



# AiP16C23

## Ram Mapping 55 Seg×4 Com or 51 Seg×8 Com LCD Driver and Controller with 2-Line Serial Interface

### Product Specification

#### Specification Revision History:

| Version    | Date    | Description                         |
|------------|---------|-------------------------------------|
| 2020-07-A1 | 2020-07 | New                                 |
| 2023-09-B1 | 2023-09 | Update the template                 |
| 2023-12-B2 | 2023-12 | Update the instructions description |
|            |         |                                     |



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## 1、General Description

AiP16C23 is a kind of LCD controller/driver .The device provides two display modes: 1/4 duty and 1/8 duty display modes. The display segments of the device are 220 patterns (55×4) or 408 patterns (51×8). AiP16C21 has a built-in clock generator, LCD bias voltage generation module, LCD drive voltage follower and standard I<sup>2</sup>C interface.

### Features:

- Operating voltage: 2.4 to 5.5V
- Display Mode:
  - LQFP64:
    - 1/4 duty, 55×4 patterns: 55 SEGs and 4 COMs
    - 1/8 duty, 16×8 patterns: 51 SEGs and 8 COMs
  - LQFP48:
    - 1/8 duty, 35 SEG×8 COM
- I<sup>2</sup>C interface
- Low power consumption
- Versatile blinking modes, Two selectable LCD frame frequencies: 80Hz or 160Hz
- 16×8 bit display data register
- Internal 32kHz RC oscillator
- Internal LCD bias generator with voltage follower
- 16-step V<sub>LCD</sub> voltage adjustable
- LCD drive voltage can be adjusted by external resistor
- Bias: 1/3 or 1/4
- Package form: LQFP48/LQFP64

### Ordering Information:

#### Tube packing specifications:

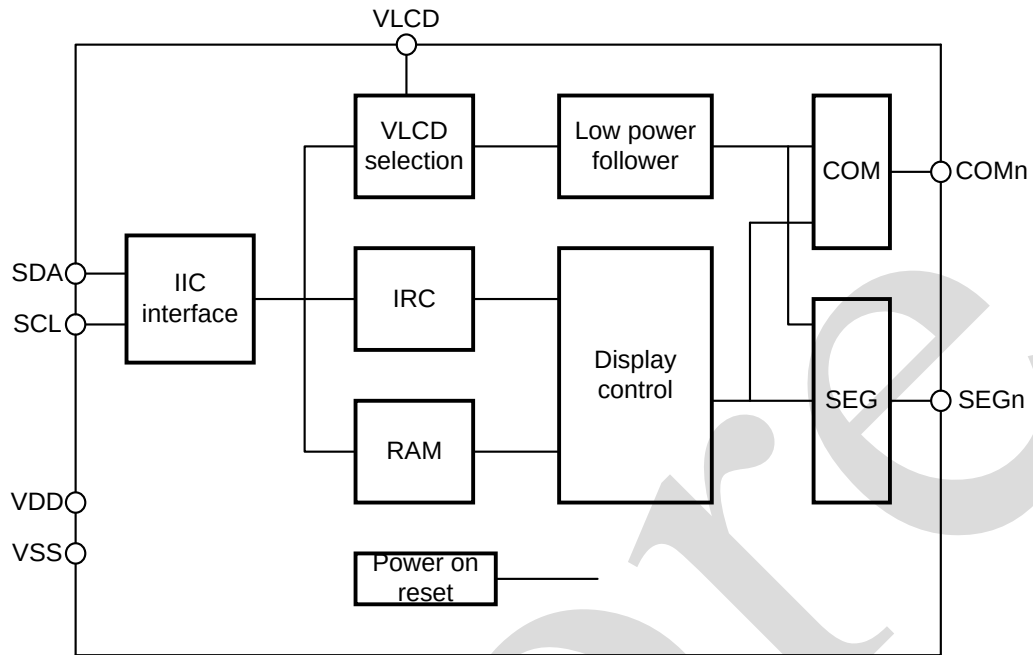
| Part number     | Packaging form | Marking code | Tube quantity | Boxed tube quantity | Boxed quantity | Notes                                                              |
|-----------------|----------------|--------------|---------------|---------------------|----------------|--------------------------------------------------------------------|
| AiP16C23LA48.TB | LQFP48         | AiP16C23     | 250 PCS/plate | 10 plate/box        | 2500 PCS/box   | Dimensions of plastic enclosure: 7.0mm×7.0mm<br>Pin spacing: 0.5mm |
| AiP16C23LA64.TB | LQFP64         | AiP16C23     | 250 PCS/plate | 10 plate/box        | 2500 PCS/box   | Dimensions of plastic enclosure: 7.0mm×7.0mm<br>Pin spacing: 0.4mm |

Note: If the physical information is inconsistent with the ordering information, please refer to the actual product.



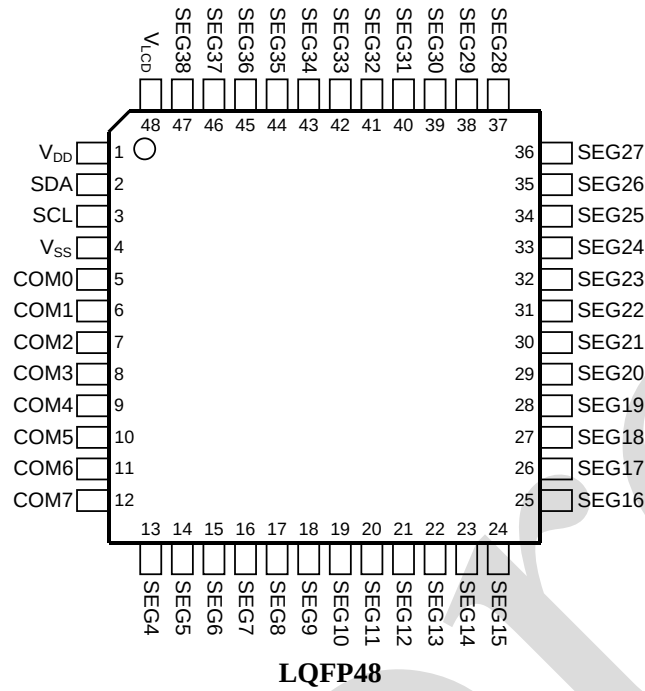
## 2、Block Diagram And Pin Description

### 2.1、Block Diagram

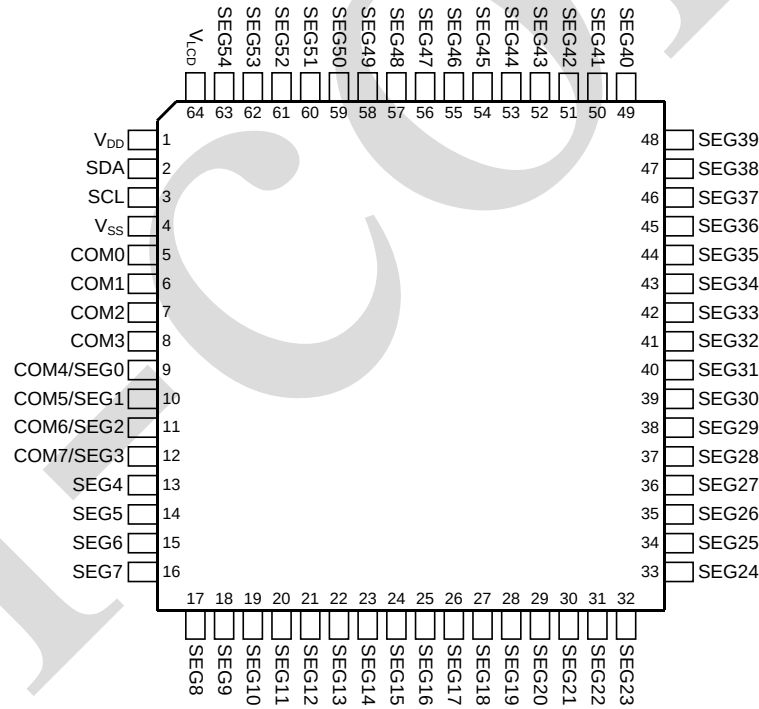




## 2.2、Pin Configurations



**LQFP48**



**LQFP64**

Note:

1. Application condition:  $V_{DD} \leq V_{LCD}$  or  $V_{LCD} \leq V_{DD}$ .
2. The LQFP48 package of this series of chips does not supply LCD 1/4 duty.



## 2.3、Pin Description

| Pin No. |        | Pin Name            | Type | Description                                             |
|---------|--------|---------------------|------|---------------------------------------------------------|
| LQFP48  | LQFP64 |                     |      |                                                         |
| 2       | 2      | SDA                 | I/O  | Serial data input/output for I <sup>2</sup> C interface |
| 3       | 3      | SCL                 | I    | Serial clock input for I <sup>2</sup> C interface       |
| 1       | 1      | V <sub>DD</sub>     | -    | Positive power supply                                   |
| 4       | 4      | V <sub>SS</sub>     | -    | Negative power supply, ground                           |
| 48      | 64     | V <sub>LCD</sub>    | -    | LCD driver power supply                                 |
| 5~8     | 5~8    | COM0~COM3           | O    | LCD COM output                                          |
| 9~12    | -      | COM4~COM7           | O    | LCD COM output                                          |
| -       | 9~12   | COM4/SEG0~COM7/SEG3 | O    | LCD COM/SEG multiplexed driver outputs                  |
| 13~47   | 13~47  | SEG4~SEG38          | O    | LCD SEG output                                          |
| -       | 48~63  | SEG39~SEG54         | O    | LCD SEG output                                          |

## 3、Electrical Parameter

### 3.1、Absolute Maximum Ratings

(T<sub>amb</sub>=25℃, All voltage referenced to V<sub>SS</sub>, unless otherwise specified)

| Characteristic        | Symbol           | Conditions | Value                                        | Unit |
|-----------------------|------------------|------------|----------------------------------------------|------|
| supply voltage        | -                | -          | V <sub>SS</sub> -0.3 to V <sub>SS</sub> +6.5 | V    |
| input voltage         | V <sub>IN</sub>  | -          | V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3 | V    |
| operating temperature | T <sub>amb</sub> | -          | -40 to +85                                   | ℃    |
| storage temperature   | T <sub>stg</sub> | -          | -55 to +150                                  | ℃    |
| Soldering temperature | T <sub>L</sub>   | 10S        | 260                                          | ℃    |



## 3.2、Electrical Characteristics

### 3.2.1、DC Characteristics 1

( $T_{amb}=-40$  to  $+85^{\circ}\text{C}$ ,  $V_{DD}=2.4$  to  $5.5\text{V}$ ,  $V_{SS}=0\text{V}$ , unless otherwise specified)

| Parameter                | Symbol    | Conditions |                                                                                                                                         | Min.        | Typ. | Max.        | Unit          |
|--------------------------|-----------|------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------|------|-------------|---------------|
|                          |           | $V_{DD}$   | Conditions                                                                                                                              |             |      |             |               |
| operating voltage        | $V_{DD}$  | -          | -                                                                                                                                       | 2.4         | -    | 5.5         | V             |
| operating voltage        | $V_{LCD}$ | -          | -                                                                                                                                       | -           | -    | 5.5         | V             |
| operating current        | $I_{DD}$  | 3V         | no load, $V_{LCD}=V_{DD}$ , 1/3 bias, $f_{LCD}=80\text{Hz}$ , LCD display on, internal system oscillator on, DA0~DA3 are set to "0000"  | -           | 25   | 40          | $\mu\text{A}$ |
|                          |           | 5V         |                                                                                                                                         | -           | 35   | 50          | $\mu\text{A}$ |
| operating current        | $I_{DD1}$ | 3V         | no load, $V_{LCD}=V_{DD}$ , 1/3 bias, $f_{LCD}=80\text{Hz}$ , LCD display off, internal system oscillator on, DA0~DA3 are set to "0000" | -           | 2    | 5           | $\mu\text{A}$ |
|                          |           | 5V         |                                                                                                                                         | -           | 4    | 10          | $\mu\text{A}$ |
| standby current          | $I_{STB}$ | 3V         | no load, $V_{LCD}=V_{DD}$ , LCD display off, internal system oscillator off                                                             | -           | -    | 1           | $\mu\text{A}$ |
|                          |           | 5V         |                                                                                                                                         | -           | -    | 2           | $\mu\text{A}$ |
| HIGH level input current | $V_{IH}$  | -          | SDA, SCL                                                                                                                                | $0.7V_{DD}$ | -    | $V_{DD}$    | V             |
| LOW level input current  | $V_{IL}$  | -          | SDA, SCL                                                                                                                                | 0           | -    | $0.3V_{DD}$ | V             |
| input leakage current    | $I_{IL}$  | -          | $V_{IN}=V_{SS}$ or $V_{DD}$                                                                                                             | -1          | -    | 1           | $\mu\text{A}$ |
| LOW level output current | $I_{OL}$  | 3V         | $V_{OL}=0.4\text{V}$ , SDA                                                                                                              | 3           | -    | -           | mA            |
|                          |           | 5V         |                                                                                                                                         | 6           | -    | -           | mA            |
| LCD COM sink current     | $I_{OL1}$ | 3V         | $V_{LCD}=3\text{V}$ , $V_{OL}=0.3\text{V}$                                                                                              | 250         | 400  | -           | $\mu\text{A}$ |
|                          |           | 5V         | $V_{LCD}=5\text{V}$ , $V_{OL}=0.5\text{V}$                                                                                              | 500         | 800  | -           | $\mu\text{A}$ |
| LCD COM source current   | $I_{OH1}$ | 3V         | $V_{LCD}=3\text{V}$ , $V_{OH}=2.7\text{V}$                                                                                              | -140        | -230 | -           | $\mu\text{A}$ |
|                          |           | 5V         | $V_{LCD}=5\text{V}$ , $V_{OH}=4.5\text{V}$                                                                                              | -300        | -500 | -           | $\mu\text{A}$ |
| LCD SEG sink current     | $I_{OL2}$ | 3V         | $V_{LCD}=3\text{V}$ , $V_{OL}=0.3\text{V}$                                                                                              | 250         | 400  | -           | $\mu\text{A}$ |
|                          |           | 5V         | $V_{LCD}=5\text{V}$ , $V_{OL}=0.5\text{V}$                                                                                              | 500         | 800  | -           | $\mu\text{A}$ |
| LCD SEG source current   | $I_{OH2}$ | 3V         | $V_{LCD}=3\text{V}$ , $V_{OH}=2.7\text{V}$                                                                                              | -140        | -230 | -           | $\mu\text{A}$ |
|                          |           | 5V         | $V_{LCD}=5\text{V}$ , $V_{OH}=4.5\text{V}$                                                                                              | -300        | -500 | -           | $\mu\text{A}$ |



## 3.2.2、AC Characteristics 1

( $T_{amb}=-40$  to  $+85^{\circ}\text{C}$ ,  $V_{DD}=2.4$  to  $5.5\text{V}$ ,  $V_{SS}=0\text{V}$ , unless otherwise specified)

| Parameter           | Symbol     | Conditions |                                                  | Min. | Typ. | Max. | Unit |
|---------------------|------------|------------|--------------------------------------------------|------|------|------|------|
|                     |            | $V_{DD}$   | Conditions                                       |      |      |      |      |
| LCD frame frequency | $f_{LCD1}$ | 4V         | 1/4 duty, $T_{amb}=+25^{\circ}\text{C}$          | -    | 80   | -    | Hz   |
| LCD frame frequency | $f_{LCD2}$ | 4V         | 1/4 duty, $T_{amb}=+25^{\circ}\text{C}$          | -    | 160  | -    | Hz   |
| LCD frame frequency | $f_{LCD3}$ | 4V         | 1/4 duty, $T_{amb}=-40$ to $+85^{\circ}\text{C}$ | -    | 80   | -    | Hz   |
| LCD frame frequency | $f_{LCD4}$ | 4V         | 1/4 duty, $T_{amb}=-40$ to $+85^{\circ}\text{C}$ | -    | 160  | -    | Hz   |
| $V_{DD}$ off time   | $t_{OFF}$  | -          | $V_{DD}$ drop down to 0V                         | 20   | -    | -    | ms   |
| $V_{DD}$ slew rate  | $t_{SR}$   | -          | -                                                | 0.05 | -    | -    | V/ms |

Note:

1. During the power on/off period, if the conditions of the power-on reset sequence are not met, the internal power-on reset (POR) circuit cannot work normally.
2. During operating, if the  $V_{DD}$  voltage drops below the specified minimum operating voltage, the power-on reset sequence conditions must be satisfied. In other words, the  $V_{DD}$  voltage must drop to 0V and must maintain a 0V voltage of at least 20ms before rising to the normal operating voltage.

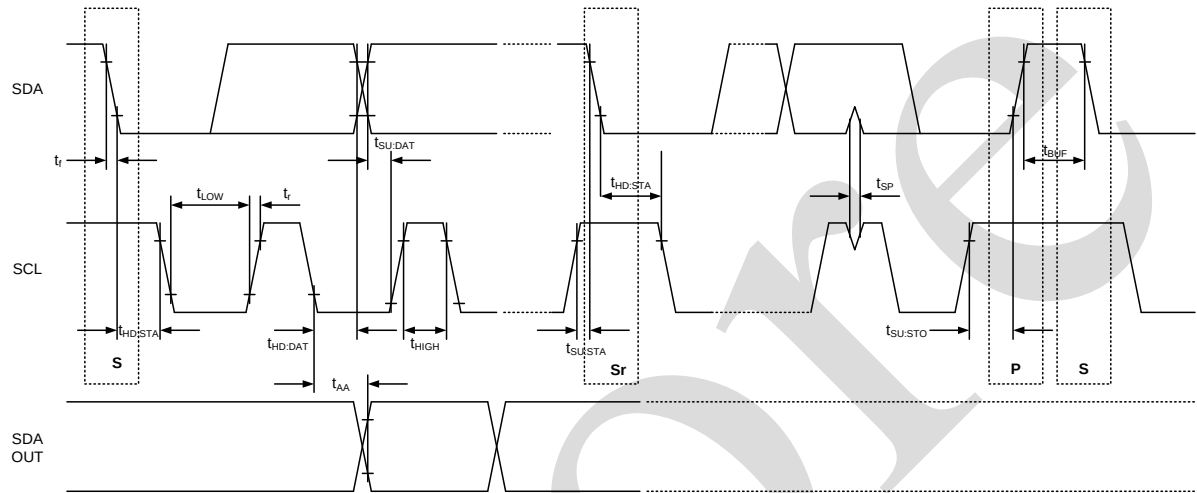
## 3.2.3、AC Characteristics 2 (I<sup>2</sup>C Interface)

| Parameter                  | Symbol        | Conditions                                                              | $V_{DD}=2.4\text{V to }5.5\text{V}$ |      | $V_{DD}=3.0\text{V to }5.5\text{V}$ |      | Unit |
|----------------------------|---------------|-------------------------------------------------------------------------|-------------------------------------|------|-------------------------------------|------|------|
|                            |               |                                                                         | Min.                                | Max. | Min.                                | Max. |      |
| clock frequency            | $f_{SCL}$     | -                                                                       | -                                   | 100  | -                                   | 400  | kHz  |
| bus free time              | $t_{BUF}$     | during this period the bus must be free until a new transmission starts | 4.7                                 | -    | 1.3                                 | -    | us   |
| Start condition hold time  | $t_{HD: STA}$ | after this period, the first clock pulse is generated                   | 4                                   | -    | 0.6                                 | -    | us   |
| SCL LOW time               | $t_{LOW}$     | -                                                                       | 4.7                                 | -    | 1.3                                 | -    | us   |
| SCL HIGH time              | $t_{HIGH}$    | -                                                                       | 4                                   | -    | 0.6                                 | -    | us   |
| Start condition setup time | $t_{SU: STA}$ | only relevant for repeated START condition                              | 4.7                                 | -    | 0.6                                 | -    | us   |
| data hold time             | $t_{HD: DAT}$ | -                                                                       | 0                                   | -    | 0                                   | -    | ns   |
| data setup time            | $t_{SU: DAT}$ | -                                                                       | 250                                 | -    | 100                                 | -    | ns   |
| SDA and SCL rise time      | $t_R$         | -                                                                       | -                                   | 1    | -                                   | 0.3  | us   |
| SDA and SCL fall time      | $t_F$         | -                                                                       | -                                   | 0.3  | -                                   | 0.3  | us   |



|                                       |              |                        |   |     |     |     |    |
|---------------------------------------|--------------|------------------------|---|-----|-----|-----|----|
| Stop condition setup time             | $t_{SU:STO}$ | -                      | 4 | -   | 0.6 | -   | us |
| effective clock output time           | $t_{AA}$     | -                      | - | 3.5 | -   | 0.9 | us |
| input filter time constant (SDA, SCL) | $t_{SP}$     | noise suppression time | - | 100 | -   | 50  | ns |

## I<sup>2</sup>C timing diagram





## 4、Precautions When Powering On

An internal reset circuit automatically initializes AiP16C23 when power is turned on.

Tips:

1. When the power is off, the power drop time is recommended to be  $>1\text{ms}$
2. After the power is turned off, the voltage on the power supply is recommended to be  $<0.1\text{V}$
3. It is recommended to keep the power off for  $>100\text{ms}$  before powering it back on
4. When the power is powered on, it is recommended that the power rise time be  $>1\text{ms}$

When the power is applied, the device is initialized by an internal power-on reset circuit. The status of the internal circuits after initialization is as follows:

| Function                 | Reset status        |
|--------------------------|---------------------|
| LCD display              | OFF                 |
| System oscillator        | OFF                 |
| Blinking function        | OFF                 |
| LCD bias generator       | OFF                 |
| VLCD adjustment function | OFF                 |
| VLCD pin                 | VLCD output disable |
| COM/SEG output           | VLCD                |
| Frame frequency          | 80Hz                |
| Duty                     | 1/4 duty            |
| VLCD bias                | 1/3 bias            |

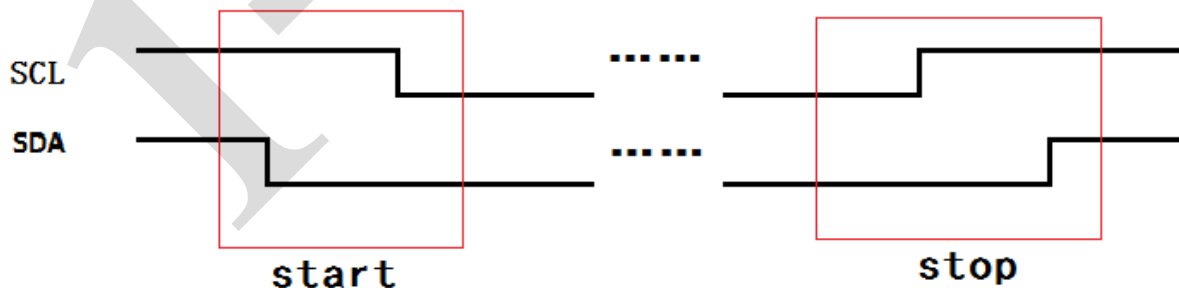
## 5、Function Description

### 5.1、I<sup>2</sup>C Interface

The chip provides a standard I<sup>2</sup>C serial interface that include two PADs, a serial data line SDA and a serial clock line SCL. Each of these lines is connected to the positive power supply via a pull-up resistor with a typical value of  $4.7\text{K}\Omega$ . Both lines are high when the I<sup>2</sup>C bus is idle. The microcontroller connected to the I<sup>2</sup>C interface must have an open drain output to achieve wired-or function.

### 5.2、Data Validity

The start and stop signs of the clock signal are detected at high power level:



Therefore, in the data transmission phase, during  $\text{SCL}=1$ , the data bit of the SDA pin must remain stable, and only when  $\text{SCL}=0$ , the level of the SDA pin is allowed to change. Otherwise, an incorrect start or stop flag will be detected, resulting in transmission interruption.

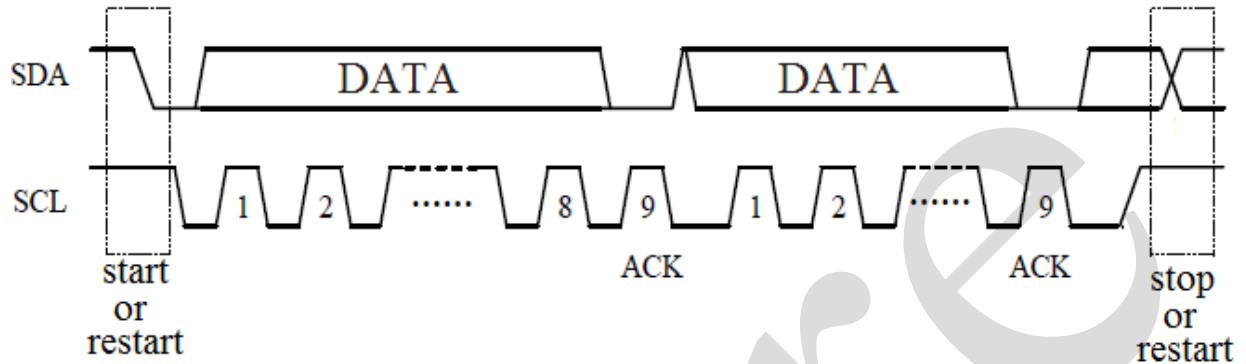
The chip can detect the restart (repeat start) flag by typing the START flag again at any moment before the stop flag. Restart stops the current communication cycle directly, while restarting a new communication



cycle.

## 5.3、Byte Format

Refer to the standard I<sup>2</sup>C format for 8 data clocks and 1 answer clock per communication cycle. The sender sends 8 bits of data each time, after which the receiver sends 1bit of low level answer signal (ACK) in the ninth, informing the sender that the data is sent and can continue to send data.



In the reply phase, the data receiver may also send a 1bit high level No answer signal (NACK) to inform the sender of the end of the data transmission. In this case, the host should generate either a stop signal or a restart signal.

## 5.4、Slave Address

Referring to the standard I<sup>2</sup>C format, after the host sends the START signal, it first sends the slave address bytes to match the slave. The AiP16C23 address bit is "0111110".

The addressing byte 8bit of data is the read/write control bit (R/W), which is used to indicate whether the subsequent operation is a read or write operation. R/W is 1 for subsequent read operations, and R/W is 0 for subsequent write operations.

|   |   |   |   |   |   |   |     |
|---|---|---|---|---|---|---|-----|
| 0 | 1 | 1 | 1 | 1 | 1 | 0 | R/W |
|---|---|---|---|---|---|---|-----|

Slave Address



## 6、Instruction Set

| No | Function                | period | MSB-----LSB |    |     |     |     |     |     |     | Description           |
|----|-------------------------|--------|-------------|----|-----|-----|-----|-----|-----|-----|-----------------------|
|    |                         |        | B7          | B6 | B5  | B4  | B3  | B2  | B1  | B0  |                       |
| 1  | Write/read Display data | 1      | 1           | 0  | 0   | 0   | 0   | 0   | 0   | 0   | Instruction code 0x80 |
|    |                         | 2      | X           | X  | AD5 | AD4 | AD3 | AD2 | AD1 | AD0 | Starting address      |
|    |                         | 3~n    | X           | X  | X   | X   | X   | X   | X   | X   | Write or read data    |
| 2  | Mode Setting 1          | 1      | 1           | 0  | 0   | 0   | 0   | 0   | 1   | 0   | Instruction code 0x82 |
|    |                         | 2      | -           | -  | -   | -   | -   | -   | D   | B   | Set values            |
| 3  | Mode Setting 2          | 1      | 1           | 0  | 0   | 0   | 0   | 1   | 0   | 0   | Instruction code 0x84 |
|    |                         | 2      | -           | -  | -   | -   | -   | -   | S   | E   | Set values            |
| 4  | Frame rate setting      | 1      | 1           | 0  | 0   | 0   | 0   | 1   | 1   | 0   | Instruction code 0x86 |
|    |                         | 2      | -           | -  | -   | -   | -   | -   | -   | F   | Set values            |
| 5  | Flicker Settings        | 1      | 1           | 0  | 0   | 0   | 1   | 0   | 0   | 0   | Instruction code 0x88 |
|    |                         | 2      | -           | -  | -   | -   | -   | -   | BK1 | BK0 | Set values            |
| 6  | VLCD Setting            | 1      | 1           | 0  | 0   | 0   | 1   | 0   | 1   | 0   | Instruction code 0x8A |
|    |                         | 2      | -           | -  | DE  | VE  | DA3 | DA2 | DA1 | DA0 | Set values            |

### 6.1、Instruction Description

| NO      | Function                   | period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | MSB-----LSB |    |     |     |     |     |     |     | 描述                       |
|---------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|-----|-----|-----|-----|-----|-----|--------------------------|
|         |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | B7          | B6 | B5  | B4  | B3  | B2  | B1  | B0  |                          |
| 1       | Write/read<br>Display data | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1           | 0  | 0   | 0   | 0   | 0   | 0   | 0   | Instruction code<br>0x80 |
|         |                            | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | X           | X  | AD5 | AD4 | AD3 | AD2 | AD1 | AD0 | Starting address         |
|         |                            | 3~n                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | X           | X  | X   | X   | X   | X   | X   | X   | Write or read<br>data    |
| AD[5:0] |                            | Reset value: 000000<br>The value of AD[5:0] in 1/4 duty mode ranges from 000000~011011<br>The range of AD[5:0] in 1/8 duty display mode is 000000~110011<br>"-" is an invalid bit, and setting any value does not affect function<br>"X" is the input RAM data, 0 means press, 1 means light, the corresponding relationship with the display array is seen in the RAM introduction chapter<br>When writing RAM data in cycles 3 to n, the RAM address has a self-adding function, when the address reaches the last address of the corresponding range, continuing to write will return 000000 |             |    |     |     |     |     |     |     |                          |



| NO                                                                    | Function       | period                                                                   | MSB-----LSB |    |    |    |    |    |    |    | 描述                       |
|-----------------------------------------------------------------------|----------------|--------------------------------------------------------------------------|-------------|----|----|----|----|----|----|----|--------------------------|
|                                                                       |                |                                                                          | B7          | B6 | B5 | B4 | B3 | B2 | B1 | B0 |                          |
| 2                                                                     | Mode Setting 1 | 1                                                                        | 1           | 0  | 0  | 0  | 0  | 0  | 1  | 0  | Instruction code<br>0x82 |
|                                                                       |                | 2                                                                        | -           | -  | -  | -  | -  | -  | D  | B  | Set values               |
| D                                                                     |                | Reset value: 0<br>=0 1/4duty display<br>=1 1/8duty display               |             |    |    |    |    |    |    |    |                          |
| B                                                                     |                | Reset value: 0<br>=0, VLCD voltage 1/3 bias<br>=1, VLCD voltage 1/4 bias |             |    |    |    |    |    |    |    |                          |
| "-" is an invalid bit, setting any value does not affect the function |                |                                                                          |             |    |    |    |    |    |    |    |                          |

| NO                                                                    | Function       | period                                                            | MSB-----LSB |    |    |    |    |    |    |    | Description              |
|-----------------------------------------------------------------------|----------------|-------------------------------------------------------------------|-------------|----|----|----|----|----|----|----|--------------------------|
|                                                                       |                |                                                                   | B7          | B6 | B5 | B4 | B7 | B2 | B1 | B0 |                          |
| 3                                                                     | Mode Setting 2 | 1                                                                 | 1           | 0  | 0  | 0  | 0  | 1  | 0  | 0  | Instruction code<br>0x84 |
|                                                                       |                | 2                                                                 | -           | -  | -  | -  | -  | -  | S  | E  | Set values               |
| S                                                                     |                | Reset value: 0<br>=0, internal clock off<br>=1, internal clock on |             |    |    |    |    |    |    |    |                          |
| E                                                                     |                | Reset value: 0<br>=0, display off<br>=1, display is on            |             |    |    |    |    |    |    |    |                          |
| "-" is an invalid bit, setting any value does not affect the function |                |                                                                   |             |    |    |    |    |    |    |    |                          |

| NO                                                                    | Function           | period                                                        | MSB-----LSB |    |    |    |    |    |    |    | Description              |
|-----------------------------------------------------------------------|--------------------|---------------------------------------------------------------|-------------|----|----|----|----|----|----|----|--------------------------|
|                                                                       |                    |                                                               | B7          | B6 | B5 | B4 | B7 | B2 | B1 | B0 |                          |
| 4                                                                     | Frame rate setting | 1                                                             | 1           | 0  | 0  | 0  | 0  | 1  | 1  | 0  | Instruction code<br>0x86 |
|                                                                       |                    | 2                                                             | -           | -  | -  | -  | -  | -  | -  | F  | Set values               |
| F                                                                     |                    | Reset value: 0<br>=0, frame rate 80Hz<br>=1, frame rate 160Hz |             |    |    |    |    |    |    |    |                          |
| "-" is an invalid bit, setting any value does not affect the function |                    |                                                               |             |    |    |    |    |    |    |    |                          |



| NO                                                                    | Function         | period                                                                                                                                                                                                                                                     | MSB-----LSB |    |    |    |    |    |     |     | Description              |
|-----------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|----|----|----|----|-----|-----|--------------------------|
|                                                                       |                  |                                                                                                                                                                                                                                                            | B7          | B6 | B5 | B4 | B7 | B2 | B1  | B0  |                          |
| 5                                                                     | Flicker Settings | 1                                                                                                                                                                                                                                                          | 1           | 0  | 0  | 0  | 1  | 0  | 0   | 0   | Instruction code<br>0x88 |
|                                                                       |                  | 2                                                                                                                                                                                                                                                          | -           | -  | -  | -  | -  | -  | BK1 | BK0 | Set values               |
| BK[1:0]                                                               |                  | Reset value: 00<br>=00 to turn off the blinking function<br>=01, turn on the blinking function, blinking frequency 2Hz<br>=10: The blinking function is enabled and the blinking frequency is 1Hz<br>=11, turn on the blinking function and blink at 0.5Hz |             |    |    |    |    |    |     |     |                          |
| "-" is an invalid bit, setting any value does not affect the function |                  |                                                                                                                                                                                                                                                            |             |    |    |    |    |    |     |     |                          |

| NO                                                                     | Function     | period                                                                                                                                                                                                                                                                                                                                      | MSB-----LSB |    |    |    |     |     |     |     | Description              |
|------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----|----|----|-----|-----|-----|-----|--------------------------|
|                                                                        |              |                                                                                                                                                                                                                                                                                                                                             | B7          | B6 | B5 | B4 | B7  | B2  | B1  | B0  |                          |
| 6                                                                      | VLCD Setting | 1                                                                                                                                                                                                                                                                                                                                           | 1           | 0  | 0  | 0  | 1   | 0   | 1   | 0   | Instruction code<br>0x8A |
|                                                                        |              | 2                                                                                                                                                                                                                                                                                                                                           | -           | -  | S1 | S0 | DA3 | DA2 | DA1 | DA0 | Set values               |
| S[1:0]                                                                 |              | Reset value: 00<br>=00, VLCD voltage flows into the VLCD pin and is not controlled by the DA bit<br>=01, VLCD voltage flows into the VLCD pin and is controlled by the DA bit<br>=10, VLCD voltage flows into the VLCD pin and is not controlled by the DA bit<br>=11, VLCD voltage flows into the VLCD pin and is controlled by the DA bit |             |    |    |    |     |     |     |     |                          |
| DA[3:0]                                                                |              | Reset value: 0000<br>Used to adjust VLCD when S=01 or 11<br>=0000, VLCD voltage highest, VLCD voltage follower off<br>=1111, VLCD voltage lowest, VLCD voltage follower on<br>See the VLCD Voltage Adjustment section for specific information                                                                                              |             |    |    |    |     |     |     |     |                          |
| "- " is an invalid bit, setting any value does not affect the function |              |                                                                                                                                                                                                                                                                                                                                             |             |    |    |    |     |     |     |     |                          |



## 7、Display RAM

AiP16C23 has static RAM for storing LCD display data. Write "1" to it and the corresponding LCD will light up, write "0" and the corresponding LCD will dim.

The RAM data content is mapped directly to the LCD. The SEGs in column 1 of RAM work with its corresponding COM0. In complex LCD applications, the SEGs in columns 2, 3, and 4 are time-multiplexed with their COM1, COM2, and COM3 counterparts, respectively. RAM data is mapped to LCD mode as follows:

| RAM Address | Display point |        |        |        |        |        |        |        |
|-------------|---------------|--------|--------|--------|--------|--------|--------|--------|
|             | D7            | D6     | D5     | D4     | D3     | D2     | D1     | D0     |
| 00H         | C3×S1         | C2×S1  | C1×S1  | C0×S1  | C3×S0  | C2×S0  | C1×S0  | C0×S0  |
| 01H         | C3×S3         | C2×S3  | C1×S3  | C0×S3  | C3×S2  | C2×S2  | C1×S2  | C0×S2  |
| 02H         | C3×S5         | C2×S5  | C1×S5  | C0×S5  | C3×S4  | C2×S4  | C1×S4  | C0×S4  |
| 03H         | C3×S7         | C2×S7  | C1×S7  | C0×S7  | C3×S6  | C2×S6  | C1×S6  | C0×S6  |
| 04H         | C3×S9         | C2×S9  | C1×S9  | C0×S9  | C3×S8  | C2×S8  | C1×S8  | C0×S8  |
| 05H         | C3×S11        | C2×S11 | C1×S11 | C0×S11 | C3×S10 | C2×S10 | C1×S10 | C0×S10 |
| 06H         | C3×S13        | C2×S13 | C1×S13 | C0×S13 | C3×S12 | C2×S12 | C1×S12 | C0×S12 |
| 07H         | C3×S15        | C2×S15 | C1×S15 | C0×S15 | C3×S14 | C2×S14 | C1×S14 | C0×S14 |
| 08H         | C3×S17        | C2×S17 | C1×S17 | C0×S17 | C3×S16 | C2×S16 | C1×S16 | C0×S16 |
| 09H         | C3×S19        | C2×S19 | C1×S19 | C0×S19 | C3×S18 | C2×S18 | C1×S18 | C0×S18 |
| .....       | .....         | .....  | .....  | .....  | .....  | .....  | .....  | .....  |
| 1AH         | C3×S53        | C2×S53 | C1×S53 | C0×S53 | C3×S52 | C2×S52 | C1×S52 | C0×S52 |
| 1BH         | DUMMY         | DUMMY  | DUMMY  | DUMMY  | C3×S54 | C2×S54 | C1×S54 | C0×S54 |

55 x 4 RAM map for display mode

Note:

Cn x Sn indicates the pixel points controlled by COMn and SEGn.

Writing any data to the DUMMY has no effect on the display.



| RAM Address | Display point |        |        |        |        |        |        |        |
|-------------|---------------|--------|--------|--------|--------|--------|--------|--------|
|             | D7            | D6     | D5     | D4     | D3     | D2     | D1     | D0     |
| 00H         | C7×S4         | C6×S4  | C5×S4  | C4×S4  | C3×S4  | C2×S4  | C1×S4  | C0×S4  |
| 01H         | C7×S5         | C6×S5  | C5×S5  | C4×S5  | C3×S5  | C2×S5  | C1×S5  | C0×S5  |
| 02H         | C7×S6         | C6×S6  | C5×S6  | C4×S6  | C3×S6  | C2×S6  | C1×S6  | C0×S6  |
| 03H         | C7×S7         | C6×S7  | C5×S7  | C4×S7  | C3×S7  | C2×S7  | C1×S7  | C0×S7  |
| 04H         | C7×S8         | C6×S8  | C5×S8  | C4×S8  | C3×S8  | C2×S8  | C1×S8  | C0×S8  |
| 05H         | C7×S9         | C6×S9  | C5×S9  | C4×S9  | C3×S9  | C2×S9  | C1×S9  | C0×S9  |
| 06H         | C7×S10        | C6×S10 | C5×S10 | C4×S10 | C3×S10 | C2×S10 | C1×S10 | C0×S10 |
| 07H         | C7×S11        | C6×S11 | C5×S11 | C4×S11 | C3×S11 | C2×S11 | C1×S11 | C0×S11 |
| 08H         | C7×S12        | C6×S12 | C5×S12 | C4×S12 | C3×S12 | C2×S12 | C1×S12 | C0×S12 |
| 09H         | C7×S13        | C6×S13 | C5×S13 | C4×S13 | C3×S13 | C2×S13 | C1×S13 | C0×S13 |
| 0AH         | C7×S14        | C6×S14 | C5×S14 | C4×S14 | C3×S14 | C2×S14 | C1×S14 | C0×S14 |
| 0BH         | C7×S15        | C6×S15 | C5×S15 | C4×S15 | C3×S15 | C2×S15 | C1×S15 | C0×S15 |
| 0CH         | C7×S16        | C6×S16 | C5×S16 | C4×S16 | C3×S16 | C2×S16 | C1×S16 | C0×S16 |
| 0DH         | C7×S17        | C6×S17 | C5×S17 | C4×S17 | C3×S17 | C2×S17 | C1×S17 | C0×S17 |
| 0EH         | C7×S18        | C6×S18 | C5×S18 | C4×S18 | C3×S18 | C2×S18 | C1×S18 | C0×S18 |
| 0FH         | C7×S19        | C6×S19 | C5×S19 | C4×S19 | C3×S19 | C2×S19 | C1×S19 | C0×S19 |
| .....       | .....         | .....  | .....  | .....  | .....  | .....  | .....  | .....  |
| 31H         | C7×S53        | C6×S53 | C5×S53 | C4×S53 | C3×S53 | C2×S53 | C1×S53 | C0×S53 |
| 32H         | C7×S54        | C6×S54 | C5×S54 | C4×S54 | C3×S54 | C2×S54 | C1×S54 | C0×S54 |
| 33H         | DUMMY         | DUMMY  | DUMMY  | DUMMY  | DUMMY  | DUMMY  | DUMMY  | DUMMY  |

51 x 8 Display mode for RAM mapping

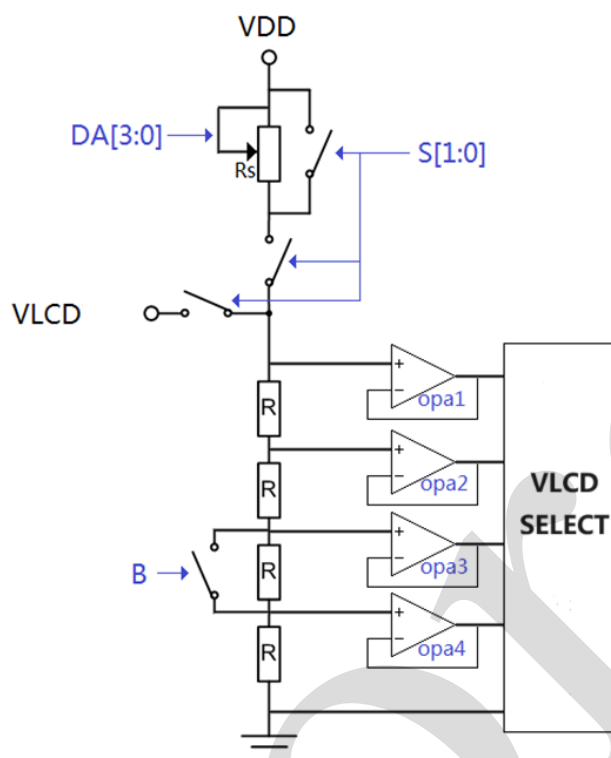
Note:

Cn x Sn indicates the pixel points controlled by COMn and SEGn.

Writing any data to the DUMMY has no effect on the display.



## 8、VLCD Generator



- The relationship between 4-bit programmable analog switch and VLCD output voltage is shown in the following table:

| <b>Bias</b><br><b>DA3~DA0</b> | <b>1/3</b>             | <b>1/4</b>             | <b>Description</b> |
|-------------------------------|------------------------|------------------------|--------------------|
| 00H                           | $1.000 \times V_{LCD}$ | $1.000 \times V_{LCD}$ | Reset value        |
| 01H                           | $0.944 \times V_{LCD}$ | $0.957 \times V_{LCD}$ |                    |
| 02H                           | $0.894 \times V_{LCD}$ | $0.918 \times V_{LCD}$ |                    |
| 03H                           | $0.849 \times V_{LCD}$ | $0.882 \times V_{LCD}$ |                    |
| 04H                           | $0.808 \times V_{LCD}$ | $0.849 \times V_{LCD}$ |                    |
| 05H                           | $0.771 \times V_{LCD}$ | $0.818 \times V_{LCD}$ |                    |
| 06H                           | $0.738 \times V_{LCD}$ | $0.789 \times V_{LCD}$ |                    |
| 07H                           | $0.707 \times V_{LCD}$ | $0.763 \times V_{LCD}$ |                    |
| 08H                           | $0.678 \times V_{LCD}$ | $0.738 \times V_{LCD}$ |                    |
| 09H                           | $0.652 \times V_{LCD}$ | $0.714 \times V_{LCD}$ |                    |
| 0AH                           | $0.628 \times V_{LCD}$ | $0.692 \times V_{LCD}$ |                    |
| 0BH                           | $0.605 \times V_{LCD}$ | $0.672 \times V_{LCD}$ |                    |
| 0CH                           | $0.584 \times V_{LCD}$ | $0.652 \times V_{LCD}$ |                    |
| 0DH                           | $0.565 \times V_{LCD}$ | $0.634 \times V_{LCD}$ |                    |
| 0EH                           | $0.547 \times V_{LCD}$ | $0.616 \times V_{LCD}$ |                    |
| 0FH                           | $0.529 \times V_{LCD}$ | $0.600 \times V_{LCD}$ |                    |



## 9、SEG Drive Output

SEG should be directly connected to the LCD panel. Generate SEG output signals based on the multiplexed COM signal and the data inside the display latch, and the unused SEG output should remain open.

## 10、COM Drive Output

COM should be directly connected to the LCD panel. Generate a COM output signal according to the selected LCD driver mode, and the unused COM output should remain open.

## 11、LCD Driver Mode Waveform

When the LCD driver mode is selected 1/4 duty and 1/3 bias, its waveform and LCD display are as shown in the following figure:

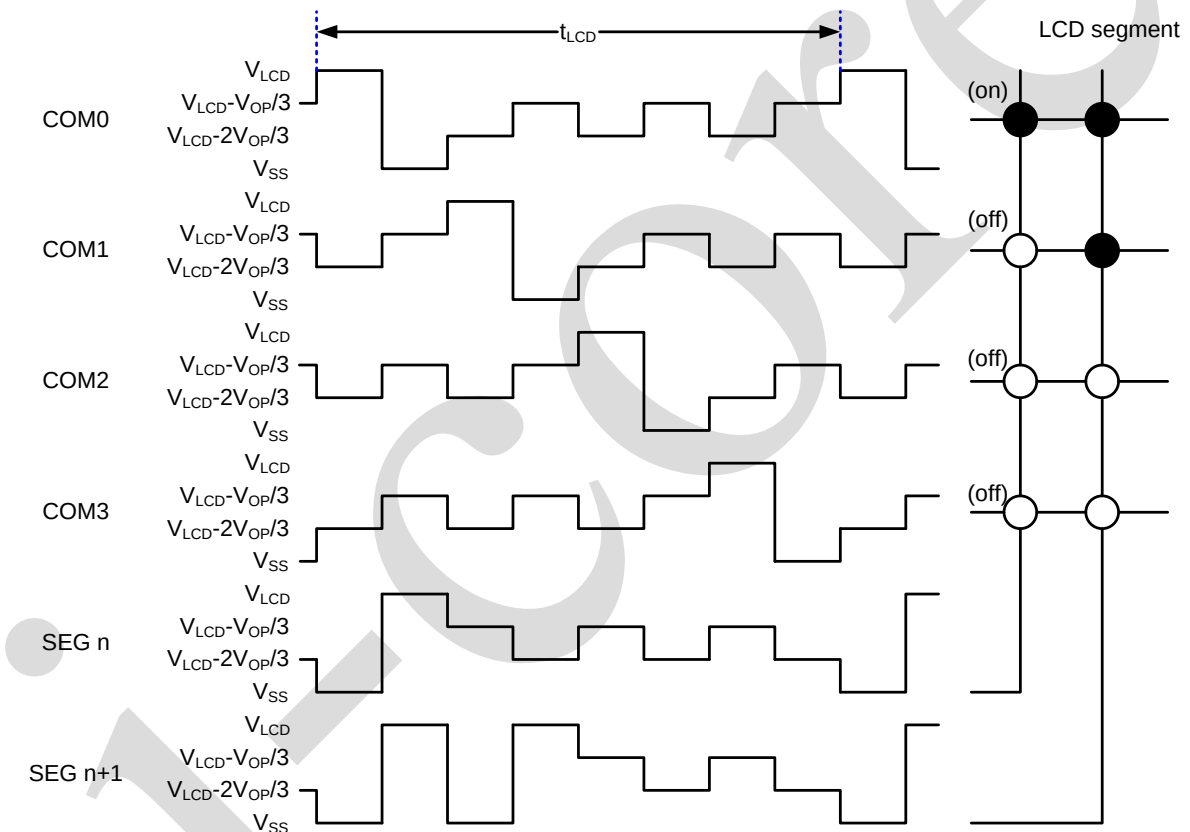
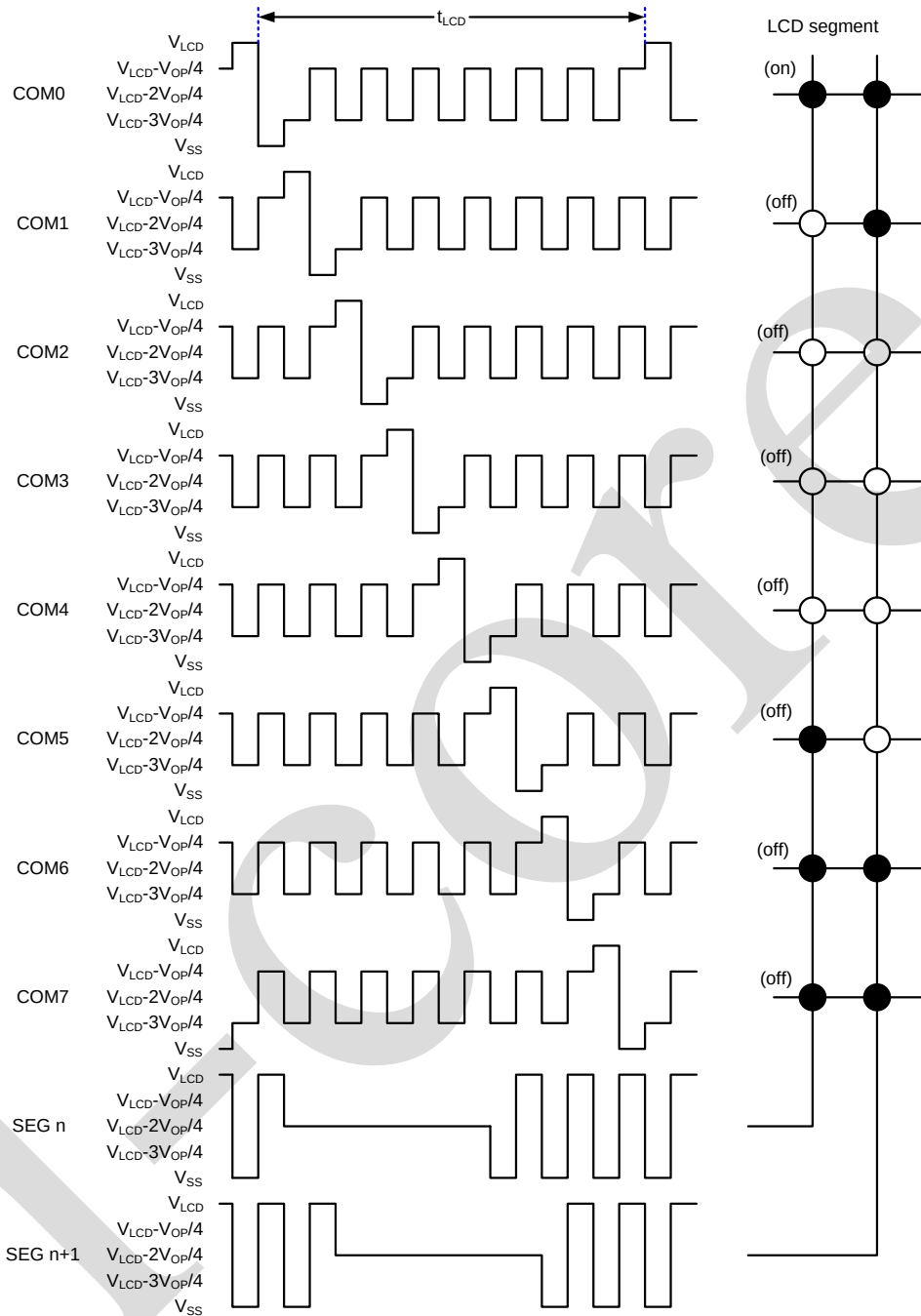


Diagram of waveform for 1/4 duty and 1/3 bias drive modes ( $V_{OP}=V_{LCD}-V_{SS}$ )

Note:  $t_{LCD}=1/f_{LCD}$



When the LCD driver mode is selected 1/8 duty and 1/4 bias, its waveform and LCD display are as shown in the image below:



1/8 duty and 1/4 bias Drive mode waveform diagram ( $V_{OP}=V_{LCD}-V_{SS}$ )

Note:  $t_{LCD}=1/f$



## 12、Recommend Workflow

### 12.1、Initialization

1. Power-on
2. Delay until the power supply is stable
3. Set VLCD bias and duty cycle
4. Set the frame rate
5. Set the VLCD/SEG shared pin function
6. Set the flicker function

### 12.2、Display Data Read/Write (Address Setting)

1. Set the RAM address
2. Read/write RAM data
3. Turn on the internal clock and display

### 12.3、Power Supply Sequence

If the VLCD and VDD pins are powered separately, it is highly recommended to follow the power supply sequence requirements:

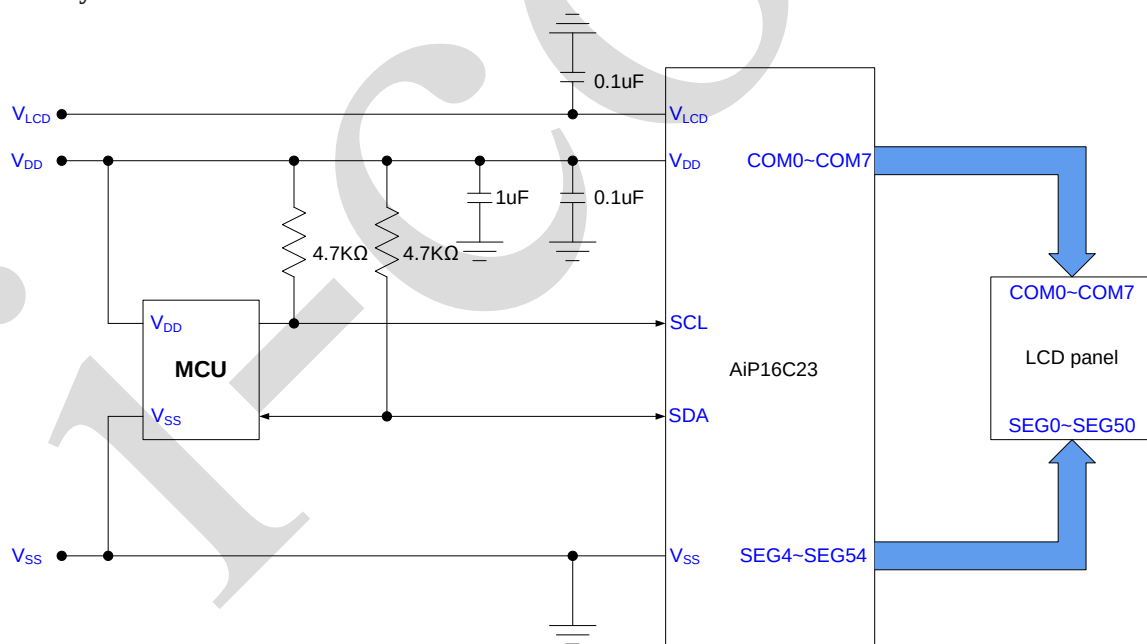
1. Power on VDD first when starting, and then power on VLCD after VDD stabilizes
2. Shutdown VLCD first power off, VLCD reduced to 0.3V below, and then make VDD power off

If the startup process violates the above power supply voltage supply sequence, it may cause initialization errors.

If the shutdown process violates the above power supply voltage supply sequence, it may cause confusion during the power failure process.

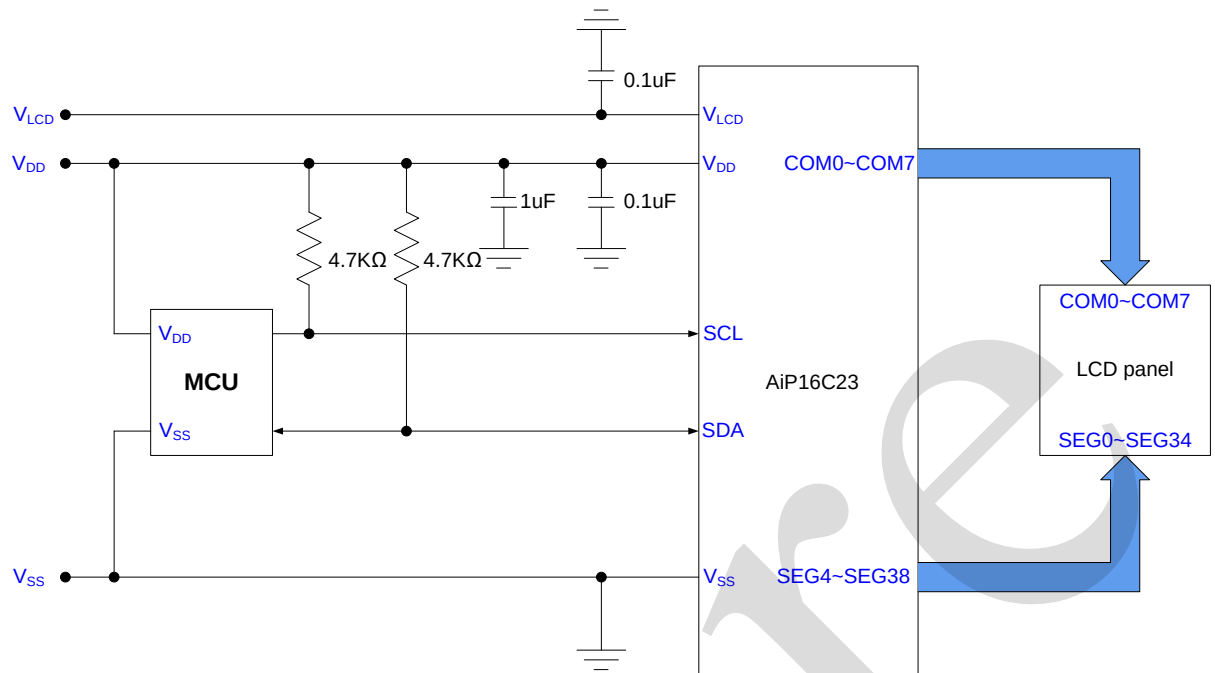
### 13.1、 64-pin

- **1/4 duty**





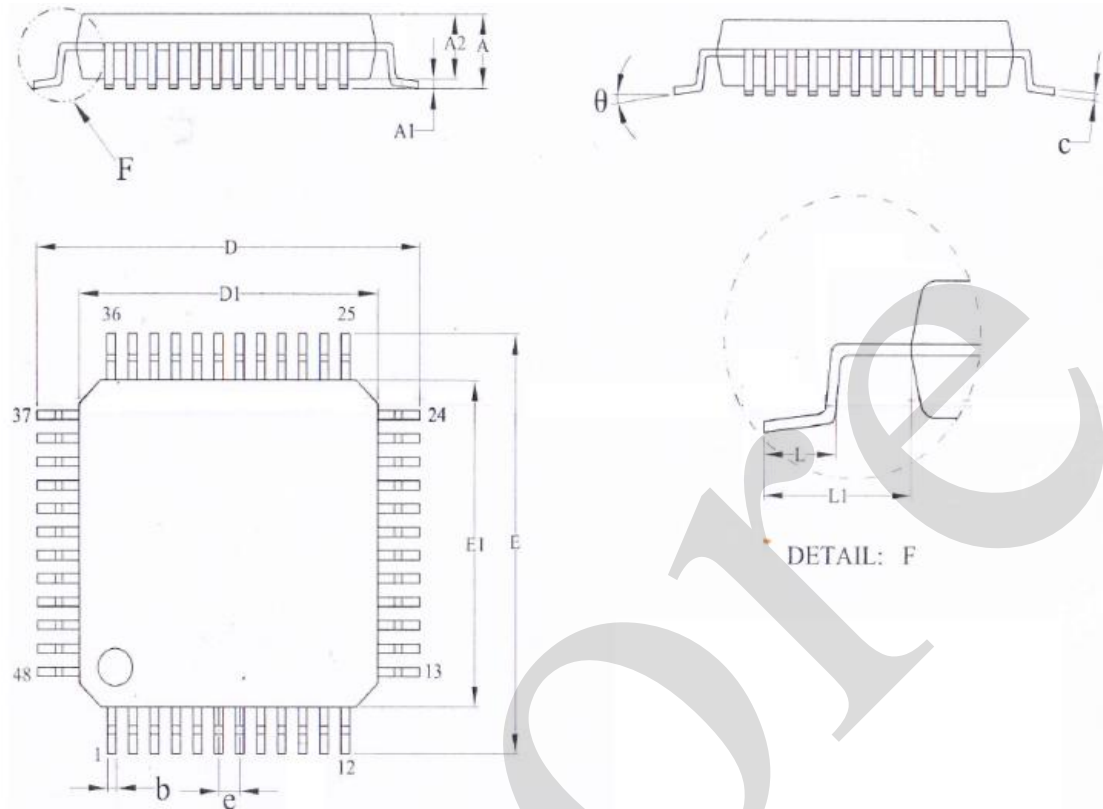
### 13.2、 48-pin (only support 1/8 duty LCD )





## 14、Package Information

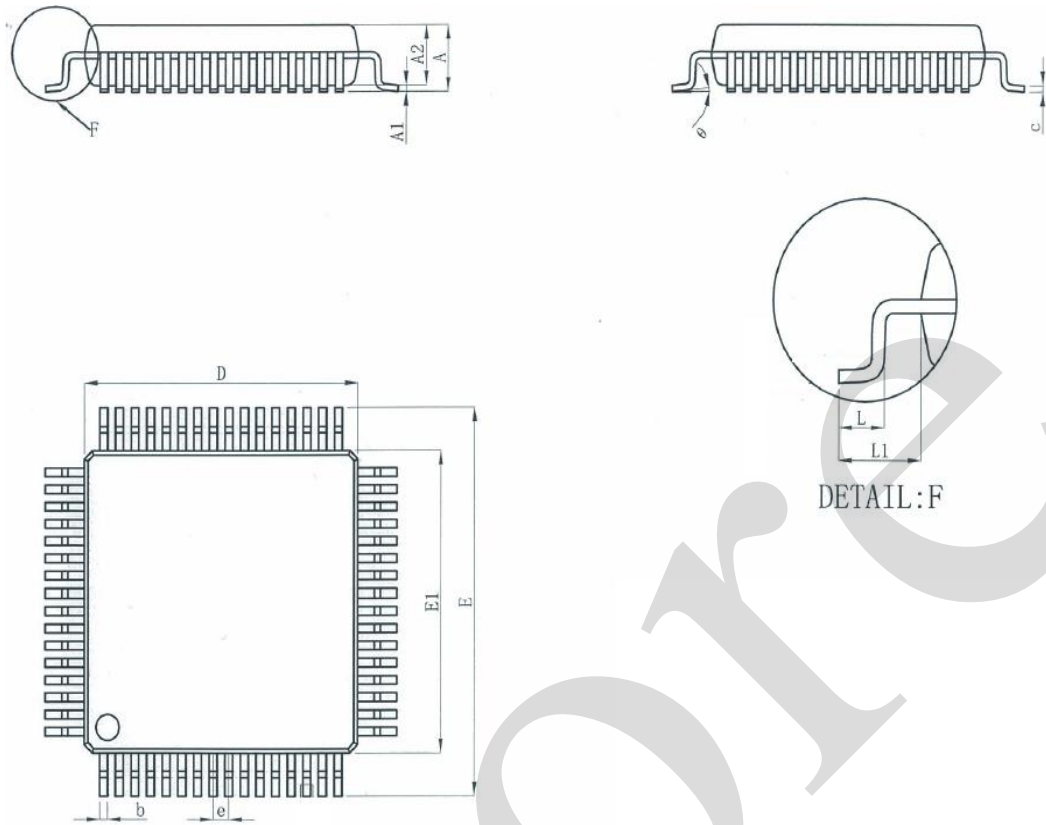
### 14.1、LQFP48



| 2023/12/A | Dimensions In Millimeters |      |
|-----------|---------------------------|------|
| Symbol    | Min                       | Max  |
| A         | 1.45                      | 1.65 |
| A1        | 0.05                      | 0.20 |
| A2        | 1.30                      | 1.50 |
| b         | 0.17                      | 0.27 |
| c         | 0.09                      | 0.20 |
| D         | 8.80                      | 9.20 |
| D1        | 6.90                      | 7.10 |
| E         | 8.80                      | 9.20 |
| E1        | 6.90                      | 7.10 |
| e         | 0.50                      |      |
| L         | 0.43                      | 0.80 |
| L1        | 1.00                      |      |
| $\theta$  | 0°                        | 10°  |



## 14.2、LQFP64



| 2023/12/A | Dimensions In Millimeters |      |
|-----------|---------------------------|------|
| Symbol    | Min                       | Max  |
| A         | 1.45                      | 1.65 |
| A1        | 0.05                      | 0.20 |
| A2        | 1.30                      | 1.50 |
| b         | 0.13                      | 0.24 |
| c         | 0.09                      | 0.20 |
| D         | 6.90                      | 7.10 |
| E         | 8.80                      | 9.20 |
| E1        | 6.90                      | 7.10 |
| e         | 0.40                      |      |
| L         | 0.43                      | 0.75 |
| L1        | 0.95                      | 1.15 |
| θ         | 0°                        | 10°  |



## 15、Statements And Notes

### 15.1、The name and content of Hazardous substances or Elements in the product

| Part name               | Hazardous substances or Elements                                                                                                                                                                                                                                      |                               |                               |                               |                          |                                |                   |                       |                           |                      |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------|--------------------------------|-------------------|-----------------------|---------------------------|----------------------|
|                         | Lead and lead compounds                                                                                                                                                                                                                                               | Mercury and mercury compounds | Cadmium and cadmium compounds | Hexavalent chromium compounds | Polybrominated biphenyls | Polybrominated biphenyl ethers | Dibutyl phthalate | Butylbenzyl phthalate | Di-2-ethylhexyl phthalate | Diisobutyl phthalate |
| Lead frame              | ○                                                                                                                                                                                                                                                                     | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| Plastic resin           | ○                                                                                                                                                                                                                                                                     | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| Chip                    | ○                                                                                                                                                                                                                                                                     | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| The lead                | ○                                                                                                                                                                                                                                                                     | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| Plastic sheet installed | ○                                                                                                                                                                                                                                                                     | ○                             | ○                             | ○                             | ○                        | ○                              | ○                 | ○                     | ○                         | ○                    |
| explanation             | ○: Indicates that the content of hazardous substances or elements in the detection limit of the following the SJ/T11363-2006 standard.<br>×: Indicates that the content of hazardous substances or elements exceeding the SJ/T11363-2006 Standard limit requirements. |                               |                               |                               |                          |                                |                   |                       |                           |                      |

### 15.2、Notes

We recommend you to read this chapter carefully before using this product.

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