



CUSTOMER APPROVAL SHEET

Company
Name

MODEL

A035VL01 V4

CUSTOMER
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Title :

Name :

- ☐ APPROVAL FOR SPECIFICATIONS ONLY (Spec. Ver.____)
- ☐ APPROVAL FOR SPECIFICATIONS AND ES SAMPLE (Spec. Ver.____)
- ☐ APPROVAL FOR SPECIFICATIONS AND CS SAMPLE (Spec. Ver.0.4)
- ☐ CUSTOMER REMARK :

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Product Specification 3.5" COLOR TFT-LCD MODULE


Model Name : **A035VL01 V0**

| | | |
|-----------------------|--|----|
| Planned Lifetime: | From 2009/July 2010/Dec | To |
| Phase-out Control: | From 2010/Nov 2010/Dec | To |
| EOL Schedule: | 2010/Dec | |

< ◆ > Preliminary Specification
< > Final Specification


Note: The content of this specification is subject to change.

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|--|--------------------------|----------|------|
|  | A035VL01 V0 Product Spec | Version: | 0.4 |
| | | Page: | 3/46 |


Record of Revision

| Version | Revise Date | Page | Content |
|---------|-------------|---------------------|---|
| 0.0 | 2009/4/21 | - | First Draft |
| 0.1 | 2009/6/02 | 45 | Driver IC Register Table |
| 0.2 | 2009/06/05 | 9 38 41 44 | Modify VDDIO range Modify Reliability Test Item: low temperature operation Add Packing Form Add Driver IC Register Table |
| 0.3 | 2009/07/10 | 9 44 | Update electrical characteristics Modify suggested initial command |
| 0.4 | 2009/10/29 | 9 15 16 46 | Update VDDIO voltage range (For IC2.0) Add 36h scan direction function (For IC2.0) Add B1h HV/DE mode setting (For IC2.0) Modify power on/off sequence (For IC2.0) |

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|--|--------------------------|----------|------|
|  | A035VL01 V0 Product Spec | Version: | 0.4 |
| | | Page: | 4/46 |

Contents

| | |
|--|-----------|
| A. General Information | 5 |
| B. Electrical Specifications | 6 |
| 1. Pin Assignment For LCD | 6 |
| 2. Absolute maximum ratings | 9 |
| 3. Electrical characteristics | 9 |
| 3.1 Recommended operating conditions (GND=0V) | 9 |
| 3.2 Electrical characteristics (GND=0V) | 9 |
| 3.3 Backlight driving conditions | 9 |
| 4. Input timing AC characteristic | 10 |
| 5. Input timing format | 11 |
| 5.1 Vertical timing | 11 |
| 6. Serial control interface AC characteristic | 12 |
| 6.1 Timing chart | 12 |
| 6.2 Register table | 13 |
| C. Touch Panel Command and Register Map | 27 |
| 1. I2C Protocol Definition | 27 |
| 2. I2C Data Map | 29 |
| 2.1 Register Data Map | 29 |
| 2.2 Default Setting | 29 |
| 3. Raw Data Register Map | 30 |
| 4. Coordinate Register Map | 30 |
| 5. Sensitivity and Noise Threshold | 31 |
| 6. Interrupt Operation Mode | 31 |
| 6.1 Interrupt Mode Setting | 32 |
| 6.2 Sensing Periodical Mode (INT_MODE[1:0] = [0,0]) | 32 |
| 6.3 Coordinate Compare Mode (INT_MODE[1:0] = [0,1]) | 32 |
| 6.4 Touch Indicate Mode (INT_MODE[1:0] = [1,0]) | 32 |
| 7. Power Mode | 34 |
| 8. Power on/off Sequence (both have two cases) | 35 |
| D. Optical Specification (Note1, Note 2 and Note 3) | 36 |
| E. Reliability Test Items | 39 |
| F. Outline dimension | 42 |
| G. Application note | 43 |
| 2. Power on/off sequence | 44 |
| 2.1 Power on (Standby Disabling) | 44 |
| 2.2 Power off (Standby Enabling) | 44 |
| 3. Recommended power on/off serial command settings | 45 |
| 3.1 Recommended power on register setting (Just for reference,) | 45 |
| 3.2 Recommended power off register setting | 46 |

| | | | |
|--|--------------------------|----------|------|
|  | A035VL01 V0 Product Spec | Version: | 0.4 |
| | | Page: | 5/46 |

A. General Information

| NO. | Item | Specification | Remark |
|-----|----------------------------|----------------------|--------|
| 1 | Display resolution (dot) | 800RGB(W) x 480(H) | |
| 2 | Active area (mm) | 75.60 x 45.36 | |
| 3 | Screen size (inch) | 3.471 (Diagonal) | |
| 4 | Dot pitch (um) | 31.5 X 94.5 | |
| 5 | Color configuration | R, G, B stripe | |
| 6 | Overall dimension (mm) | 86.1 x 51.66 x 2.495 | Note 1 |
| 7 | Weight (g) | 25±10% | |
| 8 | Panel surface treatment | Glare type | |


Note 1: Refer to F. Outline Dimension

B. Electrical Specifications

1. Pin Assignment For LCD

| Pin no | Symbol | I/O | Description | Remark |
|--------|--------|-----|---------------------------------|--------|
| 1 | VLED+ | P | Backlight LED anode | |
| 2 | VLED- | P | Backlight LED cathode | |
| 3 | DR7 | I | Red data Input (MSB) | |
| 4 | DR6 | I | Red data input | |
| 5 | DR5 | I | Red data input | |
| 6 | DR4 | I | Red data input | |
| 7 | DR3 | I | Red data input | |
| 8 | DR2 | I | Red data input | |
| 9 | DR1 | I | Red data input | |
| 10 | DR0 | I | Red data input (LSB) | |
| 11 | DG7 | I | Green data Input (MSB) | |
| 12 | DG6 | I | Green data input | |
| 13 | DG5 | I | Green data input | |
| 14 | DG4 | I | Green data input | |
| 15 | DG3 | I | Green data input | |
| 16 | DG2 | I | Green data input | |
| 17 | DG1 | I | Green data input | |
| 18 | DG0 | I | Green data input (LSB) | |
| 19 | DB7 | I | Blue data Input (MSB) | |
| 20 | DB6 | I | Blue data input | |
| 21 | DB5 | I | Blue data input | |
| 22 | DB4 | I | Blue data input | |
| 23 | DB3 | I | Blue data input | |
| 24 | DB2 | I | Blue data input | |
| 25 | DB1 | I | Blue data input | |
| 26 | DB0 | I | Blue data input (LSB) | |
| 27 | SDA | I/O | Data input/output of SPI | |
| 28 | CS | I | Chip select (Low active) of SPI | |
| 29 | SCL | I | Clock input of SPI | |
| 30 | GND | P | Ground for digital circuit | |
| 31 | DCLK | I | Data clock Input | Note |
| 32 | GND | P | Ground for digital circuit | |
| 33 | DEN | I | Data enable Input (High active) | |

| | | | | |
|----|--------|---|---|--|
| 34 | HSYNC | I | Horizontal sync input | |
| 35 | VSYNC | I | Vertical sync input | |
| 36 | RESET | I | H/W reset pin. (Low active) | |
| 37 | VDDIO | P | Digital interface supply voltage of digital | |
| 38 | VCC | C | Intermediate voltage for charge pump | |
| 39 | VREF | C | Intermediate voltage for charge pump | |
| 40 | NGVDD | C | Intermediate voltage for charge pump | |
| 41 | GVDD | C | Intermediate voltage for charge pump | |
| 42 | VDD | P | Analog power supply voltage | |
| 43 | VC11 | C | Intermediate voltage for charge pump | |
| 44 | C11P | C | Pins to connect capacitance for power circuitry | |
| 45 | C11N | C | Pins to connect capacitance for power circuitry | |
| 46 | C12P | C | Pins to connect capacitance for power circuitry | |
| 47 | C12N | C | Pins to connect capacitance for power circuitry | |
| 48 | VDDA | C | Intermediate voltage for charge pump | |
| 49 | C41P | C | Pins to connect capacitance for power circuitry | |
| 50 | C41N | C | Pins to connect capacitance for power circuitry | |
| 51 | C42P | C | Pins to connect capacitance for power circuitry | |
| 52 | C42N | C | Pins to connect capacitance for power circuitry | |
| 53 | NVDDA | C | Intermediate voltage for charge pump | |
| 54 | C31N | C | Pins to connect capacitance for power circuitry | |
| 55 | C31P | C | Pins to connect capacitance for power circuitry | |
| 56 | C32N | C | Pins to connect capacitance for power circuitry | |
| 57 | C32P | C | Pins to connect capacitance for power circuitry | |
| 58 | VCL | C | Intermediate voltage for charge pump | |
| 59 | C21N | C | Pins to connect capacitance for power circuitry | |
| 60 | C21P | C | Pins to connect capacitance for power circuitry | |
| 61 | C22N | C | Pins to connect capacitance for power circuitry | |
| 62 | C22P | C | Pins to connect capacitance for power circuitry | |
| 63 | VGL | C | Pins to connect capacitance for power circuitry | |
| 64 | VGH | C | Pins to connect capacitance for power circuitry | |
| 65 | VCOMDC | C | Pins to connect capacitance for power circuitry | |
| 66 | VDD_TP | P | Voltage input pin for touch panel | |
| 67 | INT | O | Touched Interrupt Indicator | |
| 68 | SDA_TP | I | Data input pin of SPI mode for touch panel | |
| 69 | SCL_TP | I | Clock input pin of SPI mode for touch panel | |

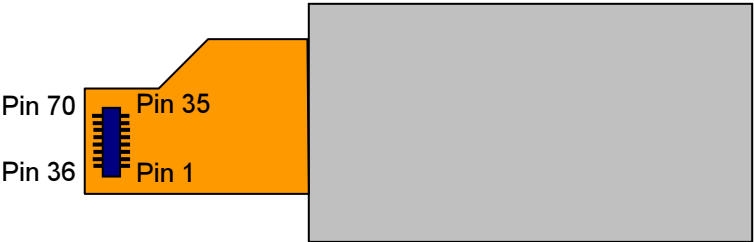
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|---|--------------------------|--|----------|------|
|  | A035VL01 V0 Product Spec | | Version: | 0.4 |
| | | | Page: | 8/46 |

| | | | | |
|----|--------|---|-----------------------|--|
| 70 | GND_TP | P | Ground of touch panel | |
|----|--------|---|-----------------------|--|

I : Input, O : Output, C : Capacitor, P : Power, D : Dummy

Note: DCLK signal can not be stopped when panel is operating or display off mode.

Definition of scanning direction, Refer to figure as below :



2. Absolute maximum ratings

| Item | Symbol | Condition | Min. | Max. | Unit | Remark |
|-----------------------|---------------------------------------|-----------|------|---------------|------|---------------------|
| Supply Voltage | VDD | GND=0V | -0.3 | 4.2 | V | |
| | VDDIO | GND=0V | -0.3 | 3.6 | V | |
| Input Signal Voltage | CS,SDA,SCL,Vsync, Hsync,DCLK,D0~D7 | GND=0V | -0.3 | VDDIO+ 0.3 | V | |
| Storage Temperature | Tstg | - | TBD | TBD | °C | Ambient temperature |
| Operating Temperature | Topa | - | TBD | TBD | °C | Ambient temperature |

3. Electrical characteristics

3.1 Recommended operating conditions (GND=0V)

| Item | Symbol | Min. | Typ. | Max. | Unit | Remark |
|--------------|---------|-----------------|------------|------|------------|--------|
| Power supply | VDD | 3.1 | 3.3 | 3.5 | V | |
| | VDDIO | 1.65 | 3.3 | 3.6 | V | |
| Input Signal | H Level | V _{IH} | 0.7* VDDIO | - | VDDIO | V |
| | L Level | V _{IL} | GND | - | 0.3* VDDIO | V |

3.2 Electrical characteristics (GND=0V)

| Symbol | Condition | Min. | Typ. | Max. | Unit | Remark |
|--------------------|--------------------------|------|------|------|------|--------|
| I _{VDD} | V _{VDD} =3.3V | - | 17.5 | 25 | mA | Note |
| I _{VDDTP} | V _{VDDTP} =3.3V | - | 3.5 | 5 | mA | Note |
| I _{VDDIO} | V _{VDDIO} =3.3V | | 2.2 | 3 | mA | Note |
| I _{VDDIO} | V _{VDDIO} =2.0V | | 2.2 | 3 | mA | Note |
| I _{VDDIO} | V _{VDDIO} =1.8V | | 2.0 | 3 | mA | Note |

Note 1: Test Condition: 8colorbar+Grayscale pattern, Frame rate: 60Hz, other registers are default setting.

3.3 Backlight driving conditions

| Parameter | Symbol | Min. | Typ. | Max.[Note1] | Unit | Remark |
|-------------------|----------------|------|------|-------------|------|--------|
| Backlight Current | | | 25 | | mA | Note2 |
| Backlight voltage | V _L | 15 | 16.5 | 17.5 | V | |

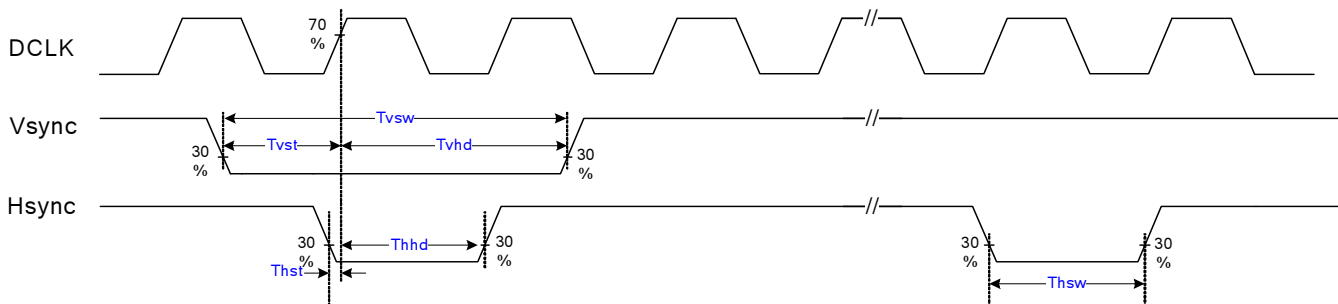
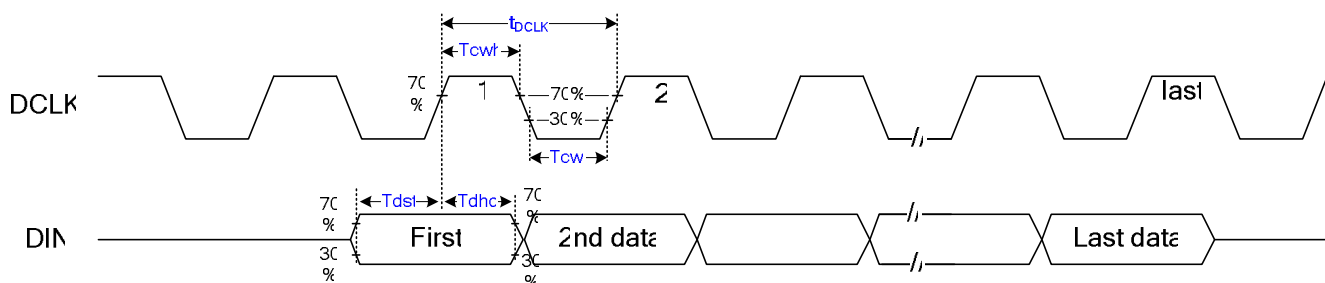
Note1: To consider LED driver and feedback resistor tolerance.

Note2: If using LCD internal LED driver controller the maximum setting should be typical value. Ta=25°C

4. Input timing AC characteristic

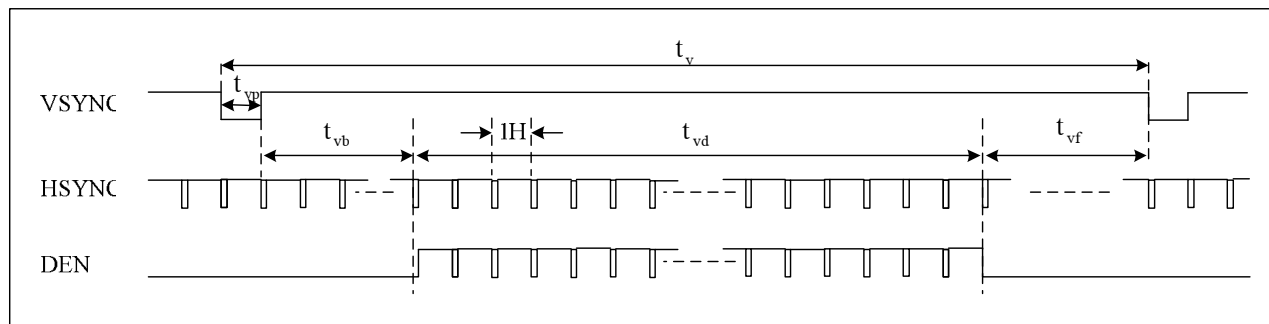
(VDD=3.0 ~3.6V, AGND=GND=0V, TA=25°C)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Remark |
|------------------|------------------|------|------|------|------|--------|
| DCLK duty cycle | T _{cw} | 40 | 50 | 60 | % | |
| VSYNC setup time | T _{vst} | 15 | - | - | ns | |
| VSYNC hold time | T _{vhd} | 15 | - | - | ns | |
| HSYNC setup time | T _{hst} | 15 | - | - | ns | |
| HSYNC hold time | T _{hhd} | 15 | - | - | ns | |
| Data setup time | T _{dst} | 15 | - | - | ns | |
| Data hold time | T _{dhd} | 15 | - | - | ns | |

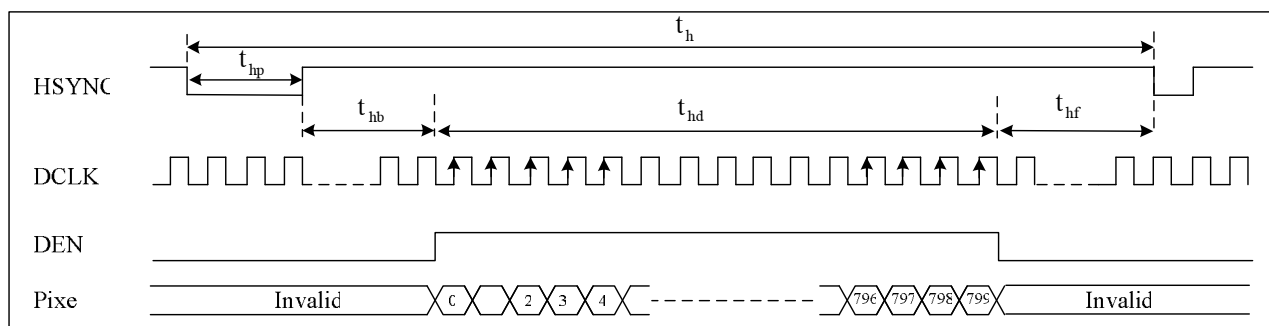


5. Input timing format

5.1 Vertical timing



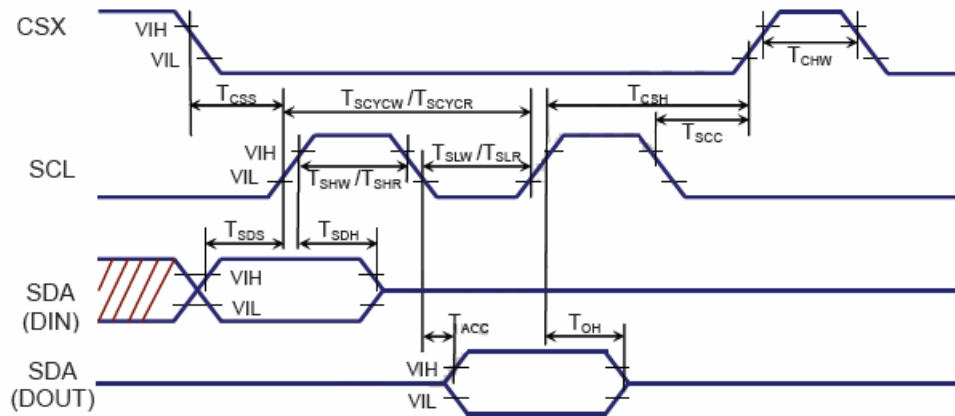
5.2 Horizontal timing



5.3 Timing parameters

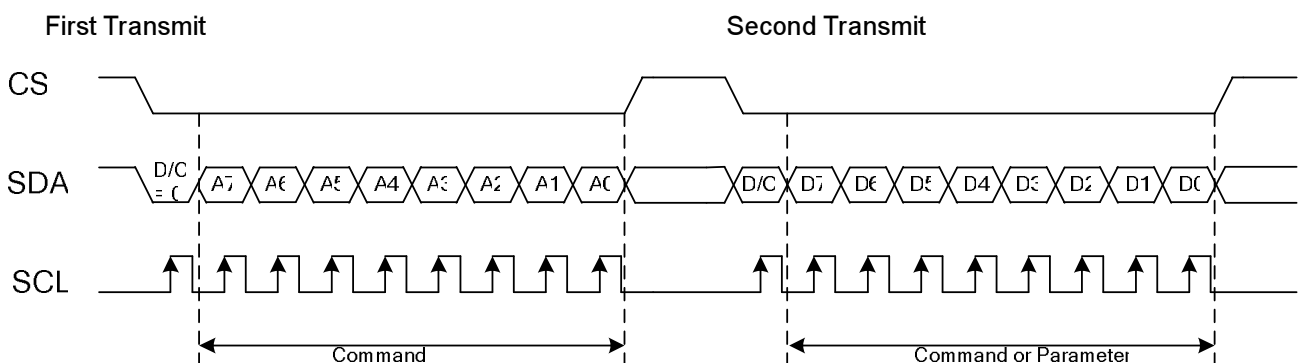
| PARAMETER | Symbol | Min | Typ | Max | Unit |
|---------------------------|-------------|------|------|------|------|
| Clock cycle | $1/t_{CLK}$ | 20 | 27 | 30 | MHz |
| Hsync cycle | $1/t_{fh}$ | 24.2 | 29.3 | 31.3 | KHz |
| Vsync cycle | $1/t_{fv}$ | 50 | 60 | 65 | Hz |
| Horizontal Signal | | | | | |
| Horizontal cycle | t_h | 824 | 920 | 956 | CLK |
| Horizontal display period | t_{hd} | - | 800 | - | CLK |
| Horizontal front porch | t_{hf} | 2 | 50 | 52 | CLK |
| Horizontal pulse width | t_{hp} | 2 | 20 | 52 | CLK |
| Horizontal back porch | t_{hb} | 2 | 50 | 52 | CLK |
| Vertical Signal | | | | | |
| Vertical cycle | t_v | 486 | 488 | 492 | H |
| Vertical display period | t_{vd} | - | 480 | - | H |
| Vertical front porch | t_{vf} | 2 | 3 | 4 | H |
| Vertical pulse width | t_{vp} | 2 | 2 | 4 | H |
| Vertical back porch | t_{vb} | 2 | 3 | 4 | H |

6. Serial control interface AC characteristic



| Item | Symbol | Min | Typical | Max | Unit |
|---------------------------------|--------------|-----|---------|-----|------|
| CS input setup Time | T_{CSS} | 60 | - | - | ns |
| CS input hold Time | T_{SCC} | 60 | - | - | ns |
| CS pulse high width | T_{CHW} | 40 | - | - | ns |
| Serial data input setup Time | T_{SDS} | 10 | - | - | ns |
| Serial data input hold Time | T_{SDH} | 10 | - | - | ns |
| Serial data output disable Time | T_{OH} | 15 | - | - | ns |
| Serial clock cycle(Write) | $T_{SCYC W}$ | 66 | - | - | ns |
| SCL pulse low width(Write) | T_{SLW} | 20 | - | - | ns |
| SCL pulse high width(Write) | T_{SHW} | 20 | - | - | ns |
| Serial clock cycle(Read) | $T_{SCYC R}$ | 150 | - | - | ns |
| SCL pulse low width(Read) | T_{SLR} | 60 | - | - | ns |
| SCL pulse high width(Read) | T_{SHR} | 60 | - | - | ns |

6.1 Timing chart



6.2 Register table

| Register | D/C | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|----------|-----|----|----|----|----|----|----|----|----|---------------------------------|
| 01h | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Software reset |
| 10h | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | Sleep in & booster off |
| 11h | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | Sleep out & booster on |
| 28h | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | Display off |
| 29h | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | Display on |
| 36h | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | Scan Direction |
| B1h | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | HV/DE mode selection |
| C5h | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | VCOM setting |
| C6h | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | GVDD/GVSS setting |
| C7h | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | NGVDD/NGVSS setting |
| E0h | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | Positive polarity gamma setting |
| E1h | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | Negative polarity gamma setting |

| Register | 01h (Software reset) |
|-------------|---|
| Description | When the software Reset command is written, it causes a software reset. It resets the commands and parameters to their S/W Reset default values and all source & gate outputs are set to VSS(display off). Note: The frame memory contents are not affected by this command. |
| Restriction | It will be necessary to wait 10 msec before sending new command following software reset. |

| Register | 10h (Sleep in) |
|-------------|---|
| Description | This command causes the LCD module to enter the minimum power consumption mode. In this mode the DC/DC converter is stopped, internal display oscillator is stopped, and panel scanning is stopped. Note: The memory keeps its contents. |
| Restriction | It will be necessary to wait 5 msec before sending next command, this is to allow time for the supply voltage and clock circuits to stabilize. |

| Register | 11h (Sleep out) |
|-------------|---|
| Description | This command turns off sleep mode. In this mode the DC/DC converter is enabled, internal display oscillator is started, and panel scanning is started. |
| Restriction | It will be necessary to wait 120 msec before sending next command, this is to allow time for the supply voltage and clock circuits to stabilize. |

Register **28h (Display off)**

Description This command is used to enter into DISPLAY OFF mode.
 In this mode, the output from Frame memory is disabled and blank page inserted.

Restriction -

Register **29h (Display on)**

Description This command is used to recover from DISPLAY OFF mode.
 Output from Frame memory is enabled.

Restriction -

| 36H | Scan Direction | | | | | | | | | |
|---------------------------|----------------|----|----|----|----|----|----|----|----|-----|
| | D/CX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX |
| Command | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 36 |
| 1 st Parameter | 1 | MY | MX | 0 | 0 | 0 | 0 | 0 | 0 | 00h |

| | |
|-------------|--|
| Description | Set the scan direction of LCD. MY = '0': Scan direction is from top to bottom, MY = '1': Scan direction is from bottom to top. MX = '0': Scan direction is from left to right, MX = '1': Scan direction is from right to left. |
| Default | Default value is {0000 0000} |

| B1H | HV/DE Mode Setting | | | | | | | | | |
|-----|--------------------|----|----|----|----|----|----|----|----|-----|
| | D/CX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX |

| | | | | | | | | | | |
|---------------------------|---|-----------|---|---|---|---|---|-------|---|-----|
| Command | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | B1 |
| 1 st Parameter | 1 | 0 | 0 | 0 | 0 | 0 | 1 | HV/DE | 0 | 04h |
| 2 nd Parameter | 1 | HBlanking | | | | | | | | 00h |
| 3 rd Parameter | 1 | VBlanking | | | | | | | | 00h |

| | | |
|-------------|--|---|
| Description | HV/DE: HV/DE mode setting. | |
| | HV/DE | Description |
| | 0 | DE mode is selected. DE signal is needs input externally. HBlanking and VBlanking parameters are ineffective. |
| | 1 | HV mode is selected. DE signal doesn't need input. Blanking settings are controlled by HBlanking/VBlanking parameters. |
| | <p>HBlanking[7:0]: horizontal blanking setting. HBlanking should be set as value of t_{hp} add t_{hb}. Ex: $t_{hp} = 20(\text{decimal})$, $t_{hb} = 50(\text{decimal})$. HBlanking = $20 + 50 = 70(\text{decimal}) = \text{"0100 0110"}(\text{binary})$</p> <p>VBlanking[7:0]: vertical blanking setting. VBlanking should be set as value of t_{vp} add t_{vb}. Ex: $t_{vp} = 2(\text{decimal})$, $t_{vb} = 3(\text{decimal})$. VBlanking = $2 + 3 = 5(\text{decimal}) = \text{"0000 0101"}(\text{binary})$</p> | |

| C5H | VCOMDC(VCOM Setting) | | | | | | | | | |
|---------------------------|----------------------|--------|----------------|--------|--------|--------|--------|--------|--------|-----|
| | D/CX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX |
| Command | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | C5 |
| 1 st Parameter | 1 | NVM2 | VCOMDC CGND | - | - | - | - | - | - | 00h |
| 2 nd Parameter | 1 | COMDC7 | COMDC6 | COMDC5 | COMDC4 | COMDC3 | COMDC2 | COMDC1 | COMDC0 | |

NOTE: "-" Don't care

| | | | | | | | | | | |
|-----------------------|---|--|--|--|--|--|--|--|--|--|
| Description | NVM2=0, VCOMDC setting is from NVM, NVM2=1, VCOMDC setting is from register | | | | | | | | | |
| Restriction | | | | | | | | | | |
| Register Availability | | | | | | | | | | |
| Default | Default value is {0101 1101} | | | | | | | | | |
| Flow Chart | - | | | | | | | | | |

| COMDC[7:0] | VCOMDC(V) | COMDC[7:0] | VCOMDC(V) | COMDC[7:0] | VCOMDC(V) | COMDC[7:0] | VCOMDC(V) |
|------------|-----------|------------|-----------|------------|-----------|------------|-----------|
| FFh | 1.905 | BFh | 0.945 | 7Fh | 0.000 | 3Fh | -0.960 |
| FEh | 1.890 | BEh | 0.930 | 7Eh | -0.015 | 3Eh | -0.975 |
| FDh | 1.875 | BDh | 0.915 | 7Dh | -0.030 | 3Dh | -0.990 |
| FCh | 1.860 | BCh | 0.900 | 7Ch | -0.045 | 3Ch | -1.005 |
| FBh | 1.845 | BBh | 0.885 | 7Bh | -0.060 | 3Bh | -1.020 |

| | | | | | | | |
|-----|-------|-----|-------|-----|--------|-----|--------|
| FAh | 1.830 | BAh | 0.870 | 7Ah | -0.075 | 3Ah | -1.035 |
| F9h | 1.815 | B9h | 0.855 | 79h | -0.090 | 39h | -1.050 |
| F8h | 1.800 | B8h | 0.840 | 78h | -0.105 | 38h | -1.065 |
| F7h | 1.785 | B7h | 0.825 | 77h | -0.120 | 37h | -1.080 |
| F6h | 1.770 | B6h | 0.810 | 76h | -0.135 | 36h | -1.095 |
| F5h | 1.755 | B5h | 0.795 | 75h | -0.150 | 35h | -1.110 |
| F4h | 1.740 | B4h | 0.780 | 74h | -0.165 | 34h | -1.125 |
| F3h | 1.725 | B3h | 0.765 | 73h | -0.180 | 33h | -1.140 |
| F2h | 1.710 | B2h | 0.750 | 72h | -0.195 | 32h | -1.155 |
| F1h | 1.695 | B1h | 0.735 | 71h | -0.210 | 31h | -1.170 |
| F0h | 1.680 | B0h | 0.720 | 70h | -0.225 | 30h | -1.185 |
| EFh | 1.665 | AFh | 0.705 | 6Fh | -0.240 | 2Fh | -1.200 |
| EEh | 1.650 | AEh | 0.690 | 6Eh | -0.255 | 2Eh | -1.215 |
| EDh | 1.635 | ADh | 0.675 | 6Dh | -0.270 | 2Dh | -1.230 |
| ECh | 1.620 | ACH | 0.660 | 6Ch | -0.285 | 2Ch | -1.245 |
| EBh | 1.605 | ABh | 0.645 | 6Bh | -0.300 | 2Bh | -1.260 |
| EAh | 1.590 | AAh | 0.630 | 6Ah | -0.315 | 2Ah | -1.275 |
| E9h | 1.575 | A9h | 0.615 | 69h | -0.330 | 29h | -1.290 |
| E8h | 1.560 | A8h | 0.600 | 68h | -0.345 | 28h | -1.305 |
| E7h | 1.545 | A7h | 0.585 | 67h | -0.360 | 27h | -1.320 |
| E6h | 1.530 | A6h | 0.570 | 66h | -0.375 | 26h | -1.335 |
| E5h | 1.515 | A5h | 0.555 | 65h | -0.390 | 25h | -1.350 |
| E4h | 1.500 | A4h | 0.540 | 64h | -0.405 | 24h | -1.365 |
| E3h | 1.485 | A3h | 0.525 | 63h | -0.420 | 23h | -1.380 |
| E2h | 1.470 | A2h | 0.510 | 62h | -0.435 | 22h | -1.395 |
| E1h | 1.455 | A1h | 0.495 | 61h | -0.450 | 21h | -1.410 |
| E0h | 1.440 | A0h | 0.480 | 60h | -0.465 | 20h | -1.425 |
| DFh | 1.425 | 9Fh | 0.465 | 5Fh | -0.480 | 1Fh | -1.440 |
| DEh | 1.410 | 9Eh | 0.450 | 5Eh | -0.495 | 1Eh | -1.455 |
| DDh | 1.395 | 9Dh | 0.435 | 5Dh | -0.510 | 1Dh | -1.470 |
| DCh | 1.380 | 9Ch | 0.420 | 5Ch | -0.525 | 1Ch | -1.485 |
| DBh | 1.365 | 9Bh | 0.405 | 5Bh | -0.540 | 1Bh | -1.500 |
| DAh | 1.350 | 9Ah | 0.390 | 5Ah | -0.555 | 1Ah | -1.515 |
| D9h | 1.335 | 99h | 0.375 | 59h | -0.570 | 19h | -1.530 |
| D8h | 1.320 | 98h | 0.360 | 58h | -0.585 | 18h | -1.545 |
| D7h | 1.305 | 97h | 0.345 | 57h | -0.600 | 17h | -1.560 |
| D6h | 1.290 | 96h | 0.330 | 56h | -0.615 | 16h | -1.575 |
| D5h | 1.275 | 95h | 0.315 | 55h | -0.630 | 15h | -1.590 |
| D4h | 1.260 | 94h | 0.300 | 54h | -0.645 | 14h | -1.605 |
| D3h | 1.245 | 93h | 0.285 | 53h | -0.660 | 13h | -1.620 |
| D2h | 1.230 | 92h | 0.270 | 52h | -0.675 | 12h | -1.635 |
| D1h | 1.215 | 91h | 0.255 | 51h | -0.690 | 11h | -1.650 |
| D0h | 1.200 | 90h | 0.240 | 50h | -0.705 | 10h | -1.665 |
| CFh | 1.185 | 8Fh | 0.225 | 4Fh | -0.720 | 0Fh | -1.680 |
| CEh | 1.170 | 8Eh | 0.210 | 4Eh | -0.735 | 0Eh | -1.695 |
| CDh | 1.155 | 8Dh | 0.195 | 4Dh | -0.750 | 0Dh | -1.710 |
| CCh | 1.140 | 8Ch | 0.180 | 4Ch | -0.765 | 0Ch | -1.725 |
| CBh | 1.125 | 8Bh | 0.165 | 4Bh | -0.780 | 0Bh | -1.740 |
| CAh | 1.110 | 8Ah | 0.150 | 4Ah | -0.795 | 0Ah | -1.755 |
| C9h | 1.095 | 89h | 0.135 | 49h | -0.810 | 09h | -1.770 |
| C8h | 1.080 | 88h | 0.120 | 48h | -0.825 | 08h | -1.785 |
| C7h | 1.065 | 87h | 0.105 | 47h | -0.840 | 07h | -1.800 |
| C6h | 1.050 | 86h | 0.090 | 46h | -0.855 | 06h | -1.815 |
| C5h | 1.035 | 85h | 0.075 | 45h | -0.870 | 05h | -1.830 |
| C4h | 1.020 | 84h | 0.060 | 44h | -0.885 | 04h | -1.845 |
| C3h | 1.005 | 83h | 0.045 | 43h | -0.900 | 03h | -1.860 |
| C2h | 0.990 | 82h | 0.030 | 42h | -0.915 | 02h | -1.875 |

| | | | | | | | |
|-----|-------|-----|-------|-----|--------|-----|--------|
| C1h | 0.975 | 81h | 0.015 | 41h | -0.930 | 01h | -1.890 |
| C0h | 0.960 | 80h | 0.000 | 40h | -0.945 | 00h | -1.905 |

| C6H | GVDD/GVSS(GVDD/GVSS Setting) | | | | | | | | | |
|---------------------------|------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| | D/CX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX |
| Command | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | C6 |
| 1 st Parameter | 1 | GVDD7 | GVDD6 | GVDD5 | GVDD4 | GVDD3 | GVDD2 | GVDD1 | GVDD0 | |
| 2 nd Parameter | 1 | NVM4 | - | GVSS5 | GVSS4 | GVSS3 | GVSS2 | GVSS1 | GVSS0 | |

NOTE: "-" Don't care

| | |
|-----------------------|---|
| Description | NVM4=0, GVDD setting is from NVM, NVM4=1, GVDD setting is from register |
| Restriction | |
| Register Availability | |
| Default | GVDD default value is {1010 1011} ; GVSS default value is {0000 0100} |
| Flow Chart | - |

- GVDD voltage setting

| GVDD[7:0] | GVDD(V) | GVDD[7:0] | GVDD(V) | GVDD[7:0] | GVDD(V) | GVDD[7:0] | GVDD(V) |
|-----------|---------|-----------|---------|-----------|---------|-----------|---------|
| FFh | 6 | BFh | 5.04 | 7Fh | 4.08 | 3Fh | 3.12 |
| FEh | 5.985 | BEh | 5.025 | 7Eh | 4.065 | 3Eh | 3.105 |
| FDh | 5.97 | BDh | 5.01 | 7Dh | 4.05 | 3Dh | 3.09 |
| FCCh | 5.955 | BCh | 4.995 | 7Ch | 4.035 | 3Ch | 3.075 |
| FBh | 5.94 | BBh | 4.98 | 7Bh | 4.02 | 3Bh | 3.06 |
| FAh | 5.925 | BAh | 4.965 | 7Ah | 4.005 | 3Ah | 3.045 |
| F9h | 5.91 | B9h | 4.95 | 79h | 3.99 | 39h | 3.03 |
| F8h | 5.895 | B8h | 4.935 | 78h | 3.975 | 38h | 3.015 |
| F7h | 5.88 | B7h | 4.92 | 77h | 3.96 | 37h | 3 |
| F6h | 5.865 | B6h | 4.905 | 76h | 3.945 | 36h | 2.985 |
| F5h | 5.85 | B5h | 4.89 | 75h | 3.93 | 35h | 2.97 |
| F4h | 5.835 | B4h | 4.875 | 74h | 3.915 | 34h | 2.955 |
| F3h | 5.82 | B3h | 4.86 | 73h | 3.9 | 33h | 2.94 |
| F2h | 5.805 | B2h | 4.845 | 72h | 3.885 | 32h | 2.925 |
| F1h | 5.79 | B1h | 4.83 | 71h | 3.87 | 31h | 2.91 |
| F0h | 5.775 | B0h | 4.815 | 70h | 3.855 | 30h | 2.895 |
| EFh | 5.76 | AFh | 4.8 | 6Fh | 3.84 | 2Fh | 2.88 |
| EEh | 5.745 | AEnh | 4.785 | 6Eh | 3.825 | 2Eh | 2.865 |
| EDh | 5.73 | ADh | 4.77 | 6Dh | 3.81 | 2Dh | 2.85 |
| ECh | 5.715 | ACh | 4.755 | 6Ch | 3.795 | 2Ch | 2.835 |
| EBh | 5.7 | ABh | 4.74 | 6Bh | 3.78 | 2Bh | 2.82 |
| EAh | 5.685 | AAh | 4.725 | 6Ah | 3.765 | 2Ah | 2.805 |

| | | | | | | | |
|-----|-------|-----|-------|-----|-------|-----|-------|
| E9h | 5.67 | A9h | 4.71 | 69h | 3.75 | 29h | 2.79 |
| E8h | 5.655 | A8h | 4.695 | 68h | 3.735 | 28h | 2.775 |
| E7h | 5.64 | A7h | 4.68 | 67h | 3.72 | 27h | 2.76 |
| E6h | 5.625 | A6h | 4.665 | 66h | 3.705 | 26h | 2.745 |
| E5h | 5.61 | A5h | 4.65 | 65h | 3.69 | 25h | 2.73 |
| E4h | 5.595 | A4h | 4.635 | 64h | 3.675 | 24h | 2.715 |
| E3h | 5.58 | A3h | 4.62 | 63h | 3.66 | 23h | 2.7 |
| E2h | 5.565 | A2h | 4.605 | 62h | 3.645 | 22h | 2.685 |
| E1h | 5.55 | A1h | 4.59 | 61h | 3.63 | 21h | 2.67 |
| E0h | 5.535 | A0h | 4.575 | 60h | 3.615 | 20h | 2.655 |
| DFh | 5.52 | 9Fh | 4.560 | 5Fh | 3.600 | 1Fh | 2.655 |
| DEh | 5.505 | 9Eh | 4.545 | 5Eh | 3.585 | 1Eh | 2.655 |
| DDh | 5.49 | 9Dh | 4.530 | 5Dh | 3.570 | 1Dh | 2.655 |
| DCh | 5.475 | 9Ch | 4.515 | 5Ch | 3.555 | 1Ch | 2.655 |
| DBh | 5.46 | 9Bh | 4.500 | 5Bh | 3.540 | 1Bh | 2.655 |
| DAh | 5.445 | 9Ah | 4.485 | 5Ah | 3.525 | 1Ah | 2.655 |
| D9h | 5.43 | 99h | 4.470 | 59h | 3.510 | 19h | 2.655 |
| D8h | 5.415 | 98h | 4.455 | 58h | 3.495 | 18h | 2.655 |
| D7h | 5.4 | 97h | 4.440 | 57h | 3.480 | 17h | 2.655 |
| D6h | 5.385 | 96h | 4.425 | 56h | 3.465 | 16h | 2.655 |
| D5h | 5.37 | 95h | 4.410 | 55h | 3.450 | 15h | 2.655 |
| D4h | 5.355 | 94h | 4.395 | 54h | 3.435 | 14h | 2.655 |
| D3h | 5.34 | 93h | 4.380 | 53h | 3.420 | 13h | 2.655 |
| D2h | 5.325 | 92h | 4.365 | 52h | 3.405 | 12h | 2.655 |
| D1h | 5.31 | 91h | 4.350 | 51h | 3.390 | 11h | 2.655 |
| D0h | 5.295 | 90h | 4.335 | 50h | 3.375 | 10h | 2.655 |
| CFh | 5.28 | 8Fh | 4.320 | 4Fh | 3.360 | 0Fh | 2.655 |
| CEh | 5.265 | 8Eh | 4.305 | 4Eh | 3.345 | 0Eh | 2.655 |
| CDh | 5.25 | 8Dh | 4.290 | 4Dh | 3.330 | 0Dh | 2.655 |
| CCh | 5.235 | 8Ch | 4.275 | 4Ch | 3.315 | 0Ch | 2.655 |
| CBh | 5.22 | 8Bh | 4.260 | 4Bh | 3.300 | 0Bh | 2.655 |
| CAh | 5.205 | 8Ah | 4.245 | 4Ah | 3.285 | 0Ah | 2.655 |
| C9h | 5.19 | 89h | 4.230 | 49h | 3.270 | 09h | 2.655 |
| C8h | 5.175 | 88h | 4.215 | 48h | 3.255 | 08h | 2.655 |
| C7h | 5.16 | 87h | 4.200 | 47h | 3.240 | 07h | 2.655 |
| C6h | 5.145 | 86h | 4.185 | 46h | 3.225 | 06h | 2.655 |
| C5h | 5.13 | 85h | 4.170 | 45h | 3.210 | 05h | 2.655 |

| | | | | | | | |
|-----|-------|-----|-------|-----|-------|-----|-------|
| C4h | 5.115 | 84h | 4.155 | 44h | 3.195 | 04h | 2.655 |
| C3h | 5.1 | 83h | 4.140 | 43h | 3.180 | 03h | 2.655 |
| C2h | 5.085 | 82h | 4.125 | 42h | 3.165 | 02h | 2.655 |
| C1h | 5.07 | 81h | 4.110 | 41h | 3.150 | 01h | 2.655 |
| C0h | 5.055 | 80h | 4.095 | 40h | 3.135 | 00h | 2.655 |

- GVSS voltage setting

| GVSS[5:0] | GVSS (V) | GVSS[5:0] | GVSS (V) |
|-----------|----------|-----------|----------|
| 3Fh | 1.05 | 1Fh | 0.57 |
| 3Eh | 1.035 | 1Eh | 0.555 |
| 3Dh | 1.02 | 1Dh | 0.54 |
| 3Ch | 1.005 | 1Ch | 0.525 |
| 3Bh | 0.99 | 1Bh | 0.51 |
| 3Ah | 0.975 | 1Ah | 0.495 |
| 39h | 0.96 | 19h | 0.48 |
| 38h | 0.945 | 18h | 0.465 |
| 37h | 0.93 | 17h | 0.45 |
| 36h | 0.915 | 16h | 0.435 |
| 35h | 0.9 | 15h | 0.42 |
| 34h | 0.885 | 14h | 0.405 |
| 33h | 0.87 | 13h | 0.39 |
| 32h | 0.855 | 12h | 0.375 |
| 31h | 0.84 | 11h | 0.36 |
| 30h | 0.825 | 10h | 0.345 |
| 2Fh | 0.81 | 0Fh | 0.33 |
| 2Eh | 0.795 | 0Eh | 0.315 |
| 2Dh | 0.78 | 0Dh | 0.3 |
| 2Ch | 0.765 | 0Ch | 0.285 |
| 2Bh | 0.75 | 0Bh | 0.27 |
| 2Ah | 0.735 | 0Ah | 0.255 |
| 29h | 0.72 | 09h | 0.24 |
| 28h | 0.705 | 08h | 0.225 |
| 27h | 0.69 | 07h | 0.21 |
| 26h | 0.675 | 06h | 0.195 |
| 25h | 0.66 | 05h | 0.18 |
| 24h | 0.645 | 04h | 0.165 |
| 23h | 0.63 | 03h | 0.15 |

| | | | |
|-----|-------|-----|-------|
| 22h | 0.615 | 02h | 0.135 |
| 21h | 0.6 | 01h | 0.12 |
| 20h | 0.585 | 00h | 0.105 |

| C7H | NGVDD/NGVSS(NGVDD/NGVSS Setting) | | | | | | | | | |
|---------------------------|----------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| | D/CX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX |
| Command | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | C7 |
| 1 st Parameter | 1 | NGVDD7 | NGVDD6 | NGVDD5 | NGVDD4 | NGVDD3 | NGVDD2 | NGVDD1 | NGVDD0 | |
| 2 nd Parameter | 1 | NVM5 | - | NGVSS5 | NGVSS4 | NGVSS3 | NGVSS2 | NGVSS1 | NGVSS0 | |

NOTE: "-" Don't care

| | |
|-----------------------|---|
| Description | NVM5=0, NGVDD setting is from NVM, NVM5=1, NGVDD setting is from register |
| Restriction | |
| Register Availability | |
| Default | NGVDD default value is {1010 1011} ; NGVSS default value is {0000 0100} |
| Flow Chart | - |

- NGVDD voltage setting

| NGVDD[7:0] | NGVDD(V) | NGVDD[7:0] | NGVDD(V) | NGVDD[7:0] | NGVDD(V) | NGVDD[7:0] | NGVDD(V) |
|------------|----------|------------|----------|------------|----------|------------|----------|
| FFh | -6 | BFh | -5.04 | 7Fh | -4.08 | 3Fh | -3.12 |
| FEh | -5.985 | BEh | -5.025 | 7Eh | -4.065 | 3Eh | -3.105 |
| FDh | -5.97 | BDh | -5.01 | 7Dh | -4.05 | 3Dh | -3.09 |
| FCh | -5.955 | BCh | -4.995 | 7Ch | -4.035 | 3Ch | -3.075 |
| FBh | -5.94 | BBh | -4.98 | 7Bh | -4.02 | 3Bh | -3.06 |
| FAh | -5.925 | BAh | -4.965 | 7Ah | -4.005 | 3Ah | -3.045 |
| F9h | -5.91 | B9h | -4.95 | 79h | -3.99 | 39h | -3.03 |
| F8h | -5.895 | B8h | -4.935 | 78h | -3.975 | 38h | -3.015 |
| F7h | -5.88 | B7h | -4.92 | 77h | -3.96 | 37h | -3 |
| F6h | -5.865 | B6h | -4.905 | 76h | -3.945 | 36h | -2.985 |
| F5h | -5.85 | B5h | -4.89 | 75h | -3.93 | 35h | -2.97 |
| F4h | -5.835 | B4h | -4.875 | 74h | -3.915 | 34h | -2.955 |
| F3h | -5.82 | B3h | -4.86 | 73h | -3.9 | 33h | -2.94 |
| F2h | -5.805 | B2h | -4.845 | 72h | -3.885 | 32h | -2.925 |
| F1h | -5.79 | B1h | -4.83 | 71h | -3.87 | 31h | -2.91 |
| F0h | -5.775 | B0h | -4.815 | 70h | -3.855 | 30h | -2.895 |
| EFh | -5.76 | AFh | -4.8 | 6Fh | -3.84 | 2Fh | -2.88 |
| EEh | -5.745 | A Eh | -4.785 | 6Eh | -3.825 | 2Eh | -2.865 |
| EDh | -5.73 | ADh | -4.77 | 6Dh | -3.81 | 2Dh | -2.85 |

| | | | | | | | |
|-----|--------|-----|--------|-----|--------|-----|--------|
| ECh | -5.715 | ACh | -4.755 | 6Ch | -3.795 | 2Ch | -2.835 |
| EBh | -5.7 | ABh | -4.74 | 6Bh | -3.78 | 2Bh | -2.82 |
| EAh | -5.685 | AAh | -4.725 | 6Ah | -3.765 | 2Ah | -2.805 |
| E9h | -5.67 | A9h | -4.71 | 69h | -3.75 | 29h | -2.79 |
| E8h | -5.655 | A8h | -4.695 | 68h | -3.735 | 28h | -2.775 |
| E7h | -5.64 | A7h | -4.68 | 67h | -3.72 | 27h | -2.76 |
| E6h | -5.625 | A6h | -4.665 | 66h | -3.705 | 26h | -2.745 |
| E5h | -5.61 | A5h | -4.65 | 65h | -3.69 | 25h | -2.73 |
| E4h | -5.595 | A4h | -4.635 | 64h | -3.675 | 24h | -2.715 |
| E3h | -5.58 | A3h | -4.62 | 63h | -3.66 | 23h | -2.7 |
| E2h | -5.565 | A2h | -4.605 | 62h | -3.645 | 22h | -2.685 |
| E1h | -5.55 | A1h | -4.59 | 61h | -3.63 | 21h | -2.67 |
| E0h | -5.535 | A0h | -4.575 | 60h | -3.615 | 20h | -2.655 |
| DFh | -5.52 | 9Fh | -4.56 | 5Fh | -3.6 | 1Fh | -2.655 |
| DEh | -5.505 | 9Eh | -4.545 | 5Eh | -3.585 | 1Eh | -2.655 |
| DDh | -5.49 | 9Dh | -4.53 | 5Dh | -3.57 | 1Dh | -2.655 |
| DCh | -5.475 | 9Ch | -4.515 | 5Ch | -3.555 | 1Ch | -2.655 |
| DBh | -5.46 | 9Bh | -4.5 | 5Bh | -3.54 | 1Bh | -2.655 |
| DAh | -5.445 | 9Ah | -4.485 | 5Ah | -3.525 | 1Ah | -2.655 |
| D9h | -5.43 | 99h | -4.47 | 59h | -3.51 | 19h | -2.655 |
| D8h | -5.415 | 98h | -4.455 | 58h | -3.495 | 18h | -2.655 |
| D7h | -5.4 | 97h | -4.44 | 57h | -3.48 | 17h | -2.655 |
| D6h | -5.385 | 96h | -4.425 | 56h | -3.465 | 16h | -2.655 |
| D5h | -5.37 | 95h | -4.41 | 55h | -3.45 | 15h | -2.655 |
| D4h | -5.355 | 94h | -4.395 | 54h | -3.435 | 14h | -2.655 |
| D3h | -5.34 | 93h | -4.38 | 53h | -3.42 | 13h | -2.655 |
| D2h | -5.325 | 92h | -4.365 | 52h | -3.405 | 12h | -2.655 |
| D1h | -5.31 | 91h | -4.35 | 51h | -3.39 | 11h | -2.655 |
| D0h | -5.295 | 90h | -4.335 | 50h | -3.375 | 10h | -2.655 |
| CFh | -5.28 | 8Fh | -4.32 | 4Fh | -3.36 | 0Fh | -2.655 |
| CEh | -5.265 | 8Eh | -4.305 | 4Eh | -3.345 | 0Eh | -2.655 |
| CDh | -5.25 | 8Dh | -4.29 | 4Dh | -3.33 | 0Dh | -2.655 |
| CCh | -5.235 | 8Ch | -4.275 | 4Ch | -3.315 | 0Ch | -2.655 |
| CBh | -5.22 | 8Bh | -4.26 | 4Bh | -3.3 | 0Bh | -2.655 |
| CAh | -5.205 | 8Ah | -4.245 | 4Ah | -3.285 | 0Ah | -2.655 |
| C9h | -5.19 | 89h | -4.23 | 49h | -3.27 | 09h | -2.655 |
| C8h | -5.175 | 88h | -4.215 | 48h | -3.255 | 08h | -2.655 |

| | | | | | | | |
|-----|--------|-----|--------|-----|--------|-----|--------|
| C7h | -5.16 | 87h | -4.2 | 47h | -3.24 | 07h | -2.655 |
| C6h | -5.145 | 86h | -4.185 | 46h | -3.225 | 06h | -2.655 |
| C5h | -5.13 | 85h | -4.17 | 45h | -3.21 | 05h | -2.655 |
| C4h | -5.115 | 84h | -4.155 | 44h | -3.195 | 04h | -2.655 |
| C3h | -5.1 | 83h | -4.14 | 43h | -3.18 | 03h | -2.655 |
| C2h | -5.085 | 82h | -4.125 | 42h | -3.165 | 02h | -2.655 |
| C1h | -5.07 | 81h | -4.11 | 41h | -3.15 | 01h | -2.655 |
| C0h | -5.055 | 80h | -4.095 | 40h | -3.135 | 00h | -2.655 |

- NGVSS voltage setting

| NGVSS[5:0] | NGVSS (V) | NGVSS[5:0] | NGVSS (V) |
|------------|-----------|------------|-----------|
| 3Fh | -1.050 | 1Fh | -0.570 |
| 3Eh | -1.035 | 1Eh | -0.555 |
| 3Dh | -1.020 | 1Dh | -0.540 |
| 3Ch | -1.005 | 1Ch | -0.525 |
| 3Bh | -0.990 | 1Bh | -0.510 |
| 3Ah | -0.975 | 1Ah | -0.495 |
| 39h | -0.960 | 19h | -0.480 |
| 38h | -0.945 | 18h | -0.465 |
| 37h | -0.930 | 17h | -0.450 |
| 36h | -0.915 | 16h | -0.435 |
| 35h | -0.900 | 15h | -0.42 |
| 34h | -0.885 | 14h | -0.405 |
| 33h | -0.870 | 13h | -0.39 |
| 32h | -0.855 | 12h | -0.375 |
| 31h | -0.840 | 11h | -0.36 |
| 30h | -0.825 | 10h | -0.345 |
| 2Fh | -0.810 | 0Fh | -0.33 |
| 2Eh | -0.795 | 0Eh | -0.315 |
| 2Dh | -0.780 | 0Dh | -0.3 |
| 2Ch | -0.765 | 0Ch | -0.285 |
| 2Bh | -0.750 | 0Bh | -0.27 |
| 2Ah | -0.735 | 0Ah | -0.255 |
| 29h | -0.720 | 09h | -0.24 |
| 28h | -0.705 | 08h | -0.225 |
| 27h | -0.690 | 07h | -0.21 |
| 26h | -0.675 | 06h | -0.195 |

| | | | |
|-----|--------|-----|--------|
| 25h | -0.660 | 05h | -0.18 |
| 24h | -0.645 | 04h | -0.165 |
| 23h | -0.630 | 03h | -0.15 |
| 22h | -0.615 | 02h | -0.135 |
| 21h | -0.600 | 01h | -0.12 |
| 20h | -0.585 | 00h | -0.105 |

| E0H | GMCTRP1(Gamma Correction Characteristics Setting (Positive polarity)) | | | | | | | | | |
|----------------------------|---|----|----|--------|--------|--------|--------|--------|--------|-----|
| | D/CX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX |
| Command | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | E0 |
| 1 st Parameter | 1 | | | GP1R5 | GP1R4 | GP1R3 | GP1R2 | GP1R1 | GP1R0 | |
| 2 nd Parameter | 1 | | | GP2R5 | GP2R4 | GP2R3 | GP2R2 | GP2R1 | GP2R0 | |
| 3 rd Parameter | 1 | | | GP3R5 | GP3R4 | GP3R3 | GP3R2 | GP3R1 | GP3R0 | |
| 4 th Parameter | 1 | | | - | GP4R4 | GP4R3 | GP4R2 | GP4R1 | GP4R0 | |
| 5 th Parameter | 1 | | | - | GP5R4 | GP5R3 | GP5R2 | GP5R1 | GP5R0 | |
| 6 th Parameter | 1 | | | - | GP6R4 | GP6R3 | GP6R2 | GP6R1 | GP6R0 | |
| 7 th Parameter | 1 | | | - | - | GP7R3 | GP7R2 | GP7R1 | GP7R0 | |
| 8 th Parameter | 1 | | | - | - | GP8R3 | GP8R2 | GP8R1 | GP8R0 | |
| 9 th Parameter | 1 | | | - | - | GP9R3 | GP9R2 | GP9R1 | GP9R0 | |
| 10 th Parameter | 1 | | | - | - | GP10R3 | GP10R2 | GP10R1 | GP10R0 | |
| 11 th Parameter | 1 | | | - | GP11R4 | GP11R3 | GP11R2 | GP11R1 | GP11R0 | |
| 12 th Parameter | 1 | | | - | GP12R4 | GP12R3 | GP12R2 | GP12R1 | GP12R0 | |
| 13 th Parameter | 1 | | | - | GP13R4 | GP13R3 | GP13R2 | GP13R1 | GP13R0 | |
| 14 th Parameter | 1 | | | GP14R5 | GP14R4 | GP14R3 | GP14R2 | GP14R1 | GP14R0 | |
| 15 th Parameter | 1 | | | GP15R5 | GP15R4 | GP15R3 | GP15R2 | GP15R1 | GP15R0 | |
| 16 th Parameter | 1 | | | GP16R5 | GP16R4 | GP16R3 | GP16R2 | GP16R1 | GP16R0 | |

NOTE: "-" Don't care

| | |
|-----------------------|---|
| Description | <p>Gamma adjustment for positive polarity setting.</p> <p>GP1R : For Positive polarity Gamma Level 0 GP2R : For Positive polarity Gamma Level 4 GP3R : For Positive polarity Gamma Level 8 GP4R : For Positive polarity Gamma Level 16 GP5R : For Positive polarity Gamma Level 32 GP6R : For Positive polarity Gamma Level 52 GP7R : For Positive polarity Gamma Level 80 GP8R : For Positive polarity Gamma Level 108 GP9R : For Positive polarity Gamma Level 147 GP10R : For Positive polarity Gamma Level 175 GP11R : For Positive polarity Gamma Level 203 GP12R : For Positive polarity Gamma Level 223 GP13R : For Positive polarity Gamma Level 239 GP14R : For Positive polarity Gamma Level 247 GP15R : For Positive polarity Gamma Level 251 GP16R : For Positive polarity Gamma Level 255</p> |
| Restriction | |
| Register Availability | |
| Default | |
| Flow Chart | - |

| E1H | GMCTRN1(Gamma Correction Characteristics Setting (Negative polarity)) | | | | | | | | | |
|----------------------------|---|----|----|--------|--------|--------|--------|--------|--------|-----|
| | D/CX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | HEX |
| Command | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | E1 |
| 1 st Parameter | 1 | | | GN1R5 | GN1R4 | GN1R3 | GN1R2 | GN1R1 | GN1R0 | |
| 2 nd Parameter | 1 | | | GN2R5 | GN2R4 | GN2R3 | GN2R2 | GN2R1 | GN2R0 | |
| 3 rd Parameter | 1 | | | GN3R5 | GN3R4 | GN3R3 | GN3R2 | GN3R1 | GN3R0 | |
| 4 th Parameter | 1 | | | - | GN4R4 | GN4R3 | GN4R2 | GN4R1 | GN4R0 | |
| 5 th Parameter | 1 | | | - | GN5R4 | GN5R3 | GN5R2 | GN5R1 | GN5R0 | |
| 6 th Parameter | 1 | | | - | GN6R4 | GN6R3 | GN6R2 | GN6R1 | GN6R0 | |
| 7 th Parameter | 1 | | | - | - | GN7R3 | GN7R2 | GN7R1 | GN7R0 | |
| 8 th Parameter | 1 | | | - | - | GN8R3 | GN8R2 | GN8R1 | GN8R0 | |
| 9 th Parameter | 1 | | | - | - | GN9R3 | GN9R2 | GN9R1 | GN9R0 | |
| 10 th Parameter | 1 | | | - | - | GN10R3 | GN10R2 | GN10R1 | GN10R0 | |
| 11 th Parameter | 1 | | | - | GN11R4 | GN11R3 | GN11R2 | GN11R1 | GN11R0 | |
| 12 th Parameter | 1 | | | - | GN12R4 | GN12R3 | GN12R2 | GN12R1 | GN12R0 | |
| 13 th Parameter | 1 | | | - | GN13R4 | GN13R3 | GN13R2 | GN13R1 | GN13R0 | |
| 14 th Parameter | 1 | | | GN14R5 | GN14R4 | GN14R3 | GN14R2 | GN14R1 | GN14R0 | |
| 15 th Parameter | 1 | | | GN15R5 | GN15R4 | GN15R3 | GN15R2 | GN15R1 | GN15R0 | |

| | | | | | | | | | | |
|----------------------------|---|--|--|--------|--------|--------|--------|--------|--------|--|
| 16 th Parameter | 1 | | | GN16R5 | GN16R4 | GN16R3 | GN16R2 | GN16R1 | GN16R0 | |
|----------------------------|---|--|--|--------|--------|--------|--------|--------|--------|--|

NOTE: "-" Don't care

| | |
|-----------------------|--|
| Description | <p>Gamma adjustment for negative porlarity setting.</p> <p>GN1R : For Negative polarity Gamma Level 0 GN2R : For Negative polarity Gamma Level 4 GN3R : For Negative polarity Gamma Level 8 GN4R : For Negative polarity Gamma Level 16 GN5R : For Negative polarity Gamma Level 32 GN6R : For Negative polarity Gamma Level 52 GN7R : For Negative polarity Gamma Level 80 GN8R : For Negative polarity Gamma Level 108 GN9R : For Negative polarity Gamma Level 147 GN10R : For Negative polarity Gamma Level 175 GN11R : For Negative polarity Gamma Level 203 GN12R : For Negative polarity Gamma Level 223 GN13R : For Negative polarity Gamma Level 239 GN14R : For Negative polarity Gamma Level 247 GN15R : For Negative polarity Gamma Level 251 GN16R : For Negative polarity Gamma Level 255</p> |
| Restriction | |
| Register Availability | |
| Default | |
| Flow Chart | - |

C. Touch Panel Command and Register Map

1. I2C Protocol Definition

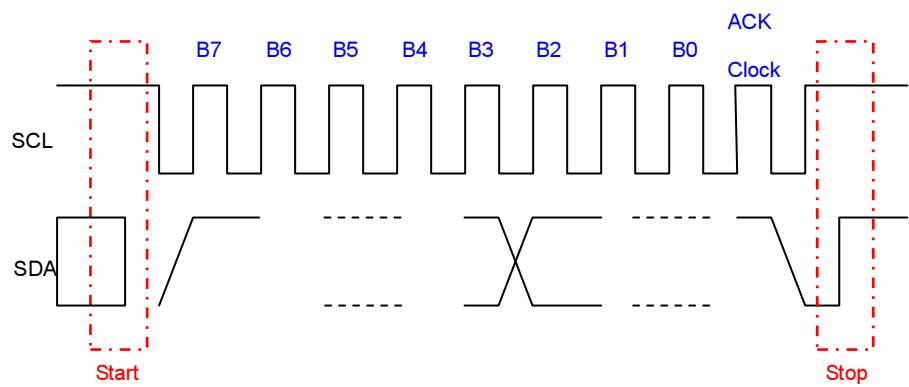


Figure 1. Standard I²C Transaction Unit

The sensor controller supports standard I²C protocol with SCL up to 400KHz. The device address is 0x5C. The chip also provides both single and sequential access. Figure 2 shows the write operation using single or sequential mode. Figure 3 also depicts the standard I2C transaction for single for sequential read mechanism.

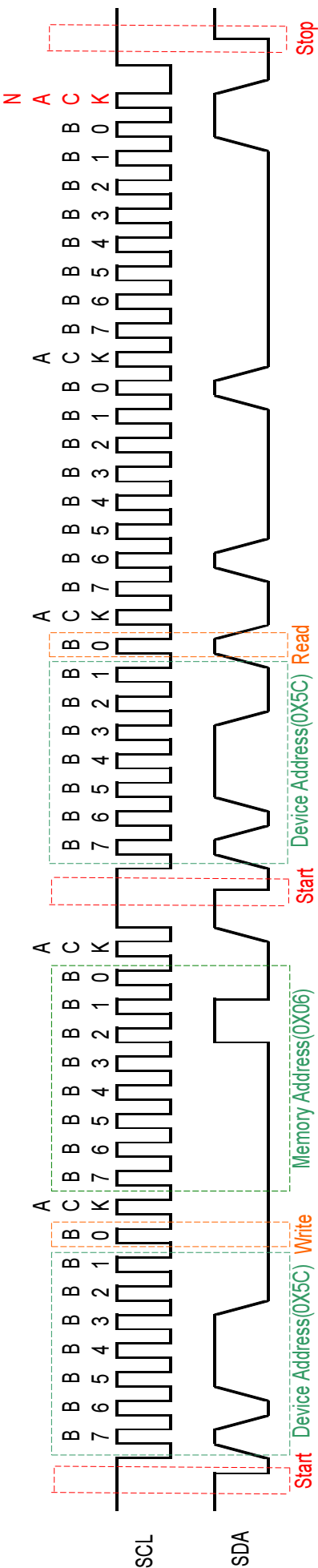
| Write Operation | | | | | | | | | |
|-----------------|-------|--------------------|---|----------|---|---------|---|---------|---|
| Single | Start | Device Address (W) | A | Mem Addr | A | Data[0] | A | Stop | |
| Sequential | Start | Device Address (W) | A | Mem Addr | A | Data[0] | A | Data[1] | A |
| | | | | | | | | | A |
| | | | | | | | | Data[n] | A |
| | | | | | | | | Stop | |

Figure 2. Write Operation with Single/Multiple Access

| Read Operation | | | | | | | | | | | |
|----------------|-------|--------------------|---|----------|---|-------|--------------------|---|---------|---------|-------|
| Single | Start | Device Address (W) | A | Mem Addr | A | Start | Device Address (R) | A | Data[0] | NA | Stop |
| Sequential | Start | Device Address (W) | A | Mem Addr | A | Start | Device Address (R) | A | Data[0] | A | |
| | | | | | | | | | A | Data[n] | NA |
| | | | | | | | | | | Stop | |

Figure 3. Read Operation with Single/Multiple Access

Suppose the Y[3] raw data is 321. If only Y[3] is read, user should issue the waveform as following:



2. I2C Data Map

2.1 Register Data Map

[illegible]

2.2 Default Setting

| | | | | | | | | | | | |
|-----|----|---------------|-----|-----|---|---|---|---|---|---|---|
| 103 | 67 | X_SENSITIVITY | R/W | TBD | | | | | | | |
| 104 | 68 | Y_SENSITIVITY | R/W | TBD | | | | | | | |
| 110 | 6E | INT_SETTING | R/W | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 111 | 6F | INT_WIDTH | R/W | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 112 | 70 | Power Mode | R/W | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

3. Raw Data Register Map

[illegible]

Note: Chip provides 10-bit ADC capability at least. While the unused ADC bit should be reserved as '0'

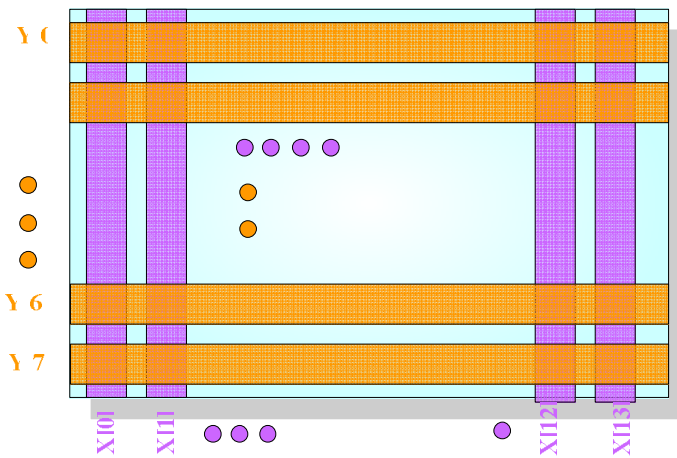


Figure 4. Reference of channel location diagram

4. Coordinate Register Map

[illegible]

Note: (1) (X1, Y1) means left-up touched point

(X2, Y2) means right-down touched point

(2) The coordinate of $X1 = X1(\text{LSB}) + X1(\text{MSB}) * 256$, $X2 = X2(\text{LSB}) + X2(\text{MSB}) * 256$, $Y1 = Y1(\text{LSB}) + Y1(\text{MSB}) * 256$, $Y2 = Y2(\text{LSB}) + Y2(\text{MSB}) * 256$

(3) If panel resolution is smaller than 256, user doesn't need reading address 68 ~ 71

(4)

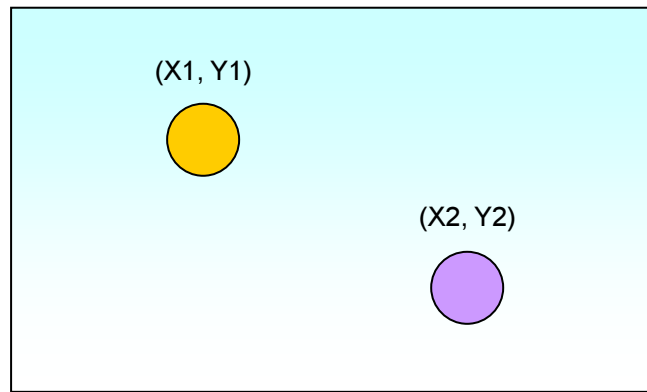


Figure 5. Reference of touched point diagram

If touched point of (X1,Y1) \ (X2, Y2) is (14,50) and (280,160), the coordinate register map will be recorded as following:

| Addr. | Addr.(HEX) | Description | R/W | B7 | B7 | B7 | B7 | B7 | B7 | B7 | B7 | B7 | B7 |
|-------|------------|-------------|-----|----|----|----|----|----|----|----|----|----|----|
| 77 | 77 | X7 (LS B) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 77 | 77 | Y7 (LS B) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 77 | 77 | X7 (LS B) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 77 | 77 | Y7 (LS B) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 77 | 77 | X7 (SB) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 77 | 77 | Y7 (SB) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 77 | 77 | X7 (SB) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 77 | 77 | Y7 (SB) | R | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

5. Sensitivity and Noise Threshold

| Addr. | Addr.(HEX) | Description | R/W | B7 | B7 | B7 | B7 | B7 | B7 | B7 | B7 | B7 | B7 |
|-------|------------|---------------|-----|----|----|----|----|----|----|----|----|----|----|
| 777 | 77 | X_SENSITIVITY | R/W | | | | | | | | | | |
| 777 | 7Y | Y_SENSITIVITY | R/W | | | | | | | | | | |

Note: (1) X_SENSITIVITY/Y_SENSITIVITY

X and Y Channels' sensitivity should be adjustable for coordinate calculation. These parameter doesn't effect the raw data output.

(2) The sensitivity is divided into 256 steps; '0' means most sensitive and '255' means least sensitive.

The coordinate calculation should according to given sensitivity setting. while the touch's raw data is greater than given parameter X_SENSITIVITY/Y_SENSITIVITY, the data is regarded as valid or will be seen as useless.

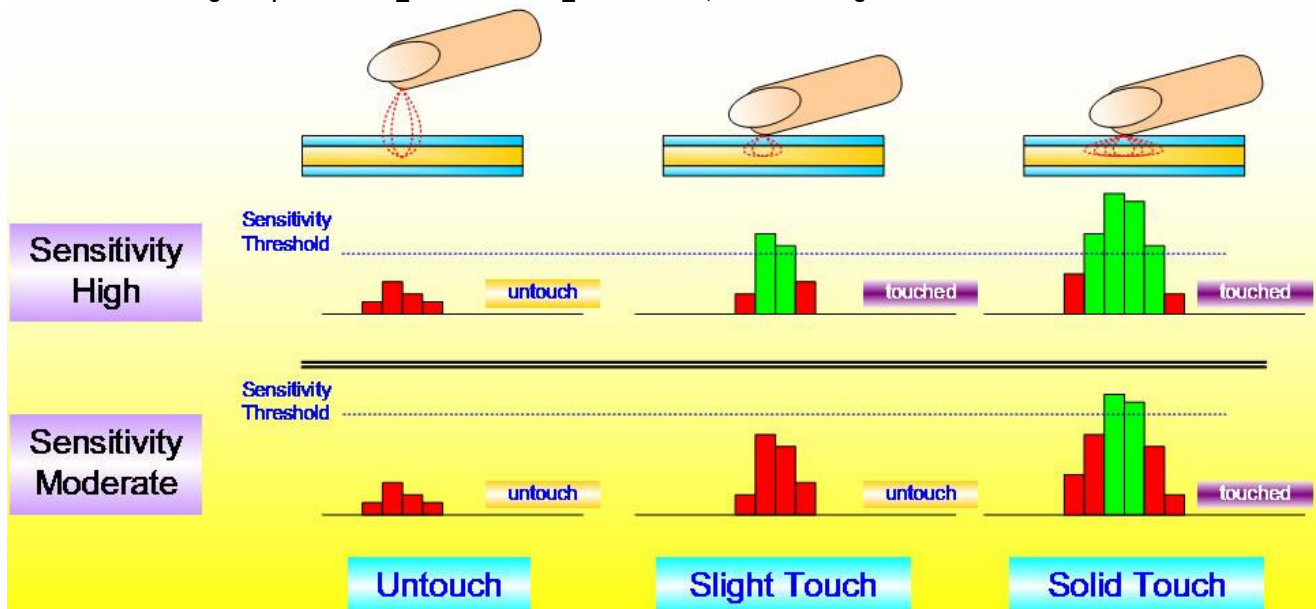


Figure 6. Sensitivity Adjustment

6. Interrupt Operation Mode

This chip should support both polling and interrupt way to get the coordinate and raw data by I2C interface. The figure below depicts the interruption operation.

6.1 Interrupt Mode Setting

| Addr. | Addr.(HEX) | Description | R/W | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|-------|------------|-------------|-----|----------------|----|----|----|--------|---------|-------------|-------------|
| 110 | 6E | INT_SETTING | R/W | 0 | 0 | 0 | 0 | EN_INT | INT_POL | INT_MODE[1] | INT_MODE[0] |
| 111 | 6F | INT_WIDTH | R/W | INT_WIDTH[7:0] | | | | | | | |

Note: (1) EN_INT

0: Disable interrupt mechanism 1: Enable interrupt mechanism

(2) INT_POL

0: The interrupt is low-active 1: the interrupt is high-active

(3) INT_MODE[1:0]

00: INT assert periodically

01: INT assert only when coordinate difference

10: Touch Indicate

11: Reserved (INT disabled)

6.2 Sensing Periodical Mode (INT_MODE[1:0] = [0,0]).

For sensing periodical mode, the INT_MODE[1:0] should be [0,0].

The data must be ready (including coordinate and raw data) before signal 'INT' rising.

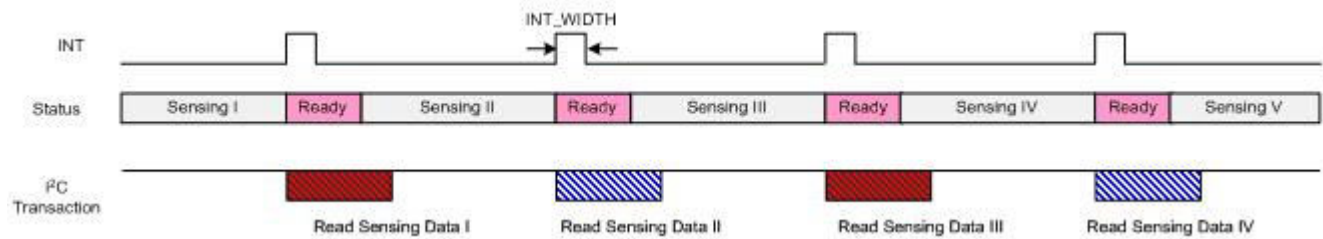


Figure 7: Interruption with INT_R auto-reset

6.3 Coordinate Compare Mode (INT_MODE[1:0] = [0,1]).

The INT signal will be asserted while coordinate changes under comparison mode (INT_MODE[1:0] = [0,1]).

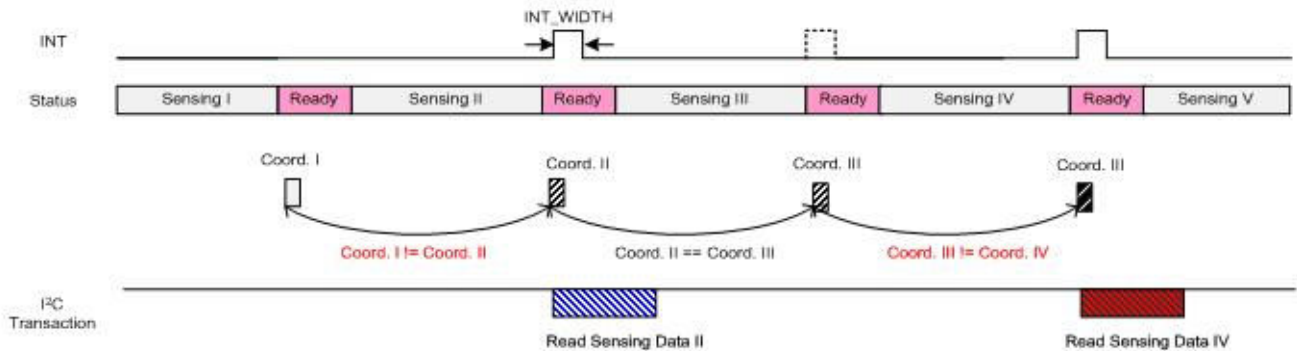


Figure 8: Interruption Flag under Coordinate Compare Mode

6.4 Touch Indicate Mode (INT_MODE[1:0] = [1,0]).

The interrupt will assert when the touch is valid. The interrupt should keep high until the touch is released.

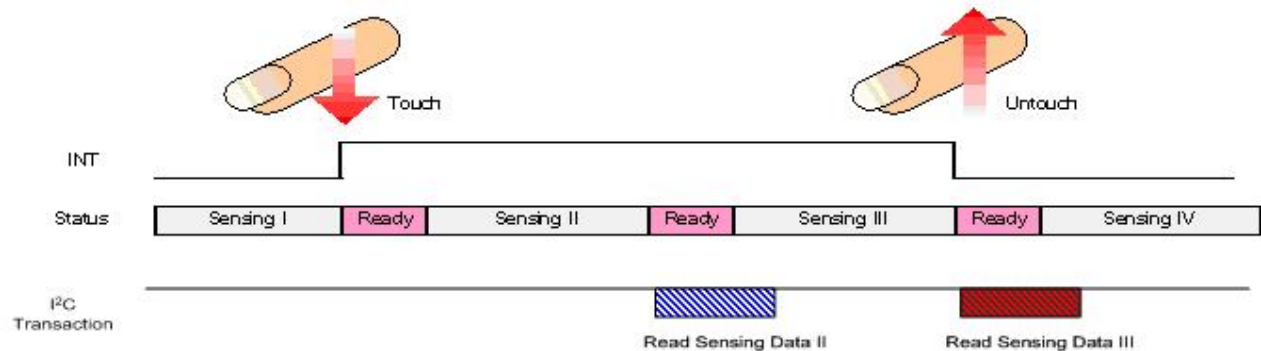
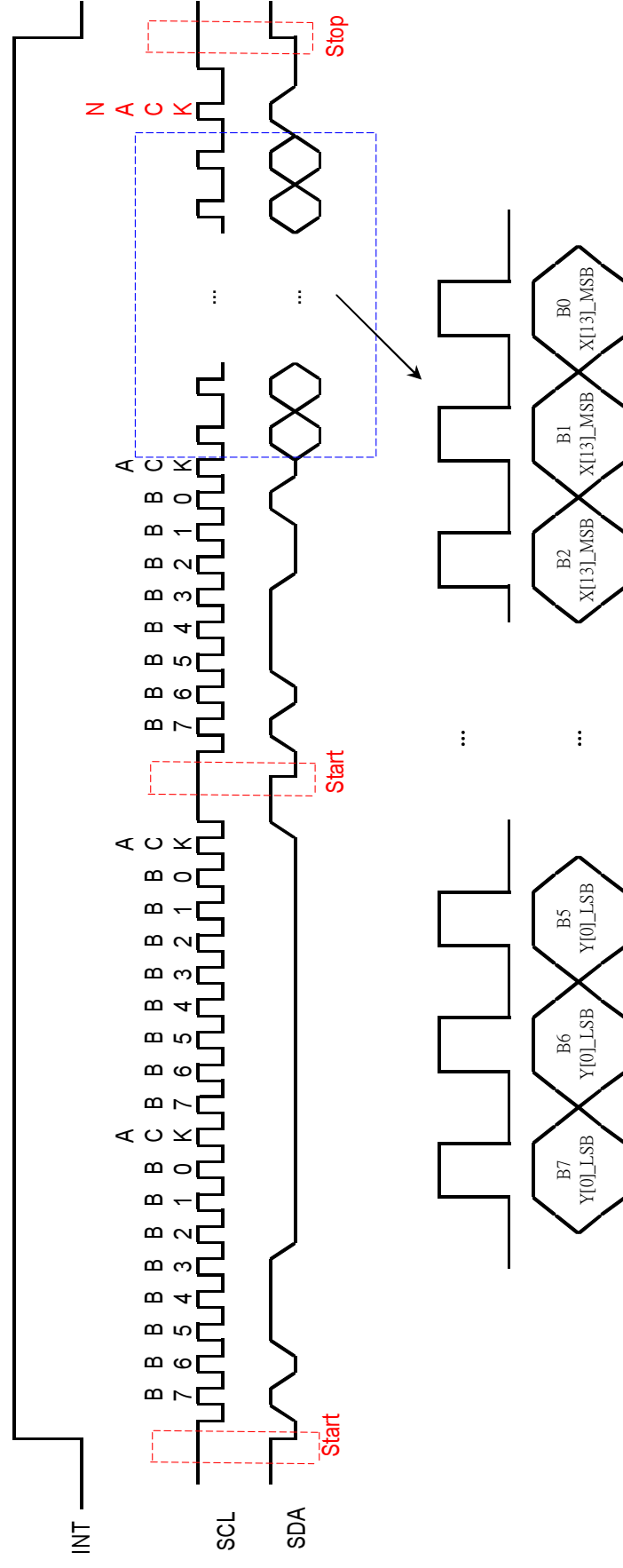


Figure 9: Touch Indicate Mode

Combination interrupt with I2C sequential read raw data operation for as following (for INT_MODE[1:0] = [1,0])



7. Power Mode

| Addr. | Addr.(HEX) | Description | R/W | B7 | B7 | B7 | B7 | B7 | B7 | B7 | B7 |
|-------|------------|-------------|-----|----------------|----------------|----------------|----------------|----|-------------|---------------|---------------|
| 777 | 77 | Power Mode | R/W | IDLE_PERIOD[7] | IDLE_PERIOD[7] | IDLE_PERIOD[7] | IDLE_PERIOD[7] | 7 | ALLOW_SLEEP | POWER_MODE[7] | POWER_MODE[7] |

The capacitive sensor controller support 3 steps of power saving: Active, Sleep, Deep Sleep, the following section describe relative scan rate and power consumption:

Active Mode:

The scan speed will reach 60Hz, this mode makes full-speed sensing and data process to provide best performance. the Power Mode is '0'.

Sleep Mode:

This mode will lower the scan speed down to 10Hz. Active Mode can enter sleep mode automatically or by command. When the system issues a command to change power mode to '1', the scan rate will switch to 10Hz at next scan cycle. When allow_sleep parameter is given, and user don't touch the screen longer than IDLE_PERIOD ms. the controller should also enter sleep mode directly and change the scan rate to 10 Hz immediately.

When user touches the screen in active region, the controller should return to Active mode. besides, when system assert a command to change the power mode to '0', the scan rate should also rise to 60Hz

Deep Sleep Mode:

When the chip enter deep sleep mode, all scan circuit should be shutdown to achieve minimum power consumption. When the chip enter deep sleep mode, all the registers are still accessible. The only way to leave/enter deep sleep mode is change the power mode by specific command. The power mode is defined as '2'

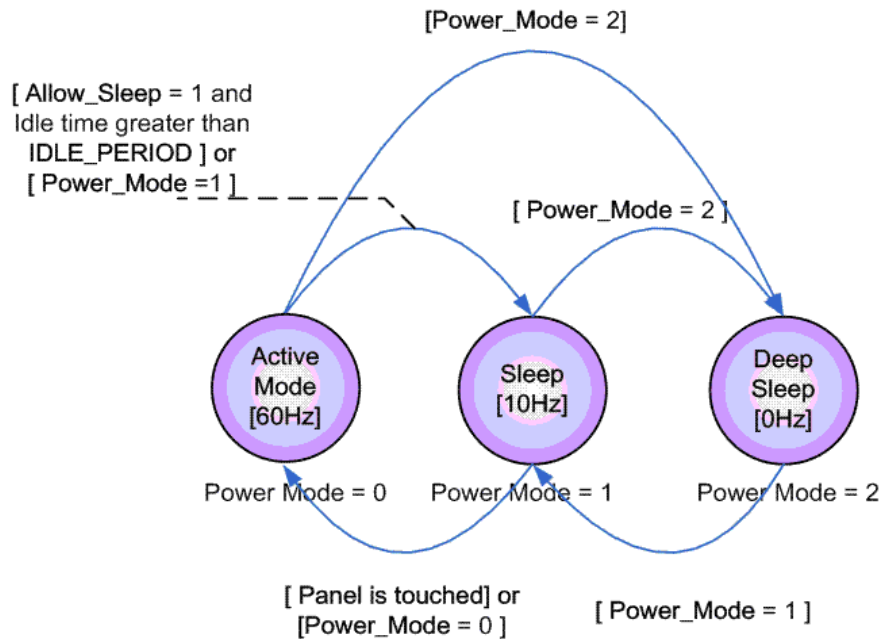
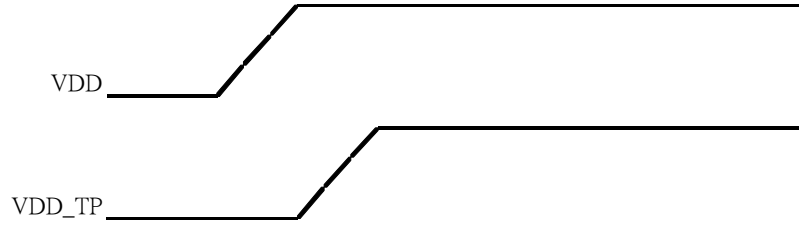


Figure 7.10. Power Mode Diagram

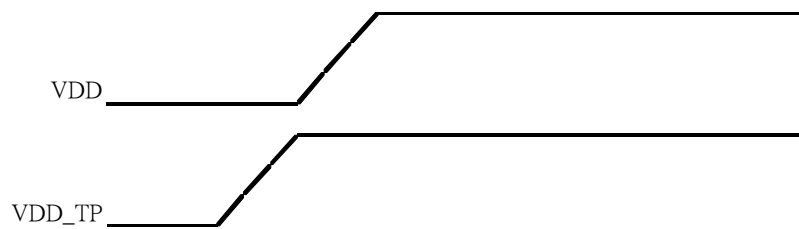
8. Power on/off Sequence (both have two cases)

- Power on Sequence

Case1:

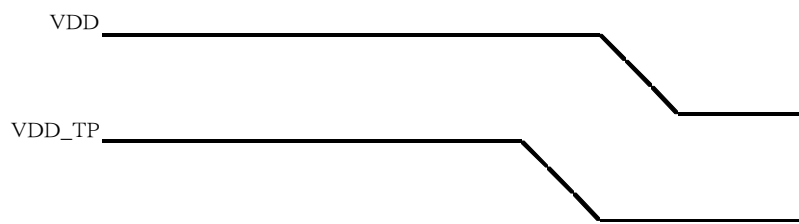


Case2:

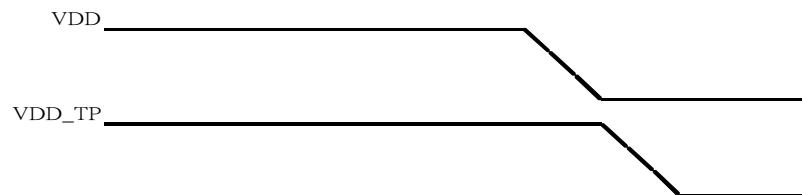


- Power off Sequences

Case1:



Case2:



D. Optical Specification (Note1, Note 2 and Note 3)

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Remark |
|----------------|--------------|----------------------------|------------------|------|------|-------------------|----------|
| Response Time | | | | | | | |
| Rise | T_r | $\theta=0^\circ$ | -- | 15 | 30 | ms | Note 4 |
| Fall | T_f | | -- | 30 | 50 | ms | |
| Contrast ratio | CR | At optimized viewing angle | 600 | 800 | -- | | Note 5,6 |
| Viewing Angle | | | | | | | |
| Top | Φ_T | $CR \geq 10$ | 70 | 80 | -- | deg. | Note 7 |
| Bottom | Φ_B | | 70 | 80 | -- | | |
| Left | Φ_L | | 70 | 80 | -- | | |
| Right | Φ_R | | 70 | 80 | -- | | |
| Brightness | Y_L | $\theta=0^\circ$ | 250 | 315 | -- | cd/m ² | Note 8 |
| Chromaticity | White | X | $\theta=0^\circ$ | 0.26 | 0.31 | 0.36 | |
| | | Y | $\theta=0^\circ$ | 0.28 | 0.33 | 0.38 | |
| | Red | X | $\theta=0^\circ$ | 0.52 | 0.57 | 0.62 | |
| | | Y | $\theta=0^\circ$ | 0.29 | 0.34 | 0.39 | |
| | Green | X | $\theta=0^\circ$ | 0.27 | 0.32 | 0.37 | |
| | | Y | $\theta=0^\circ$ | 0.52 | 0.57 | 0.62 | |
| | Blue | X | $\theta=0^\circ$ | 0.12 | 0.17 | 0.22 | |
| | | Y | $\theta=0^\circ$ | 0.04 | 0.09 | 0.14 | |
| Uniformity | ΔY_L | % | 70 | 75 | -- | % | Note 9 |

Note 1. Ambient temperature =25℃.

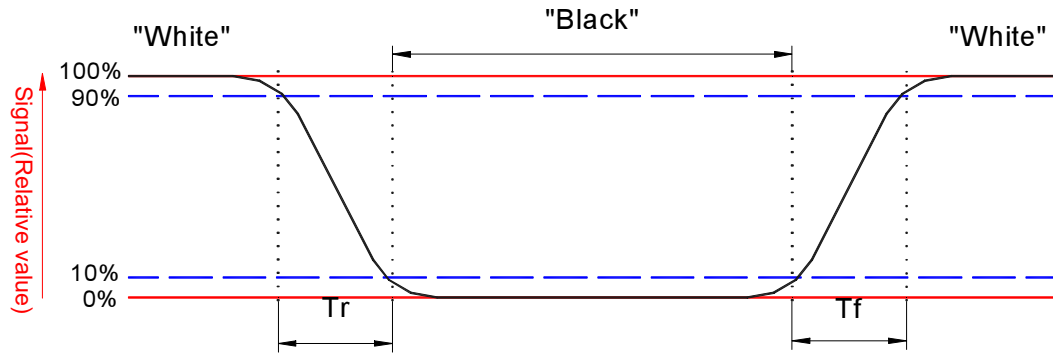
Note 2. To be measured in the dark room.

Note 3.To be measured on the center area of panel with a field angle of 1°by Topcon luminance meter BM-5A, after 10 minutes operation.

Note 4. Definition of response time:

The output signals of photo detector are measured when the input signals are changed from “black” to “white”(falling time) and from “white” to “black”(rising time), respectively.

The response time is defined as the time interval between the 10% and 90% of amplitudes. Refer to figure as below.



Note 5. Definition of contrast ratio:

Contrast ratio is calculated with the following formula.

$$\text{Contrast ratio (CR)} = \frac{\text{Photo detector output when LCD is at "White" state}}{\text{Photo detector output when LCD is at "Black" state}}$$

Note 6. White $V_i = V_{i50} + 1.5V$

Black $V_i = V_{i50} \pm 2.0V$

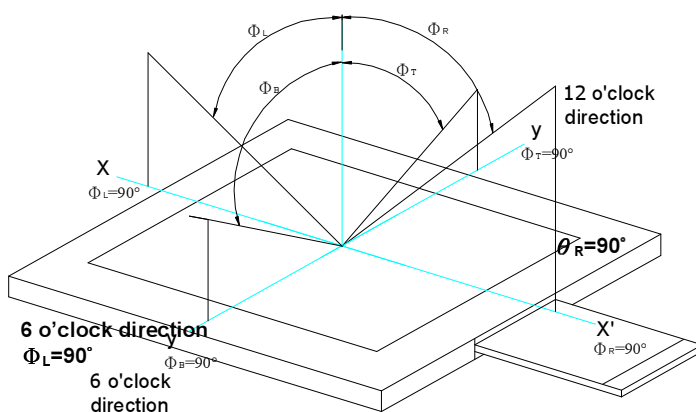
" \pm " Means that the analog input signal swings in phase with COM signal.

" $+$ " Means that the analog input signal swings out of phase with COM signal.

V_{i50} : The analog input voltage when transmission is 50%

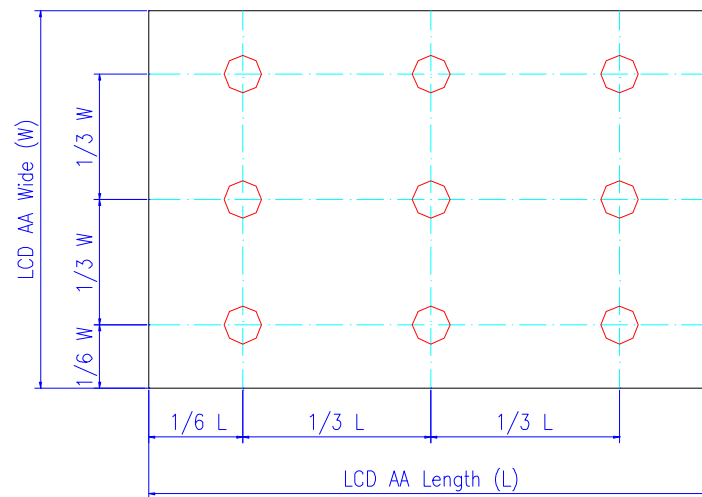
The 100% transmission is defined as the transmission of LCD panel when all the input terminals of module are electrically opened.

Note 7. Definition of viewing angle, ϕ , Refer to figure as below.



Note 8. Measured at the center area of the panel in gray level 255

Note 9. Luminance Uniformity of these 9 points is defined as below:



$$\text{Uniformity} = \frac{\text{minimum luminance in 9 points (1-9)}}{\text{maximum luminance in 9 points (1-9)}}$$

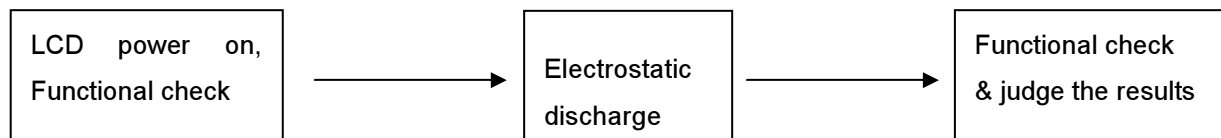
E. Reliability Test Items

| No. | Test items | Conditions | Remark |
|-----|----------------------------------|--|--|
| 1 | High Temperature Storage | Ta= 70℃ 240Hrs | |
| 2 | Low Temperature Storage | Ta= -25℃ 240Hrs | |
| 3 | High Ttemperature Operation | Tp= 60℃ 240Hrs | |
| 4 | Low Temperature Operation | Ta= -10℃ 240Hrs | Note 2 |
| 5 | High Temperature & High Humidity | Tp= 60℃ . 90% RH 240Hrs | Operation |
| 6 | Heat Shock | -25℃~80℃ , 50 cycle, 2Hrs/cycle | Non-operation |
| 7 | Electrostatic Discharge | Air-mode : +/- 8kV Contact-mode : +/- 4kV | Note 3,4 |
| 8 | Vibration | Frequency range : 10~55Hz Stoke : 1.5mm Sweep : 10~55Hz~10Hz 2 hours for each direction of X,Y,Z (6 hours for total) | Non-operation JIS C7021, A-10 condition A |
| 10 | Mechanical Shock | 100G . 6ms, ±X,±Y,±Z 3 times for each direction | Non-operation JIS C7021, A-7 condition C |
| 11 | Vibration (With Carton) | Random vibration: 0.015G ² /Hz from 5~200Hz -6dB/Octave from 200~500Hz | IEC 68-34 |
| 12 | Drop (With Carton) | Height: 60cm 1 corner, 3 edges, 6 surfaces | |

Note 1. Ta: Ambient temperature.

Note.2. Judged by the on/off testing results of AUO's standard w/o functional fail.

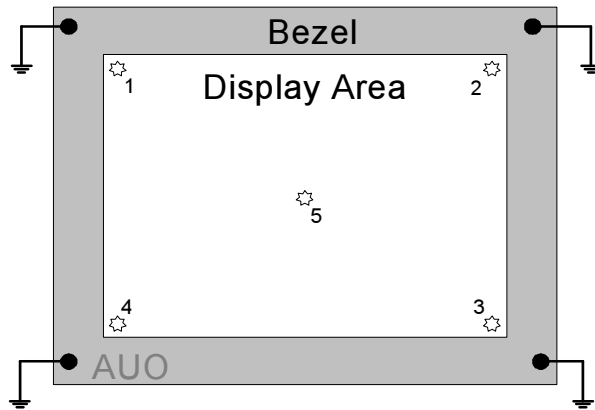
Note 3. ESD Testing Flow as the below,



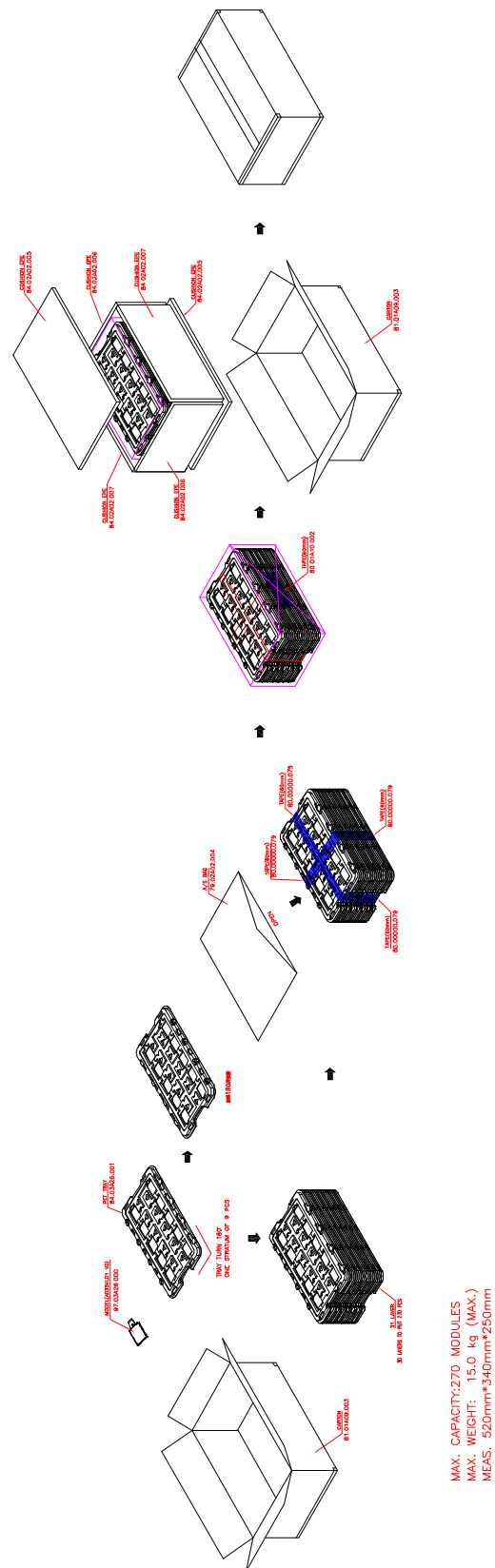
Note 4. ESD testing method.

1. Ambient: 24~26℃, 56~65%RH

2. Instruments: Noiseken ESS-2000,
3. Operation System: "CX40FL-B"
4. Test Mode: Operating mode, test pattern: colorbar+8Gray scale
5. Test Method:
 - a. Contact Discharge: 150pF(330Ω) 1sec, 5 points, 10 times/point
 - b. Air Discharge: 150pF(330Ω) 1sec, 5 points, 10 times/point
6. Test point:

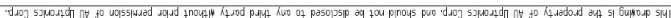


7. The metal casing is connected to power supply ground (0V) at four corners.
8. All register commands are repeating transfer.



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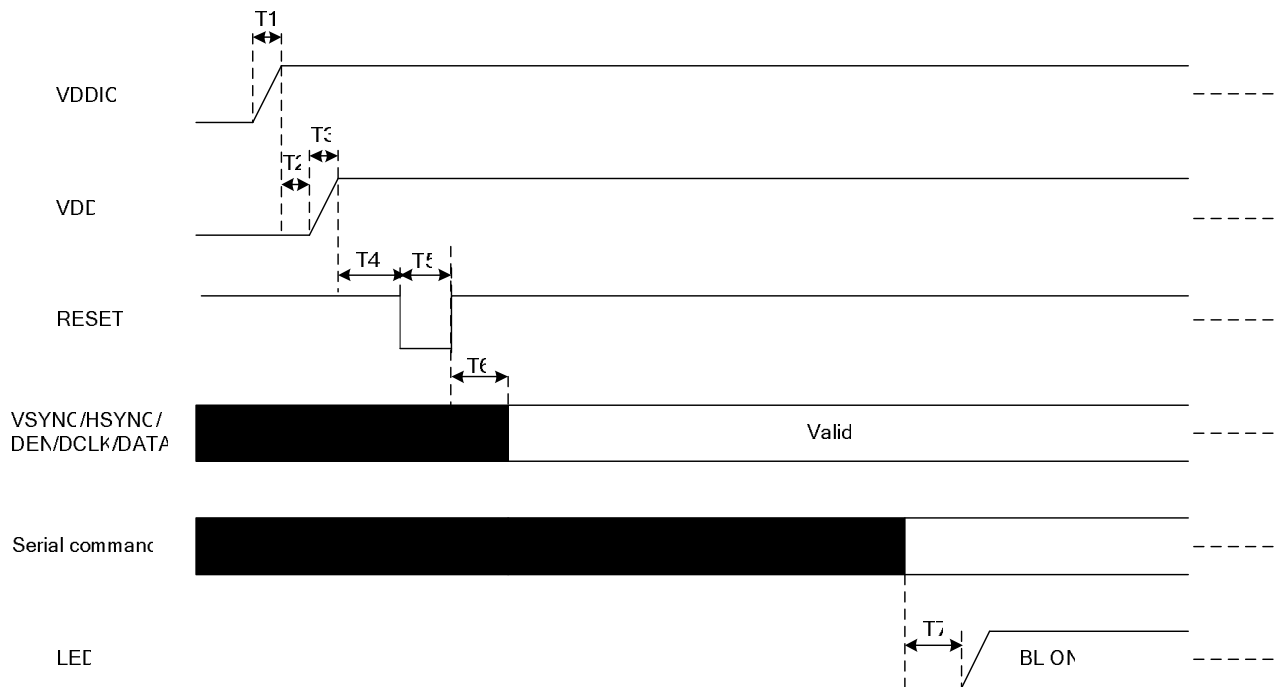
1. Application circuit



2. Power on/off sequence

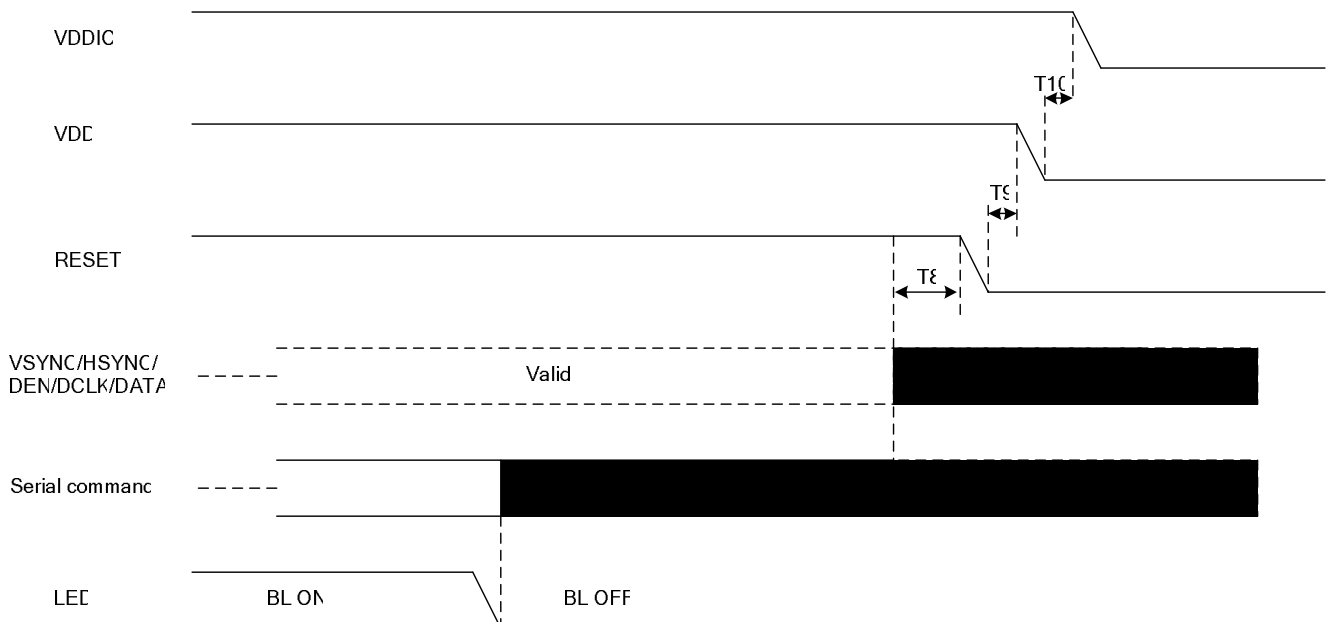
The register setting of standby mode disabling / enabling is used to control the build-in power on / off sequence.

2.1 Power on (Standby Disabling)



Note: $0\text{us} < T_1 < 500\text{us}$; $100\text{us} > T_2 \geq 0\text{us}$; $0\text{us} < T_3 < 500\text{us}$; $T_4 \geq 5\text{ms}$; $T_5 \geq 50\text{us}$; $T_6 \geq 120\text{ms}$; $T_7 \geq 120\text{ms}$

2.2 Power off (Standby Enabling)



Note: $T_8 \geq 70\text{ms}$; $T_9 \geq 1\text{ms}$; $T_{10} \geq 1\text{ms}$

3. Recommended power on/off serial command settings

3.1 Recommended power on register setting (Just for reference,)

| Number | Command(Binary) | | Number | Command(Binary) | |
|------------|-----------------|------------------------------------|--------|-----------------|------------------------|
| 1 | 000000001 | SW reset | 31 | 100001101 | Positive gamma setting |
| WAIT 120ms | | | 32 | 100000000 | |
| 2 | 011000001 | VGH/VGL Setting | 33 | 100000100 | |
| 3 | 110101000 | | 34 | 100001001 | |
| 4 | 110110001 | | 35 | 100010011 | |
| 5 | 101000101 | | 36 | 100010100 | |
| 6 | 100000100 | | 37 | 100101011 | |
| 7 | 011000101 | VCOMDC | 38 | 100100110 | |
| 8 | 110000000 | | 39 | 100100011 | |
| 9 | 101101000 | | 40 | 011100001 | Negative gamma setting |
| 10 | 011000110 | GVDD/GVSS | 41 | 100000000 | |
| 11 | 110111101 | | 42 | 100000110 | |
| 12 | 110000100 | | 43 | 100001011 | |
| 13 | 011000111 | NGVDD/NGVSS | 44 | 100001101 | |
| 14 | 110111101 | | 45 | 100001111 | |
| 15 | 110000100 | | 46 | 100010011 | |
| 16 | 000010001 | Sleep out | 47 | 100001101 | |
| WAIT 120ms | | | 48 | 100001101 | |
| 17 | 011110010 | Gamma setting follow 26h, E0h, E1h | 49 | 100000000 | |
| 18 | 100000000 | | 50 | 100000100 | |
| 19 | 100000000 | | 51 | 100001001 | |
| 20 | 110000010 | | 52 | 100010011 | |
| 21 | 000100110 | Enable gamma setting | 53 | 100010100 | |
| 22 | 100001000 | | 54 | 100101011 | |
| 23 | 011100000 | Positive gamma setting | 55 | 100100110 | |
| 24 | 100000000 | | 56 | 100100011 | |
| 25 | 100000110 | | 57 | 000100110 | Enable gamma setting |
| 26 | 100001011 | | 58 | 100001000 | Enable 2-dot function |
| 27 | 100001101 | | 59 | 011111101 | |
| 28 | 100001111 | | 60 | 100000000 | |
| 29 | 100010011 | | 61 | 100001000 | |
| 30 | 100001101 | | 62 | 000101001 | Display on |

3.2 Recommended power off register setting

| Number | Command(Binary) |
|--------|-----------------|
| 1 | 000010000 |