



深圳市华远显示器件有限公司

SHENZHEN HUAYUAN DISPLAY CO.,LTD.

液晶显示模块规格书

Specification for Liquid Crystal Display Module

HYG32024027T-FFC2L-VD

| Prepared By | Reviewed By | Approved By |
|-------------|-------------|-------------|
| Date: | Date: | Date: |



Title
HYG32024027T-FFC2L-VD
SPECIFICATION


DOC#:
Effective Date: 2010-04-10

Rev. : R00

REVISION HISTORY


The following table tracks the history of the changes made to this document.

| SN | Rev. | Content | Date | Design |
|----|------|-----------------|------------|--------|
| 1 | R00 | Origin Released | 2010-04-10 | |
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|  华远显示 H-Y DISPLAY | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

CONTENTS

| | |
|--|----|
| REVISION HISTORY | 2 |
| CONTENTS | 3 |
| 1.0 GENERAL DESCRIPTION | 4 |
| 2.0 FEATURES | 4 |
| 3.0 MECHANICAL SPECIFICATION | 4 |
| 4.0 BLOCK DIAGRAM | 5 |
| 5.0 EXTERNAL DIMENSIONS | 6 |
| 6.0 INTERFACE PIN DESCRIPTIONS | 7 |
| 7.0 ABSOLUTE MAXIMUM RATINGS | 8 |
| 8.0 ELECTRICAL CHARACTERISTICS | 8 |
| 9.0 OPTICAL CHARACTERISTICS | 9 |
| 10.0 TIMING CHARACTERICS | 11 |
| 11.0 BACKLIGHT CHARACTERISTICS | 13 |
| 12.0 OPERATING PRINCIPLES & METHODS | 14 |
| 13.0 INSTRUCTION DESCRIPTION | 18 |
| 14.0 QUALITY GUARANTEE | 38 |
| 15.0 RELIABILITY | 43 |
| 16.0 PRECAUTIONS FOR USING LCD MODULES | 44 |
| 17.0 USING LCD MODULES | 46 |
| 18.0 APPENDIX | 50 |

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

1.0 GENERAL DESCRIPTION

The [HYG32024027T-FFC2L-VD](#) is a [320x240](#) dots dot-matrix LCD module. It has a [FSTN](#) panel composed of [320](#) segments and [240](#) commons. The LCM can be easily accessed by microcontroller [via 8080 series](#) interface.

2.0 FEATURES

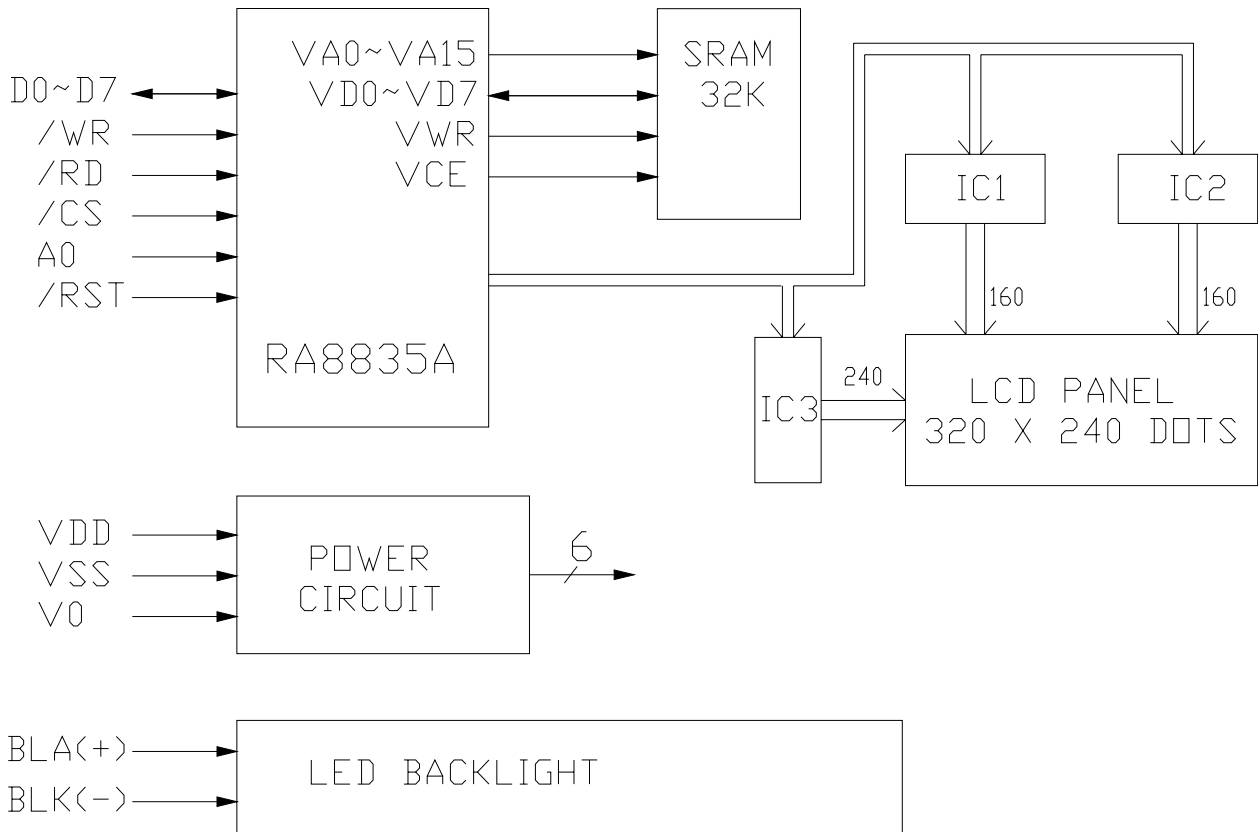
| | |
|-------------------|--|
| Display Format | 320 x 240 dots |
| LCD Type | FSTN-POSITIVE |
| Polarizer Mode | TRANSFLECTIVE |
| Drive Method | 1/240 Duty, 1/16 Bias |
| Viewing Direction | 12 O'clock |
| Controller | RA8835AP3N |
| Interface | 8080 Series 8-Bit Parallel Interface |
| Backlight | White LED Backlight |

3.0 MECHANICAL SPECIFICATION

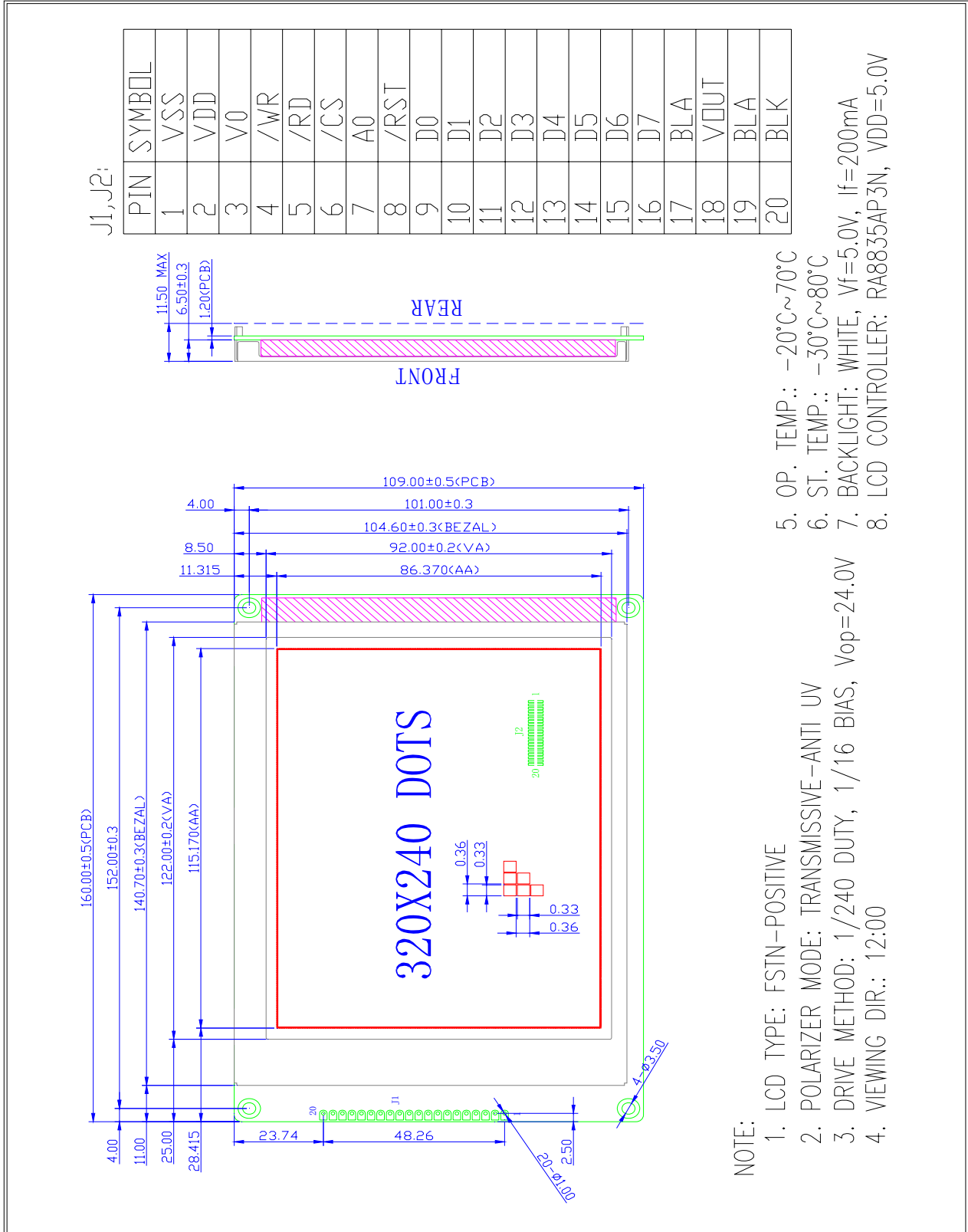
| Item | Description | Unit |
|------------------|--|------|
| Module Dimension | 160.0(W) × 109.0(H) × 11.5(Max)(T) | mm |
| Viewing Area | 122.0(W) × 92.0(H) | mm |
| Active Area | 115.17(W) × 86.37(H) | mm |
| Dot Size | 0.33(W) × 0.33(H) | mm |
| Dot Pitch | 0.36(W) × 0.36(H) | mm |
| Character Size | —— | mm |



4.0 BLOCK DIAGRAM



5.0 EXTERNAL DIMENSIONS





| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

6.0 INTERFACE PIN DESCRIPTIONS

| PIN No. | Symbol | Level | Description |
|---------|-----------------|-------|--|
| 1 | V _{SS} | P | Ground |
| 2 | V _{DD} | P | Power supply for logic(+5.0V) |
| 3 | V ₀ | P | Power supply for LCD |
| 4 | /WR | H/L | Write Control. This signal acts as the active-LOW write strobe. The bus data is latched on the rising edge of this signal. |
| 5 | /RD | H/L | Read Control. This signal acts as the active-LOW read strobe. The output buffers are enabled when this signal is active. |
| 6 | /CS | H/L | Chip Select. This active-LOW input enables the RA8835A series. |
| 7 | A0 | H/L | Command/Data Select. A0=0 : Display data and parameter A0=1 : Command |
| 8 | /RST | H/L | Hardware Reset. This active-LOW input performs a hardware reset. |
| 9 | D0 | H/L | Data bit 0 |
| 10 | D1 | H/L | Data bit 1 |
| 11 | D2 | H/L | Data bit 2 |
| 12 | D3 | H/L | Data bit 3 |
| 13 | D4 | H/L | Data bit 4 |
| 14 | D5 | H/L | Data bit 5 |
| 15 | D6 | H/L | Data bit 6 |
| 16 | D7 | H/L | Data bit 7 |
| 17 | BLA | P | Power supply for LED Backlight (+5.0V) |
| 18 | VOUT | P | Built-in Booster Positive Voltage Output |
| 19 | BLA | P | Power supply for LED Backlight (+5.0V) |
| 20 | BLK | P | Power supply for LED Backlight (0V) |



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|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

7.0 ABSOLUTE MAXIMUM RATINGS

| Item | Symbol | Min. | Max. | Unit |
|------------------------|----------|------|--------------|------|
| Supply Voltage (Logic) | V_{DD} | -0.3 | 7.0 | V |
| Supply Voltage (LCD) | V0 | -- | 27.0 | V |
| Input Voltage | V_I | -0.3 | $V_{DD}+0.3$ | V |
| Operating Temperature | Topr | -20 | 70 | °C |
| Storage Temperature | Tstg | -30 | 80 | °C |

8.0 ELECTRICAL CHARACTERISTICS

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|--------------------------|-----------|------------------------------------|--------------|------|-------------|------|
| Supply voltage for Logic | V_{DD} | -- | 4.8 | 5.0 | 5.2 | V |
| LCD Operating Voltage | V0 | -20°C | | | | V |
| | | +25°C | 23.8 | 24.0 | 24.2 | V |
| | | +70°C | | | | V |
| Input voltage H level | V_{IHC} | See note 1,2 | $0.5V_{DD}$ | --- | V_{DD} | V |
| Input voltage L level | V_{ILC} | See note 1,2 | V_{SS} | --- | $0.2V_{DD}$ | V |
| Output High Voltage | V_{OHC} | $I_{OH}= 4.0$ mA. See note 1, 2 | $V_{DD}-0.3$ | --- | V_{DD} | V |
| Output Low Voltage | V_{OLC} | $I_{OL}= -2$ mA. See note 1, 2 | 0 | --- | 0.3 | V |
| Operating supply current | I_{OPR} | See note 3 | — | 3.5 | 8 | mA |

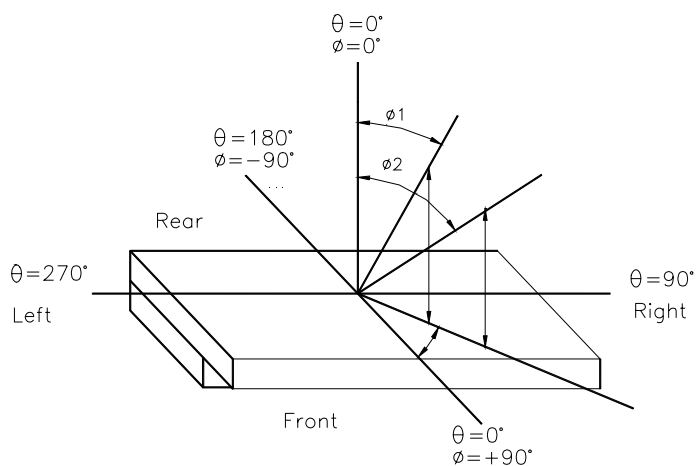
Notes:

1. /CS, /RD, /WR, A0 are inputs.
2. D0 to D7 are Bi-direction.
3. fOSC = 10 MHz, no load (no display memory), internal character generator, 256x 200 pixel display. The operating supply current can be reduced by approximately 1mA by setting both CLO and the display OFF.

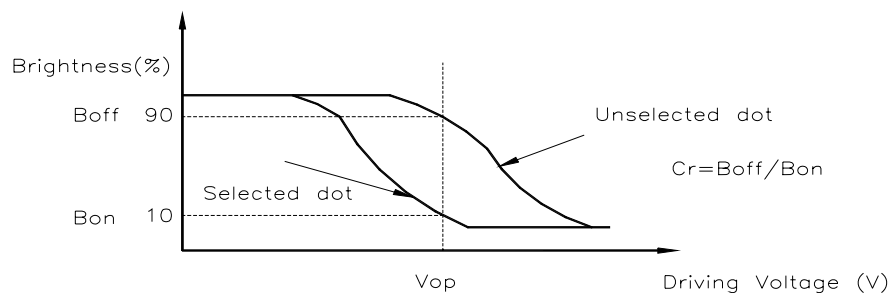
9.0 OPTICAL CHARACTERISTICS

| Item | Symbol | Condition | Min | Typ | Max | Unit |
|-----------------|----------|--|---|-----|-----|------|
| Response time | Ton | $\theta=0^\circ$ and $T_a=-20^\circ\text{C}$ | | -- | | ms |
| | | $\theta=0^\circ$ and $T_a=+25^\circ\text{C}$ | | -- | | ms |
| | | $\theta=0^\circ$ and $T_a=+70^\circ\text{C}$ | | -- | | ms |
| | Toff | $\theta=0^\circ$ and $T_a=-20^\circ\text{C}$ | | -- | | ms |
| | | $\theta=0^\circ$ and $T_a=+25^\circ\text{C}$ | | -- | | ms |
| | | $\theta=0^\circ$ and $T_a=+70^\circ\text{C}$ | | -- | | ms |
| Contrast ration | CR(MAX) | $T_a=25^\circ\text{C}$ | 5 | 10 | | --- |
| Viewing Angle | θ | Deg $\theta=0^\circ$ | CR \geq 2.0 $T_a=25^\circ\text{C}$ | 50 | | Deg |
| | | Deg $\theta=90^\circ$ | | 35 | | |
| | | Deg $\theta=180^\circ$ | | 30 | | |
| | | Deg $\theta=270^\circ$ | | 35 | | |
| Crosstalk | | $T_a=25^\circ\text{C}$ | | 1.2 | | --- |

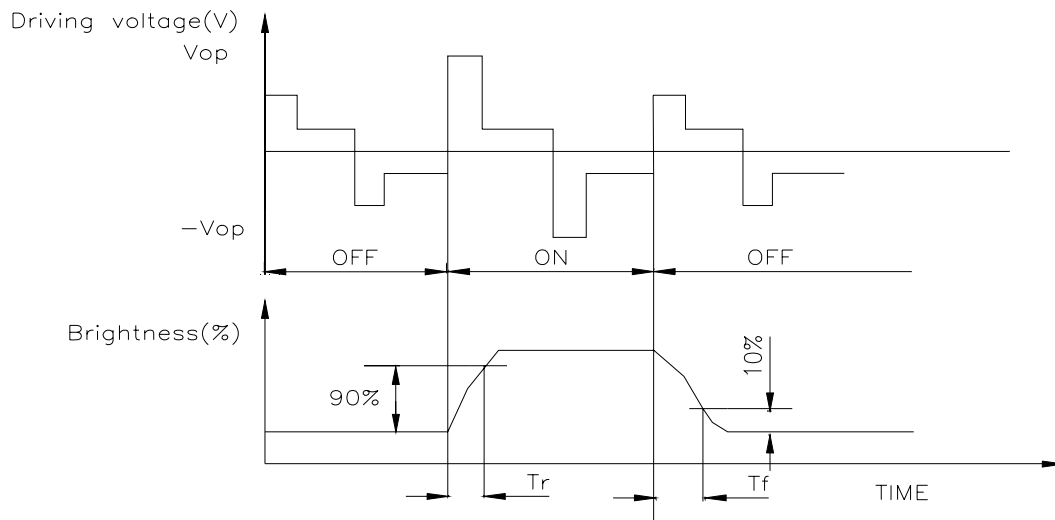
9.1 Viewing Angle θ , θ and Viewing Angle Range: $\Delta\theta = |\theta_2 - \theta_1|$



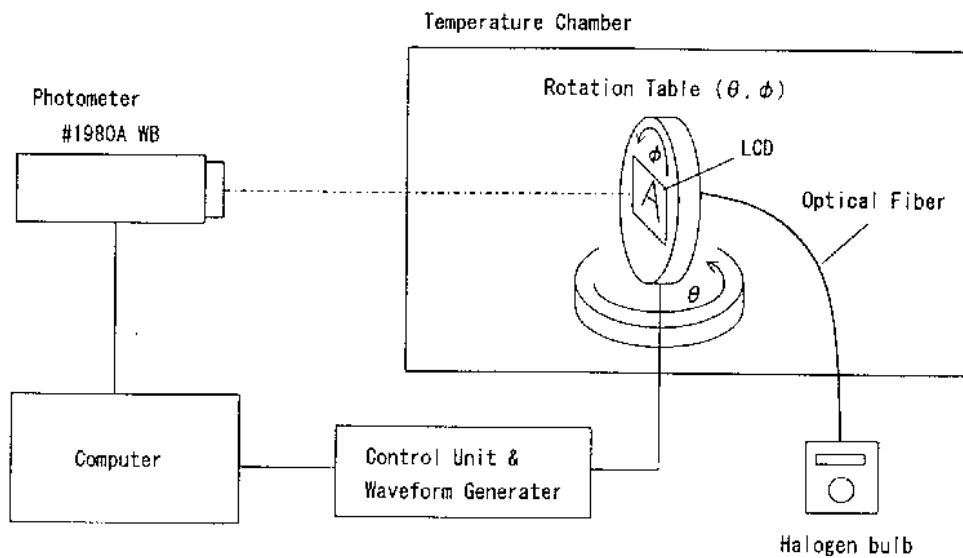
9.2 Contrast ratio(CR)



9.3 Response Time



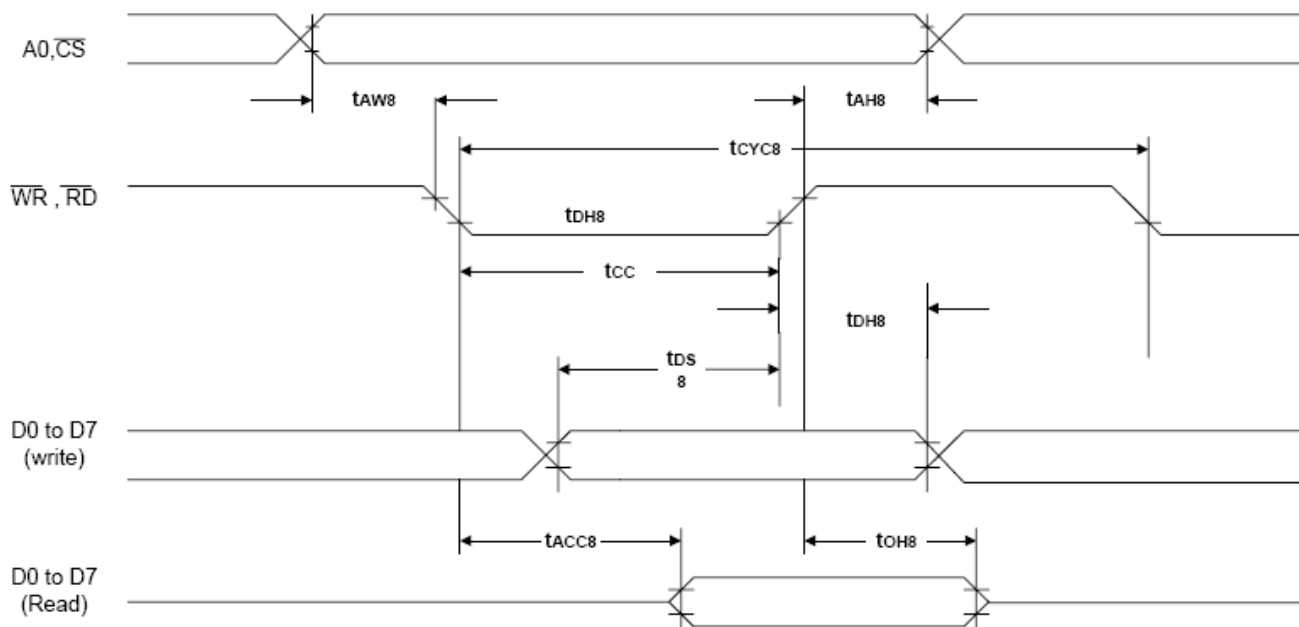
9.4 Optical Measurement System





10.0 TIMING CHARACTERICS

10.1 8080 Family Interface Timing



| Signal | Symbol | Parameter | Min. | Max. | Conditions | Unit |
|----------|--------|---------------------|-------|------|------------|------|
| A0,CS | tAW8 | Address setup time | 10 | — | CL = 100pF | ns |
| | tAH8 | Address hold time | 0 | — | | |
| /WR,/RD | tCYC8 | System cycle time | Note. | — | | |
| | tCC | Strobe pulse width | 120 | — | | |
| D0 to D7 | tDS8 | Data setup time | 120 | — | | |
| | tDH8 | Data hold time | 5 | — | | |
| | tACC8 | RD access time | — | 50 | | |
| | tOH8 | Output disable time | 10 | 50 | | |

Note :

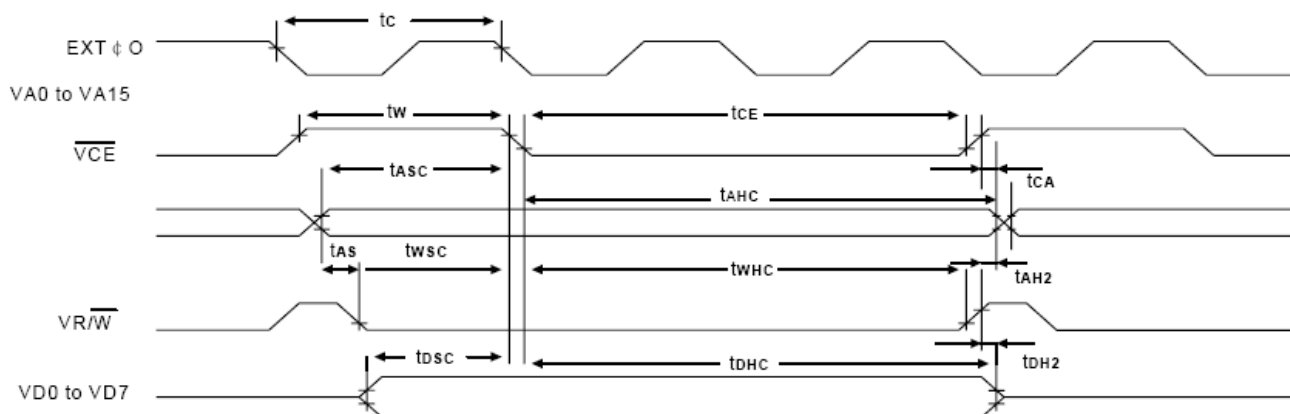
For memory control and system control commands:

$$tCYC8 = 2tC + tCC + tCEA + 75 > tACV + 245$$

For all other commands:

$$tCYC8 = 4tC + tCC + 30$$

10.2 Display Memory Write Timing



| Signal | Symbol | Parameter | Min. | Max. | Unit | Condition |
|-------------|--------|---|----------|------|------|-------------|
| EXT Φ0 | tC | Clock period | 55.5 | — | ns | |
| VCE | tW | VCE HIGH-level pulse width | tC – 50 | — | ns | CL = 100 pF |
| | tCE | VCE LOW-level pulse width | 2tC – 30 | — | ns | |
| VA0 to VA15 | tCYW | Write cycle time | 3tC | — | ns | |
| | tAHC | Address hold time from falling edge of VCE | 2tC – 30 | — | ns | |
| | tASC | Address setup time to falling edge of VCE | tC – 70 | — | ns | |
| | tCA | Address hold time from rising edge of VCE | 0 | — | ns | |
| | tAS | Address setup time to falling edge of VWR | 0 | — | ns | |
| | tAH2 | Address hold time from rising edge of VWR | 10 | — | ns | |
| VWR | tWSC | Write setup time to falling edge of VCE | tC – 80 | — | ns | |
| | tWHC | Write hold time from falling edge of VCE | 2tC – 20 | — | ns | |
| | tDSC | Data input setup time to falling edge of VCE | tC – 85 | — | ns | |
| VD0 to VD7 | tDHC | Data input hold time from falling edge of VCE | 2tC – 30 | — | ns | |
| | tDH2 | Data hold time from rising edge of VWR | 5 | 50 | ns | |



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|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

11.0 BACKLIGHT CHARACTERISTICS

11.1 ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

| Item | Symbol | Condition | Rating | Unit |
|----------------------------------|--------|-----------|---------|------|
| Reverse Voltage | Vr | | 5 | V |
| Absolute maximum forward current | Ifm | | 200 | mA |
| Forward Current | If | Vf=5.0V | 180 | mA |
| Power Description | Pd | | 540 | mW |
| Operating temperature range | Topr | | -20~+70 | °C |
| Storage temperature range | Tst | | -30~+80 | °C |

11.2 ELECTRICAL/OPTICAL CHARACTERISTICS

(Ta=25°C)

| Item | Symbol | Min | Typ | Max | Unit | Condition |
|--------------------------|------------------|-----|-------|-----|-------------------|-----------|
| Forward Voltage | Vf | 4.8 | 5.0 | 5.1 | V | If=180mA |
| Reverse Current | Ir | | 90 | | uA | Vr=5 V |
| Dominant wave length | λ_p | | -- | | nm | If=180mA |
| Spectral Line Half width | $\Delta \lambda$ | | -- | | | If=180 mA |
| Luminance | Lv | | -- | | cd/m ² | If=180 mA |
| Color Coordinate | X | | WHITE | | | If=180 mA |
| | Y | | | | | |

12.0 OPERATING PRINCIPLES & METHODS

12.1 RESET

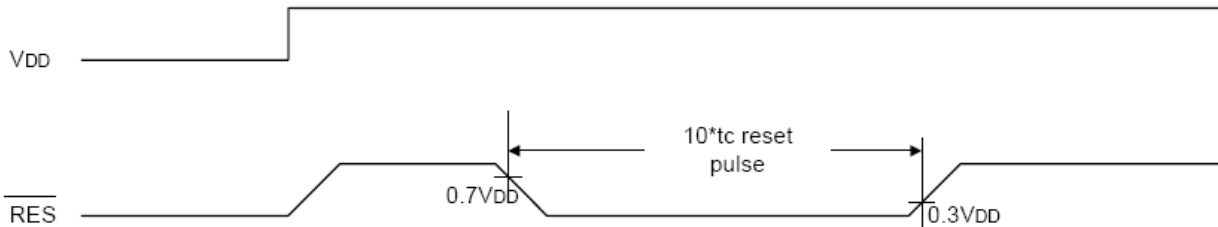


Figure 12-1 Reset Timing

The RA8835A series requires a reset pulse at least $10 \cdot t_c$ long after power-on in order to re-initialize its internal state. If the oscillator frequency is 10Mhz, then the Reset pulse is at least $1\mu s$. For maximum reliability, it is not recommended to apply a DC voltage to the LCD panel while the RA8835A series is reset. Turn off the LCD power supplies for at least one frame period after the start of the reset pulse.

The RA8835A series cannot receive commands while it is reset. Commands to initialize the internal registers should be issued soon after a reset. During reset, the LCD drive signals XD, LP and FR are halted. A delay of 3 ms (maximum) is required following the rising edges of both RES and VDD to allow for system stabilization.

12.2 RESET

Status Flag

The RA8835A series has a single bit status flag.

D6: X line standby

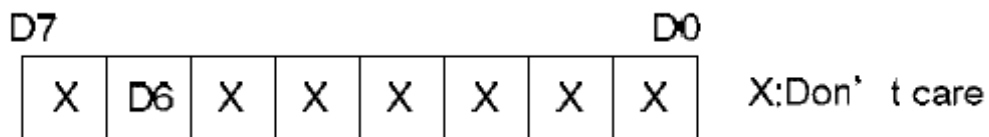


Figure 12-2 Status Flag

The D6 status flag is HIGH for the TC/R-C/R cycles at the end of each line where the RA8835A series is not reading the display memory. The microprocessor may use this period to update display memory without affecting the display, however it is recommended that the display be turned off when refreshing the whole display.

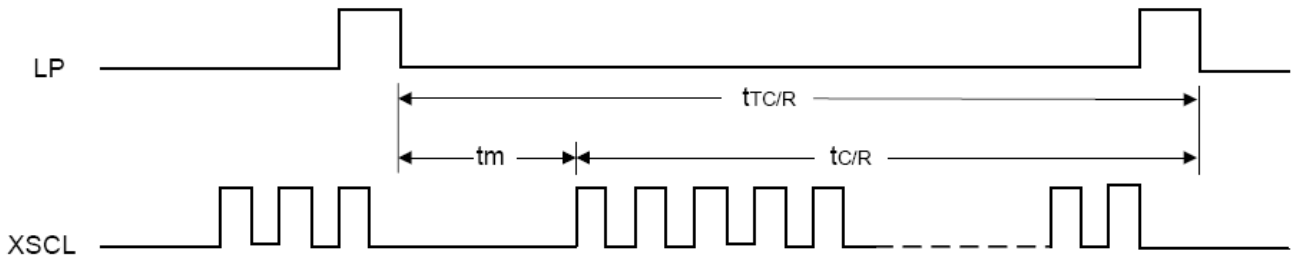


Figure 12-3 C/R to TC/R Time Difference

| CS | A0 | RD | D6(flag) |
|----|----|----|--|
| 0 | 0 | 0 | 0: Period of retrace lines 1: Period of display |

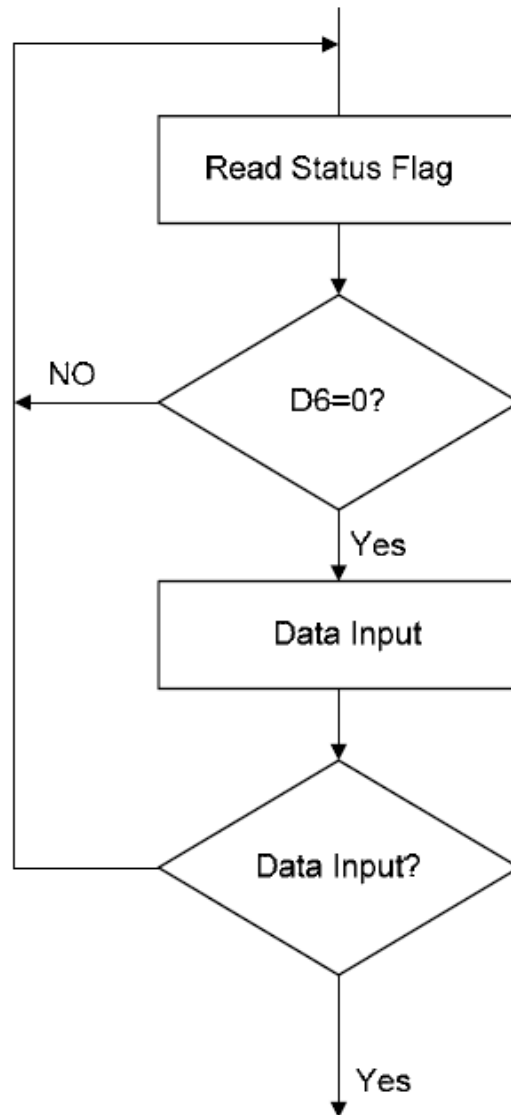


Figure 13-4 Flowchart for Busy Flag Checking

12.3 Display Address Scanning

The RA8835A series scans the display memory in the same way as a raster scan CRT screen. Each row is scanned from left to right until the address range equals C/R. Rows are scanned from top to bottom.

In graphics mode, at the start of each line, the address counter is set to the address at the start of the previous line plus the address pitch, AP.

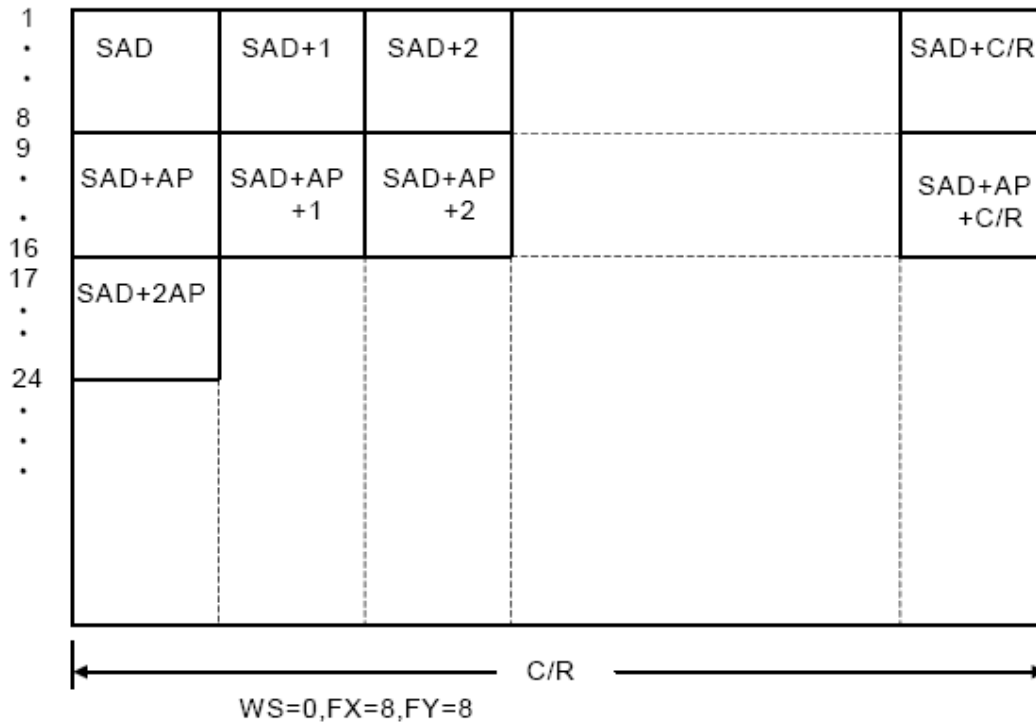


Figure 13-5 Character Position Parameters

Note: One byte of display memory corresponds to one character.

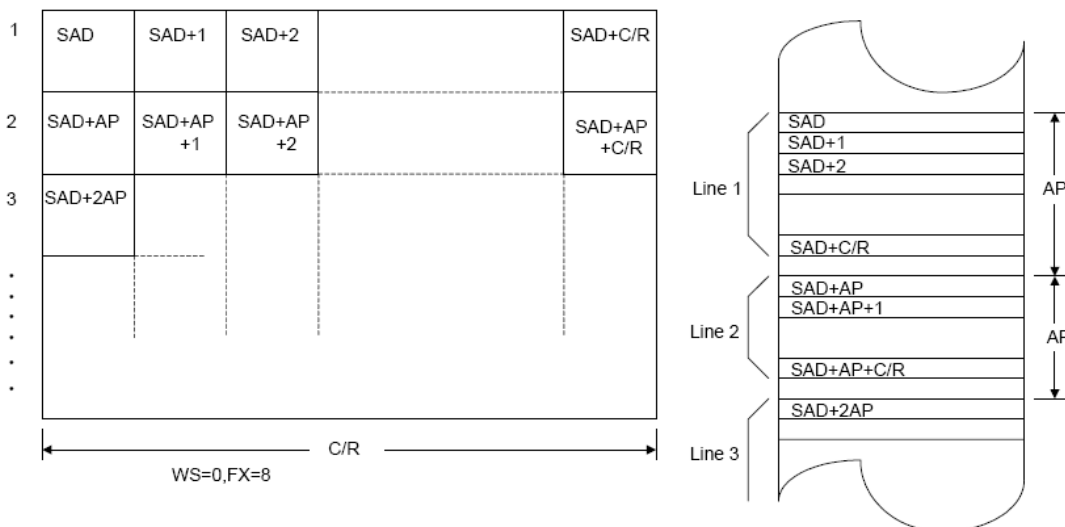


Figure 13-5 Character Parameters vs. Memory

Note: One bit of display memory corresponds to one pixel.



In text mode, the address counter is set to the same start address, and the same character data is read, for each row in the character bitmap. However, a new row of the character generator output is used each time. Once all the rows in the character bitmap have been displayed, the address counter is set to the start address plus AP and the next line of text is displayed.

12.4 On-chip character set

| | | Character code bits 0 to 3 | | | | | | | | | | | | | | | |
|----------------------------|---|----------------------------|---|---|----|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| Character code bits 4 to 7 | 2 | ! | " | # | \$ | % | & | ' | (|) | * | + | , | - | . | / | |
| | 3 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | |
| | 4 | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | |
| | 5 | P | Q | R | S | T | U | V | W | X | Y | Z | [| \ |] | ^ | |
| | 6 | ` | a | b | c | d | e | f | g | h | i | j | k | l | m | n | |
| | 7 | p | q | r | s | t | u | v | w | x | y | z | { | | } | ~ | |
| | A | | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | | |
| | C | | | | | | | | | | | | | | | | |
| | D | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | |



13.0 INSTRUCTION DESCRIPTION

13.1 INSTRUCTION TABLE

| Class | Command | Code | | | | | | | | | | | | Command Description | No. of Para. |
|-----------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|-------------|----------|---|--------------|
| | | R D | W R | A 0 | D 7 | D 6 | D 5 | D 4 | D 3 | D 2 | D 1 | D 0 | HEX | | |
| System Control | SYSTEM SET | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | Initialize device and display | 8 |
| | SLEEP IN | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 53 | Enter standby mode | 0 |
| Display Control | DISPLAY ON/OFF | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | D | 58, 59 | Enable and disable display and display flashing | 1 |
| | SCROLL | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 44 | Set display start address and display regions | 10 |
| | CSRFORM | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 5D | Set cursor type | 2 |
| | CGRAM ADR | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 5C | Set start address of character generator RAM | 2 |
| | CSRDIR | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | C D 1 | C D 0 | 4C to 4F | Set direction of cursor movement | 0 |
| | HDOT SCR | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 5A | Set horizontal scroll position | 1 |
| | OVLAY | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 5B | Set display overlay format | 1 |
| Drawing Control | CSRW | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 46 | Set cursor address | 2 |
| | CSRR | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 47 | Read cursor address | 2 |
| Memory Control | MWRITE | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 42 | Write to display memory | — |
| | MREAD | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 43 | Read from display memory | — |



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|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

13.2 SYSTEM CONTROL COMMAND

13.2.1 SYSTEM SET

Initializes the device, sets the window sizes, and selects the LCD interface format. Since this command sets the basic operating parameters of the RA8835A series, an incorrect SYSTEM SET command may cause other commands to operate incorrectly.

| | MSB | | | | | | | | LSB | | |
|----|----------|----|----|----|--------|--------|----|----|-----|-----------------|-----------------|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | A0 | \overline{WR} | \overline{RD} |
| C | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| P1 | 0 | 0 | IV | 1 | W/S | M2 | M1 | M0 | 0 | 0 | 1 |
| P2 | WF | 0 | 0 | 0 | 0 | ← FX → | | | 0 | 0 | 1 |
| P3 | 0 | 0 | 0 | 0 | ← FY → | | | | 0 | 0 | 1 |
| P4 | ← C/R → | | | | | | | | 0 | 0 | 1 |
| P5 | ← TC/R → | | | | | | | | 0 | 0 | 1 |
| P6 | ← L/F → | | | | | | | | 0 | 0 | 1 |
| P7 | ← APL → | | | | | | | | 0 | 0 | 1 |
| P8 | ← APH → | | | | | | | | 0 | 0 | 1 |

13.2.1.1 C

This control byte performs the following:

1. Resets the internal timing generator
2. Disables the display
3. Cancels sleep mode

Parameters following P1 are not needed if only canceling sleep mode.



13.2.1.2 M0

Select the internal or external character generator ROM. The internal character generator ROM contains 160, 5 X 7 pixel characters. These characters are fixed at fabrication by the metallization mask.

The external character generator ROM, on the other hand, can contain up to 256 user-defined characters.

M0 = 0: Internal CG ROM

M0 = 1: External CG ROM

Note that if the CG ROM address space overlaps the display memory address space, that portion of the display memory cannot be written to.

13.2.1.3 M1

Select the memory configuration for user-definable characters. The CG RAM codes select one of the 64 codes shown in the following figure.

| Lower 4bits | Upper 4bits | | | | | | | | | | | | | | | |
|-------------|-------------|---|----|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| 0 | | | | 0 | @ | P | ' | p | | | | | | | | |
| 1 | | | ! | 1 | A | Q | a | q | | | | | | | | |
| 2 | | | " | 2 | B | R | b | r | | | | | | | | |
| 3 | | | # | 3 | C | S | c | s | | | | | | | | |
| 4 | | | \$ | 4 | D | T | d | t | | | | | | | | |
| 5 | | | & | 5 | E | U | e | u | | | | | | | | |
| 6 | | | % | 6 | F | V | f | v | | | | | | | | |
| 7 | | | , | 7 | G | W | g | w | | | | | | | | |
| 8 | | | (| 8 | H | X | h | x | | | | | | | | |
| 9 | | |) | 9 | I | Y | i | y | | | | | | | | |
| A | | | * | : | J | Z | j | z | | | | | | | | |
| B | | | + | : | K | [| k | { | | | | | | | | |
| C | | | . | < | L | ¥ | l | ! | | | | | | | | |
| D | | | . | = | M |] | m | } | | | | | | | | |
| E | | | - | > | N | ^ | n | → | | | | | | | | |
| F | | | / | ? | O | _ | o | ← | | | | | | | | |

M1 = 0: No D6 correction.

The CG RAM1 and CG RAM2 address spaces are not contiguous, the CG RAM1 address space is treated as character generator RAM, and the CG RAM2 address space is treated as character generator ROM.

M1 = 1: D6 correction.

The CG RAM1 and CG RAM2 address spaces are contiguous and are both treated as character generator RAM.

13.2.1.4 M2

Select the height of the character bitmaps. Characters more than 16 pixels high can be displayed by creating a bitmap for each portion of each character and using the RA8835A series graphics mode to reposition them.

M2 = 0: 8-pixel character height (2716 or equivalent ROM)

M2 = 1: 16-pixel character height (2732 or equivalent ROM)

13.2.1.5 W/S

Select the LCD drive method.

W/S = 0: Single-panel drive (Fix to 0)

13.2.1.6 IV

Screen origin compensation for inverse display. IV is usually set to 1. The best way of displaying inverted characters is to Exclusive-OR the text layer with the graphics background layer. However, inverted characters at the top or left of the screen are difficult to read as the character origin is at the top-left of its bitmap and there are no background pixels either above or to the left of these characters.

The IV flag causes the RA8835A series to offset the text screen against the graphics back layer by one vertical pixel. Use the horizontal pixel scroll function (HDOT SCR) to shift the text screen 1 to 7 pixels to the right. All characters will then have the necessary surrounding background pixels that ensure easy reading of the inverted characters.

IV = 0: Screen top-line correction

IV = 1: No screen top-line correction

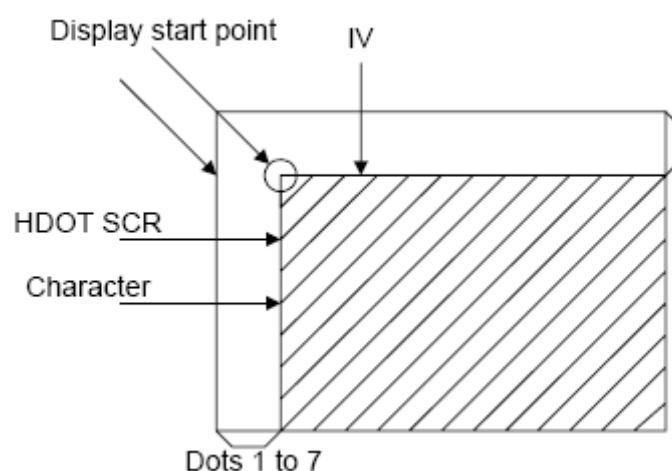


Figure 13-1: IV and HDOT SCR Adjustment

13.2.1.7 FX

Define the horizontal character size. The character width in pixels is equal to $FX + 1$, where FX can range from 00 to 07H inclusive. If data bit 3 is set (FX is in the range 08 to 0FH) and an 8-pixel font is

used, a space is inserted between characters.

| FX | | | | | [FX] character width (pixels) |
|-----|-----|-----|-----|-----|-------------------------------|
| HEX | D 3 | D 2 | D 1 | D 0 | |
| 00 | 0 | 0 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 07 | 0 | 1 | 1 | 1 | 8 |

Since the RA8835A series handles display data in 8-bit units, characters larger than 8 pixels wide must be formed from 8-pixel segments. As Figure 13-2 shows, the remainder of the second eight bits are not displayed. This also applies to the second screen layer.

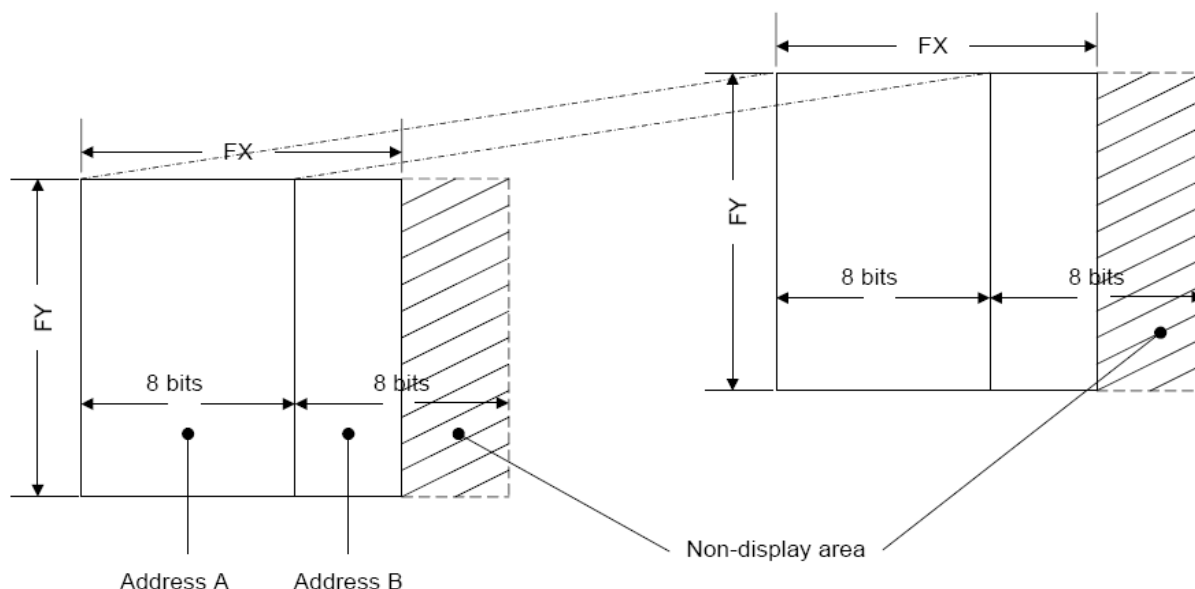


Figure 13-2: FX and FY Display Addresses

In graphics mode, the normal character field is also eight pixels. If a wider character field is used, any remainder in the second eight bits is not displayed.

13.2.1.8 WF

Select the AC frame drive waveform period. WF is usually set to 1.

WF = 0: 16-line AC drive

WF = 1: two-frame AC drive

In two-frame AC drive, the WF period is twice the frame period. In 16-line AC drive, WF inverts every 16 lines.

Although 16-line AC drive gives a more readable display, horizontal lines may appear when using high LCD drive voltages or at high viewing angles.



| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

13.2.1.9 FY

Set the vertical character size. The height in pixels is equal to $FY + 1$. FY can range from 00 to 0FH inclusive. Set FY to zero (vertical size equals one) when in graphics mode.

| HEX | FY | | | | [FY] character height (pixels) |
|-----|-----|-----|-----|-----|--------------------------------|
| | D 3 | D 2 | D 1 | D 0 | |
| 00 | 0 | 0 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 07 | 0 | 1 | 1 | 1 | 8 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 0E | 1 | 1 | 1 | 0 | 15 |
| 0F | 1 | 1 | 1 | 1 | 16 |

13.2.1.10 C/R

Set the address range covered by one display line, that is, the number of characters less one, multiplied by the number of horizontal bytes per character. C/R can range from 0 to 239.

For example, if the character width is 10 pixels, then the address range is equal to twice the number of characters, less 2. See Section 17-1-1 for the calculation of C/R . $[C/R]$ cannot be set to a value greater than the address range. It can, however, be set smaller than the address range, in which case the excess display area is blank. The number of excess pixels must not exceed 64.

| C/R | | | | | | | | | [C/R] bytes per display line |
|-----|----|----|----|----|----|----|----|----|------------------------------|
| HEX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 4F | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 80 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| EE | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 239 |
| EF | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 240 |

13.2.1.11 TC/R

Set the length, including horizontal blanking, of one line. The line length is equal to $TC/R + 1$, where TC/R can range from 0 to 255. TC/R must be greater than or equal to $C/R + 4$. Provided this condition is satisfied, $[TC/R]$ can be set according to the equation given in section 17-1-1 in order to hold the frame period constant and minimize jitter for any given main oscillator frequency, f_{OSC} .



| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

| TC/R | | | | | | | | | [TC/R] line length (bytes) |
|------|----|----|----|----|----|----|----|----|-------------------------------|
| HEX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 52 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 83 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| FE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 255 |
| FF | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 256 |

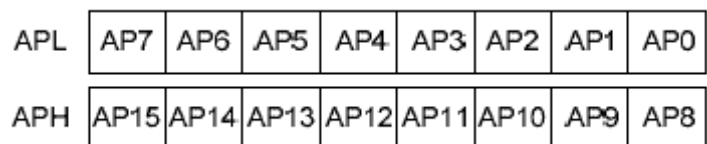
13.2.1.12 L/F

Set the height, in lines, of a frame. The height in lines is equal to L/F + 1, where L/F can range from 0 to 255.

| L/F | | | | | | | | | [L/F] lines per frame |
|-----|----|----|----|----|----|----|----|----|-----------------------|
| HEX | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 7F | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 128 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| FE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 255 |
| FF | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 256 |

3.2.1.13 AP

Define the horizontal address range of the virtual screen. APL is the least significant byte of the address.



| Hex code | | | | [AP] addresses per line |
|----------|-----|---|---|-------------------------|
| APH | APL | | | |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| 0 | 0 | 5 | 0 | 80 |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| F | F | F | E | $2^{16} - 2$ |
| F | F | F | F | $2^{16} - 1$ |

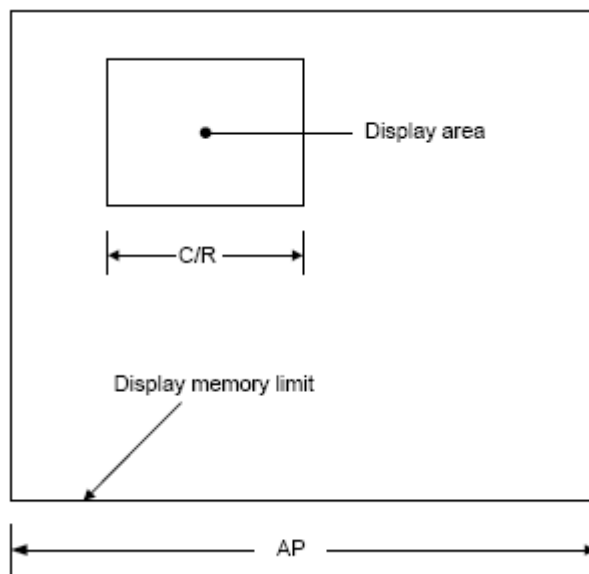


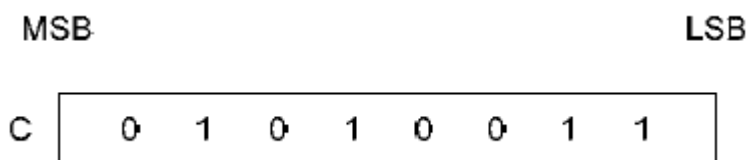
Figure 13-3: AP and C/R Relationship

13.2.2 SLEEP IN

Place the system in standby mode. This command has no parameter bytes. At least one blank frame after receiving this command, the RA8835A halts all internal operations, including the oscillator, and enters the sleep state.

Blank data is sent to the X-drivers, and the Y-drivers have their bias supplies turned off by the YDIS signal. Using the YDIS signal to disable the Y-drivers guards against any spurious displays.

The internal registers of the RA8835A series maintain their values during the sleep state. The display memory control pins maintain their logic levels to ensure that the display memory is not corrupted. The RA8835A series can be removed from the sleep state by sending the SYSTEM SET command with only the P1 parameter. The DISP ON command should be sent next to enable the display.



1. The YDIS signal goes LOW between one and two frames after the SLEEP IN command is received. Since YDIS forces all display driver outputs to go to the deselected output voltage, YDIS can be used as a power-down signal for the LCD unit. This can be done by having YDIS turn off the relatively high power LCD drive supplies at the same time as it blanks the display.

2. Since all internal clocks in the RA8835A series are halted while in the sleep state, a DC voltage will be applied to the LCD panel if the LCD drive supplies remain on. If reliability is a prime consideration, turn off the LCD drive supplies before issuing the SLEEP IN command.

3. Note that, although the bus lines become high impedance in the sleep state, pull-up or pulldown resistors on the bus will force these lines to a known state.

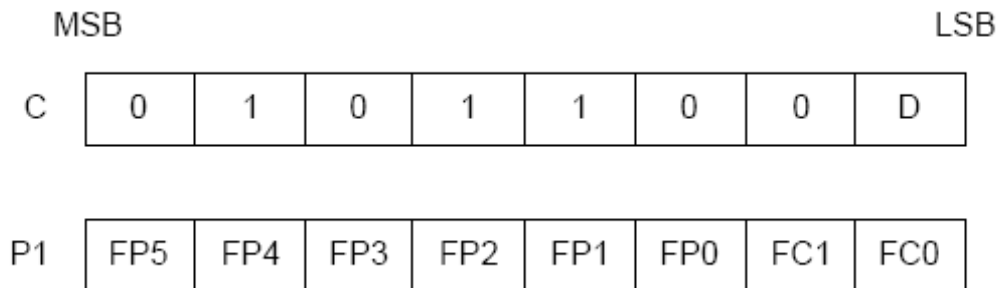


| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

13.3 Display Control Commands

13.3.1 DISP ON/OFF

Turn the whole display on or off. The single-byte parameter enables and disables the cursor and layered screens, and sets the cursor and screen flash rates. The cursor can be set to flash over one character or over a whole line.



13.3.1.1 D

Turn the display ON or OFF. The D bit takes precedence over the FP bits in the parameter.

D = 0: Display OFF

D = 1: Display ON

13.3.1.2 FC

Enables/disables the cursor and sets the flash rate. The cursor flashes with a 70% duty cycle (ON/OFF).

| FC1 | FC0 | Cursor display | |
|-----|-----|----------------|-----------------------------------|
| 0 | 0 | OFF (blank) | |
| 0 | 1 | ON | No flashing |
| 1 | 0 | | Flash at fFR/32 Hz (approx. 2 Hz) |
| 1 | 1 | | Flash at fFR/64 Hz (approx. 1 Hz) |

13.3.1.3 FP

Each pair of bits in FP sets the attributes of one screen block, as follows. The display attributes are as follows:



| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

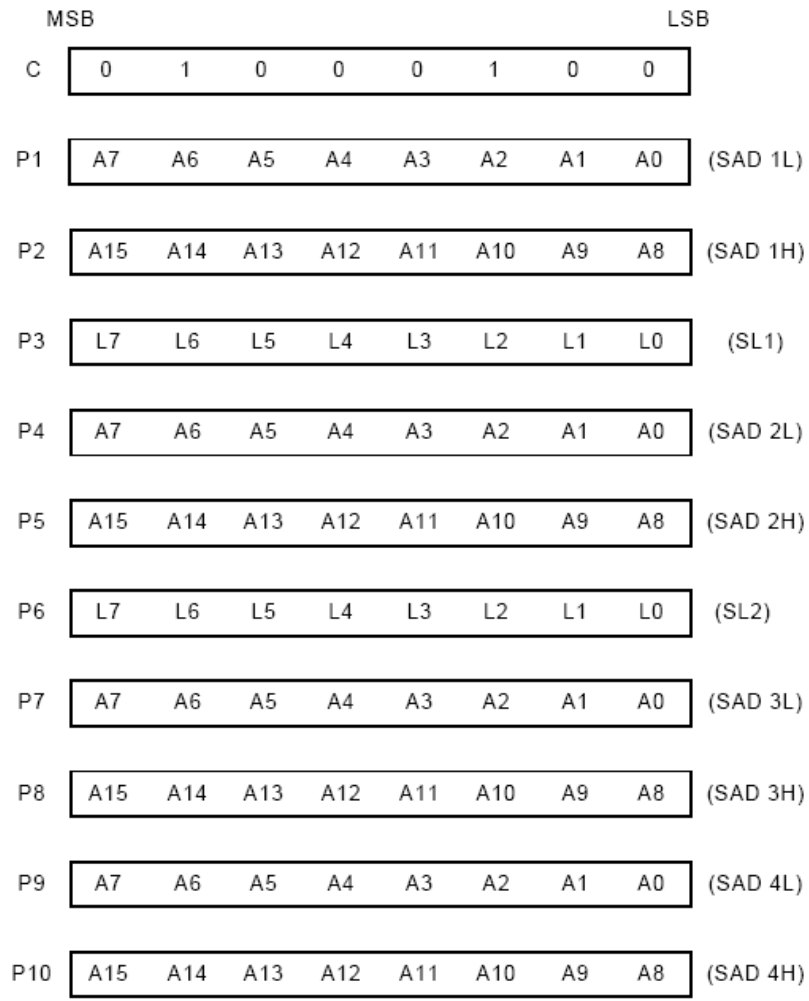
| | | | |
|-----|-----|---|-----------------------------------|
| FP1 | FP0 | First screen block (SAD1) | |
| FP3 | FP2 | Second screen block (SAD2, SAD4). See note. | |
| FP5 | FP4 | Third screen block (SAD3) | |
| 0 | 0 | OFF (blank) | |
| 0 | 1 | ON | No flashing |
| 1 | 0 | | Flash at fFR/32 Hz (approx. 2 Hz) |
| 1 | 1 | | Flash at fFR/4 Hz (approx. 16 Hz) |

Note: If SAD4 is enabled by setting W/S to 1, FP3 and FP2 control both SAD2 and SAD4. The attributes of SAD2 and SAD4 cannot be set independently.

13.3.2 SCROLL

13.3.2.1 C

Set the scroll start address and the number of lines per scroll block. Parameters P1 to P10 can be omitted if not required. The parameters must be entered sequentially as shown in the following figure.





| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

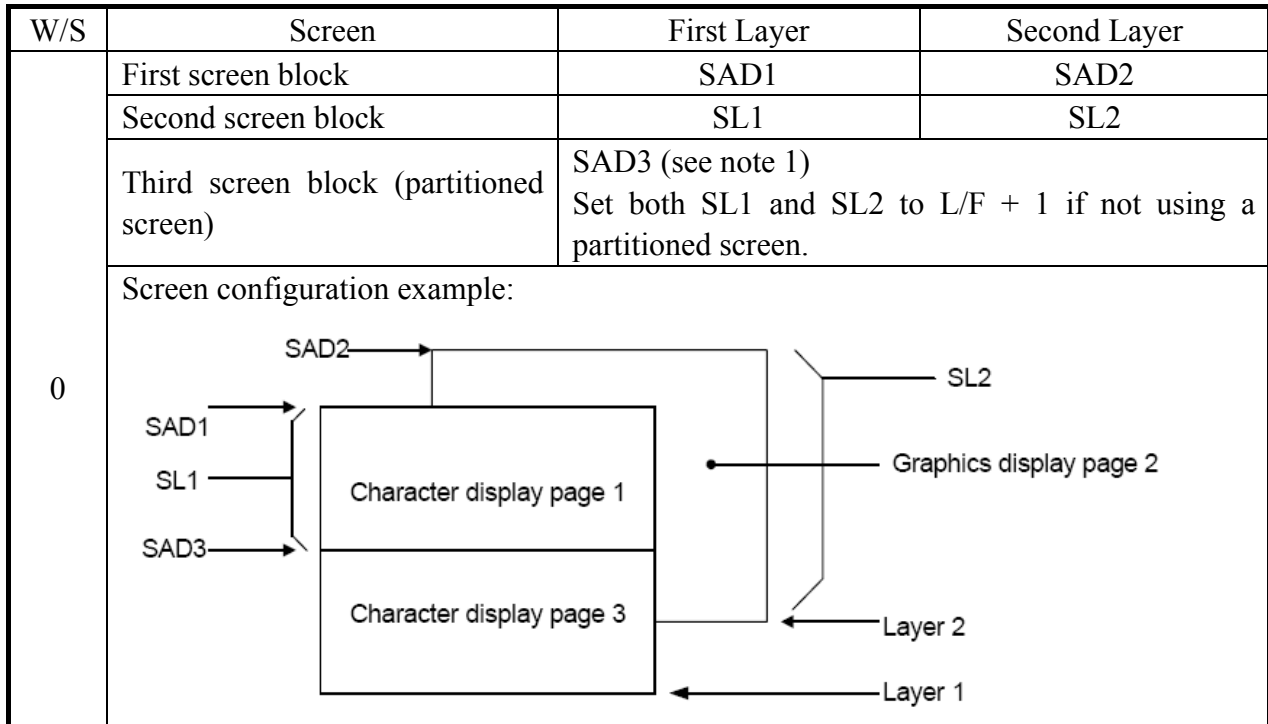
Note: Set parameters P9 and P10 only if both two-screen drive (W/S = 1) and two-layer configuration are selected. SAD4 is the fourth screen block display start address.

| SL1, SL2 | | | | | | | | | [SL] screen lines |
|----------|----|----|----|----|----|----|----|----|-------------------|
| HEX | L7 | L6 | L5 | L4 | L3 | L2 | L1 | L0 | |
| 00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 7F | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 128 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| FE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 255 |
| FF | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 256 |

13.3.2.2 SL1, SL2

SL1 and SL2 set the number of lines per scrolling screen. The number of lines is SL1 or SL2 plus one. The relationship between SAD, SL and the display mode is described below.

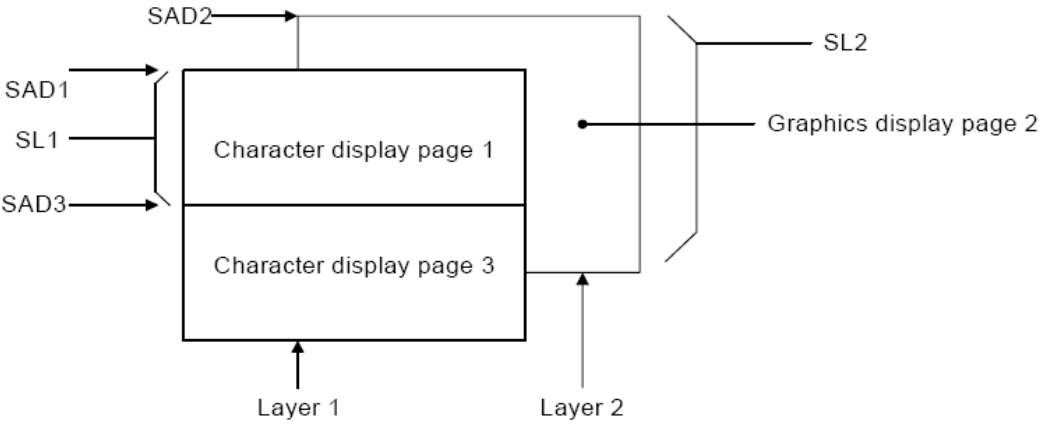
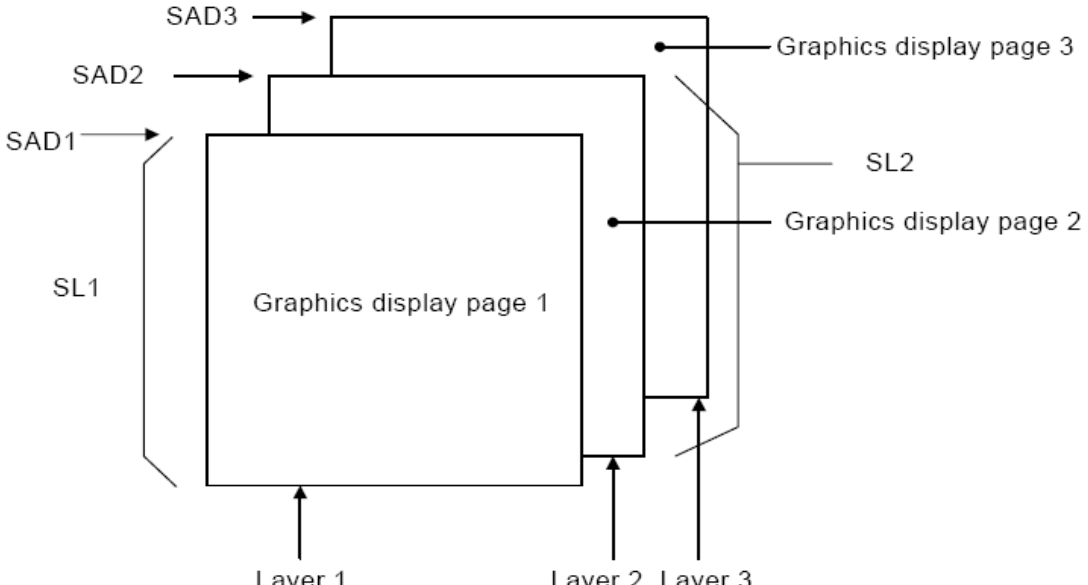
- **Text Display Mode**



Notes:

1. SAD3 has the same value as either SAD1 or SAD2, whichever has the least number of lines (set by SL1 and SL2).

● Graphics Display Mode

| W/S | Screen | First Layer | Second Layer | Third Layer |
|-----|--|--|-----------------------|-------------|
| | Two-layer composition | SAD1 SL1 | SAD2 SL2 | — |
| | Upper screen | SAD3 (see note 3) Set both SL1 and SL2 to L/F + 1 if not using a partitioned screen | | — |
| | Screen configuration example: | | | |
| |  | | | |
| 0 | Three-layer configuration | SAD1 SL1 = L/F + 1 | SAD2 SL1 = L/F + 1 | SAD3 — |
| | Screen configuration example: | | | |
| |  | | | |

Notes:

1. SAD3 has the same value as either SAD1 or SAD2; whichever has the least number of lines (set by SL1 and SL2).

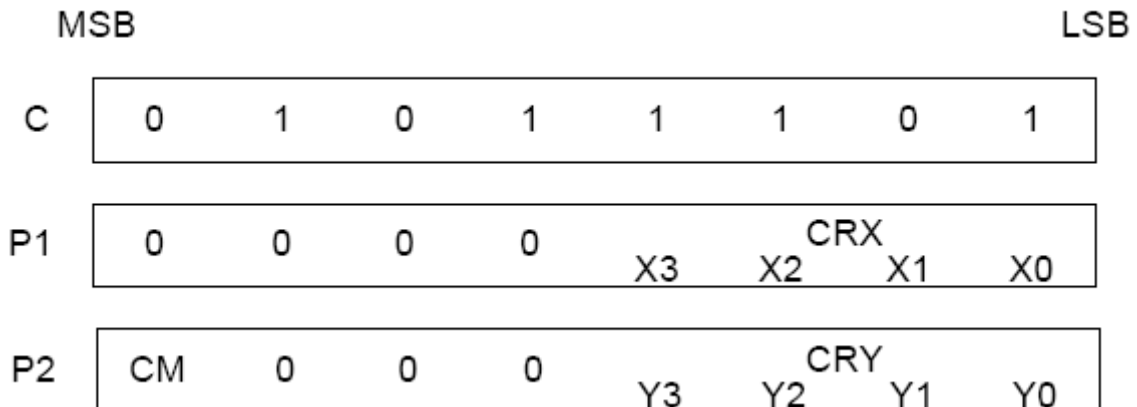


| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

2. Since the parameters corresponding to SL3 and SL4 are fixed by L/F, they do not have to be set.

13.3.3 CSRFORM

Set the cursor size and shape. Although the cursor is normally only used in text displays, it may also be used in graphics displays when displaying special characters.



13.3.3.1 CRX

Set the horizontal size of the cursor from the character origin. CRX is equal to the cursor size less one. CRX must be less than or equal to FX.

| CRX | | | | | [CRX] cursor width (pixels) |
|-----|----|----|----|----|--------------------------------|
| HEX | X3 | X2 | X1 | X0 | |
| 0 | 0 | 0 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 4 | 0 | 1 | 0 | 0 | 9 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| E | 1 | 1 | 1 | 0 | 15 |
| F | 1 | 1 | 1 | 1 | 16 |

13.3.3.2 CRY

Set the location of an underscored cursor in lines, from the character origin. When using a block cursor, CRY sets the vertical size of the cursor from the character origin. CRY is equal to the number of lines less one.

| CRY | | | | | [CRY] cursor width (lines) |
|-----|----|----|----|----|-------------------------------|
| HEX | Y3 | Y2 | Y1 | Y0 | |
| 0 | 0 | 0 | 0 | 0 | Illegal |
| 1 | 0 | 0 | 0 | 1 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 4 | 0 | 1 | 0 | 0 | 9 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| E | 1 | 1 | 1 | 0 | 15 |
| F | 1 | 1 | 1 | 1 | 16 |

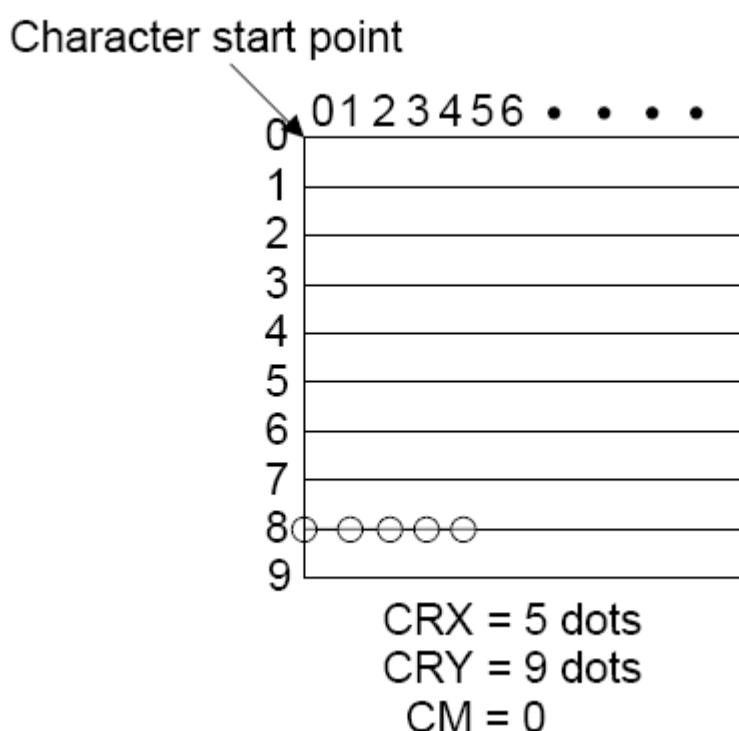


Figure 13-4: Cursor Size and Position

13.3.3.3 CM

Set the cursor shape. Always set CM to 1 when in graphics mode.

CM = 0: Underscore cursor

CM = 1: Block cursor

13.3.4 CSRDIR

Set the direction of automatic cursor increment. The cursor can move left or right one character, or up or down by the number of bytes specified by the address pitch, AP. When reading from and writing to display memory, this automatic cursor increment controls the display memory address increment on each read or write.

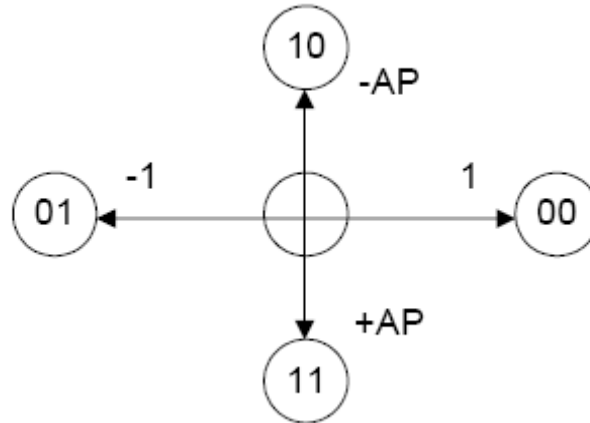
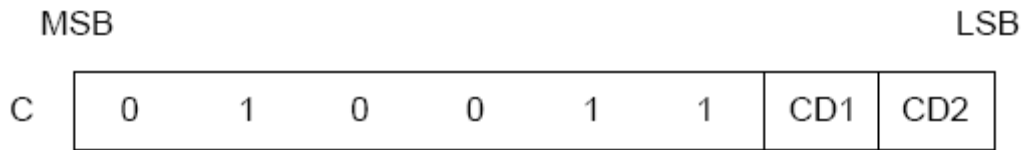


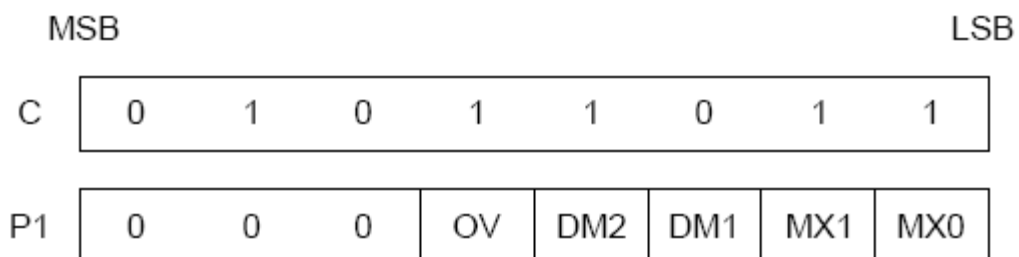
Figure 13-4: Cursor Direction


| C | CD1 | CD0 | Shift direction |
|-----|-----|-----|-----------------|
| 4CH | 0 | 0 | Right |
| 4DH | 0 | 1 | Left |
| 4EH | 1 | 0 | Up |
| 4FH | 1 | 1 | Down |

Note: Since the cursor moves in address units even if $FX \geq 9$, the cursor address increment must be preset for movement in character units.

13.3.5 OVLAY

Selects layered screen composition and screen text/ graphics mode.



| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

13.3.5.1 MX0, MX1

MX0 and MX1 set the layered screen composition method, which can be either OR, AND, Exclusive-OR or Priority-OR. Since the screen composition is organized in layers and not by screen blocks, when using a layer divided into two screen blocks, different composition methods cannot be specified for the individual screen blocks. The Priority-OR mode is the same as the OR mode unless flashing of individual screens is used.

| MX1 | MX0 | Function | Composition Method | Applications |
|-----|-----|--------------------------|--------------------|--|
| 0 | 0 | $L1 \cup L2 \cup L3$ | OR | Underlining, rules, mixed text and graphics |
| 0 | 1 | $(L1 \oplus L2) \cup L3$ | Exclusive-OR | Inverted characters, flashing regions, underlining |
| 1 | 0 | $(L1 \cap L2) \cup L3$ | AND | Simple animation, three-dimensional appearance |
| 1 | 1 | $L1 > L2 > L3$ | Priority-OR | |

Notes:

L1: First layer (text or graphics). If text is selected, layer L3 cannot be used.

L2: Second layer (graphics only)

L3: Third layer (graphics only)

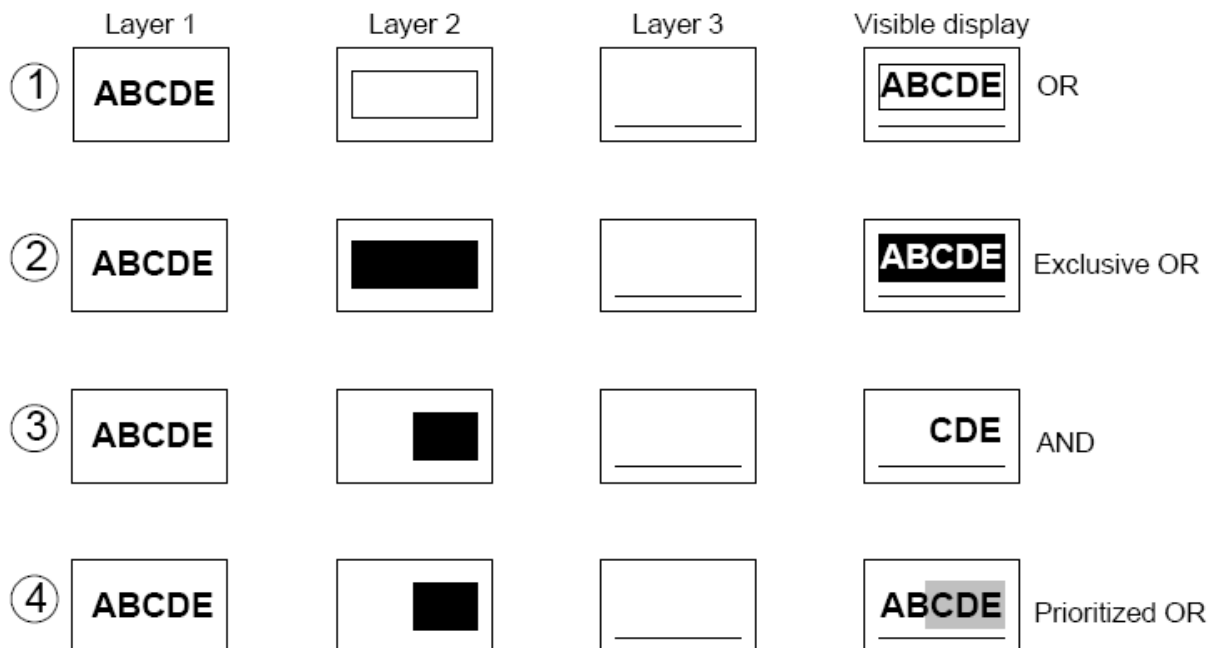



Figure 13-5: Combined Layer Display

Notes:

L1: Not flashing ; L2: Flashing at 1 Hz ; L3: Flashing at 2 Hz

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

13.3.5.2 DM1, DM2

DM1 and DM2 specify the display mode of screen blocks 1 and 3, respectively.

DM1/2 = 0: Text mode

DM1/2 = 1: Graphics mode

Note 1: Screen blocks 2 and 4 can only display graphics.

Note 2: DM1 and DM2 must be the same, regardless of the setting of W/S.

13.3.5.3 OV

Specifies two- or three-layer composition in graphics mode.

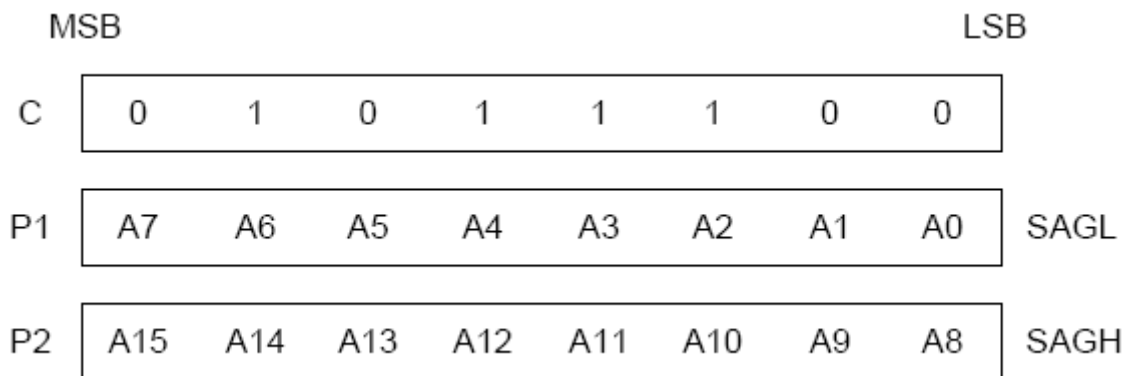
OV = 0: Two-layer composition

OV = 1: Three-layer composition

Set OV to 0 for mixed text and graphics mode.

13.3.6 CGRAM ADR

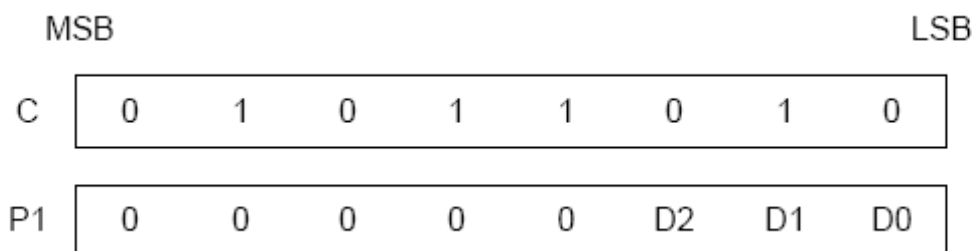
Specifies the CG RAM start address.



Note: See section 10 for information on the SAG parameters.

13.3.7 HDOT SCR

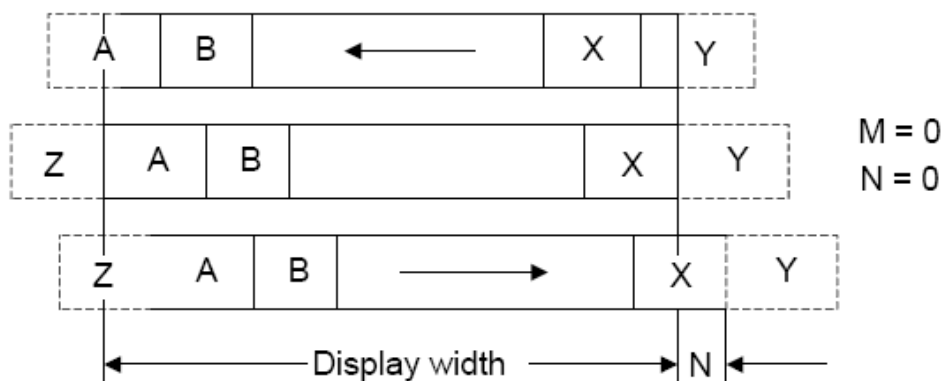
While the SCROLL command only allows scrolling by characters, HDOT SCR allows the screen to be scrolled horizontally by pixels. HDOT SCR cannot be used on individual layers.



13.3.7.1 D0 to D2


Specifies the number of pixels to scroll. The C/R parameter has to be set to one more than the number of horizontal characters before using HDOT SCR. Smooth scrolling can be simulated if the controlling microprocessor repeatedly issues the HDOT SCR command to the RA8835A series.

| P1 | | | | Number of pixels to scroll |
|-----|----|----|----|----------------------------|
| HEX | D2 | D1 | D0 | |
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 0 | 1 | 1 |
| 02 | 0 | 1 | 0 | 2 |
| ↓ | ↓ | ↓ | ↓ | ↓ |
| 06 | 1 | 1 | 0 | 6 |
| 07 | 1 | 1 | 1 | 7 |



M/N is the number of bits(dots) that parameter 1 (P1) is incremented/decremented by.

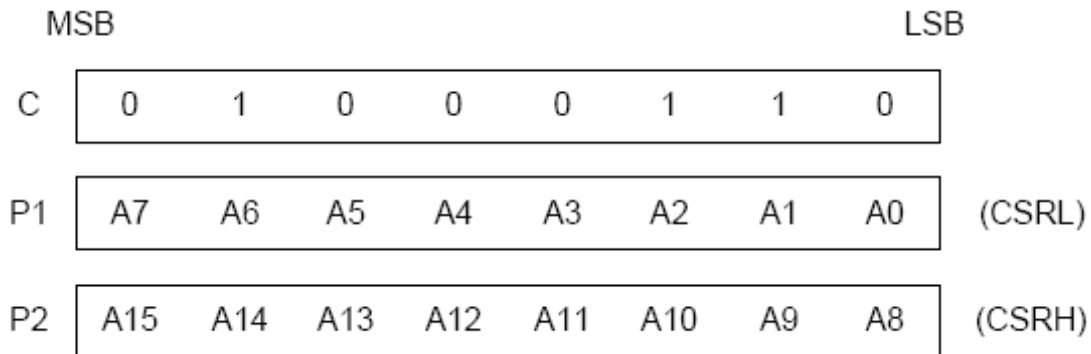
Figure 13.6 Horizontal Scrolling

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

13.4 Drawing Control Commands

13.4.1 CSRW

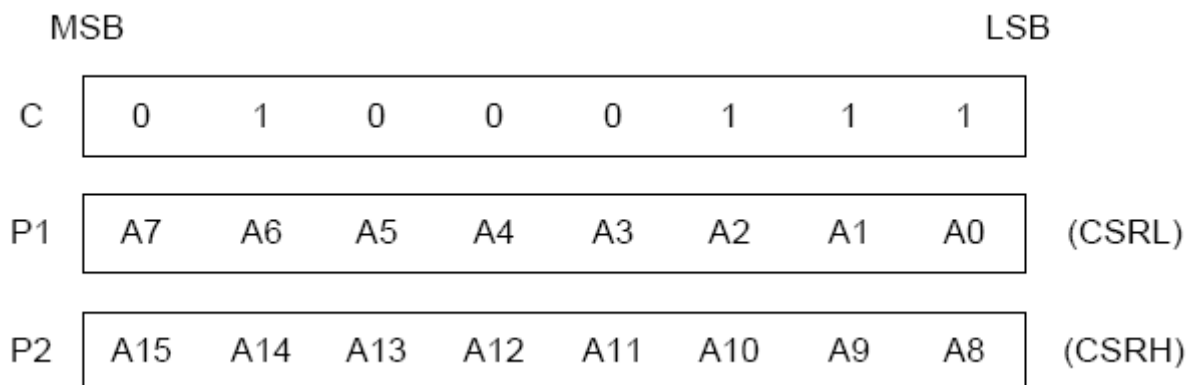
The 16-bit cursor address register contains the display memory address of the data at the cursor position as shown below. Note that the microprocessor cannot directly access the display memory. The MREAD and MWRITE commands use the address in this register.



The cursor address register can only be modified by the CSRW command, and by the automatic increment after an MREAD or MWRITE command. It is not affected by display scrolling. If a new address is not set, display memory accesses will be from the last set address or the address after previous automatic increments.

13.4.2 CSRR

Read from the cursor address register. After issuing the command, the data read address is read twice, for the low byte and then the high byte of the register.



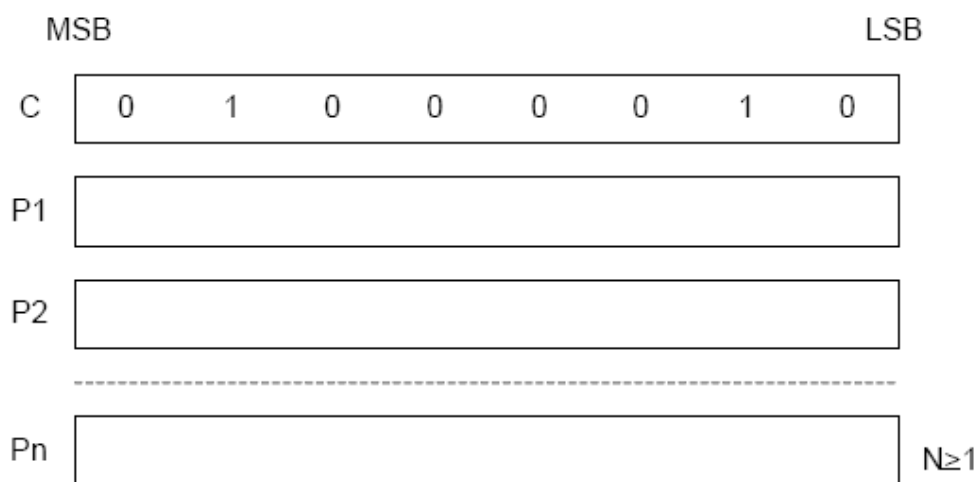


| | | |
|---|----------------------------|------------|
| Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | Effective Date: 2010-04-10 | |

13.5 Memory Control Commands

13.5.1 MWRITE

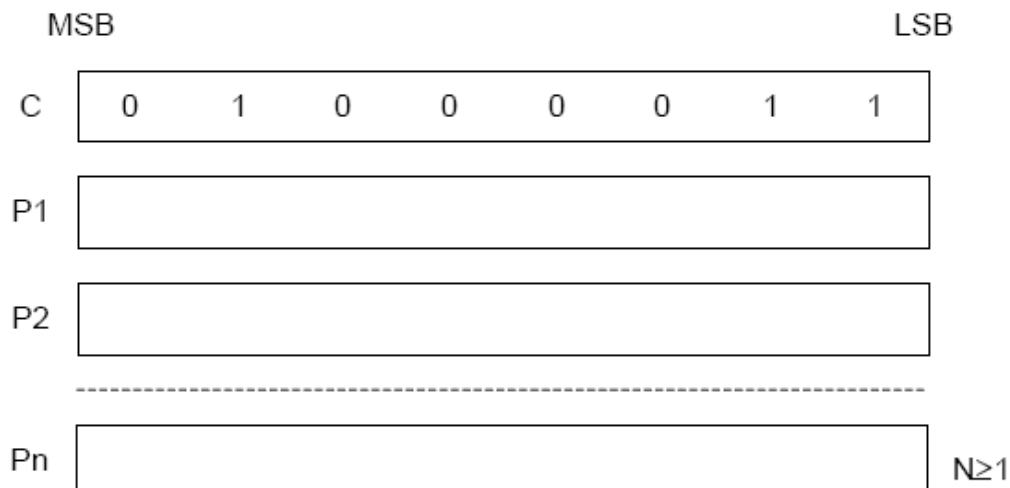
The microprocessor may write a sequence of data bytes to display memory by issuing the MREAD command and then writing the bytes to the RA8835A series. There is no need for further MWRITE commands or for the microprocessor to update the cursor address register after each byte as the cursor address is automatically incremented by the amount set with CSRDIR, in preparation for the next data write.




Note: P1, P2, ..., Pn: display data.

13.5.2 MREAD

Put the RA8835A series into the data output state. Each time the microprocessor reads the buffer, the cursor address is incremented by the amount set by CSRDIR and the next data byte fetched from memory, so a sequence of data bytes may be read without further MREAD commands or by updating the cursor address register. If the cursor is displayed, the read data will be from two positions ahead of the cursor.



| | | | |
|--|--|----------------------------|------------|
|  | Title | DOC#: | Rev. : R00 |
| | HYG32024027T-FFC2L-VD SPECIFICATION | Effective Date: 2010-04-10 | |

14.0 QUALITY GUARANTEE

14.1 ACCEPTABLE QUALITY LEVEL

| Inspection items | Sampling procedures | AQL |
|---------------------------------------|---|------|
| Visual-operating (Electro-optical) | GB2828-81 Inspection level II Normal inspection Single sample inspection | 0.65 |
| Visual-not operating | GB2828-81 Inspection level II Normal inspection Single sample inspection | 1.5 |
| Dimension measurement | GB2828-81 Inspection level II Normal inspection Single sample inspection | 1.5 |

14.2 Conditions of Cosmetic Inspection

- Environmental condition

The inspection should be performed at the 1m of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25°C and normal humidity 60±15%RH).

- Inspection method

The visual check should be performed vertically at more than 30cm distance from the LCD panel.

- Driving voltage

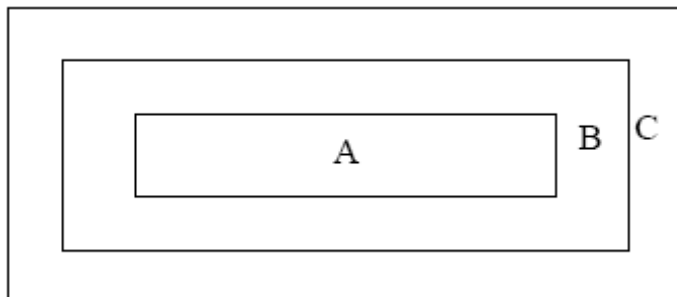
The V0 value which the most optimal contrast can be obtained near the specified V0 in the specification. (Within ±0.5V of the typical value at 25°C.).

14.3 Definition of inspection zone in LCD


Zone A: character/Digit area

Zone B: viewing area except Zone A (ZoneA+ZoneB=minimum Viewing area)

Zone C: Outside viewing area (invisible area after assembly in customer's product)



Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer's product.

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

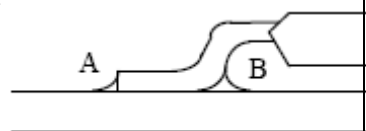
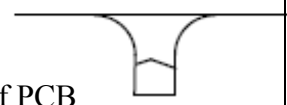
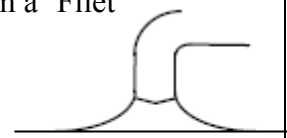
14.4 Inspection Standard


● Major Defect

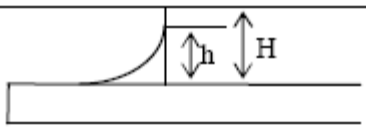
| Item No | Items to be inspected | Inspection Standard | Classification of defects |
|---------|------------------------|---|---------------------------|
| 1 | All functional defects | 1) No display 2) Display abnormally 3) Missing vertical, horizontal segment 4) Short circuit 5) Back-light no lighting, flickering and abnormal lighting. | Major |
| 2 | Missing | Missing component | |
| 3 | Outline dimension | Overall outline dimension beyond the drawing is not allowed. | |

● Module Cosmetic Criteria

| No. | Item | Judgment Criterion | Partition |
|-----|--------------------------------------|--|----------------------|
| 1 | Difference in Spec. | None allowed | Major |
| 2 | Pattern peeling | No substrate pattern peeling and floating | Major |
| 3 | Soldering defects | No soldering missing No soldering bridge No cold soldering | Major Major Minor |
| 4 | Resist flaw on substrate | Invisible copper foil ($\varnothing 0.5\text{mm}$ or more) on substrate pattern | Minor |
| 5 | Accretion of metallic Foreign matter | No soldering dust No accretion of metallic foreign matters (Not exceed $\varnothing 0.2\text{mm}$) | Minor Minor |
| 6 | Stain | No stain to spoil cosmetic badly | Minor |
| 7 | Plate discoloring | No plate fading, rusting and discoloring | Minor |
| 8 | 1. Solder amount Lead parts | a. Soldering side of PCB Solder to form a 'Filet' all around the lead. Solder should not hide the lead form perfectly. (too much) b. Components side (In case of 'Through Hole PCB') Solder to reach the Components side of PCB. | Minor |
| | 2. Flat packages | Either 'Toe' (A) or 'Seal' (B) of the lead to be covered by 'Filet'. Lead form to be assume over solder. | |



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|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

| No. | Item | Judgment Criterion | Partition |
|-----|----------|--|-----------|
| 8 | 3. Chips | $(3/2) H \geq h \geq (1/2) H$  | Minor |

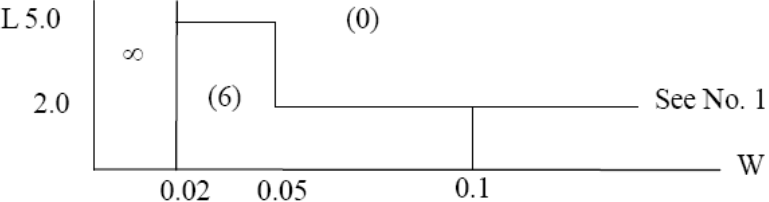
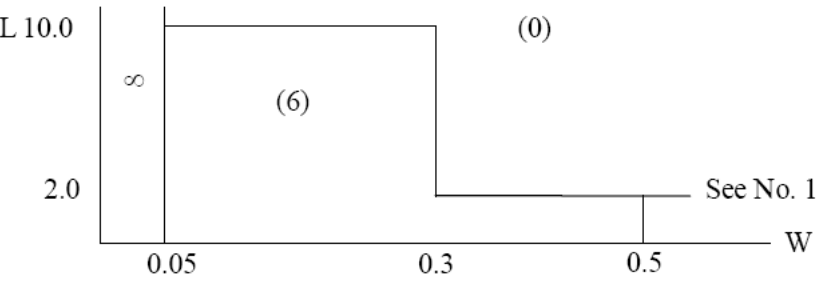
● **Screen Cosmetic Criteria (Non-Operating)**

| No. | Defect | Judgement Criterion | Partition | | | | | | | | | | | | | | | |
|----------|----------------------|--|-----------|----|-------------------------------|---|-------|-----------|---------|-------|---|---------|-------|---|---------|--|---|-------|
| 1 | Spots | In accordance with <i>Screen Cosmetic Criteria (Operating) No.1.</i> | Minor | | | | | | | | | | | | | | | |
| 2 | Lines | In accordance with <i>Screen Cosmetic Criteria (Operating) No.2.</i> | Minor | | | | | | | | | | | | | | | |
| 3 | Bubbles in polarizer | <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Size : d</th> <th>mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>d</td> <td>≤ 0.3</td> <td>Disregard</td> </tr> <tr> <td>0.3 < d</td> <td>≤ 1.0</td> <td>3</td> </tr> <tr> <td>1.0 < d</td> <td>≤ 1.5</td> <td>1</td> </tr> <tr> <td>1.5 < d</td> <td></td> <td>0</td> </tr> </tbody> </table> | Size : d | mm | Acceptable Qty in active area | d | ≤ 0.3 | Disregard | 0.3 < d | ≤ 1.0 | 3 | 1.0 < d | ≤ 1.5 | 1 | 1.5 < d | | 0 | Minor |
| Size : d | mm | Acceptable Qty in active area | | | | | | | | | | | | | | | | |
| d | ≤ 0.3 | Disregard | | | | | | | | | | | | | | | | |
| 0.3 < d | ≤ 1.0 | 3 | | | | | | | | | | | | | | | | |
| 1.0 < d | ≤ 1.5 | 1 | | | | | | | | | | | | | | | | |
| 1.5 < d | | 0 | | | | | | | | | | | | | | | | |
| 4 | Scratch | In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable. | Minor | | | | | | | | | | | | | | | |
| 5 | Allowable density | Above defects should be separated more than 30mm each other. | Minor | | | | | | | | | | | | | | | |
| 6 | Coloration | Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only. | Minor | | | | | | | | | | | | | | | |
| 7 | Contamination | Not to be noticeable. | Minor | | | | | | | | | | | | | | | |


Note: Size : d = (long length + short length) / 2



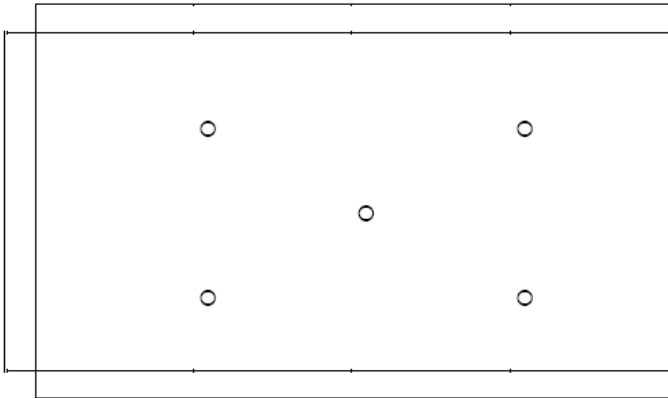
● Screen Cosmetic Criteria (Operating)

| No. | Defect | Judgment Criterion | Partition | | | | | | | | | | | | | | | | | | | | |
|--------------------|-------------------------------|---|-------------|-------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|-------------|-------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|-------|
| 1 | Spots | <p>A) Clear</p> <table border="1" data-bbox="421 443 1197 654"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>$d \leq 0.1$</td> <td>Disregard</td> </tr> <tr> <td>$0.1 < d \leq 0.2$</td> <td>6</td> </tr> <tr> <td>$0.2 < d \leq 0.3$</td> <td>2</td> </tr> <tr> <td>$0.3 < d$</td> <td>0</td> </tr> </tbody> </table> <p>Note : Including pin holes and defective dots which must be within one pixel size.</p> <p>B) Unclear</p> <table border="1" data-bbox="421 779 1197 990"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td>$d \leq 0.2$</td> <td>Disregard</td> </tr> <tr> <td>$0.2 < d \leq 0.5$</td> <td>6</td> </tr> <tr> <td>$0.5 < d \leq 0.7$</td> <td>2</td> </tr> <tr> <td>$0.7 < d$</td> <td>0</td> </tr> </tbody> </table> | Size : d mm | Acceptable Qty in active area | $d \leq 0.1$ | Disregard | $0.1 < d \leq 0.2$ | 6 | $0.2 < d \leq 0.3$ | 2 | $0.3 < d$ | 0 | Size : d mm | Acceptable Qty in active area | $d \leq 0.2$ | Disregard | $0.2 < d \leq 0.5$ | 6 | $0.5 < d \leq 0.7$ | 2 | $0.7 < d$ | 0 | Minor |
| Size : d mm | Acceptable Qty in active area | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.1$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.1 < d \leq 0.2$ | 6 | | | | | | | | | | | | | | | | | | | | | | |
| $0.2 < d \leq 0.3$ | 2 | | | | | | | | | | | | | | | | | | | | | | |
| $0.3 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| Size : d mm | Acceptable Qty in active area | | | | | | | | | | | | | | | | | | | | | | |
| $d \leq 0.2$ | Disregard | | | | | | | | | | | | | | | | | | | | | | |
| $0.2 < d \leq 0.5$ | 6 | | | | | | | | | | | | | | | | | | | | | | |
| $0.5 < d \leq 0.7$ | 2 | | | | | | | | | | | | | | | | | | | | | | |
| $0.7 < d$ | 0 | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Lines | <p>A) Clear</p>  <p>Note :</p> <ul style="list-style-type: none"> () - Acceptable Qty in active area L - Length (mm) W - Width (mm) ∞ - Disregard <p>B) Unclear</p>  <p>‘Clear’ = The shade and size are not changed by Vop. ‘Unclear’ = The shade and size are changed by Vop.</p> | Minor | | | | | | | | | | | | | | | | | | | | |

Note: Size : d = (long length + short length) / 2


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|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

● **Screen Cosmetic Criteria (Operating) (Continued)**

| No. | Defect | Judgment Criterion | Partition |
|-----|---|---|-----------|
| 3 | Rubbing line | Not to be noticeable. | Minor |
| 4 | Allowable density | Above defects should be separated more than 10mm each other. | Minor |
| 5 | Rainbow | Not to be noticeable. | Minor |
| 6 | Dot size | To be 95% ~ 105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as pot'. (see <i>Screen Cosmetic Criteria (Operating) No.1</i>) | Minor |
| 7 | Uneven brightness (only back-lit type module) | <p>Uneven brightness must be $B_{MAX} / B_{MIN} \leq 2$</p> <ul style="list-style-type: none"> - B_{MAX} : Max. value by measure in 5 points - B_{MIN} : Min. value by measure in 5 points <p>Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.</p>  <p>○ : Measuring points</p> | Minor |

Note :


- (1) The limit samples for each item have priority.
- (2) Complex defects are defined item by item, but if the numbers of defects are defined in above table, the total number should not exceed 10.
- (3) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.
 - 7 or over defects in circle of $\varnothing 5\text{mm}$.
 - 10 or over defects in circle of $\varnothing 10\text{mm}$.
 - 20 or over defects in circle of $\varnothing 20\text{mm}$.

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

15.0 RELIABILITY

15.1 Content of Reliability Test

| No. | Test Item | Test Condition | Inspection after test |
|---|---------------------------------------|---|--|
| 1 | High Temperature Storage | 80°C±2°C/200 hours | Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1.Air bubble in the LCD; 2.Sealleak; 3.Non-display; 4.missing segments; 5.Glass crack; 6.Current Idd is twice higher than initial value. |
| 2 | Low Temperature Storage | -30°C±2°C/200 hours | |
| 3 | High Temperature Operating | 70°C±2°C/120 hours | |
| 4 | Low Temperature Operating | -20°C±2°C/120 hours | |
| 5 | Temperature Cycle | -20°C±2°C~25~70°C±2°C×10cycles (30min.) (5min.) (30min.) | |
| 6 | High Temperature Humidity operation / | 50°C±5°C×90%RH/120 hours | |
| 7 | Vibration Test | Frequency : 10Hz~55Hz~10Hz Amplitude : 1.5mm, X , Y , Z direction for total 3hours (Packing condition) | |
| 8 | Drooping test | Drop to the ground from 1m height, one time, and every side of carton. (Packing condition) | |
| 9 | Static electricity test | Voltage:±8KV R: 330Ω C: 150pF Air discharge, 10time | |
| Remark: 1. The test samples should be applied to only one test item. 2. Sample size for each test item is 5~10pcs. 3. For Damp Proof Test, Pure water(Resistance>10MΩ) should be used. 4. In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part. 5. EL evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has. 6. Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic. | | | |

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

16.0 PRECAUTIONS FOR USING LCD MODULES

16.1 Handling Precautions

(1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.

(2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.

(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

(5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :

- Isopropyl alcohol
- Ethyl alcohol

(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

- Water
- Ketone
- Aromatic solvents

(7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.


(11) If the logic circuit power is off, do not apply the input signals.

(12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Be sure to ground the body when handling the LCD modules.
- Tools required for assembling, such as soldering irons, must be properly grounded.
- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.
- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

16.2 Storage Precautions

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags (avoid high temperature / high humidity and low temperatures below 0°C). Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |


16.3 Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.
- Terminal electrode sections.

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

17.0 USING LCD MODULES

17.1 About Liquid Crystal Display Modules

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

(1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

(2) Do not touch, push or rub the exposed polarizer with anything harder than an HB pencil lead (glass, tweezers, etc.).

(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizer and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzine. Do not scrub hard to avoid damaging the display surface.

(5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.

(6) Avoid contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(8) Do not put or attach anything on the display area to avoid leaving marks on.

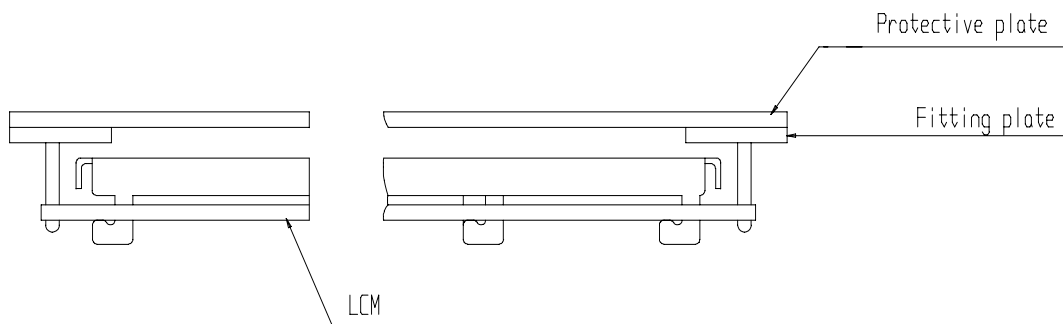
(9) Do not touch the display with bare hands. This will stain the display area and degrade insulation between terminals (some cosmetics are determinate to the polarizer).

(10) As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring.


17.2 Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

(1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



(2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be ± 0.1 mm.

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

17.3 Electro-Static Discharge Control

Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC.

- (1) Make certain that you are grounded when handing LCM.
- (2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.
- (3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not leak.
- (4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutation of the motor.
- (5) As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.
- (6) To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended.

17.4 Soldering to the LCM


- (1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.
 - Soldering iron temperature : $280^{\circ}\text{C} \pm 10^{\circ}\text{C}$.
 - Soldering time : 3-4 sec.
 - Solder : eutectic solder.

If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage due to flux spatters.

- (2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.
- (3) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

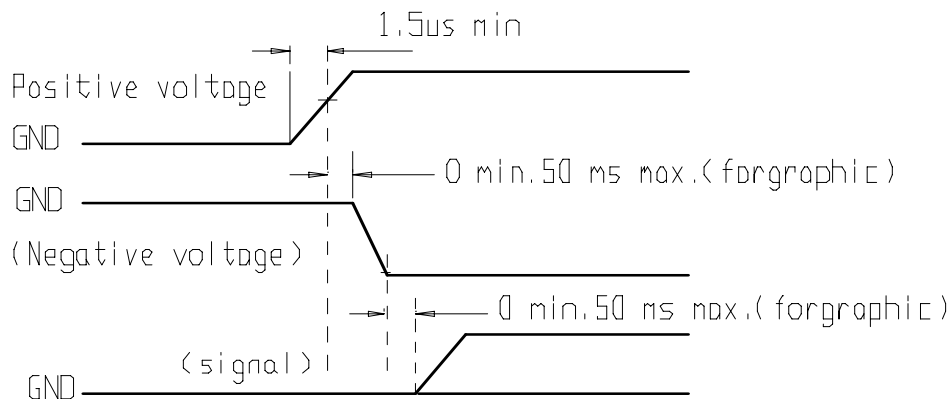
17.5 Operation

- (1) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO to show the best contrast.
- (2) Driving the LCD in the voltage above the limit shortens its life.
- (3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.
- (4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.
- (5) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit.

| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

Therefore, it must be used under the relative condition of 40°C , 50% RH.

(6) When turning the power on, input each signal after the positive/negative voltage becomes stable.



17.6 Storage

When storing LCDs as spares for some years, the following precaution are necessary.

(1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for dessicant.

(2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C.

(3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped.)

(4) Environmental conditions :

- Do not leave them for more than 168hrs. at 60°C.
- Should not be left for more than 48hrs. at -20°C.


17.7 Safety

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

17.8 Limited Warranty

Unless agreed between HYDISPLAY and customer, HYDISPLAY will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with HYDISPLAY LCD/LCM acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to HYDISPLAY within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of HYDISPLAY limited to repair and/or replacement on the terms set forth above. HYDISPLAY will not be responsible for any subsequent or consequential events.


| | | | |
|--|---|----------------------------|------------|
|  | Title HYG32024027T-FFC2L-VD SPECIFICATION | DOC#: | Rev. : R00 |
| | | Effective Date: 2010-04-10 | |

17.9 Return LCM under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- PCB eyelet's damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet, conductors and terminals.

| | | | |
|--|---|----------------------------|------------|
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18.0 APPENDIX

18.1 Initialization Code

```
void wr_cmd(uchar cmd)
```

```
{
    RD_Port = 1;
    WR_Port = 1;
    A0_Port = 1;
    CS1_Port = 0;
    WR_Port = 0;
    DataPort = cmd;
    WR_Port = 1;
    CS1_Port = 1;
}
```

```
void wr_dat(uchar dat)
```

```
{
    RD_Port = 1;
    WR_Port = 1;
    A0_Port = 0;
    CS1_Port = 0;
    WR_Port = 0;
    DataPort = dat;
    WR_Port = 1;
    CS1_Port = 1;
}
```

```
//RA8835 Initial
```

```
#pragma disable
```

```
void initial()
```

```
{
    wr_cmd(0x40); //System Set
    wr_dat(0x30); //P1:IV=1; M0=0,Internal CGRAM;M1=0,No D6 correction;
                    W/S=0,Single-Panel;M2=0,8-Pixel character
    wr_dat(0x87); //P2: WF=1,two-frame AC Driver;FX=8,Set Horizontal Character Size 87
    wr_dat(0x07); //P3: Set Vertical Character Size
    wr_dat(0x27); //P4: CR,Bytes per display line
    wr_dat(0x42); //P5: T/CR,Line Length
    wr_dat(0xEF); //P6: L/F,Lines per frame
    wr_dat(0x28); //P7: APL
    wr_dat(0x00); //P8: APH,define the horizontal address range of the virtual address
}
```



```

wr_cmd(0x44);//Scroll
wr_dat(0x00);//P1: SAD 1L
wr_dat(0x00);//P2: SAD 1H
wr_dat(0xF0);//P3: SL1
wr_dat(0x00);//P4: SAD 2L
wr_dat(0x30);//P5: SAD 2H
wr_dat(0xF0);//P6: SL2
wr_dat(0x00);//P7: SAD 3L
wr_dat(0x60);//P8: SAD 3H
wr_dat(0x00);//P9: SAD 4L
wr_dat(0x70);//P10: SAD 4H

```

```

wr_cmd(0x5D);//Set Cursor Size and Shape
wr_dat(0x07);//P1: Set Horizontal Size
wr_dat(0x87);//p2: Set Vertical Size

```

```

wr_cmd(0x5A);//HDOT SCR
wr_dat(0x00);

```

```

wr_cmd(0x5B);//Selects layered screen composition and screen text/graphics mode
wr_dat(0x0C);//P1: DM1/2=1,Graphics Mode;OV=0,Two-Layer Composition;OR Mode //0C

```

```

wr_cmd(0x59);//Display On
wr_dat(0x05);//P1: SAD2+SAD3 Blank;SAD1 No flashing;Cursor No flashing

```

}

18.2 Power Supply Circuit Diagram

