R _{PD} | KI1 to KI5 | VDD=5.0V | 50 | 100 | 250 | kΩ |
| Output Off Leakage Current | I _{OFFH} | SDO | V _O =6.0V | - | - | 6.0 | μA |
| "H" Level Input Current | I _{IH1} | SCE, SCL, SDI, OSC | V _I = 5.5V | - | - | 5.0 | μA |
| "L" Level Input Current | I _{IL1} | SCE, SCL, SDI, OSC | V _I = 0V | -5.0 | - | - | μA |
| "H" Level Output Voltage | V _{OH1} | S1 to S90 | I _O = -20μA, VLCD=1.00*VDD | VDD-0.9 | - | - | V |
| | V _{OH2} | COM1 to COM5 | I _O = -100μA, VLCD=1.00*VDD | VDD-0.9 | - | - | V |
| | V _{OH3} | P1/G1 to P9/G9 | I _O = -1mA | VDD-0.9 | - | - | V |
| | V _{OH4} | KS1 to KS6 | I _O = -500μA | VDD-1.0 | VDD-0.5 | VDD-0.2 | V |
| "L" Level Output Voltage | V _{OL1} | S1 to S90 | I _O = 20μA | - | - | 0.9 | V |
| | V _{OL2} | COM1 to COM5 | I _O = 100μA | - | - | 0.9 | V |
| | V _{OL3} | P1/G1 to P9/G9 | I _O = 1mA | - | - | 0.9 | V |
| | V _{OL4} | KS1 to KS6 | I _O = 25μA | 0.2 | 0.5 | 1.5 | V |
| | V _{OL5} | SDO | I _O = 1mA | - | 0.1 | 0.5 | V |
| Middle Level Output Voltage | V _{MID1} | S1 to S90 | 1/2 Bias I _O = ±20μA VLCD=1.00*VDD | 1/2VDD -0.9 | - | 1/2VDD +0.9 | V |
| | V _{MID2} | COM1 to COM5 | 1/2 Bias I _O = ±100μA VLCD=1.00*VDD | 1/2VDD -0.9 | - | 1/2VDD +0.9 | V |
| | V _{MID3} | S1 to S90 | 1/3 Bias I _O = ±20μA VLCD=1.00*VDD | 2/3VDD -0.9 | - | 2/3VDD +0.9 | V |
| | V _{MID4} | S1 to S90 | 1/3 Bias I _O = ±20μA VLCD=1.00*VDD | 1/3VDD -0.9 | - | 1/3VDD +0.9 | V |
| | V _{MID5} | COM1 to COM5 | 1/3 Bias I _O = ±100μA VLCD=1.00*VDD | 2/3VDD -0.9 | - | 2/3VDD +0.9 | V |
| | V _{MID6} | COM1 to COM5 | 1/3 Bias I _O = ±100μA VLCD=1.00*VDD | 1/3VDD -0.9 | - | 1/3VDD +0.9 | V |

Electrical Characteristics– continued

| Parameter | Symbol | Pin | Conditions | Limit | | | Unit |
|---------------------|------------------|-----|--|-------|-----|-----|------|
| | | | | Min | Typ | Max | |
| Current Consumption | I _{DD1} | VDD | Power-saving mode | - | - | 15 | μA |
| | I _{DD2} | VDD | VDD = 5.0V Output open 1/2 Bias Frame frequency=80Hz VLCD=1.00*VDD | - | 100 | 200 | |
| | I _{DD3} | VDD | VDD = 5.0V Output open 1/3 Bias Frame frequency=80Hz VLCD=1.00*VDD | - | 130 | 250 | |

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

| Parameter | Symbol | Pin | Conditions | Limit | | | Unit |
|--|-------------------|---------|----------------------------|-------|-----|------|------|
| | | | | Min | Typ | Max | |
| Oscillator Frequency 1 | f _{OSC1} | - | VDD = 2.7V to 6.0V | 300 | - | 720 | kHz |
| Oscillator Frequency 2 | f _{OSC2} | - | VDD = 5V | 510 | 600 | 690 | kHz |
| External Clock Frequency ^(Note) | f _{OSC3} | OSC/S90 | External clock mode (OC=1) | 30 | - | 1000 | kHz |
| External Clock Rise Time | tr | | | - | 160 | - | ns |
| External Clock Fall Time | tf | | | - | 160 | - | ns |
| External Clock Duty | t _{DTY} | | | 30 | 50 | 70 | % |

(Note) Frame frequency is decided external clock and dividing ratio of FC0,FC1,FC2,FC3 setting.

[Reference Data]

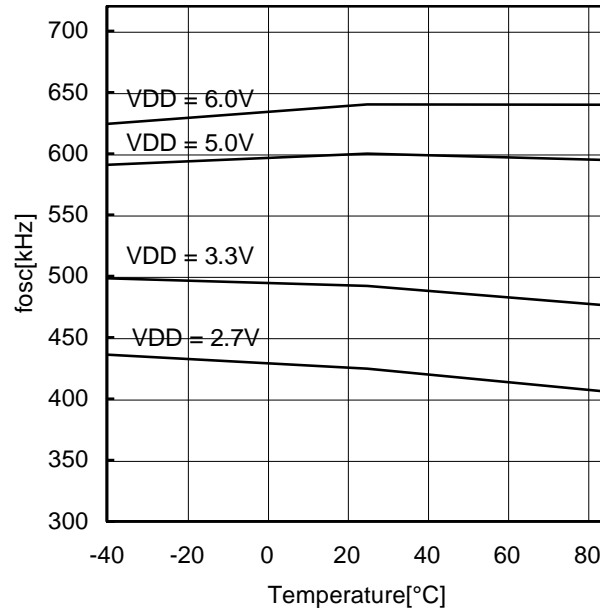


Figure 4. Frame Frequency Typical Temperature Characteristics

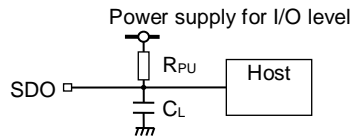
MPU Interface Characteristics (Ta = -40°C to +85°C, VDD = 2.7V to 6.0V, VSS = 0.0V)

| Parameter | Symbol | Pin | Conditions | Limit | | | Unit |
|-------------------------------------|------------|---------------|--|-------|-----|-----|---------|
| | | | | Min | Typ | Max | |
| Data Setup Time | t_{DS} | SCL, SDI | - | 120 | - | - | ns |
| Data Hold Time | t_{DH} | SCL, SDI | - | 120 | - | - | ns |
| SCE Wait Time | t_{CP} | SCE, SCL | - | 120 | - | - | ns |
| SCE Setup Time | t_{CS} | SCE, SCL | - | 120 | - | - | ns |
| SCE Hold Time | t_{CH} | SCE, SCL | - | 120 | - | - | ns |
| Clock Cycle Time | t_{CCYC} | SCL | - | 320 | - | - | ns |
| High-level Clock Pulse Width | t_{CHW} | SCL | - | 120 | - | - | ns |
| Low-level Clock Pulse Width (Write) | t_{CLWW} | SCL | - | 120 | - | - | ns |
| Low-Level Clock Pulse Width (Read) | t_{CLWR} | SCL | $R_{PU}=4.7k\Omega$ $C_L=10pF$ (Note) | 1.6 | - | - | μs |
| Rise Time | t_r | SCE, SCL, SDI | - | - | 160 | - | ns |
| Fall Time | t_f | SCE, SCL, SDI | - | - | 160 | - | ns |
| SDO Output Delay Time | t_{DC} | SDO | $R_{PU}=4.7k\Omega$ $C_L=10pF$ (Note) | - | - | 1.5 | μs |
| SDO Rise Time | t_{DR} | SDO | $R_{PU}=4.7k\Omega$ $C_L=10pF$ (Note) | - | - | 1.5 | μs |

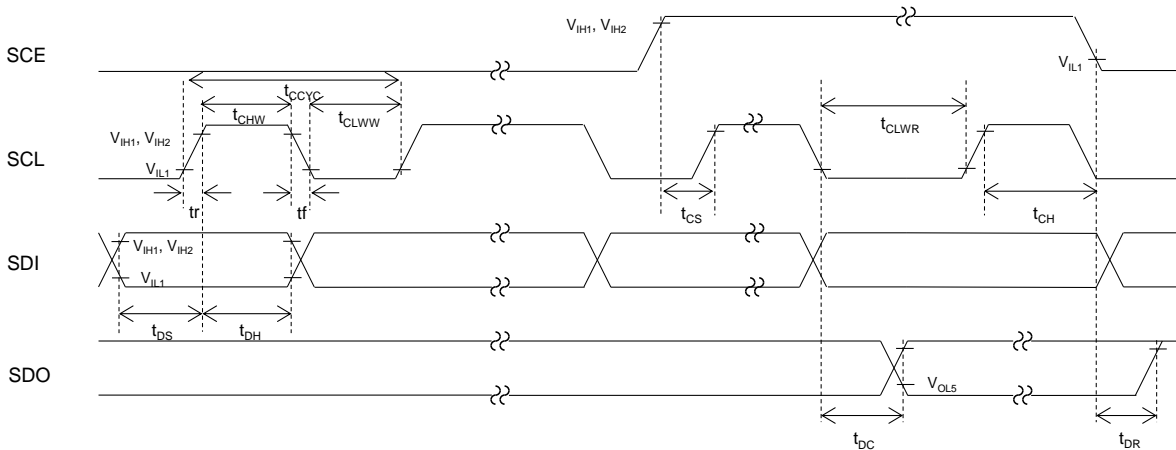
(Note) Since SDO is an open-drain output, "t_{DC}" and "t_{DR}" depend on the resistance of the pull-up resistor R_{PU} and the load capacitance C_L.

R_{PU}: 1kΩ ≤ R_{PU} ≤ 10kΩ is recommended.

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



1. When SCL is stopped at the low level



2. When SCL is stopped at the high level

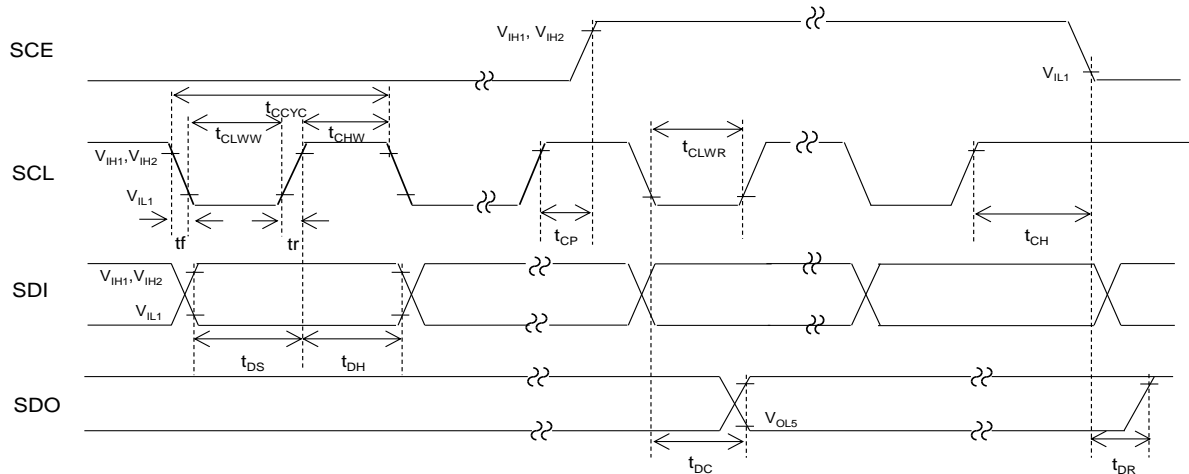


Figure 5. Serial Interface Timing

Pin Description

| Pin | Pin No. | Function | Active | I/O | Handling when unused |
|----------------------|-----------------|--|-------------|-------------|----------------------|
| S1/P1/G1 to S9/P9/G9 | 1 to 9 | Segment output for displaying the display data transferred by serial data input. The S1/P1/G1 to S9/P9/G9 pins can also be used as General-purpose or PWM outputs when so set up by the control data. | - | O | OPEN |
| S10 to S77 | 10 to 77 | Segment output for displaying the display data transferred by serial data input. | - | O | OPEN |
| KS1/S79 to KS6/S84 | 83 to 88 | Key scan outputs 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/S79 to KS6/S84 pins can be used as segment outputs when so specified by the control data. | - | O | OPEN |
| KI1/S85 to KI5/S89 | 89 to 93 | Key scan inputs These pins have built-in pull-down resistors. The KI1/S85 to KI5/S89 pins can be used as segment outputs when so specified by the control data. | - | I O | VSS OPEN |
| COM1 to COM4 | 79 to 82 | Common driver output pins. The frame frequency is fo[Hz]. | - | O | OPEN |
| COM5/S78 | 78 | Common / Segment output for LCD driving Assigned as Common output in 1/5 Duty mode and Segment output in Static, 1/3 Duty and 1/4 Duty modes | - | O | OPEN |
| OSC/S90 | 97 | Segment output for displaying the display data transferred by serial data input. The pin OSC/S90 can be used as external clock input pin when set up by the control data. | - | I O | VSS OPEN |
| SCE SCL SDI | 98 99 100 | Serial data transfer inputs. Must be connected to the controller. SCE: Chip enable SCL: Clock for serial data transfer. SDI: Transfer data | H ↑ - | I I I | VSS VSS VSS |
| SDO | 95 | Output data | - | O | OPEN |
| VDD | 94 | Power supply pin of the IC A power voltage of 2.7V to 6.0V must be applied to this pin. | - | - | - |
| VSS | 96 | Power supply pin. Must be connected to ground. | - | - | - |

IO Equivalent Circuit

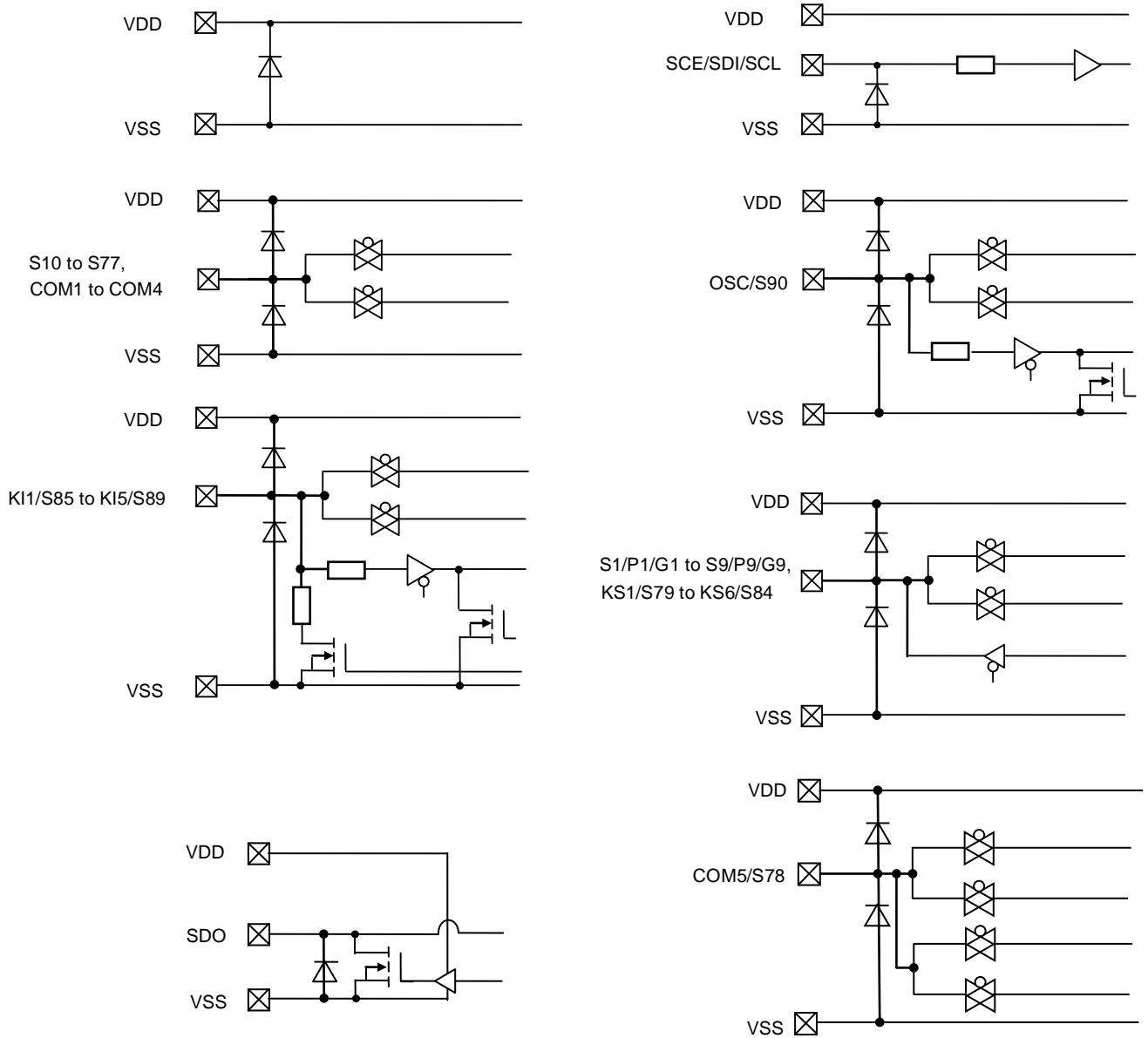


Figure 6. I/O Equivalent Circuit

Serial Data Transfer Formats

1. 1/5 Duty

(1)When SCL is stopped at the low level

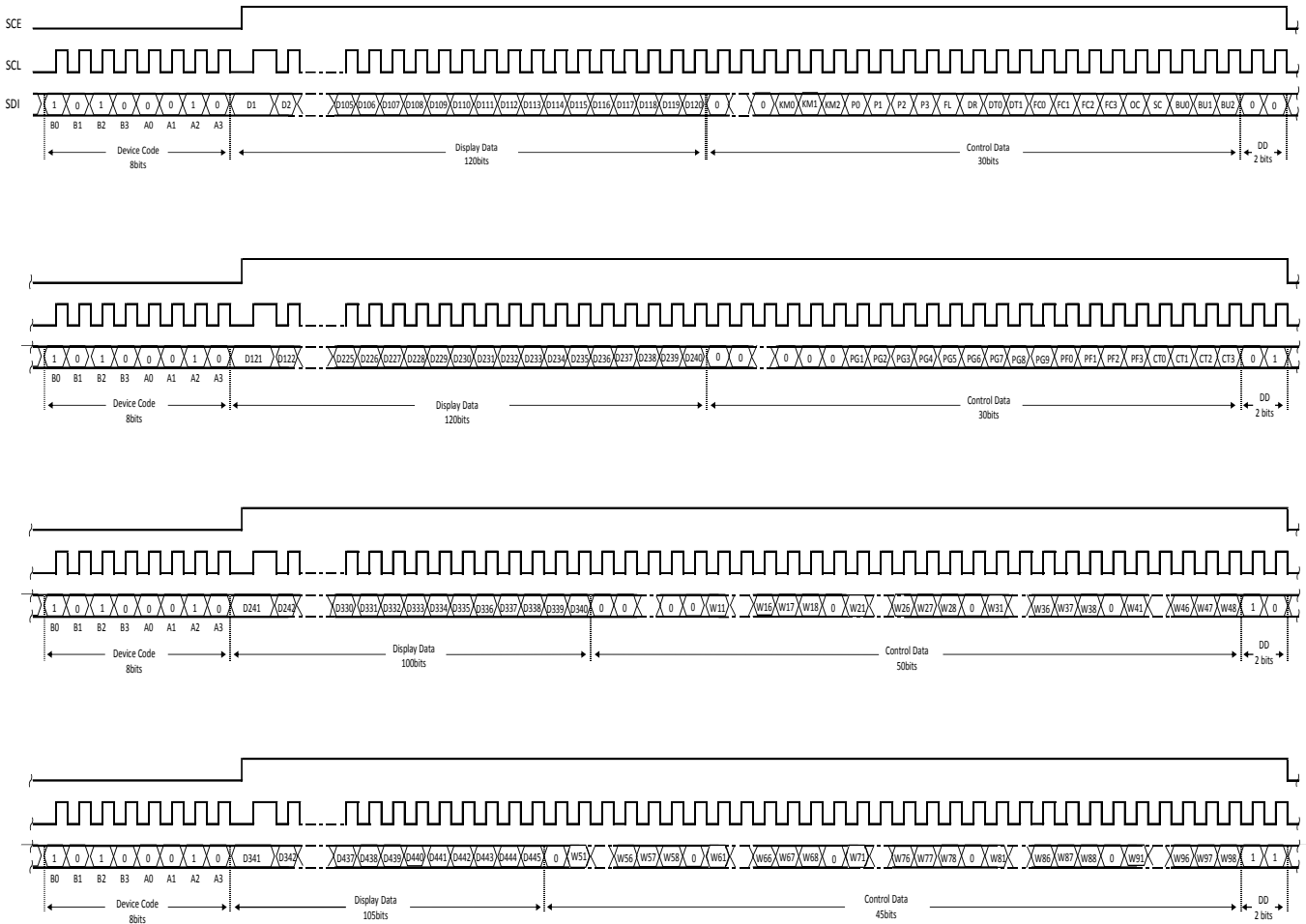


Figure 7. 3-SPI Data Transfer Format

Serial Data Transfer Formats – continued

(2)When SCL is stopped at the high level

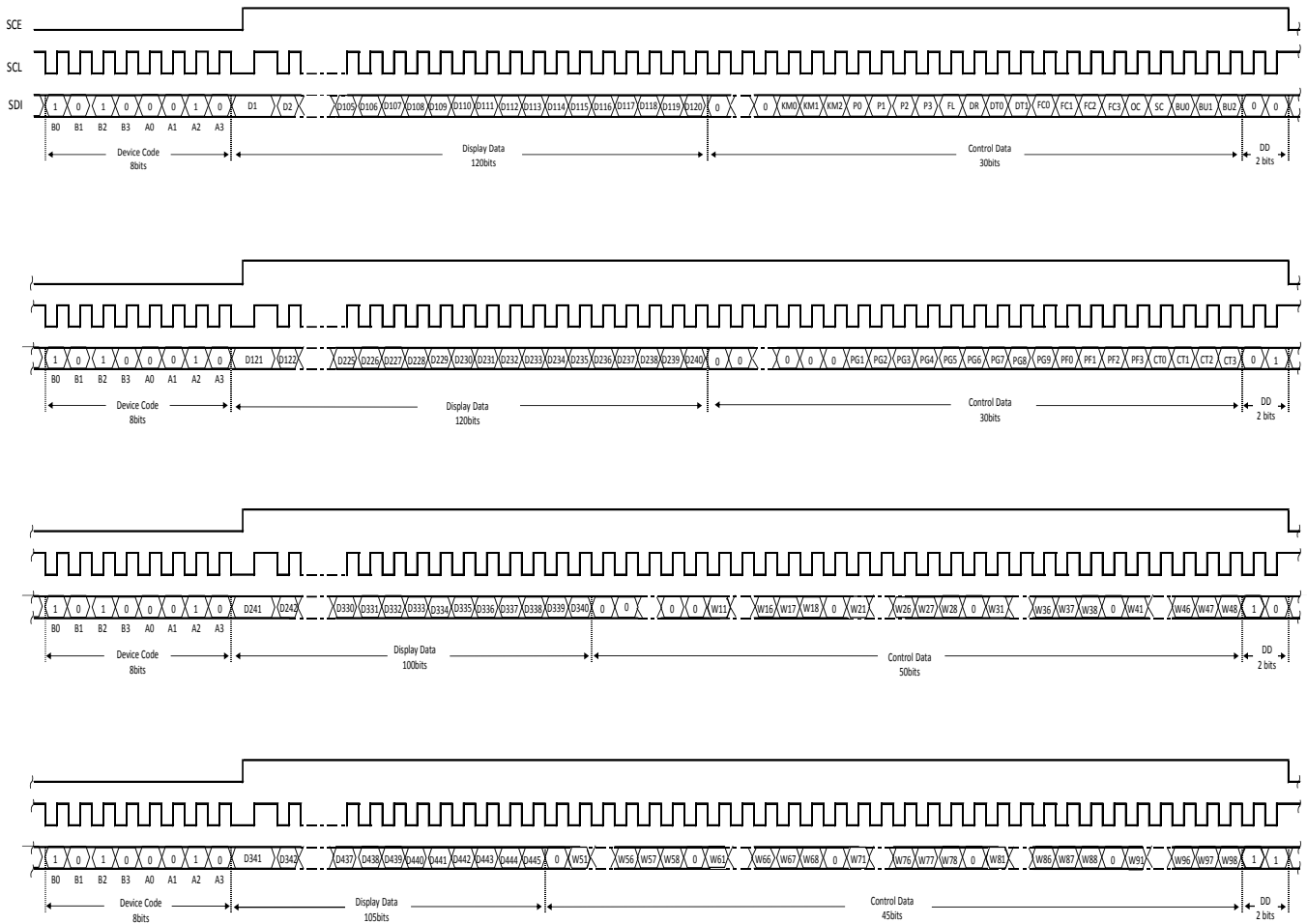


Figure 8. 3-SPI Data Transfer Format

- Device code “45H”
- KM0 to KM2 Key Scan output pin / Segment output pin switching control data
- D1 to D445..... Display data
- P0 to P3 Segment / PWM / General-purpose output pin switching control data
- FL..... Line Inversion or Frame Inversion switching control data
- DR 1/3 Bias drive or 1/2 Bias drive switching control data
- DT0 to DT1 1/5 Duty drive, 1/4 Duty drive, 1/3 Duty drive or Static drive switching control data
- FC0 to FC3 Common / Segment output waveform frame frequency switching control data
- OC..... Internal oscillator operating mode / External clock operating mode switching control data
- SC Segment on/off switching control data
- BU0 to BU2..... Normal mode / power-saving mode switching control data
- PG1 to PG9..... PWM / General-purpose output switching control data
- PF0 to PF3..... PWM output waveform frame frequency switching control data
- CT0 to CT3 LCD display contrast switching control data
- W11 to W18, W21 to W28, W31 to W38, W41 to W48, W51 to W58, W61 to W68, W71 to W78, W81 to W88, W91 to W98
..... PWM output duty switching control data
- DD Direction data

Serial Data Transfer Formats – continued

2. 1/4 Duty

(1)When SCL is stopped at the low level

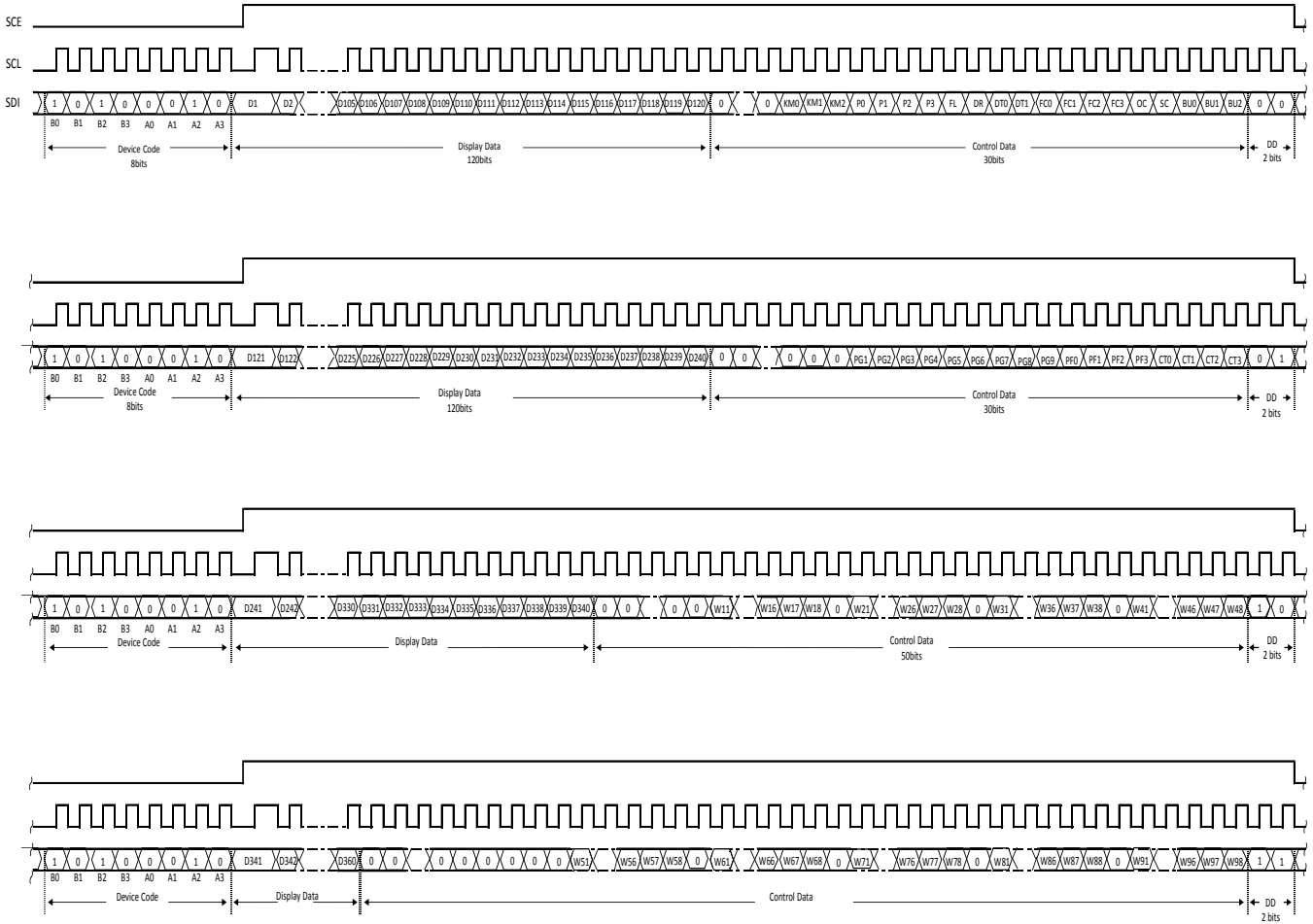


Figure 9. 3-SPI Data Transfer Format

Serial Data Transfer Formats – continued

(2)When SCL is stopped at the high level

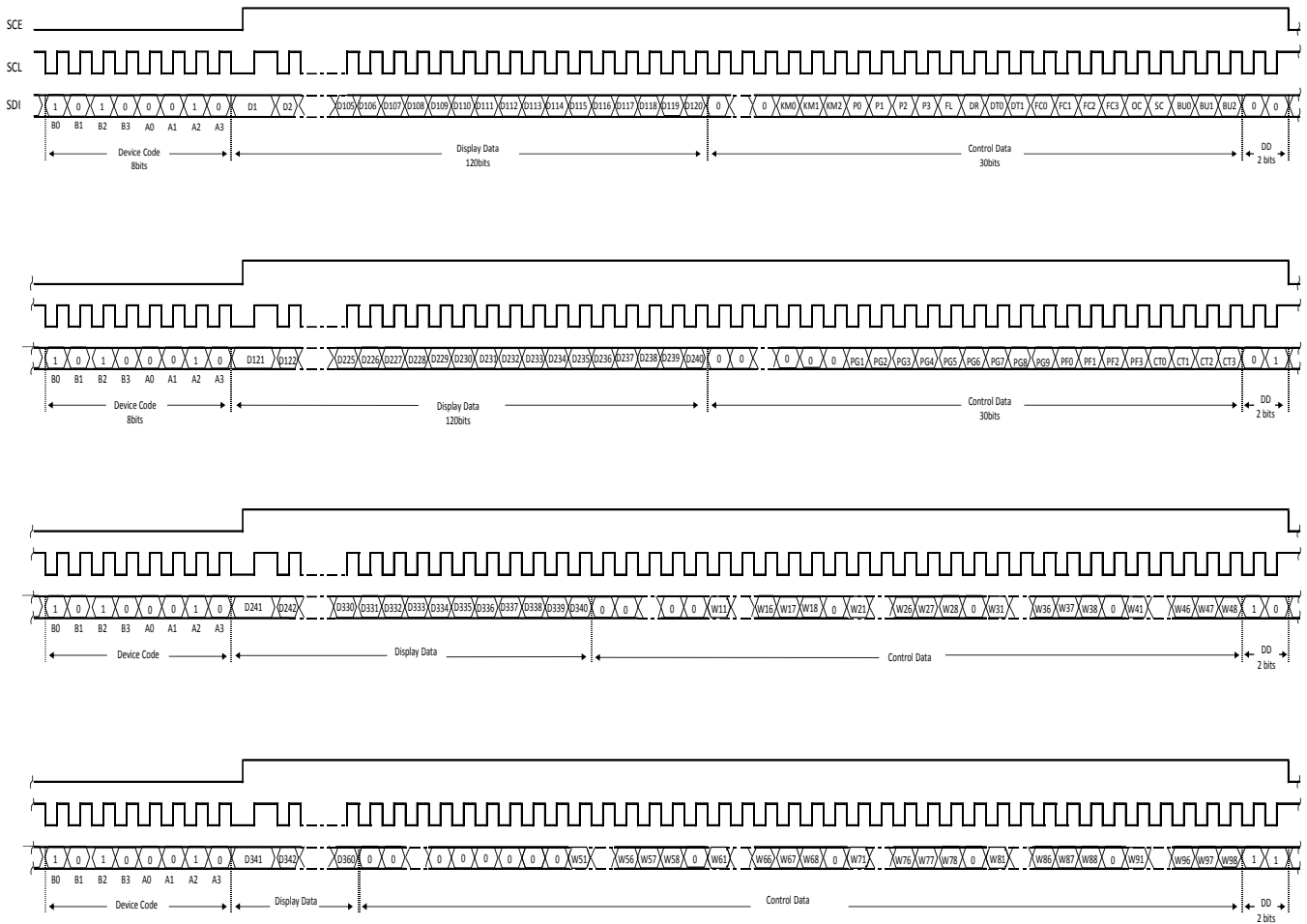


Figure 10. 3-SPI Data Transfer Format

- Device code “45H”
- KM0 to KM2 Key Scan output pin / Segment output pin switching control data
- D1 to D360..... Display data
- P0 to P3 Segment / PWM / General-purpose output pinswitching control data
- FL..... Line Inversion or Frame Inversion switching control data
- DR 1/3 Bias drive or 1/2 Bias drive switching control data
- DT0 to DT1 1/5 Duty drive, 1/4 Duty drive, 1/3 Duty drive or Static drive switching control data
- FC0 to FC3 Common / Segment output waveform frame frequency switching control data
- OC..... Internal oscillator operating mode / External clock operating mode switching control data
- SC Segment on/off switching control data
- BU0 to BU2..... Normal mode/power-saving mode switching control data
- PG1 to PG9..... PWM/ General-purpose output switching control data
- PF0 to PF3..... PWM output waveform frame frequency switching control data
- CT0 to CT3 LCD display contrast switching control data
- W11 to W18, W21 to W28, W31 to W38, W41 to W48, W51 to W58, W61 to W68, W71 to W78, W81 to W88, W91 to W98
..... PWM output duty switching control data
- DD Direction data

Serial Data Transfer Formats – continued

3. 1/3 Duty

(1) When SCL is stopped at the low level



Figure 11. 3-SPI Data Transfer Format

Serial Data Transfer Formats – continued

(2)When SCL is stopped at the high level

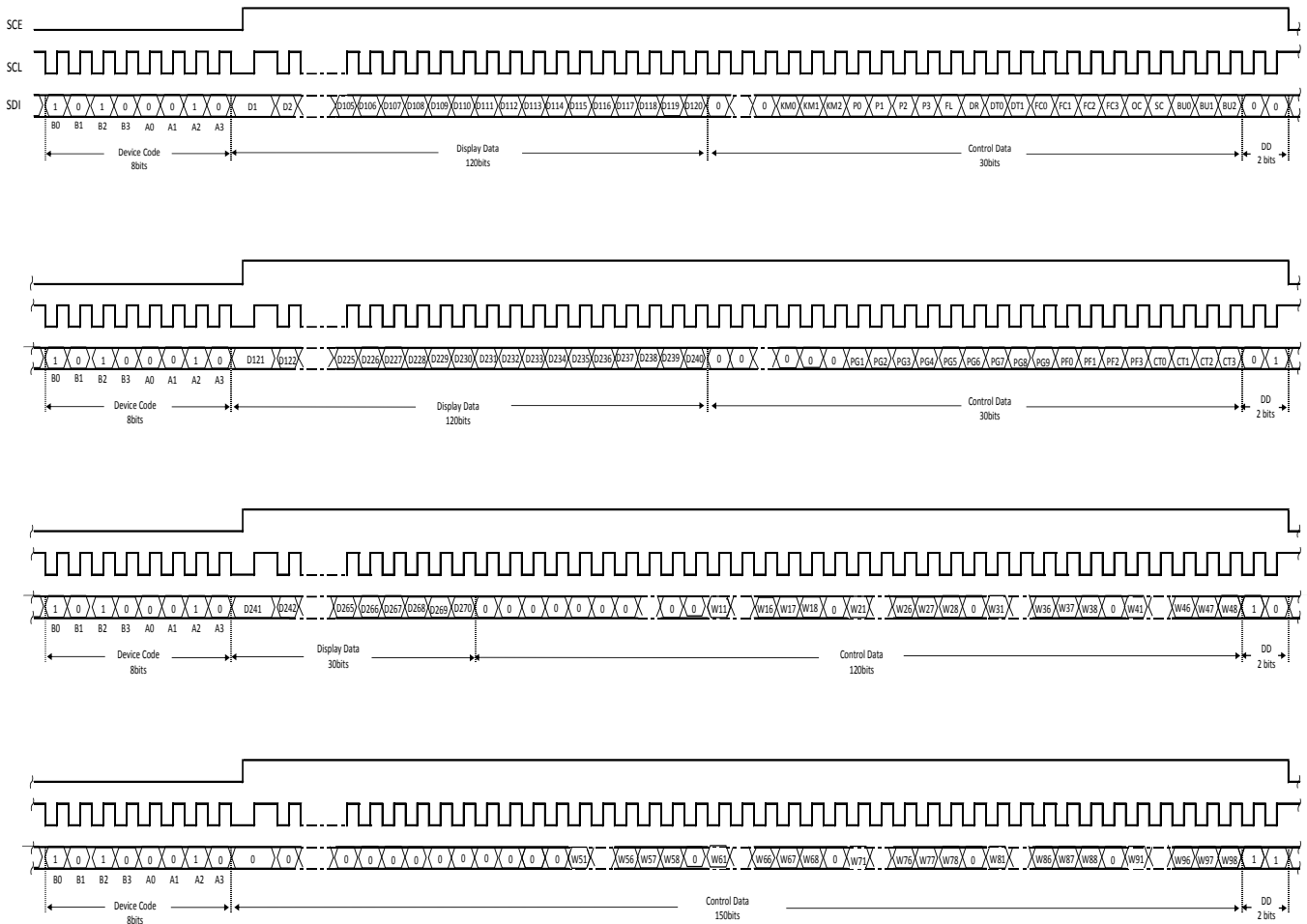


Figure 12. 3-SPI Data Transfer Format

- Device code “45H”
- KM0 to KM2 Key Scan output pin / Segment output pin switching control data
- D1 to D270..... Display data
- P0 to P3 Segment / PWM / General-purpose output pin switching control data
- FL..... Line Inversion or Frame Inversion switching control data
- DR 1/3 Bias drive or 1/2 Bias drive switching control data
- DT0 to DT1 1/5 Duty drive, 1/4 Duty drive, 1/3 Duty drive or Static drive switching control data
- FC0 to FC3 Common / Segment output waveform frame frequency switching control data
- OC..... Internal oscillator operating mode / External clock operating mode switching control data
- SC Segment on/off switching control data
- BU0 to BU2..... Normal mode / power-saving mode switching control data
- PG1 to PG9..... PWM / General-purpose output switching control data
- PF0 to PF3..... PWM output waveform frame frequency switching control data
- CT0 to CT3 LCD display contrast switching control data
- W11 to W18, W21 to W28, W31 to W38, W41 to W48, W51 to W58, W61 to W68, W71 to W78, W81 to W88, W91 to W98
..... PWM output duty switching control data
- DD Direction data

Serial Data Transfer Formats – continued

4. Static

(1)When SCL is stopped at the low level

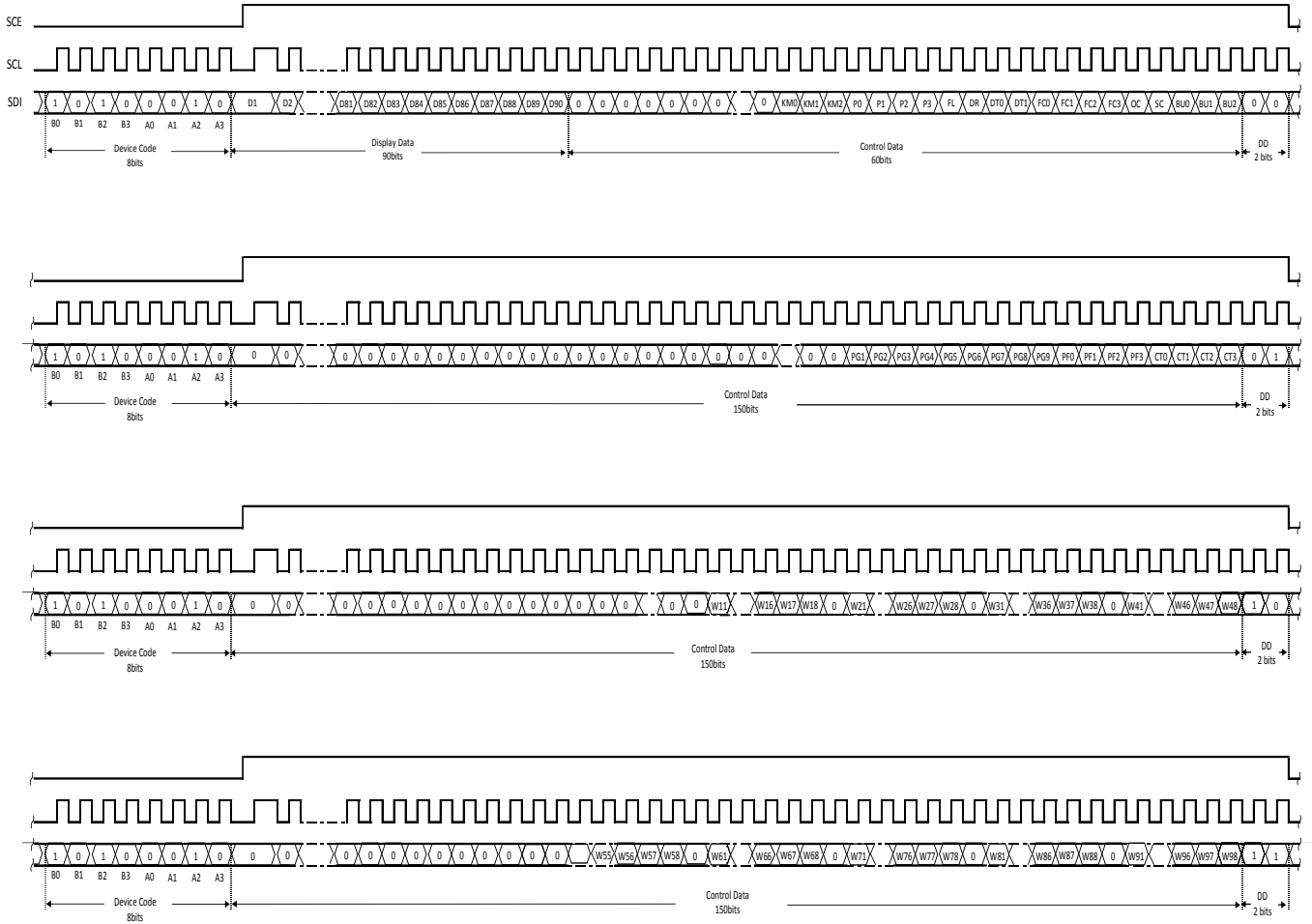


Figure 13. 3-SPI Data Transfer Format

Serial Data Transfer Formats – continued

(2)When SCL is stopped at the high level

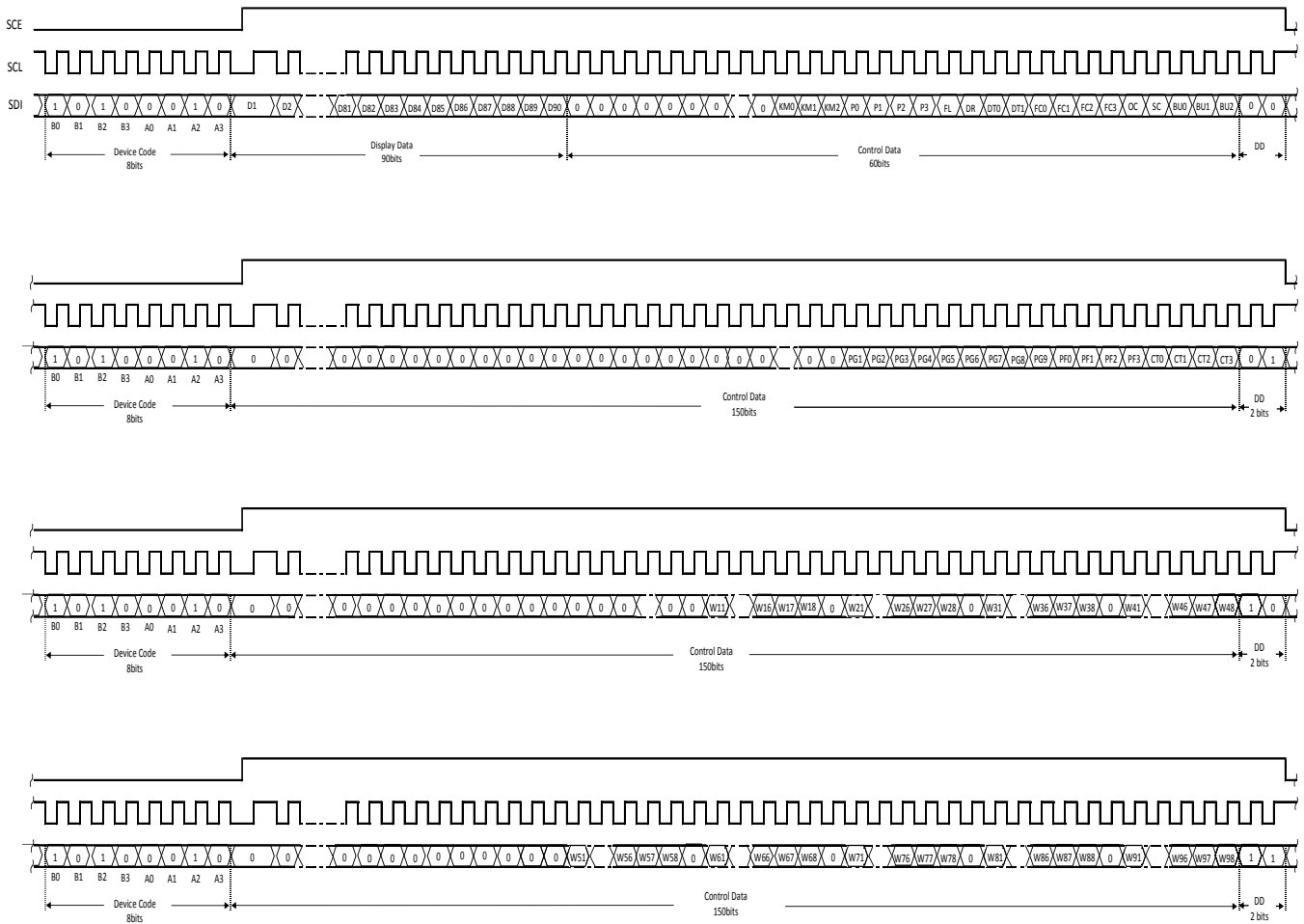


Figure 14. 3-SPI Data Transfer Format

- Device code “45H”
- KM0 to KM2 Key Scan output pin / Segment output pin switching control data
- D1 to D90 Display data
- P0 to P3 Segment / PWM / General-purpose output pin switching control data
- FL Line Inversion or Frame Inversion switching control data
- DR 1/3 Bias drive or 1/2 Bias drive switching control data
- DT0 to DT1 1/5 Duty drive, 1/4 Duty drive, 1/3 Duty drive or Static drive switching control data
- FC0 to FC3 Common / Segment output waveform frame frequency switching control data
- OC Internal oscillator operating mode / External clock operating mode switching control data
- SC Segment on/off switching control data
- BU0 to BU2 Normal mode / power-saving mode switching control data
- PG1 to PG9 PWM / General-purpose output switching control data
- PF0 to PF3 PWM output waveform frame frequency switching control data.
- CT0 to CT3 LCD display contrast switching control data.
- W11 to W18, W21 to W28, W31 to W38, W41 to W48, W51 to W58, W61 to W68, W71 to W78, W81 to W88, W91 to W98
..... PWM output duty switching control data.
- DD Direction data

Control Data Functions

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

These control data bits switch the functions of the KS1/S79 to KS6/S84 output pins between key scan output and segment output.

| KM0 | KM1 | KM2 | Output Pin State | | | | | | Maximum Number of Input Keys | Reset Condition |
|-----|-----|-----|------------------|---------|---------|---------|---------|---------|------------------------------|-----------------|
| | | | KS1/S79 | KS2/S80 | KS3/S81 | KS4/S82 | KS5/S83 | KS6/S84 | | |
| 0 | 0 | 0 | KS1 | KS2 | KS3 | KS4 | KS5 | KS6 | 30 | - |
| 0 | 0 | 1 | S79 | KS2 | KS3 | KS4 | KS5 | KS6 | 25 | - |
| 0 | 1 | 0 | S79 | S80 | KS3 | KS4 | KS5 | KS6 | 20 | - |
| 0 | 1 | 1 | S79 | S80 | S81 | KS4 | KS5 | KS6 | 15 | - |
| 1 | 0 | 0 | S79 | S80 | S81 | S82 | KS5 | KS6 | 10 | - |
| 1 | 0 | 1 | S79 | S80 | S81 | S82 | S83 | KS6 | 5 | - |
| 1 | 1 | 0 | S79 | S80 | S81 | S82 | S83 | S84 | 0 | - |
| 1 | 1 | 1 | S79 | S80 | S81 | S82 | S83 | S84 | 0 | ○ |

2. P0, P1, P2 and P3: Segment / PWM / General-purpose output pin switching control data

These control data 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 | Reset Condition |
|----|----|----|----|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------------|
| 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 pin is selected by PG_x(x=1 to 9) control data bit.

When the General-purpose Output Pin 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 | 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 Pin 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, S4/P4/G4 is used as a General-purpose Output Pin in case of 1/4 Duty, if its corresponding display data – D13 is set to "1", then S4/P4/G4 will output "HIGH(VDD)" level. Likewise, if D13 is set to "0", then S4/P4/G4 will output "LOW(VSS)" 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 | Reset Condition |
|----|-----------------|-----------------|
| 0 | Line Inversion | ○ |
| 1 | Frame Inversion | - |

Typically, when driving large capacitance LCD, Line inversion will increase the influence of crosstalk. Regarding driving waveform, refer to [LCD driving waveforms](#).

Control Data Functions – continued

4. DR: 1/3 Bias drive or 1/2 Bias drive switching control data
 This control data bit selects either 1/3 Bias drive or 1/2 Bias drive.

| DR | Bias Drive Scheme | Reset Condition |
|----|-------------------|-----------------|
| 0 | 1/3 Bias drive | ○ |
| 1 | 1/2 Bias drive | - |

5. DT: 1/5 Duty drive, 1/4 Duty drive, 1/3 Duty drive or Static drive switching control data
 These control data bits select either 1/5 Duty drive, 1/4 Duty drive, 1/3 Duty drive or Static drive

| DT0 | DT1 | Duty Drive Scheme | Reset Condition |
|-----|-----|-------------------|-----------------|
| 0 | 0 | Static drive | ○ |
| 0 | 1 | 1/3 Duty drive | - |
| 1 | 0 | 1/4 Duty drive | - |
| 1 | 1 | 1/5 Duty drive | - |

6. FC0, FC1, FC2 and FC3: Common / Segment output waveform frame frequency switching control data
 These control data bits set the display frame frequency.

| FC0 | FC1 | FC2 | FC3 | Display Frame Frequency fo(Hz) | Reset Condition |
|-----|-----|-----|-----|--------------------------------|-----------------|
| 0 | 0 | 0 | 0 | $f_{OSC}^{(Note)} / 12288$ | ○ |
| 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 | $f_{OSC} / 1536$ | - |

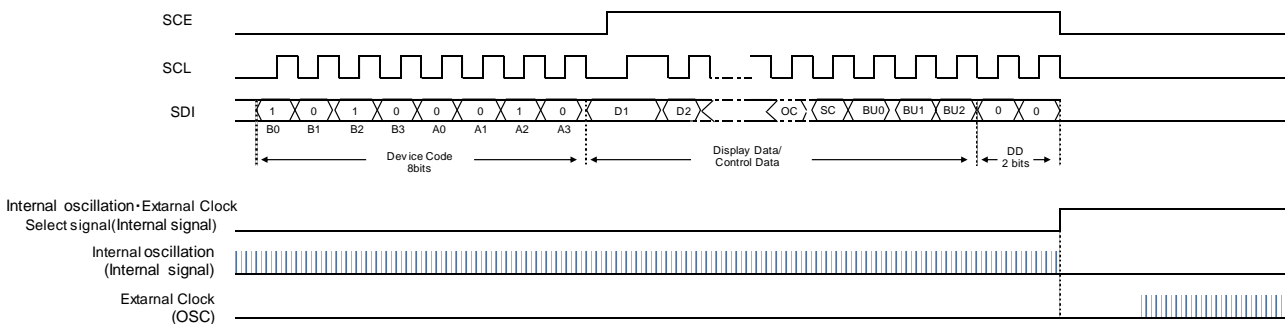
(Note) f_{OSC} : Internal oscillation frequency (600 kHz Typ)

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

| OC | Operating Mode | In/Out Pin(OSC/S90) Status | Reset Condition |
|----|---------------------|----------------------------|-----------------|
| 0 | Internal oscillator | S90 (segment output) | ○ |
| 1 | External Clock | OSC (clock input) | - |

OC=1 : OSC/S90 pin can be used as input clock pin when External Clock is set by the control data.

<External Clock input timing function>
 Internal oscillation / external clock select signal behavior is below.
 Please input external clock after serial data sending.



8. SC: Segment on/off switching control data
 This control data bit controls the on/off state of the segments.

| SC | Display State | Reset Condition |
|----|---------------|-----------------|
| 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.

Control Data Functions – continued

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

| BU0 | BU1 | BU2 | Mode | OSC Oscillator | Segment Outputs Common Outputs | Output Pin States During Key Scan Standby | | | | | | Reset Condition |
|-----|-----|-----|--------------|----------------|-----------------------------------|---|-----|-----|-----|-----|-----|-----------------|
| | | | | | | 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/S90 = low (VSS)
 COM1 to COM5 = low (VSS)
 Stop the LCD drive bias voltage generation circuit
 Stop the Internal oscillation circuit
 However, serial data transfer is possible when at Power-saving mode.

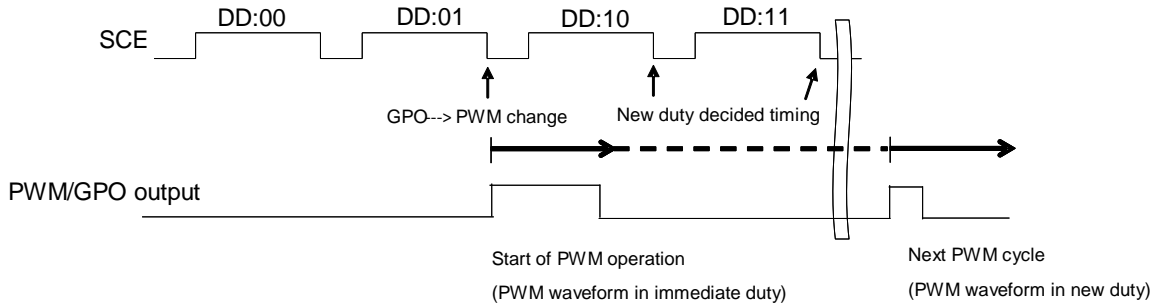
10. PG1, PG2, PG3, PG4, PG5, PG6, PG7, PG8 and PG9: PWM / General-purpose output switching control data
 This control data bit select either PWM output or General-purpose output of Sx/Px/Gx pins. (x=1 to 9)

| PGx(x=1 to 9) | Mode | Reset Condition |
|---------------|------------------------|-----------------|
| 0 | PWM output | ○ |
| 1 | General-purpose output | - |

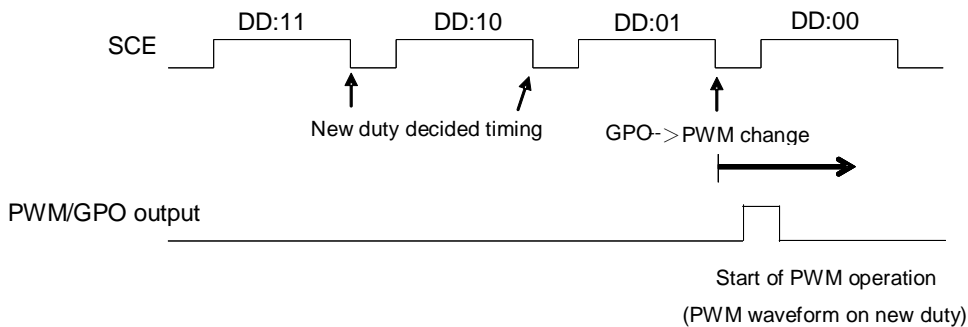
<PWM<->GPO Changing function>

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 is from the next PWM.



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



Control Data Functions – continued

11. PF0, PF1, PF2, and PF3: PWM output waveform frame frequency switching control data
These control data bits set the frame frequency for PWM output waveforms.

| PF0 | PF1 | PF2 | PF3 | PWM Output Frame Frequency fp(Hz) | Reset Condition |
|-----|-----|-----|-----|-----------------------------------|-----------------|
| 0 | 0 | 0 | 0 | $f_{osc}/4096$ | ○ |
| 0 | 0 | 0 | 1 | $f_{osc}/3840$ | - |
| 0 | 0 | 1 | 0 | $f_{osc}/3584$ | - |
| 0 | 0 | 1 | 1 | $f_{osc}/3328$ | - |
| 0 | 1 | 0 | 0 | $f_{osc}/3072$ | - |
| 0 | 1 | 0 | 1 | $f_{osc}/2816$ | - |
| 0 | 1 | 1 | 0 | $f_{osc}/2560$ | - |
| 0 | 1 | 1 | 1 | $f_{osc}/2304$ | - |
| 1 | 0 | 0 | 0 | $f_{osc}/2048$ | - |
| 1 | 0 | 0 | 1 | $f_{osc}/1792$ | - |
| 1 | 0 | 1 | 0 | $f_{osc}/1536$ | - |
| 1 | 0 | 1 | 1 | $f_{osc}/1280$ | - |
| 1 | 1 | 0 | 0 | $f_{osc}/1024$ | - |
| 1 | 1 | 0 | 1 | $f_{osc}/768$ | - |
| 1 | 1 | 1 | 0 | $f_{osc}/512$ | - |
| 1 | 1 | 1 | 1 | $f_{osc}/256$ | - |

12. CT0, CT1, CT2 and CT3: LCD display contrast switching control data
These control data bits set display contrast

| CT0 | CT1 | CT2 | CT3 | LCD Drive Bias Voltage for VLCD Level | Reset Condition |
|-----|-----|-----|-----|---------------------------------------|-----------------|
| 0 | 0 | 0 | 0 | $1.000 \cdot V_{DD}$ | ○ |
| 0 | 0 | 0 | 1 | $0.975 \cdot V_{DD}$ | - |
| 0 | 0 | 1 | 0 | $0.950 \cdot V_{DD}$ | - |
| 0 | 0 | 1 | 1 | $0.925 \cdot V_{DD}$ | - |
| 0 | 1 | 0 | 0 | $0.900 \cdot V_{DD}$ | - |
| 0 | 1 | 0 | 1 | $0.875 \cdot V_{DD}$ | - |
| 0 | 1 | 1 | 0 | $0.850 \cdot V_{DD}$ | - |
| 0 | 1 | 1 | 1 | $0.825 \cdot V_{DD}$ | - |
| 1 | 0 | 0 | 0 | $0.800 \cdot V_{DD}$ | - |
| 1 | 0 | 0 | 1 | $0.775 \cdot V_{DD}$ | - |
| 1 | 0 | 1 | 0 | $0.750 \cdot V_{DD}$ | - |
| 1 | 0 | 1 | 1 | $0.725 \cdot V_{DD}$ | - |
| 1 | 1 | 0 | 0 | $0.700 \cdot V_{DD}$ | - |
| 1 | 1 | 0 | 1 | $0.675 \cdot V_{DD}$ | - |
| 1 | 1 | 1 | 0 | $0.650 \cdot V_{DD}$ | - |
| 1 | 1 | 1 | 1 | $0.625 \cdot V_{DD}$ | - |

This control data bit set VLCD maximum voltage for LCD drive voltage.

Avoid setting VLCD voltage under 2.5V.

And ensure “ $V_{DD} - VLCD > 0.6$ ” condition is satisfied.

Unstable IC output voltage may result if the above conditions are not satisfied.

The relationship of LCD display contrast setting and VLCD voltage

| CT Setting | Formula | VDD= 6.000 | VDD= 5.500 | VDD= 5.000 | VDD= 4.500 | VDD= 4.000 | VDD= 3.000 | Unit |
|------------|----------------------|-------------|-------------|-------------|-------------|-------------|-------------|------|
| 0 | VDD | VLCD= 6.000 | VLCD= 5.500 | VLCD= 5.000 | VLCD= 4.500 | VLCD= 4.000 | VLCD= 3.000 | V |
| 1 | $0.975 \cdot V_{DD}$ | VLCD= 5.850 | VLCD= 5.363 | VLCD= 4.875 | VLCD= 4.388 | VLCD= 3.900 | VLCD= 2.925 | V |
| 2 | $0.950 \cdot V_{DD}$ | VLCD= 5.700 | VLCD= 5.225 | VLCD= 4.750 | VLCD= 4.275 | VLCD= 3.800 | VLCD= 2.850 | V |
| 3 | $0.925 \cdot V_{DD}$ | VLCD= 5.550 | VLCD= 5.088 | VLCD= 4.625 | VLCD= 4.163 | VLCD= 3.700 | VLCD= 2.775 | V |
| 4 | $0.900 \cdot V_{DD}$ | VLCD= 5.400 | VLCD= 4.950 | VLCD= 4.500 | VLCD= 4.050 | VLCD= 3.600 | VLCD= 2.700 | V |
| 5 | $0.875 \cdot V_{DD}$ | VLCD= 5.250 | VLCD= 4.813 | VLCD= 4.375 | VLCD= 3.938 | VLCD= 3.500 | VLCD= 2.625 | V |
| 6 | $0.850 \cdot V_{DD}$ | VLCD= 5.100 | VLCD= 4.675 | VLCD= 4.250 | VLCD= 3.825 | VLCD= 3.400 | VLCD= 2.550 | V |
| 7 | $0.825 \cdot V_{DD}$ | VLCD= 4.950 | VLCD= 4.538 | VLCD= 4.125 | VLCD= 3.713 | VLCD= 3.300 | VLCD= 2.475 | V |
| 8 | $0.800 \cdot V_{DD}$ | VLCD= 4.800 | VLCD= 4.400 | VLCD= 4.000 | VLCD= 3.600 | VLCD= 3.200 | VLCD= 2.400 | V |
| 9 | $0.775 \cdot V_{DD}$ | VLCD= 4.650 | VLCD= 4.263 | VLCD= 3.875 | VLCD= 3.488 | VLCD= 3.100 | VLCD= 2.325 | V |
| 10 | $0.750 \cdot V_{DD}$ | VLCD= 4.500 | VLCD= 4.125 | VLCD= 3.750 | VLCD= 3.375 | VLCD= 3.000 | VLCD= 2.250 | V |
| 11 | $0.725 \cdot V_{DD}$ | VLCD= 4.350 | VLCD= 3.988 | VLCD= 3.625 | VLCD= 3.263 | VLCD= 2.900 | VLCD= 2.175 | V |
| 12 | $0.700 \cdot V_{DD}$ | VLCD= 4.200 | VLCD= 3.850 | VLCD= 3.500 | VLCD= 3.150 | VLCD= 2.800 | VLCD= 2.100 | V |
| 13 | $0.675 \cdot V_{DD}$ | VLCD= 4.050 | VLCD= 3.713 | VLCD= 3.375 | VLCD= 3.038 | VLCD= 2.700 | VLCD= 2.025 | V |
| 14 | $0.650 \cdot V_{DD}$ | VLCD= 3.900 | VLCD= 3.575 | VLCD= 3.250 | VLCD= 2.925 | VLCD= 2.600 | VLCD= 1.950 | V |
| 15 | $0.625 \cdot V_{DD}$ | VLCD= 3.750 | VLCD= 3.438 | VLCD= 3.125 | VLCD= 2.813 | VLCD= 2.500 | VLCD= 1.875 | V |

Disabled

Control Data Functions – continued

13. W11 to W18^(Note), W21 to W28, W31 to W38, W41 to W48, W51 to W58, W61 to W68, W71 to W78, W81 to W88 and W91 to W98: PWM output waveform duty setting control data.

These control data bits set the high level pulse width (duty) for PWM output waveforms.

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

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

(Note) W11 to W18: S1/P1/G1 pwm duty data
W21 to W28: S2/P2/G2 pwm duty data
W31 to W38: S3/P3/G3 pwm duty data
W41 to W48: S4/P4/G4 pwm duty data
W51 to W58: S5/P5/G5 pwm duty data
W61 to W68: S6/P6/G6 pwm duty data
W71 to W78: S7/P7/G7 pwm duty data
W81 to W88: S8/P8/G8 pwm duty data
W91 to W98: S9/P9/G9 pwm duty data

Display Data and Output Pin Correspondence

1. 1/5 Duty

| Output Pin ^(Note) | 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 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90. Also, COM5/S78 pin is used as Common output.

Display Data and Output Pin Correspondence – continued

| Output Pin ^(Note) | COM1 | COM2 | COM3 | COM4 | COM5 |
|------------------------------|------|------|------|------|------|
| S64 | D316 | D317 | D318 | D319 | D320 |
| S65 | D321 | D322 | D323 | D324 | D325 |
| S66 | D326 | D327 | D328 | D329 | D330 |
| S67 | D331 | D332 | D333 | D334 | D335 |
| S68 | D336 | D337 | D338 | D339 | D340 |
| S69 | D341 | D342 | D343 | D344 | D345 |
| S70 | D346 | D347 | D348 | D349 | D350 |
| S71 | D351 | D352 | D353 | D354 | D355 |
| S72 | D356 | D357 | D358 | D359 | D360 |
| S73 | D361 | D362 | D363 | D364 | D365 |
| S74 | D366 | D367 | D368 | D369 | D370 |
| S75 | D371 | D372 | D373 | D374 | D375 |
| S76 | D376 | D377 | D378 | D379 | D380 |
| S77 | D381 | D382 | D383 | D384 | D385 |
| KS1/S79 | D386 | D387 | D388 | D389 | D390 |
| KS2/S80 | D391 | D392 | D393 | D394 | D395 |
| KS3/S81 | D396 | D397 | D398 | D399 | D400 |
| KS4/S82 | D401 | D402 | D403 | D404 | D405 |
| KS5/S83 | D406 | D407 | D408 | D409 | D410 |
| KS6/S84 | D411 | D412 | D413 | D414 | D415 |
| KI1/S85 | D416 | D417 | D418 | D419 | D420 |
| KI2/S86 | D421 | D422 | D423 | D424 | D425 |
| KI3/S87 | D426 | D427 | D428 | D429 | D430 |
| KI4/S88 | D431 | D432 | D433 | D434 | D435 |
| KI5/S89 | D436 | D437 | D438 | D439 | D440 |
| OSC/S90 | D441 | D442 | D443 | D444 | D445 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90. Also, COM5/S78 pin is used as Common output.

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 Segments corresponding to COM1 and COM5 are ON. |
| 1 | 0 | 0 | 1 | 0 | LCD Segments corresponding to COM1 and COM4 are ON. |
| 1 | 0 | 0 | 1 | 1 | LCD Segments corresponding to COM1, COM4 and COM5 are ON. |
| 1 | 0 | 1 | 0 | 0 | LCD Segments corresponding to COM1 and COM3 are ON. |
| 1 | 0 | 1 | 0 | 1 | LCD Segments corresponding to COM1, COM3 and COM5 are ON. |
| 1 | 0 | 1 | 1 | 0 | LCD Segments corresponding to COM1, COM3 and COM4 are ON. |
| 1 | 0 | 1 | 1 | 1 | LCD Segments corresponding to COM1, COM3, COM4 and COM5 are ON. |
| 1 | 1 | 0 | 0 | 0 | LCD Segments corresponding to COM1 and COM2 are ON. |
| 1 | 1 | 0 | 0 | 1 | LCD Segments corresponding to COM1, COM2 and COM5 are ON. |
| 1 | 1 | 0 | 1 | 0 | LCD Segments corresponding to COM1, COM2 and COM4 are ON. |
| 1 | 1 | 0 | 1 | 1 | LCD Segments corresponding to COM1, COM2, COM4 and COM5 are ON. |
| 1 | 1 | 1 | 0 | 0 | LCD Segments corresponding to COM1, COM2 and COM3 are ON. |
| 1 | 1 | 1 | 0 | 1 | LCD Segments corresponding to COM1, COM2, COM3 and COM5 are ON. |
| 1 | 1 | 1 | 1 | 0 | LCD Segments corresponding to COM1, COM2, COM3 and COM4 are ON. |
| 1 | 1 | 1 | 1 | 1 | LCD Segments corresponding to COM1, COM2, COM3, COM4 and COM5 are ON. |

Display Data and Output Pin Correspondence – continued

2. 1/4 Duty

| Output Pin ^(Note) | 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 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, COM5/S78, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90.

Display Data and Output Pin Correspondence – continued

| Output Pin ^(Note) | COM1 | COM2 | COM3 | COM4 |
|------------------------------|------|------|------|------|
| S64 | D253 | D254 | D255 | D256 |
| S65 | D257 | D258 | D259 | D260 |
| S66 | D261 | D262 | D263 | D264 |
| S67 | D265 | D266 | D267 | D268 |
| S68 | D269 | D270 | D271 | D272 |
| S69 | D273 | D274 | D275 | D276 |
| S70 | D277 | D278 | D279 | D280 |
| S71 | D281 | D282 | D283 | D284 |
| S72 | D285 | D286 | D287 | D288 |
| S73 | D289 | D290 | D291 | D292 |
| S74 | D293 | D294 | D295 | D296 |
| S75 | D297 | D298 | D299 | D300 |
| S76 | D301 | D302 | D303 | D304 |
| S77 | D305 | D306 | D307 | D308 |
| COM5/S78 | D309 | D310 | D311 | D312 |
| KS1/S79 | D313 | D314 | D315 | D316 |
| KS2/S80 | D317 | D318 | D319 | D320 |
| KS3/S81 | D321 | D322 | D323 | D324 |
| KS4/S82 | D325 | D326 | D327 | D328 |
| KS5/S83 | D329 | D330 | D331 | D332 |
| KS6/S84 | D333 | D334 | D335 | D336 |
| KI1/S85 | D337 | D338 | D339 | D340 |
| KI2/S86 | D341 | D342 | D343 | D344 |
| KI3/S87 | D345 | D346 | D347 | D348 |
| KI4/S88 | D349 | D350 | D351 | D352 |
| KI5/S89 | D353 | D354 | D355 | D356 |
| OSC/S90 | D357 | D358 | D359 | D360 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, COM5/S78, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90.

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. |

Display Data and Output Pin Correspondence – continued

3. 1/3 Duty

| Output Pin ^(Note) | 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 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, COM5/S78, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90

Display Data and Output Pin Correspondence – continued

| Output Pin ^(Note) | COM1 | COM2 | COM3 |
|------------------------------|------|------|------|
| S64 | D190 | D191 | D192 |
| S65 | D193 | D194 | D195 |
| S66 | D196 | D197 | D198 |
| S67 | D199 | D200 | D201 |
| S68 | D202 | D203 | D204 |
| S69 | D205 | D206 | D207 |
| S70 | D208 | D209 | D210 |
| S71 | D211 | D212 | D213 |
| S72 | D214 | D215 | D216 |
| S73 | D217 | D218 | D219 |
| S74 | D220 | D221 | D222 |
| S75 | D223 | D224 | D225 |
| S76 | D226 | D227 | D228 |
| S77 | D229 | D230 | D231 |
| COM5/S78 | D232 | D233 | D234 |
| KS1/S79 | D235 | D236 | D237 |
| KS2/S80 | D238 | D239 | D240 |
| KS3/S81 | D241 | D242 | D243 |
| KS4/S82 | D244 | D245 | D246 |
| KS5/S83 | D247 | D248 | D249 |
| KS6/S84 | D250 | D251 | D252 |
| KI1/S85 | D253 | D254 | D255 |
| KI2/S86 | D256 | D257 | D258 |
| KI3/S87 | D259 | D260 | D261 |
| KI4/S88 | D262 | D263 | D264 |
| KI5/S89 | D265 | D266 | D267 |
| OSC/S90 | D268 | D269 | D270 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, COM5/S78, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90

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. |

Display Data and Output Pin Correspondence – continued

4. Static

| Output Pin ^(Note) | 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 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, COM5/S78, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90.

Display Data and Output Pin Correspondence – continued

| Output Pin ^(Note) | COM1 |
|------------------------------|------|
| S64 | D64 |
| S65 | D65 |
| S66 | D66 |
| S67 | D67 |
| S68 | D68 |
| S69 | D69 |
| S70 | D70 |
| S71 | D71 |
| S72 | D72 |
| S73 | D73 |
| S74 | D74 |
| S75 | D75 |
| S76 | D76 |
| S77 | D77 |
| COM5/S78 | D78 |
| KS1/S79 | D79 |
| KS2/S80 | D80 |
| KS3/S81 | D81 |
| KS4/S82 | D82 |
| KS5/S83 | D83 |
| KS6/S84 | D84 |
| KI1/S85 | D85 |
| KI2/S86 | D86 |
| KI3/S87 | D87 |
| KI4/S88 | D88 |
| KI5/S89 | D89 |
| OSC/S90 | D90 |

(Note) The Segment Output Pin function is assumed to be selected for the output pins – S1/P1/G1 to S9/P9/G9, COM5/S78, KS1/S79 to KS6/S84, KI1/S85 to KI5/S89, OSC/S90.

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

| Display Data D21 | State of S21 Output 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^(Note 1)

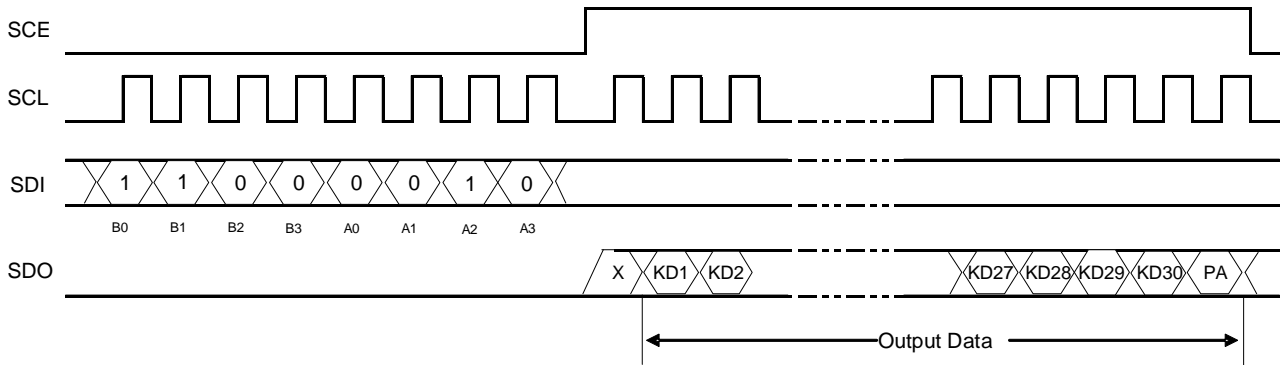


Figure 15. Serial Data Output Format

(Note 1)

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. PA: Power-saving acknowledge data
6. If a key data read operation is executed when SDO is high, the read key data (KD1 to KD30) and power-saving acknowledge data (PA) will be invalid.

2. When SCL is stopped at the high level^(Note 2)

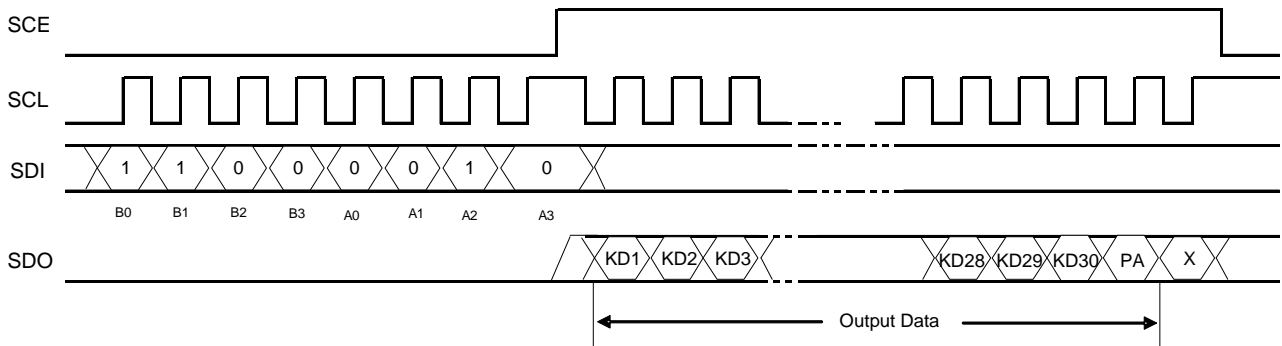


Figure 16. Serial Data Output Format

(Note 2)

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. PA: Power-saving acknowledge data
6. If a key data read operation is executed when SDO is high, the read key data (KD1 to KD30) and power-saving acknowledge data (PA) 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. PA: Power-saving 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 power-saving mode), the IC will be set to that mode. PA is set to 1 in the power-saving mode and to 0 in the normal mode.

Power-saving Mode

Power-saving mode is set up by setting at least one of control data BU0, BU1 or BU2 set 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 BU1 and BU2 set to 0. However, note that the S1/P1/G1 to S9/P9/G9 outputs can be used as General-purpose output pins according to the state of the P0 to P3 control data bits, even in power-saving mode. (See the [Control Data Functions](#).)

Key Scan Operation Function

1. Key Scan Timing

The key scan period is 4608T(s). To reliably determine the on/off state of the keys, the BU97530KVT-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 BU97530KVT-M cannot detect a key press shorter than 9840T(s).

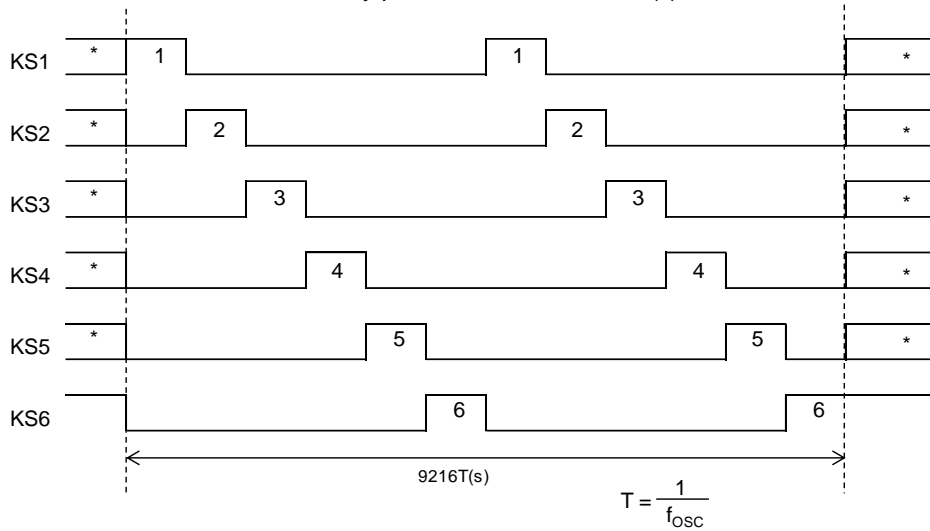


Figure 17. Key Scan Timing^(Note)

(Note) In power-saving 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 BU97530KVT-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 "H".

After the controller reads the key data, the key data read request is cleared (SDO is set high) and the BU97530KVT-M performs another key scan. Also note that SDO, being an open-drain output, requires a pull-up resistor (between 1 kΩ and 10kΩ)

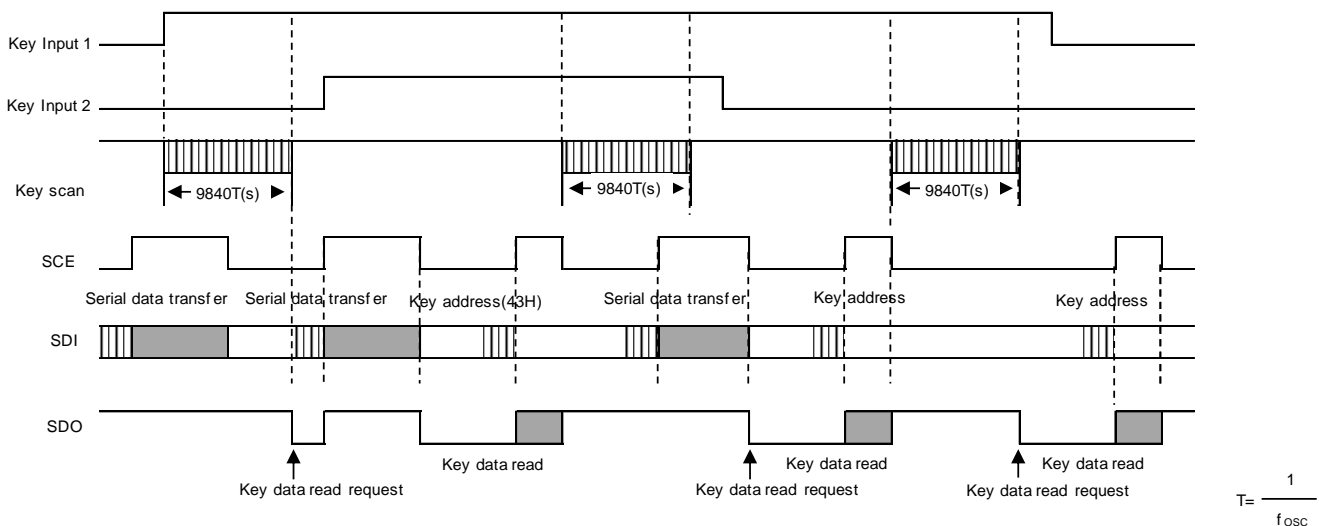


Figure 18. Key Scan Operation in Normal Mode

Key Scan Operation Function – continued

3. In Power-saving 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 Functions for details.)

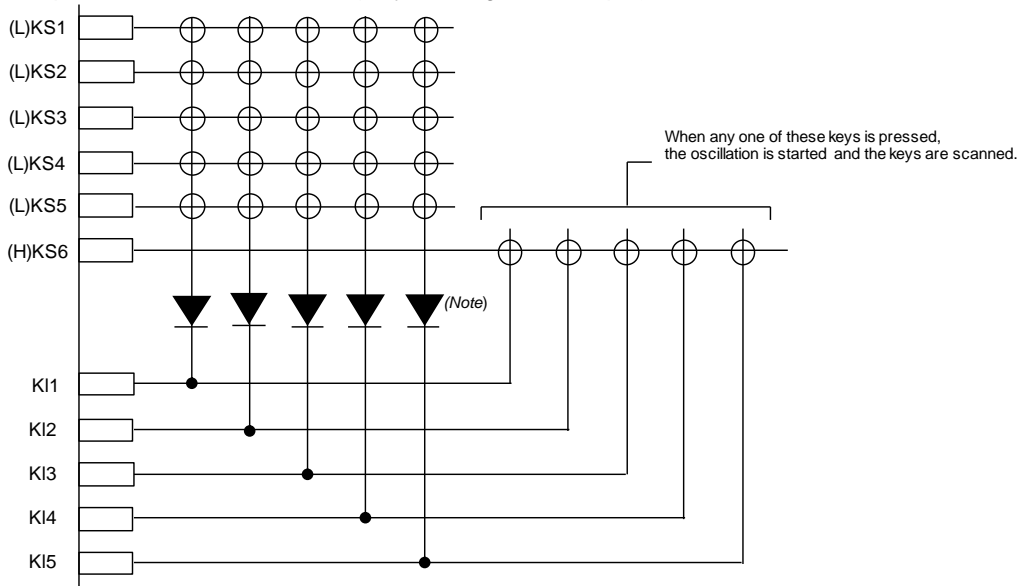
If a key on one of the lines corresponding to a KS1 to KS6 pin which is set high is pressed, the oscillation is started and a key scan is performed. Keys are scanned until all keys are released. Multiple key presses are recognized by determining whether multiple key data bits are set.

If a key is pressed for longer than 9840T(s)(Where $T=1/f_{osc}$) the BU97530KVT-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 BU97530KVT-M performs another key scan. However, this does not clear power-saving mode. Also note that SDO, being an open-drain output, requires a pull-up resistor (between 1kΩ and 10kΩ).

Power-saving mode key scan example

Example: BU0=0, BU1=0, BU2=1 (only KS6 high level output)



(Note)

These diodes are required to reliably recognize multiple key presses on the KS6 line when power-saving 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.

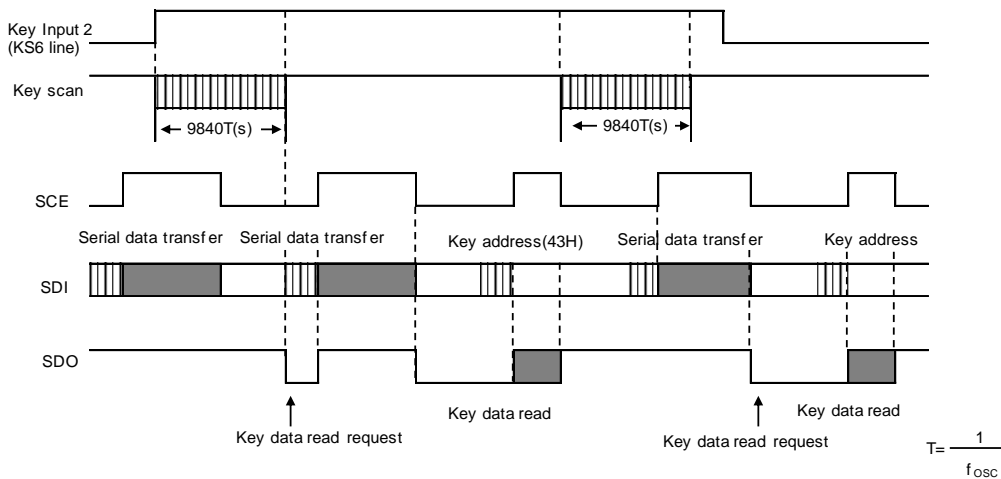


Figure 19. Key Scan Operation in Sleep Mode

Multiple Key Presses

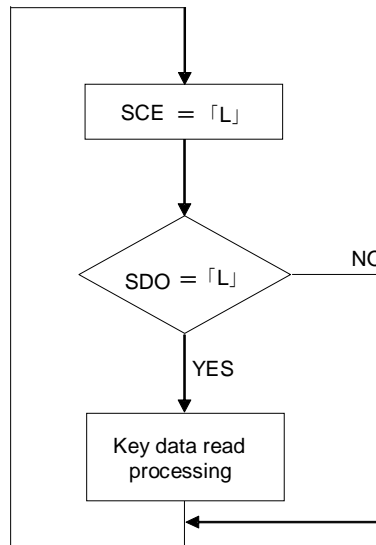
Although the BU97530KVT-M is capable of key scanning without inserting diodes for dual key presses, triple key presses on the K11 to K15 input pin lines or multiple key presses on the KS1 to KS6 output pin lines, multiple key presses other than these cases may result in keys that were not pressed recognized 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 ignore the key data if it contains three or more bits that has a value of "1".

Controller Key Data Read Technique

When the controller receives a key data read request from BU97530KVT-M, it performs a key data read acquisition operation using either the Timer Based Key Data Acquisition or the Interrupt Based Key Data Acquisition.

1. 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.



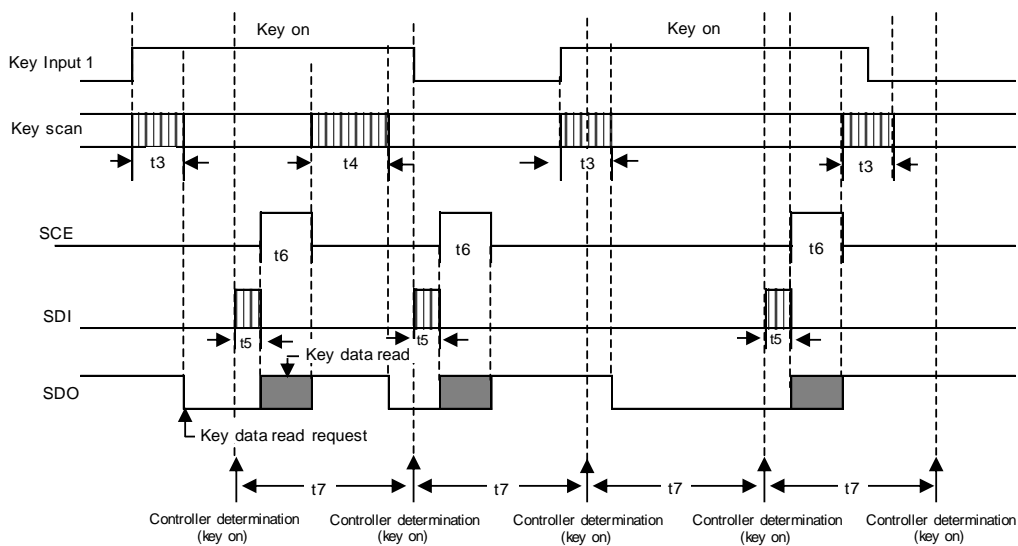
Key data read processing: Refer to “Serial Data Output”

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 KD30) and power-saving acknowledge data (PA) will be invalid.



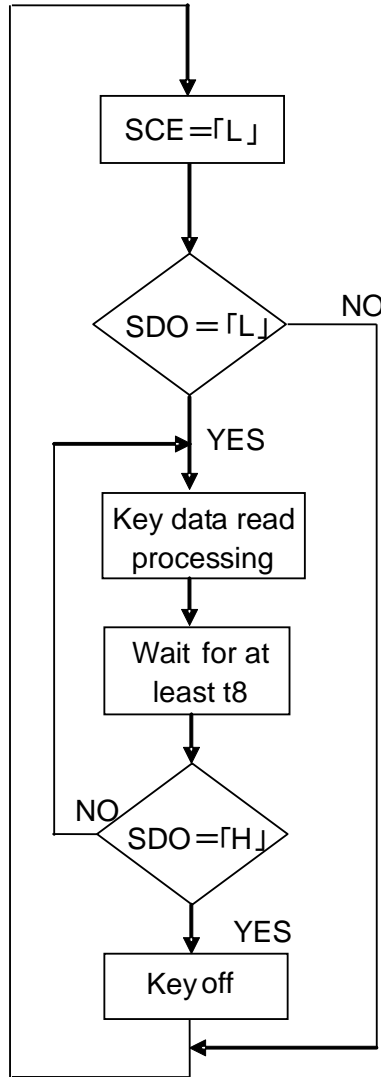
- t3: Key scan execution time when the key data agreed for two key scans. (9840T(s))
- t4: Key scan execution time when the key data did not agree for two key scans and the key scan was executed again. (19680T(s)) $T = 1 / f_{OSC}$
- t5: Key address (43H) transfer time
- t6: Key data read time

Figure 21. Timer based key data read operation

Controller Key Data Read Technique – continued

2. 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.



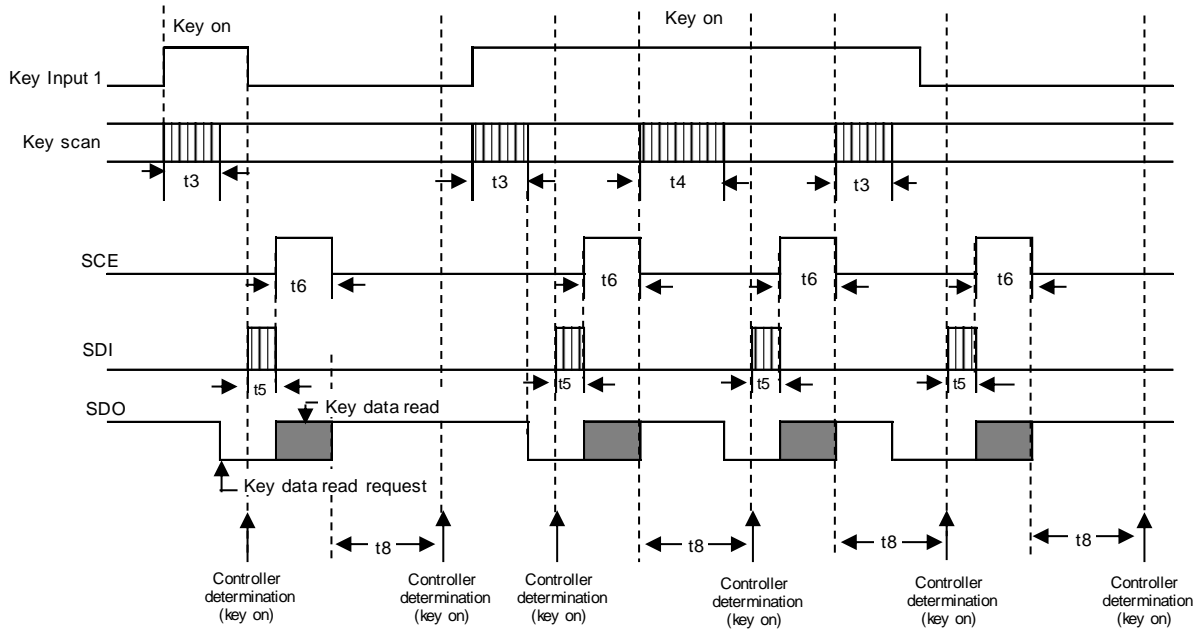
Key data read processing: Refer to “Serial Data Output”

Figure 22. Flowchart

Controller Key Data Read Technique – continued

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 t8 has elapsed by checking the SDO state when SCE is low and reading the key data. The period t8 in this technique must satisfy $t8 > t4$.

If a key data read operation is executed when SDO is high, the read key data (KD1 to KD30) and power-saving acknowledge data (PA) will be invalid.



- t3: Key scan execution time when the key data agreed for two key scans. (9840T[s])
- t4: Key scan execution time when the key data did not agree for two key scans and the key scan was executed again. (19680T[s]) $T = 1 / f_{osc}$
- t5: Key address (43H) transfer time
- t6: 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

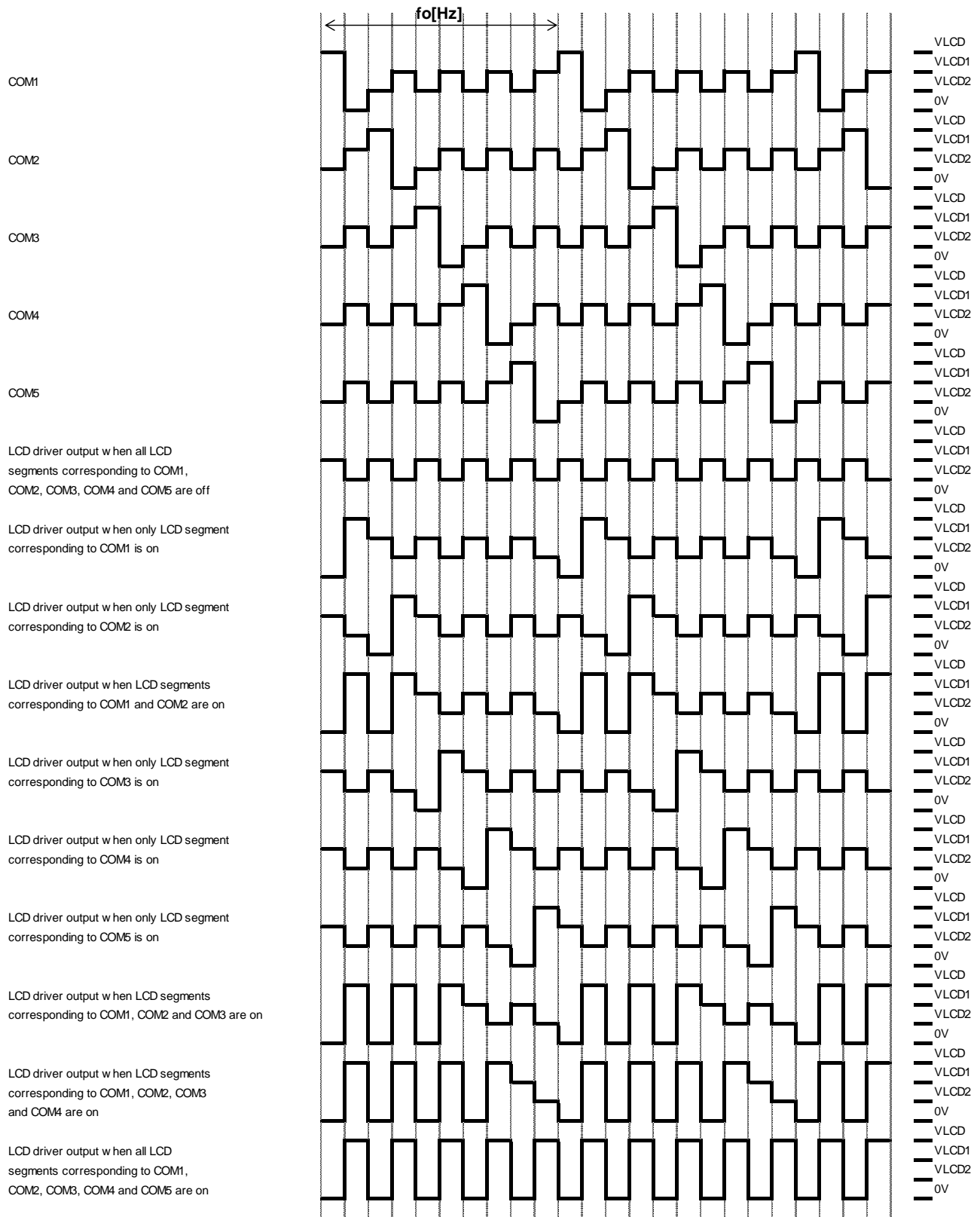


Figure 24. LCD Waveform (Line Inversion, 1/5 Duty, 1/3 Bias)

LCD Driving Waveforms – continued

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

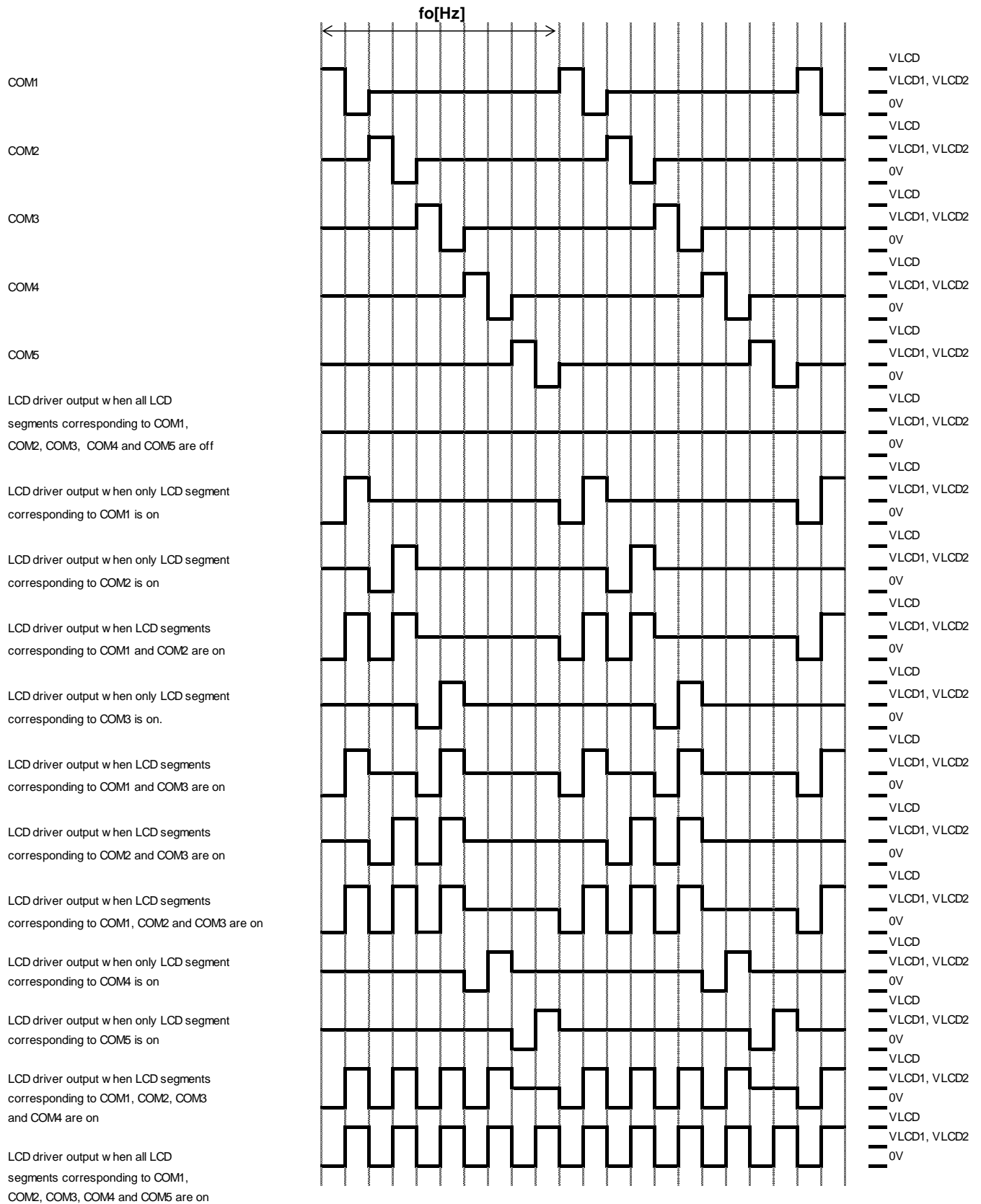


Figure 25. LCD Waveform (Line Inversion, 1/5 Duty, 1/2 Bias)

LCD Driving Waveforms – continued

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

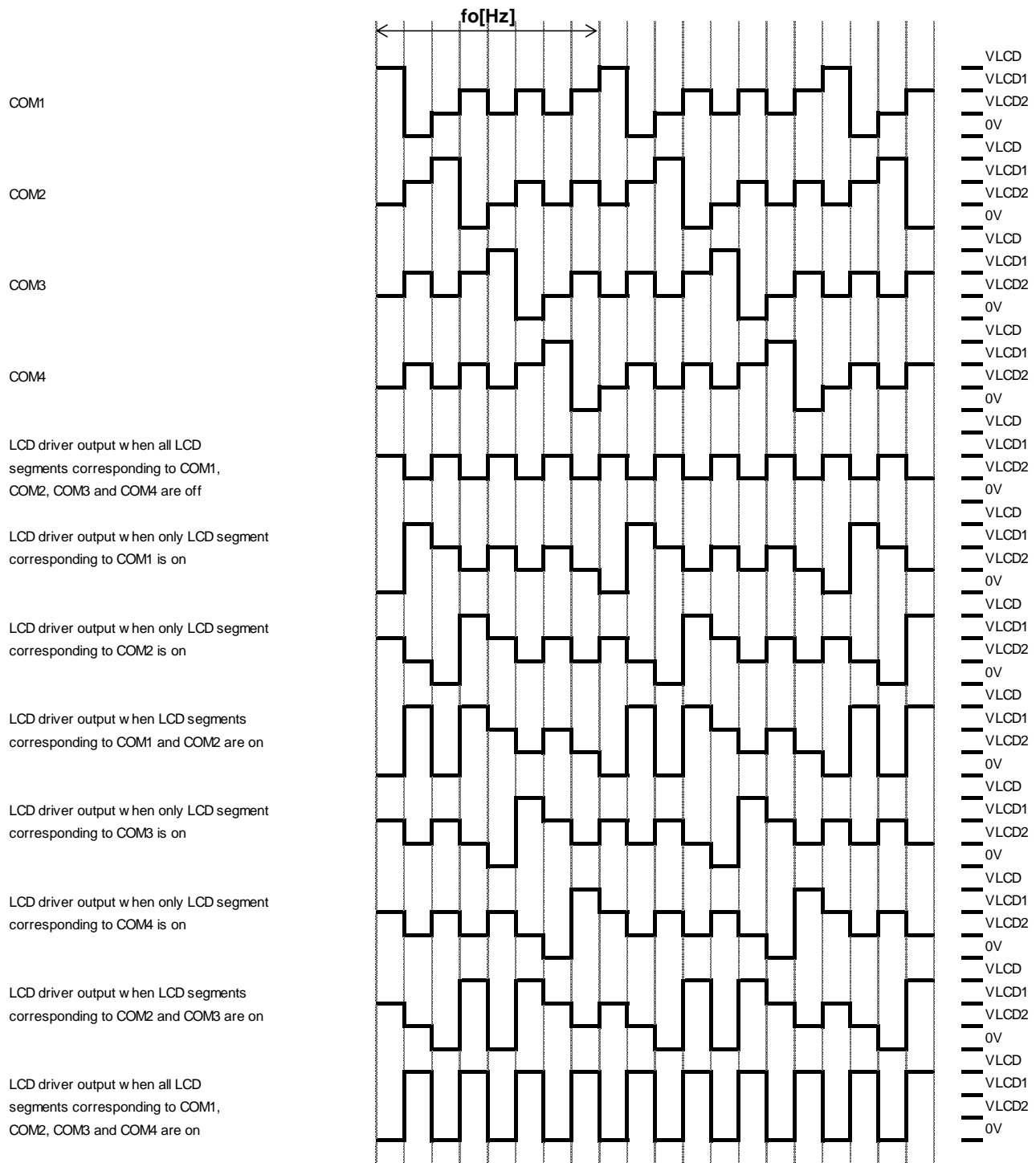


Figure 26. LCD Waveform (Line Inversion, 1/4 Duty, 1/3 Bias)

LCD Driving Waveforms – continued

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

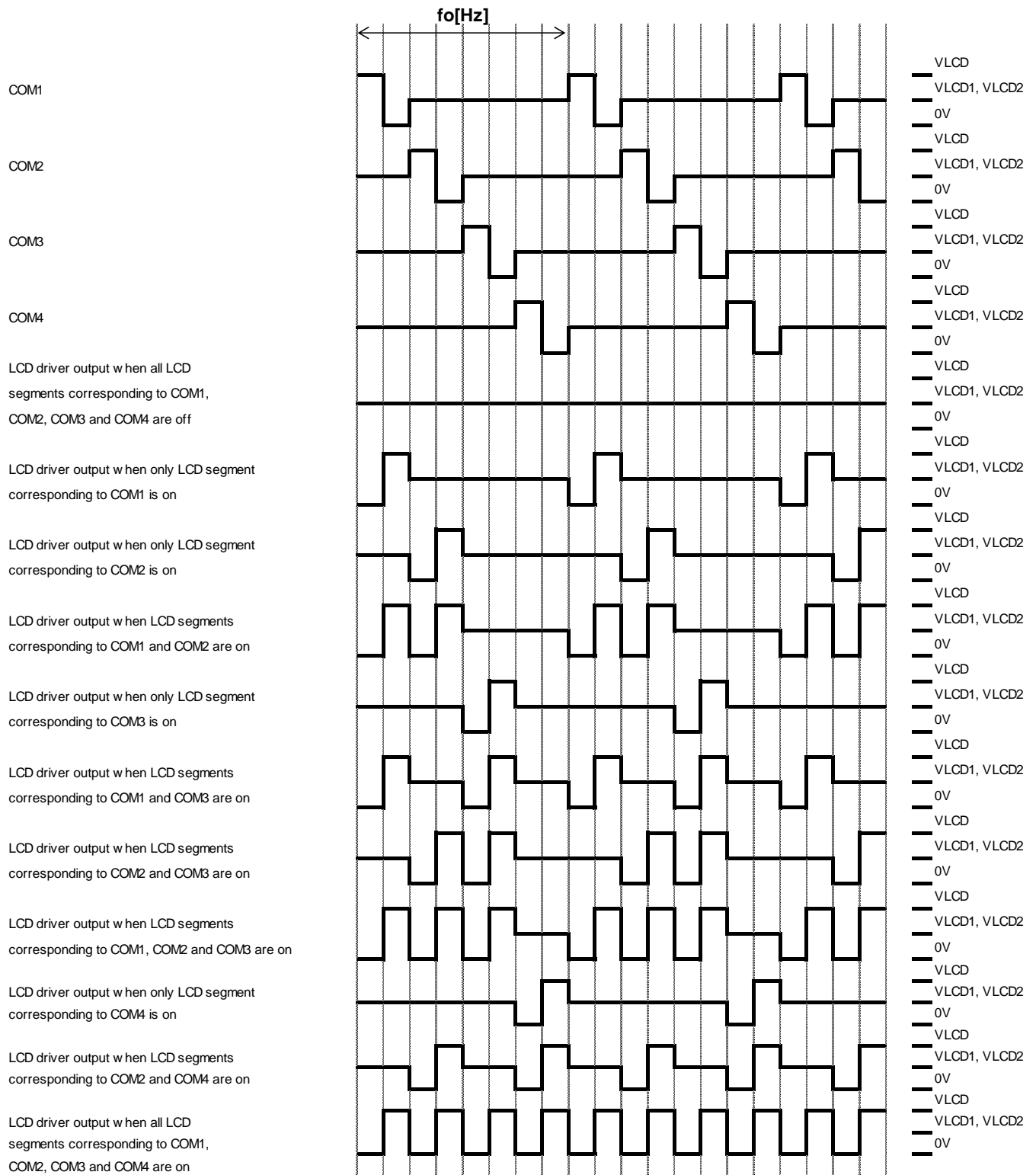


Figure 27. LCD Waveform (Line Inversion, 1/4 Duty, 1/2 Bias)

LCD Driving Waveforms – continued

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

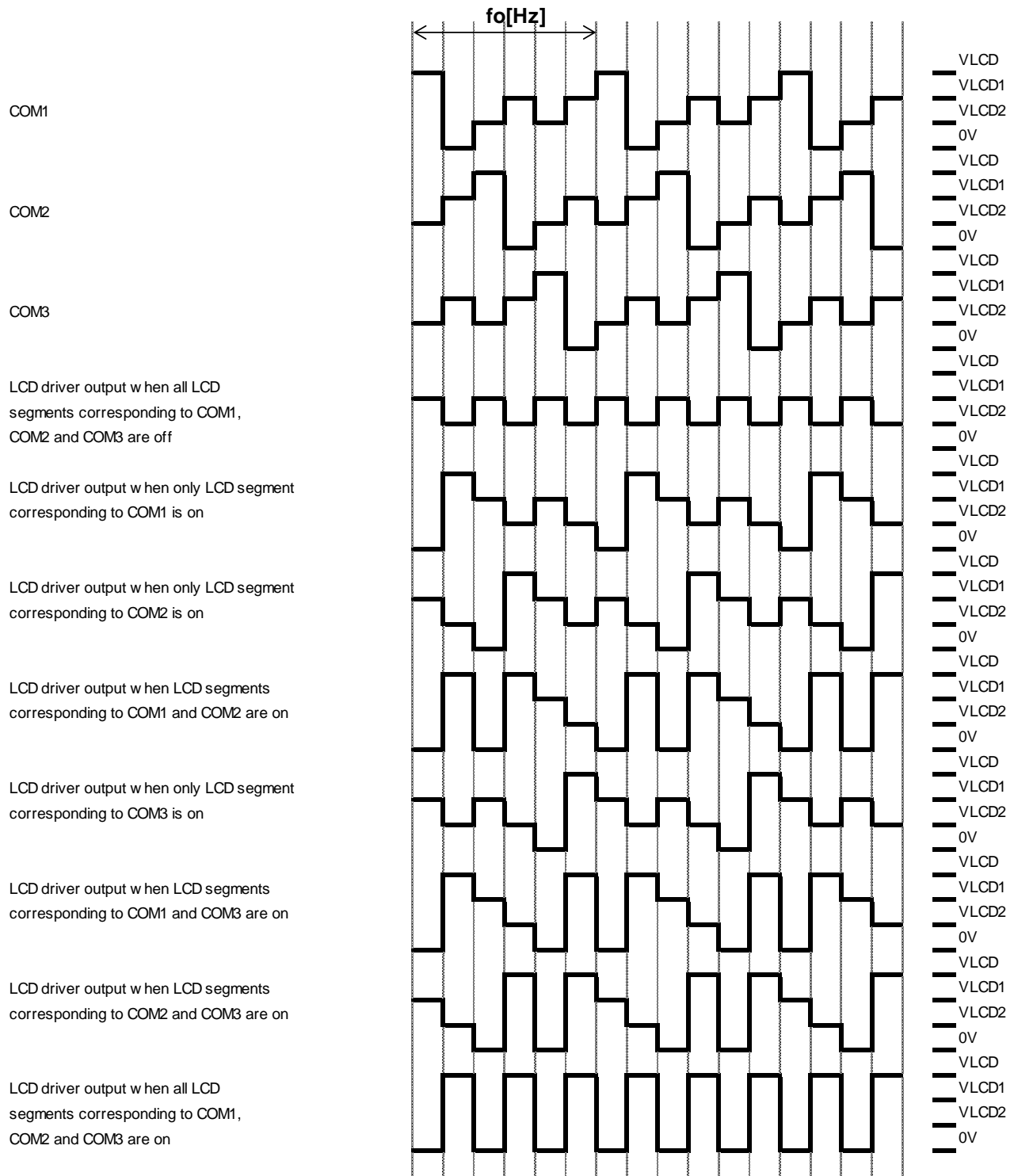


Figure 28. LCD Waveform (Line Inversion, 1/3 Duty, 1/3 Bias) ^(Note)

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

LCD Driving Waveforms – continued

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

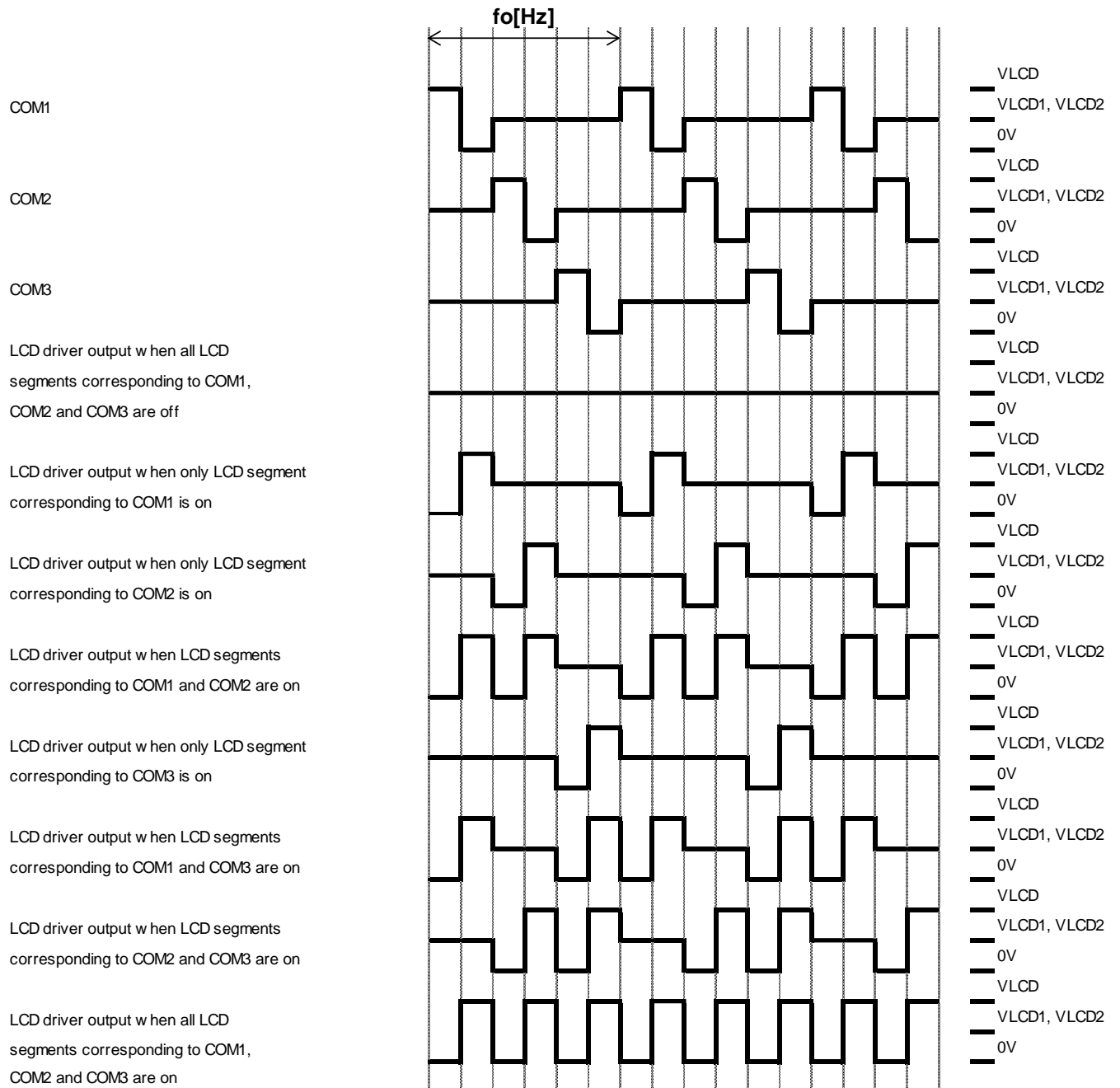


Figure 29. LCD Waveform (Line Inversion, 1/3 Duty, 1/2Bias) (Note)

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

LCD Driving Waveforms – continued

7. Line Inversion Static Drive Scheme

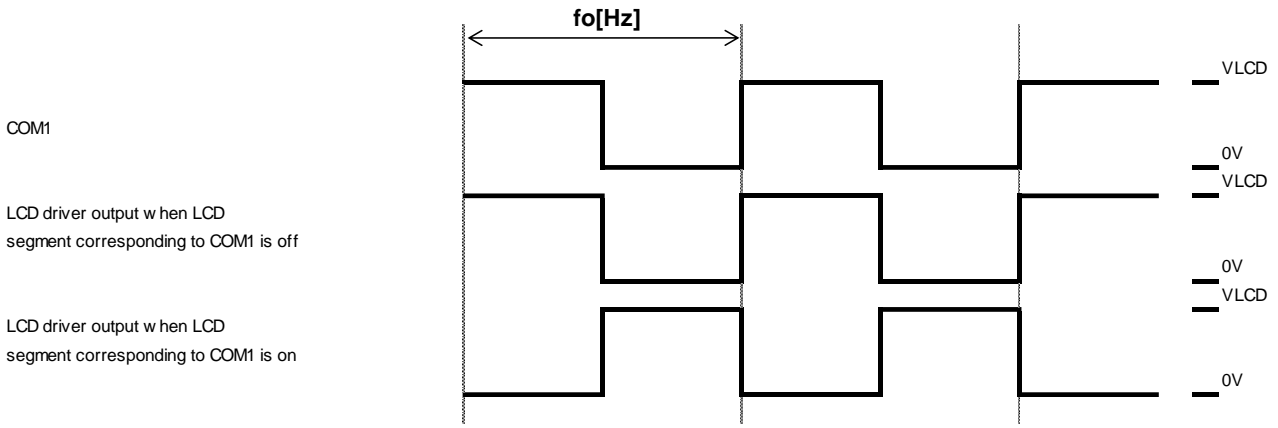


Figure 30. LCD Waveform (Line Inversion, Static) *(Note)*

(Note) COM2, COM3 and COM4 function are same as COM1 at Static.

LCD Driving Waveforms – continued

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

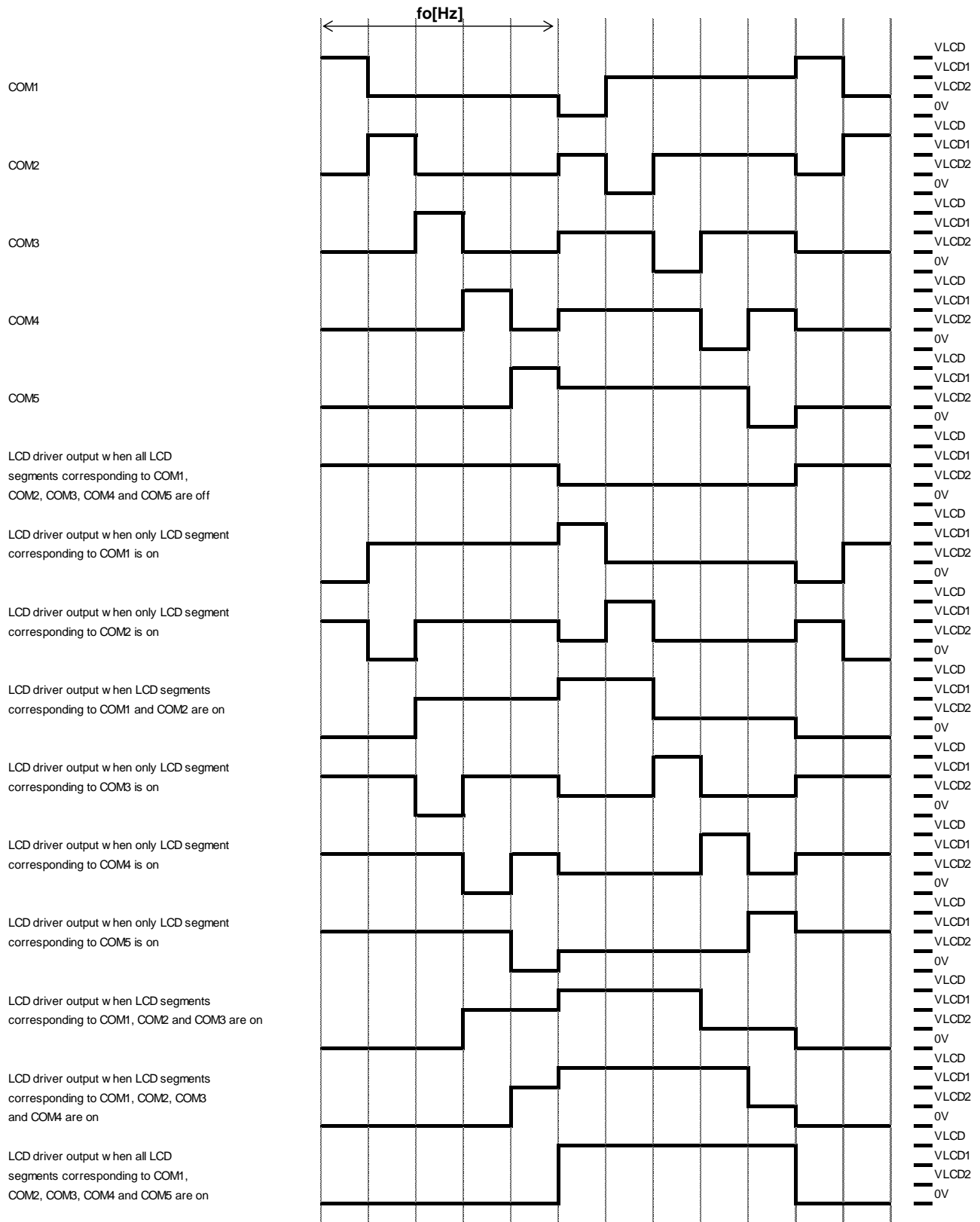


Figure 31. LCD Waveform (Frame Inversion, 1/5 Duty, 1/3Bias)

LCD Driving Waveforms – continued

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

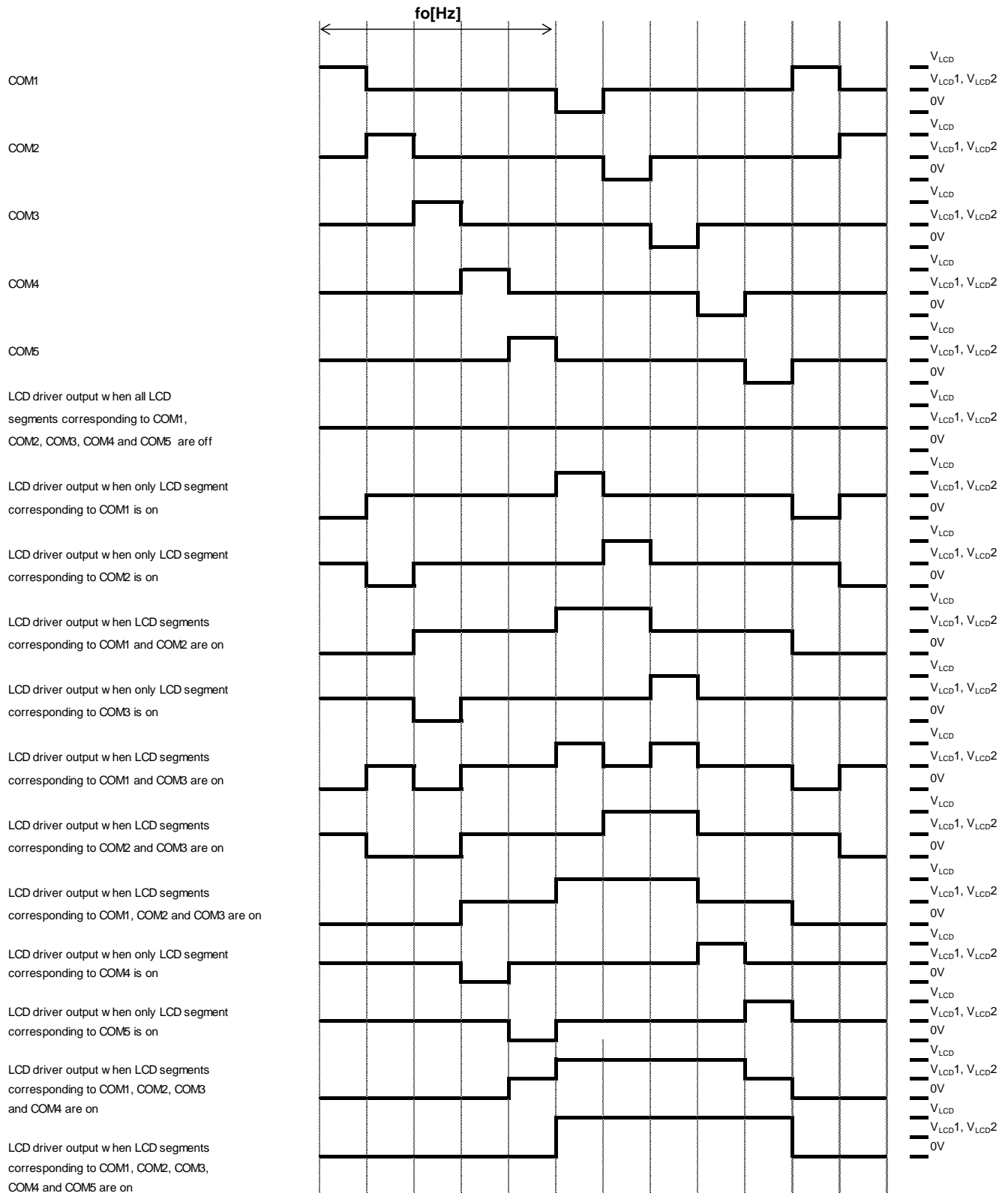


Figure 32. LCD Waveform (Frame Inversion, 1/5 Duty, 1/2Bias)

LCD Driving Waveforms – continued

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

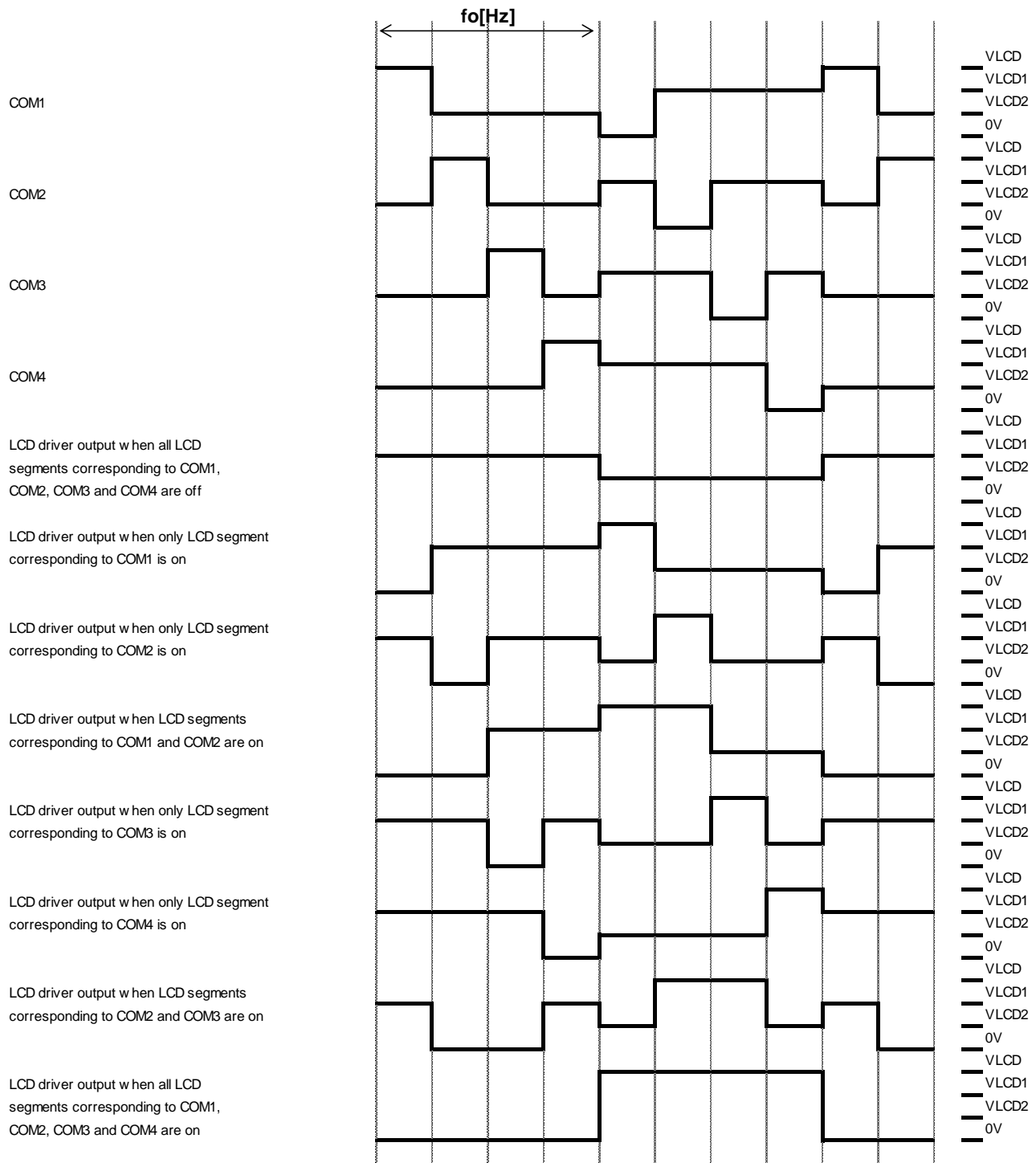


Figure 33. LCD Waveform (Frame Inversion, 1/4 Duty, 1/3Bias)

LCD Driving Waveforms – continued

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

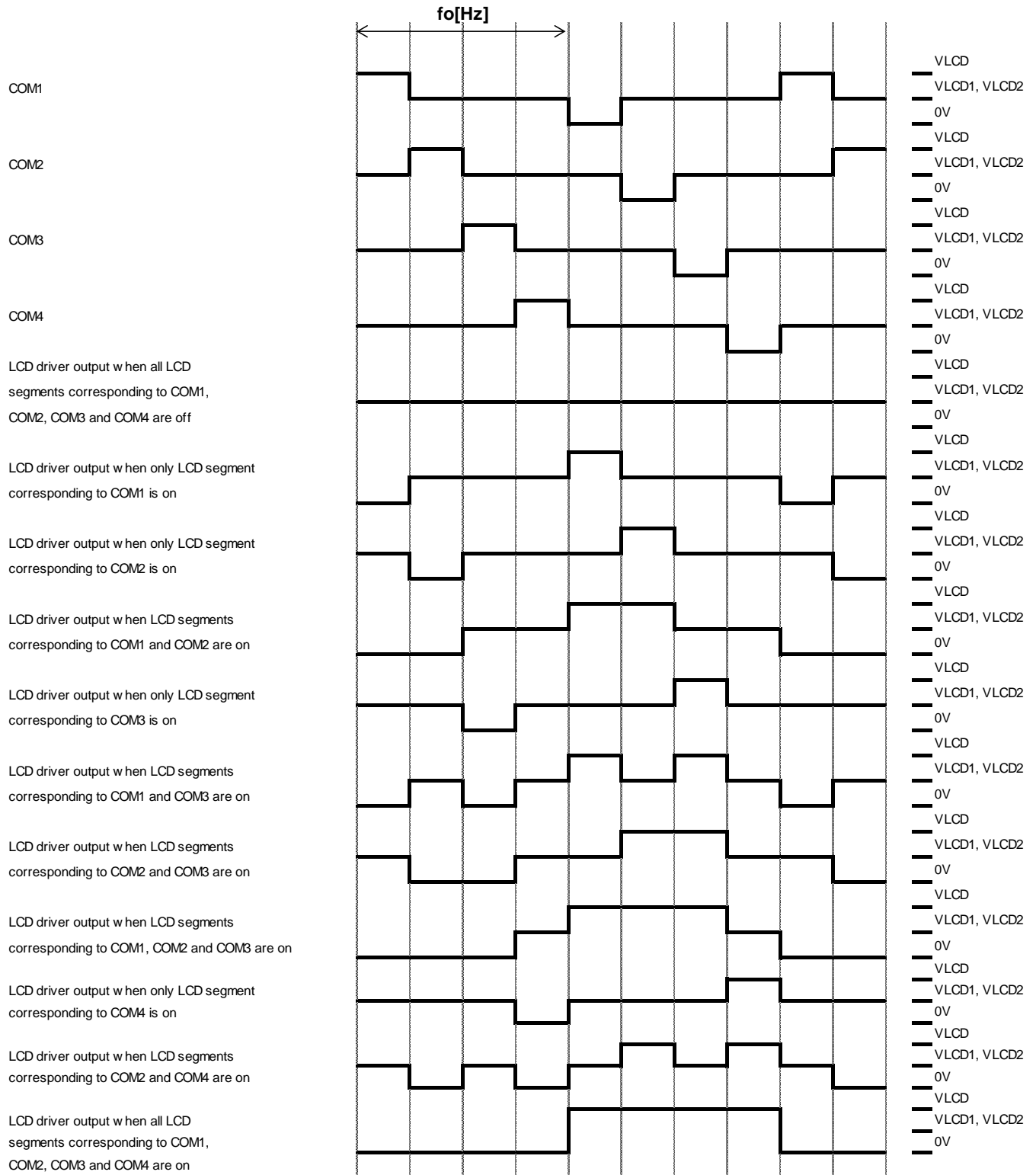


Figure 34. LCD Waveform (Frame Inversion, 1/4 Duty, 1/2Bias)

LCD Driving Waveforms – continued

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

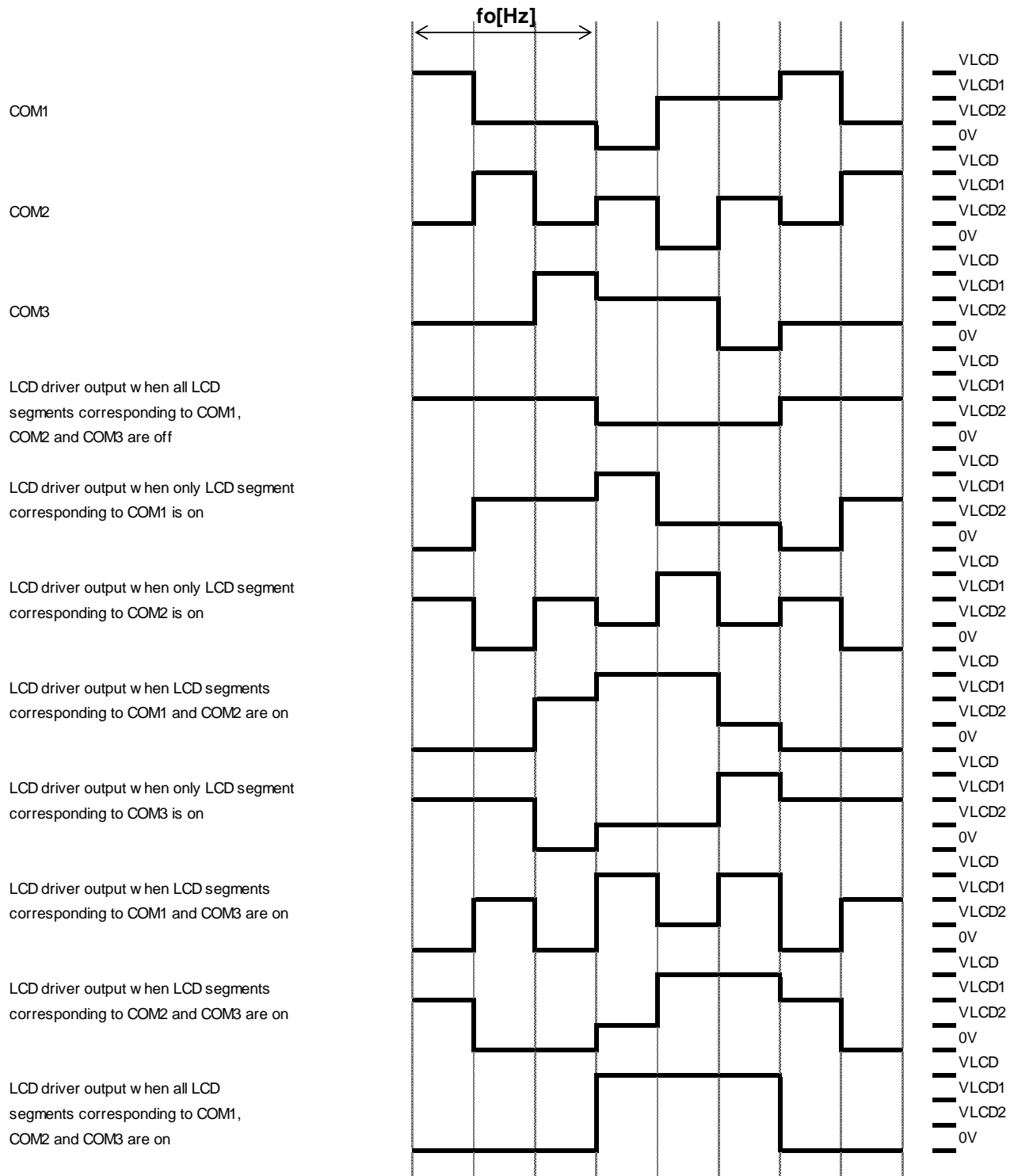


Figure 35. LCD Waveform (Frame Inversion, 1/3 Duty, 1/3Bias) *(Note)*

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

LCD Driving Waveforms – continued

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

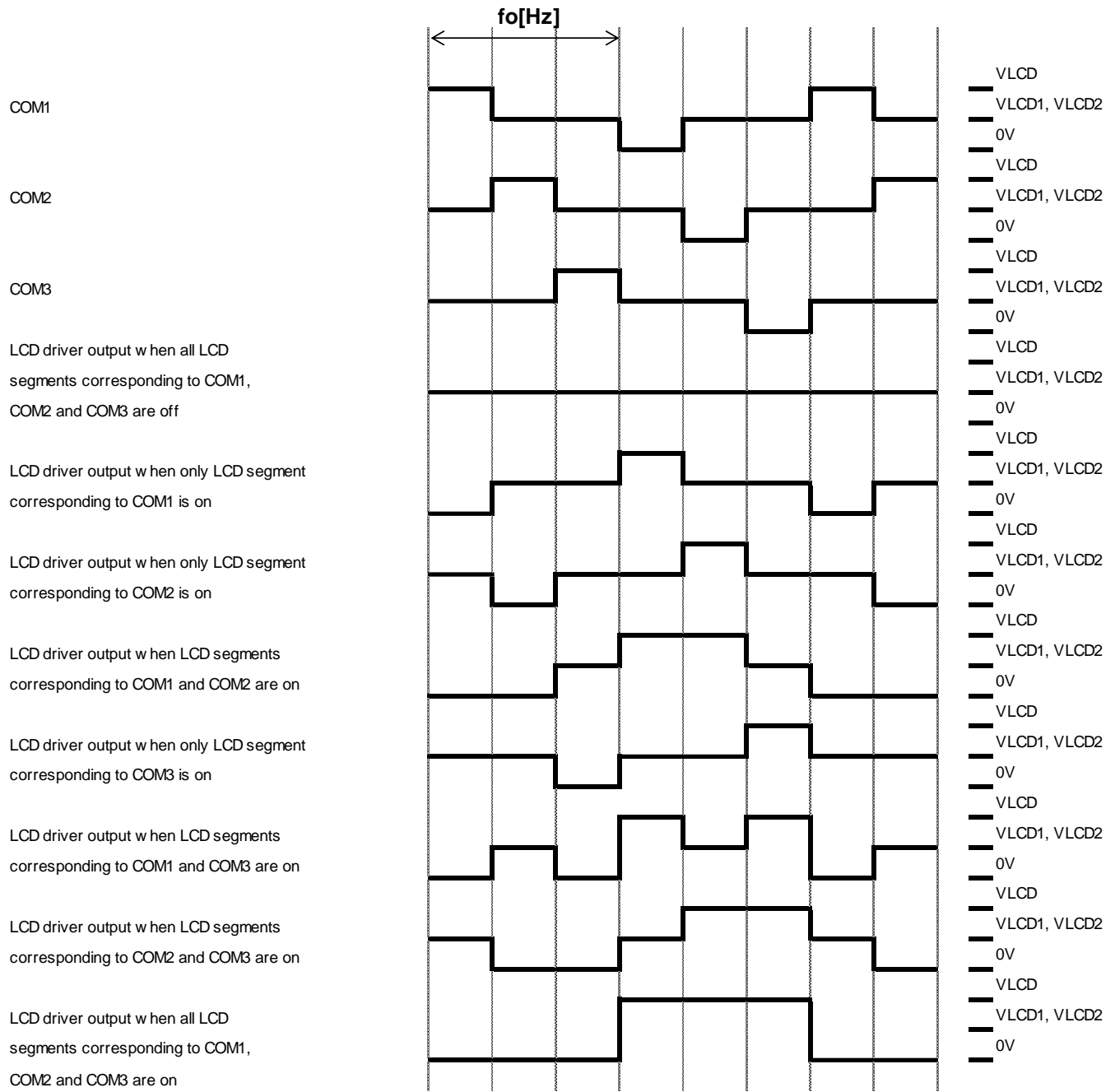


Figure 36. LCD Waveform (Frame Inversion, 1/3 Duty, 1/2 Bias) *(Note)*

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

LCD Driving Waveforms – continued

14. Frame Inversion Static

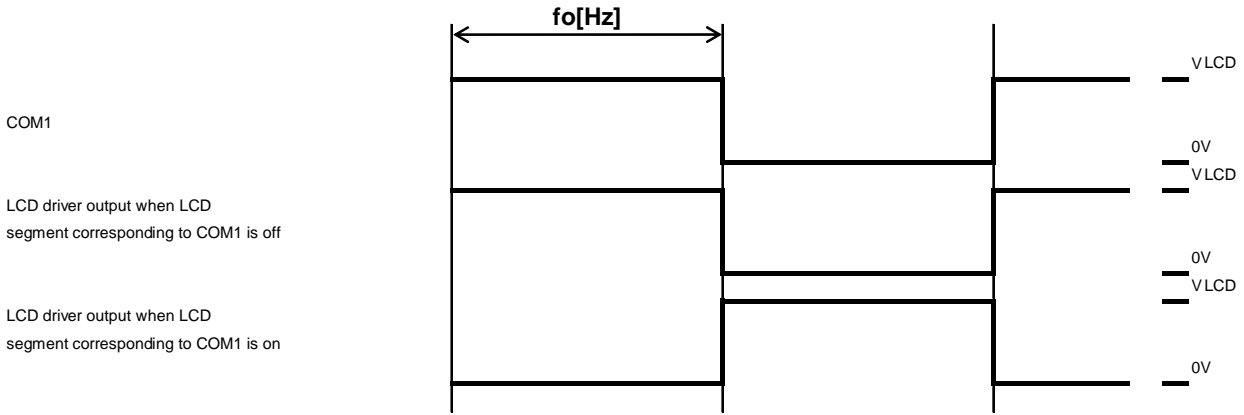


Figure 37. LCD Waveform (Frame Inversion, Static) (Note)

(Note) COM2, COM3 and COM4 function are same as COM1 at Static.

Oscillation Stabilization Time

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.

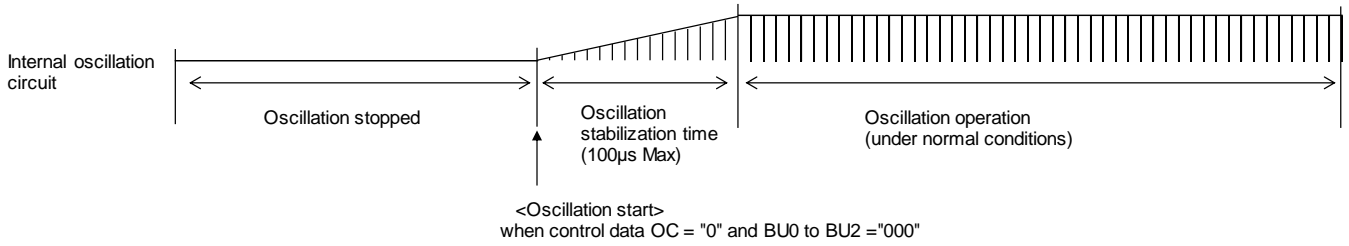


Figure 38. Oscillation Stabilization Time

Power-saving Mode Operation in External Clock Mode

After receiving [BU0,BU1,BU2]=[1,1,1], BU97530KVT-M enter to power saving mode synchronized with frame then Segment and Common pins output VSS level.

Therefore, in external clock mode, it is necessary to input the external clock based on each frame frequency setting after sending [BU0,BU1,BU2]=[1,1,1].

For the required number of clock, refer to "6. FC0, FC1, FC2 and FC3: Common / Segment output waveform frame frequency switching control data".

For example, please input the external clock as below.

[FC0,FC1,FC2,FC3]=[0,0,0,0]: In case of $f_{OSC}/12288$ setting, it needs over 12288clk,

[FC0,FC1,FC2,FC3]=[0,1,0,1]: In case of $f_{OSC}/4608$ setting, it needs over 4608clk,

[FC0,FC1,FC2,FC3]=[1,1,1,1]: In case of $f_{OSC}/1536$ setting, it needs over 1536clk

Please refer to the timing chart below.

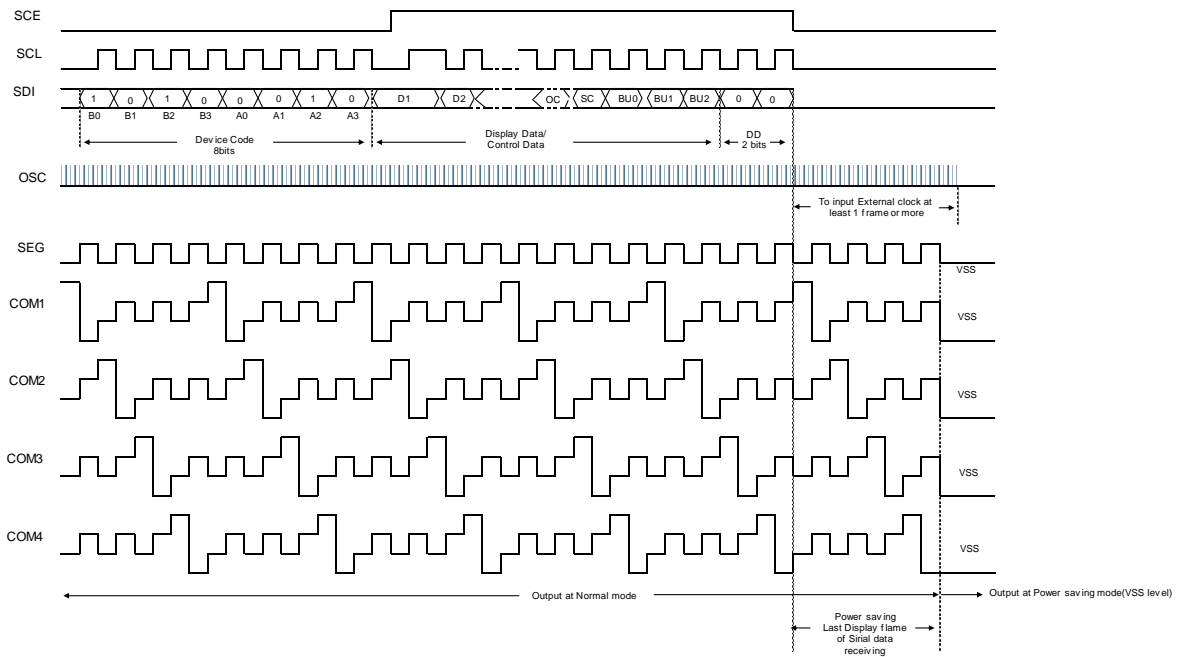


Figure 39. External Clock Stop Timing(1/4-Duty)

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 ($V_{DET} = 1.8V$ 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.

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.

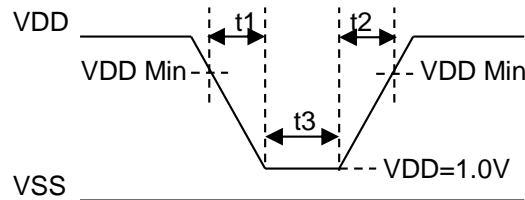


Figure 40. VDET Detection Timing

Power supply voltage VDD fall time: $t_1 > 1ms$
 Power supply voltage VDD rise time: $t_2 > 1ms$
 Internal reset power supply retain time: $t_3 > 1ms$

When it is difficult to keep above conditions, it is possibility to cause meaningless display due to no IC initialization. Please execute the IC initialization as quickly as possible after Power-on to reduce such an affect.

See the IC initialization flow as below.

But since commands are not received when the power is OFF, the IC initialization flow is not the same function as POR.

Set [BU0,BU1,BU2]=[1,1,1](power-saving mode) and SC=1(Display Off) as quickly as possible after Power-on. BU97530KVT-M can receive commands in 0ns after Power-on(VDD level is 90%).

Reset Condition

When BU97530KVT-M is initialized, the internal status after power supply has been reset as the following table.

| 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 |
| Bias Setting | DR=0:1/3 Bias |
| Duty Setting | [DT0,DT1]=[1,0]:1/4 Duty |
| Line / Frame Inversion Mode | FL=0:Line Inversion |
| Display Frame Frequency | [FC0,FC1,FC2,FC3]=[0,0,0,0]: $f_{OSC} / 12288$ |
| 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 to 9) |
| PWM Frequency | [PF0,PF1,PF2,PF3]=[0,0,0,0]: $f_{OSC} / 4096$ |
| PWM Duty | [Wn1 to Wn8]=[0,0,0,0,0,0,0,0]: $0/256 \times T_p$ (n=1 to 9, $T_p=1/f_p$) |
| Display Contrast Setting | [CT0,CT1,CT2,CT3]=[0,0,0,0]: VLCD Level is $1.00 \times VDD$ |

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. Recommended Operating Conditions

The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. 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.

7. Operation Under Strong Electromagnetic Field

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

8. 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.

9. 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**10. 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.

11. Regarding the Input Pin of the IC

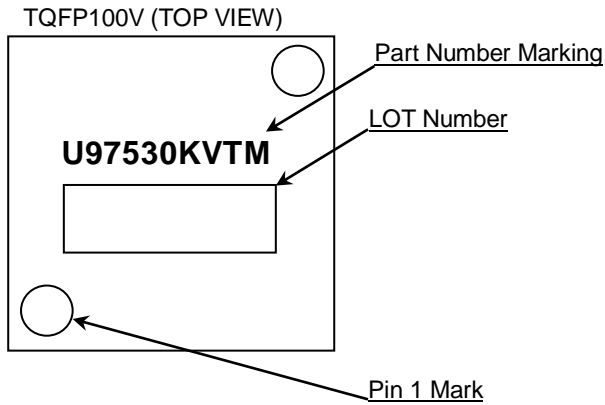
In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements 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.

Ordering Information

B U 9 7 5 3 0 K V T - ME2

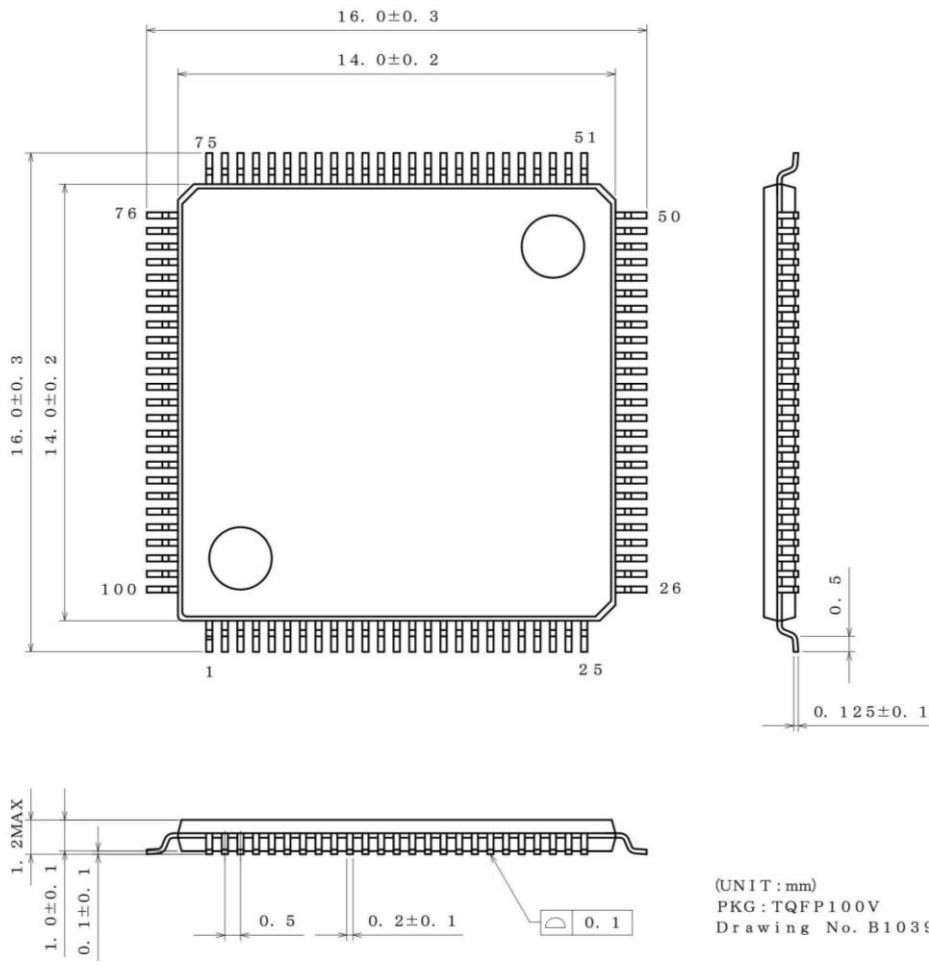
| | | |
|-------------|---------------------------|--|
| Part Number | Package KVT : TQFP100V | Product Rank M: for Automotive Packaging Specification E2: Embossed tape and reel (TQFP100V) |
|-------------|---------------------------|--|

Marking Diagram



Physical Dimension and Packing Information

| | |
|--------------|----------|
| Package Name | TQFP100V |
|--------------|----------|



<Tape and Reel information>

| | |
|-------------------|---|
| Tape | Embossed carrier tape (with dry pack) |
| Quantity | 500pcs |
| Direction of feed | E2 (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) |

Diagram of the carrier tape showing the direction of feed and the location of pin 1. The tape is shown with five individual components. An arrow labeled "Reel" points to the left, and an arrow labeled "Direction of feed" points to the right. Pin 1 is indicated at the upper left of the first component.

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

Version / Revision History

| Version | Date | Description |
|---------|---------------|--|
| 001 | 16. Mar. 2014 | New Release |
| 002 | 21. Oct. 2014 | Page 8 to 15. Modify 3-SPI Data Transfer Format Wn0 delete(fix to 0) Page 40,41,47,48. Delete COM4 description Page 51. Delete Wn0 description in RESET CONDITION Table |
| 003 | 2. Mar. 2015 | Modify Note number. Page 1. Add Note on AEC-Q100 Qualified. Page 4. Add External Clock Duty. Page 5. Modify Data Setup Time Min limit. Page 5. Modify Data Hold Time Min limit. Page 5. Modify SCE Wait Time Min limit. Page 5. Modify SCE Setup Time Min limit. Page 5. Modify SCE Hold Time Min limit. Page 5. Modify High-level Clock Pulse Width Min limit. Page 5. Modify Low-level Clock Pulse Width (Write) Min limit. Page 5. Add Clock Cycle Time. Page 5. Add Low-Level Clock Pulse Width (Read). Page 5. Add RPU and CL explanation. Page 5. Add SDO signal, tccyc and tclwr on Figure5 Serial Interface Timing. Page 5. Modify tclww from tclw on Figure5 Serial Interface Timing. Page 5. Modify reference level of tchw to VIH1,VIH2 from 50% on Figure5 Serial Interface Timing. Page 5. Modify reference level of tclww to VIL1 from 50% on Figure5 Serial Interface Timing. Page 5. Delete tcp on Figure5 Serial Interface Timing (1.When SCL is stopped at the low level) . Page 5. Delete tcs on Figure5 Serial Interface Timing (2.When SCL is stopped at the high level). Page 54, 55. Add packing specification for tray. |
| 004 | 18. Aug. 2015 | Page.8 to 15 Modify 3-SPI Data Transfer Format added FC3 |
| 005 | 27. Dec. 2017 | Page 3. Modify Temperature condition in Absolute Maximum Ratings. Ta=25°C → Removed Page 3. Modify Maximum Supply Voltage in Absolute Maximum Ratings. -0.3 to +6.5 → -0.3 to +7.0. Page 3. Modify Input Voltage in Absolute Maximum Ratings. -0.3 to +6.5 → -0.3 to +7.0. Page 3. Add OSC in Absolute Maximum Ratings Input Voltage. Page 3. Add Caution2 in Absolute Maximum Ratings condition. (Moved from Operational Notes) Page 3. Add OSC pin in Electrical Characteristics table. Page 4. Add External Clock Rise Time, External Clock Fall Time and External Clock Duty in Oscillation Characteristics. Page 6. Add K11/S85 to K15/S89 in Pin Description I/O and Handling when unused Input terminal description. Page 6. Add OSC/S90 in Pin Description I/O and Handling when unused Input terminal description Page 16 to 20. Add Reset condition in Control Data Functions. Page 16. Add 3. FL: Line Inversion or Frame Inversion control data explanation. Page 17. Add External Clock input timing function in 7. OC: Internal oscillator operating mode / External clock operating mode control data. Page 50. Add Power-saving mode operation in external clock mode. Page 51. Add Voltage Detection Type Reset Circuit (VDET) explanation. Correction of errors. |

Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment ^(Note 1), 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:
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 - [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 Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [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 depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction 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 Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [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.

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Precaution for Disposition

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

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