EVER CATCHER GROUP
WE CATCH THE BEST TECH. FOREVER

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PART NO. : **MS-10-13350**

FOR MESSRS. :

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ACCEPTED BY : _____ PROPOSED BY : _____

RECORD OF REVISION

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3. Precautions for LCM

3-1 Precautions in handling LCD Modules (hereinafter LCM's)

EVERBOUQUET INTERNATIONAL CO., LTD.'s LCM's have been assembled and accurately calibrated before delivery.

Please observe the following criteria when handling.

A. Do not subject the module to excessive shock.

B. Do not modify the tab on the metal holder.

C. Do not tamper with the printed circuit board.

D. Limit soldering of the printed circuit board to I/O terminals only.

E. Do not touch the zebra strip nor modify its location.

3-2 Static electricity warning:

EVERBOUQUET's LCM uses CMOS LSI technology. Therefore, strict measures to avoid static electricity discharge are followed through all processes from manufacturing through shipping. When handling an LCM, take sufficient care to prevent static electricity discharge as you would and CMOS IC.

A. Do not take the LCM from its anti-static bag until it's to be assembled. LCM's are individually packaged in bags specially treated to resist static electricity. When storing, keep the LCM packed in the original bags, or store them in a container processed to be resistant to static electricity, or in an electric conductive container.

B. Always use a ground strap when handling a LCM.
Always use a ground strap while working with the module, from the time it is taken out of the anti-static bag until it is assembled. When it is necessary to transfer the LCM, once it has been taken out of the bag, always place it in an electric conductive container. Avoid wearing clothes made of chemical fibers, the use of cotton or conductive treated fiber clothing is recommended.

C. Use a no-leak iron for soldering the LCM.
The soldering iron to be used for soldering the I/O terminals to the LCM are to be insulated or grounded at the iron tip.

D. Always ground electrical apparatuses required for assembly.
Electrical apparatuses required to assemble the LCM into a product, i.e. electrical screw drivers are to be first grounded to avoid transmitting spike noises from the motor.

E. Assure that the work bench is properly grounded.

F. Peel off the LCM protective film slowly. The module is attached with a film to protect the display surface from contamination, damage, adhesion of flux, etc. Peeling off this film abruptly could case static electricity to be generated, so peel the tape slowly.

G. Pay attention to the humidity in the work area.
50~60% RH is recommended.

3-3 Precautions for the soldering of an LCM

The following procedures should be followed when soldering the LCM:

A. Solder only to the I/O terminal.

B. Use a no leakage soldering iron and pay particular attention to the following:

(1) Conditions for soldering I/O terminals

Temperature at iron tip : 280°C + 10°C

Soldering time : 3-4 sec/terminal

Type of solder : Eutectic solder (rosin flux filled)

Note: Avoid using flux, because it could penetrate the module and the module may get contaminated during cleaning. Peel off protective film after soldering of the I/O terminals is finished. By following this procedure, the surface contamination, caused by the dispersion of flux while soldering, can be avoided.

(2) Removing the wiring

When a lead wire or a connector to the I/O terminal of the module is to be removed, remove it only after the solder at the connection has sufficiently melted since the I/O terminal is a through hole. If it is forcefully removed, it could cause the terminal to break or peel. The recommended procedure is to use a suction-type solder remover. Caution, do not reheat the I/O terminal more than 3 times.

3-4. Long-term storage

If the correct method of storage is not followed, deterioration of the display material polarizer and oxidation of the I/O terminal plating may make the soldering process difficult. Please comply with the following procedure.

A. Store in the shipping container.

B. If the shipping container is not available, place in anti-static bags and seal the opening

C. Store the modules where they are not subjected to direct sunlight or a fluorescent lamp.

Sore in a temperature range of 0°C~35°C with low relative humidity.

3-5. Precautions in use of LCD modules

A. Do not give any external shock.

B. Do not wipe the surface with hard materials.

C. Do not apply excessive force on the surface.

D. Do not expose to direct sunlight or fluorescent light for a long time.

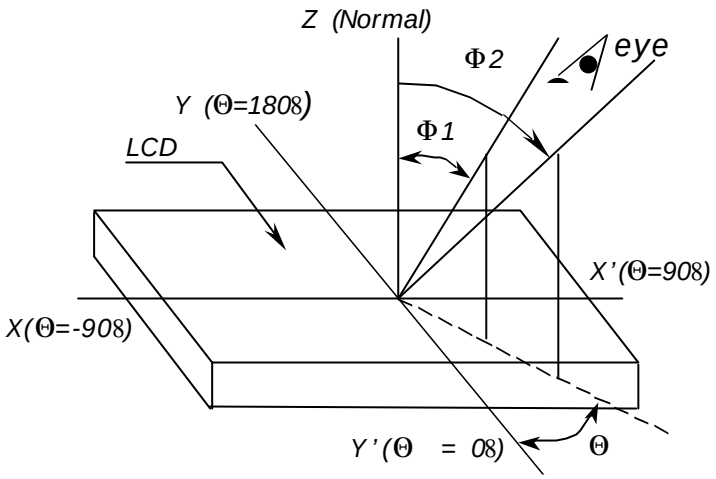
E. Avoid storage in high temperature and high humidity.

F. When storage for a long time at 40°C or higher is required, R/H shall be less than 60%.

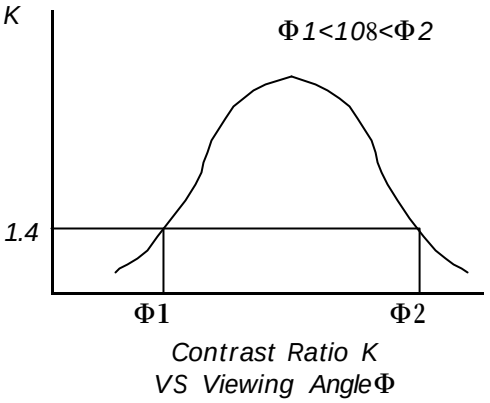
G. Liquid in LCD is hazardous substance. Must not lick, swallow when the liquid is attached to your hands, skin, clothes etc. Wash it out thoroughly.

4. Optical definitions

4.1 Definition of angle Θ and Φ



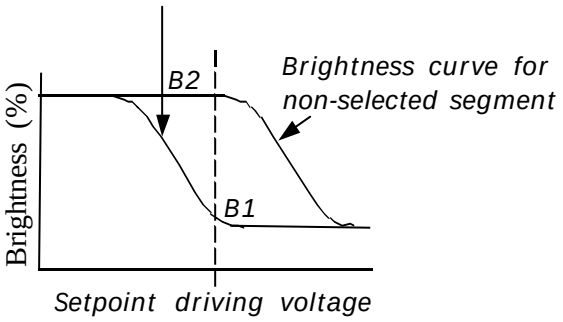
4.2 Definition of viewing angle Φ1 and Φ2



POSITIVE TYPE

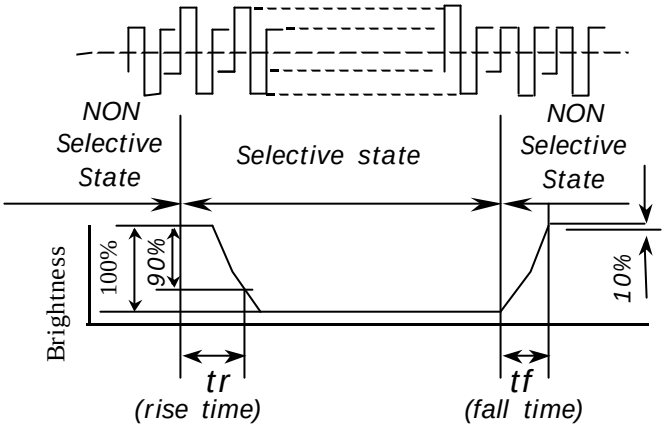
4.3 Definition of contrast "K"

$$K=\frac{\text{brightness of non-selected segment (B2)}}{\text{Brightness of selected segment (B1)}}$$



POSITIVE TYPE

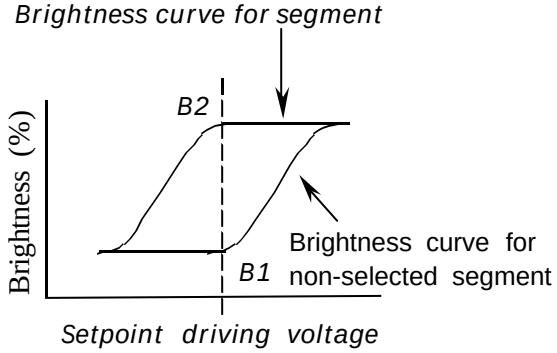
4.4 Definition of optical response



NEGATIVE TYPE

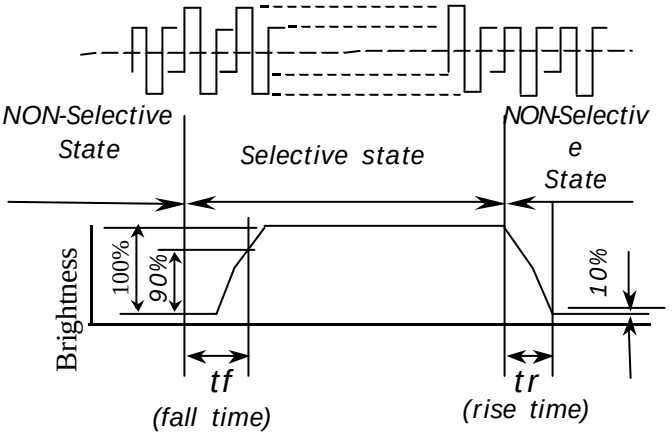
4.5 Definition of contrast "K"

$$K=\frac{\text{Brightness of selected segment (B1)}}{\text{Brightness of non-selected segment (B2)}}$$



NEGATIVE TYPE

4.6 Definition of optical response



5. Quality and reliability

5-1 Test condition

Test should be conducted under the following conditions:

Ambient temperature : 25 ± 5℃

Humidity : 60 ± 20% RH

5-2 Sampling plan

Sampling method shall be in accordance with MIL-STD-105D, inspection level II, normal inspection, and single sampling plan tables for normal tightened, and reduced inspection.

5-3 Acceptable quality level

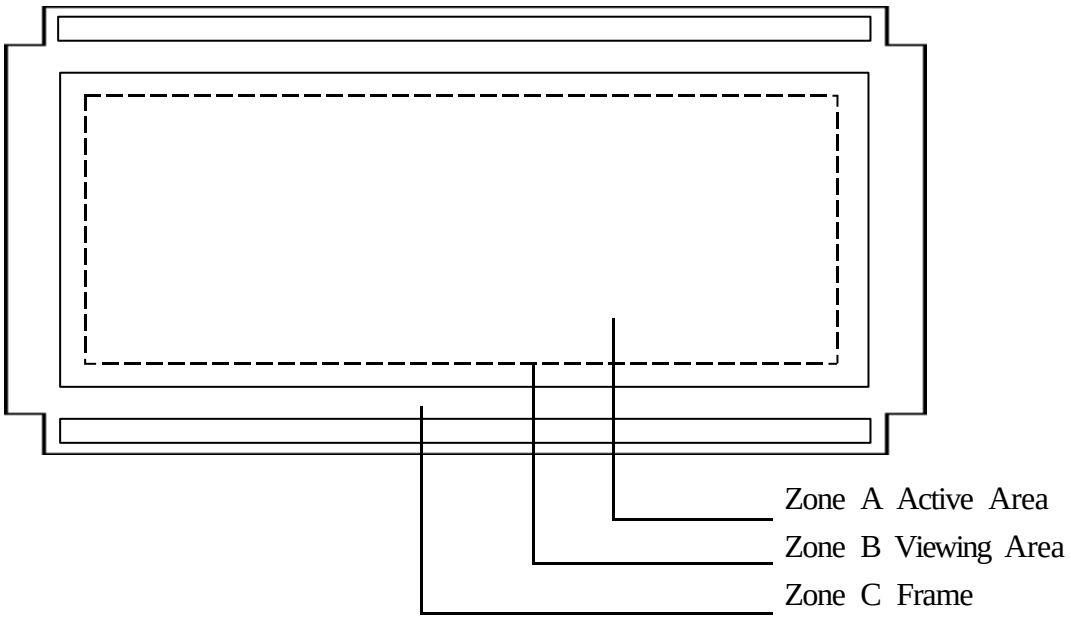
A major defect is a defect that could result in failure or materially reduce that the usability of the unit of product for its intended purpose.

A minor defect is one that does not materially reduce the usability of the unit of product for its intended purpose or is a departure from established standards having no significant bearing on the effective use or operation of the unit.

5-4 Appearance

Appearance test is to be conducted by human eyes at approximately 30cm distance from LCD module under the single fluorescent light.

The inspection area of LCD panel shall be within the range. Of following limits.



5-5 Inspection quality criteria

ITEM	*DESCRIPTION OF DEFECTS*			*Class of defects*	*Acceptable level (%)*
FUNCTION	Short circuit or Pattern cut			Major	0.65
DIMENSION	Refer to individual acceptance specification			Major	2.5
BLACK SPOTS	Ave. dia. D	area A	area B	Minor	2.5
	D0.2	disregard			
	0.2 ¢ D * 0.3	2	3		
	0.3 ¢ D * 0.4	0	1		
	0.4 ¢ D	0	0		
BLACK LINES	Width W, Length L	A	B	Minor	2.5
	W ≦ 0.03	disregard			
	0.03 < W ≦ 0.05	3	4		
	0.05 < W ≦ 0.07, L ≦ 3.0	1	1		
BUBBLES IN POLARIZER	Average diameter D 0.2 < D < 0.5 mm for N = 4 0.5 < D < 0.7 for N =1			Minor	2.5
COLOR UNIFORMITY	Rainbow color or Newton ring.			Minor	2.5
GLASS SCRATCHES	Obvious visible damage.			Minor	2.5
VIEWING ANGLE	Refer to individual acceptance specification			Minor	2.5
CONTRAST RATIO	Refer to individual acceptance specification			Minor	2.5
RESPONSE TIME	Refer to individual acceptance specification			Minor	2.5

5-6 Reliability

The LCD module should have no failure in the following reliability test.

TEST ITEM	*TEST CONDITIONS*	*NOTE*
HIGH TEMPERATURE OPERATION	60℃ , 200 hr.	NOTE
LOW TEMPERATURE STORAGE	-10℃ , 200 hr.	NOTE
HUMIDITY STORAGE	60℃ , 90%RH , 96hr.	NOTE
HIGH TEMPERATURE OPERATION	40℃, typical operating conditions, 200hr.	NOTE
TEMPERATURE CYCLING	-10℃~70℃ 10min. between each step temp. 50min. at each step temp. 5 cycles.	NOTE
MECHANICAL VIBRATION	10~55Hz sweep, 3G. amp1 =10mm(max) XYZ for 10min. Each.	NOTE

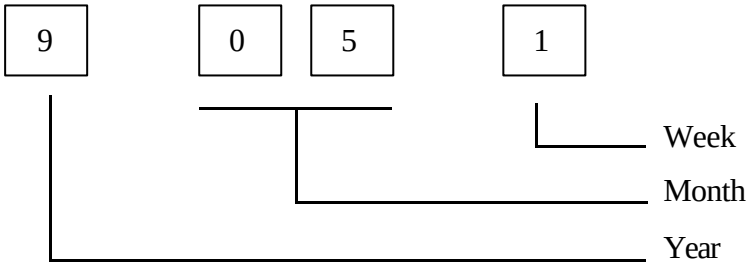
NOTE1: The module should not have condensation of water on the module.

NOTE2: The module shelled be inspected after 1 hour storage in normal conditions (15~35℃, 45~65%RH).

6. Designation of lot mark

6-1 Lot mark

Lot mark is consisted of 4 digit number.



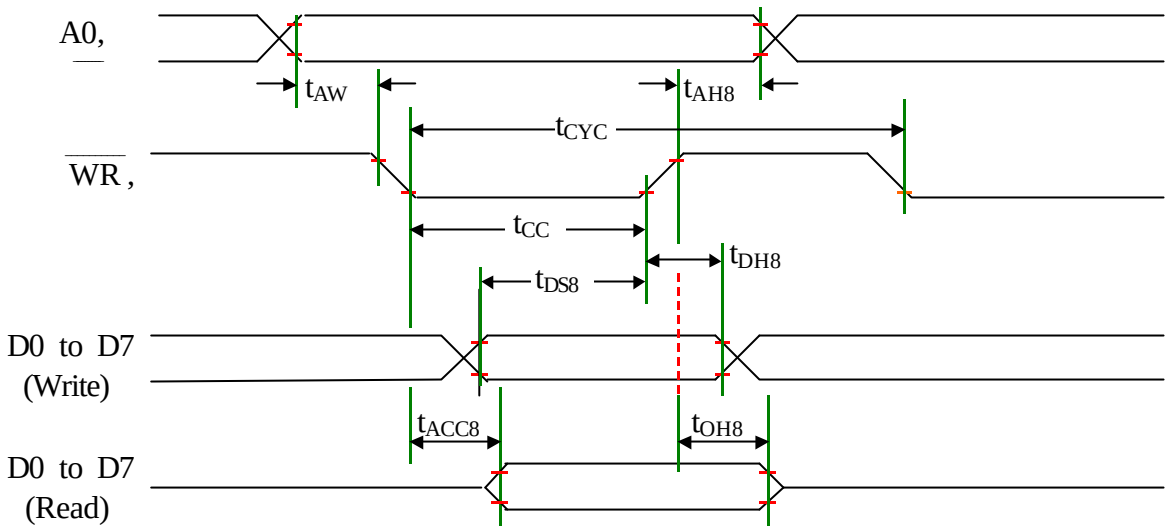
YEAR	FIGURE IN LOT MARK
1999	9
2000	0
2001	1
2002	2
2003	3
2004	4

MONTH	FIGURE IN LOT MARK	MONTH	FIGURE IN LOT MARK
Jan.	01	July	07
Feb.	02	Aug.	08
Mar.	03	Sept.	09
Apr.	04	Oct.	10
May.	05	Nov.	11
Jun.	06	Dec.	12

WEEK (DAY INCALENDAR)	FIGURE IN LOT MARK
1~7	1
8~14	2
15~21	3
22~28	4
29~31	5

7. Timing characteristics

8080 family interface timing



SED1335F

Ta = -20 to 75 deg. C

Signal	Symbol	Parameter	V_{DD} = 4.5 to 5.5V		V_{DD} = 2.7 to 4.5V		Unit	Condition
			min	max	min	max		
A0, $\overline{CS}$	t_{AH8}	Address hold time	10	—	10	—	ns	CL = 100 pF
	t_{AW8}	Address setup time	0	—	0	—	ns	
$\overline{WR}$, $\overline{RD}$	t_{CYC}	System cycle time	See note.	—	See note.	—	ns	
	t_{OC}	Strobe pulsewidth	120	—	150	—	ns	
D0 to D7	t_{DS8}	Data setup time	120	—	120	—	ns	
	t_{DH8}	Data hold time	5	—	5	—	ns	
	t_{ACC8}	$\overline{RD}$ access time	—	50	—	80	ns	
	t_{OH8}	Output disable time	10	50	10	55	ns	

Notes:

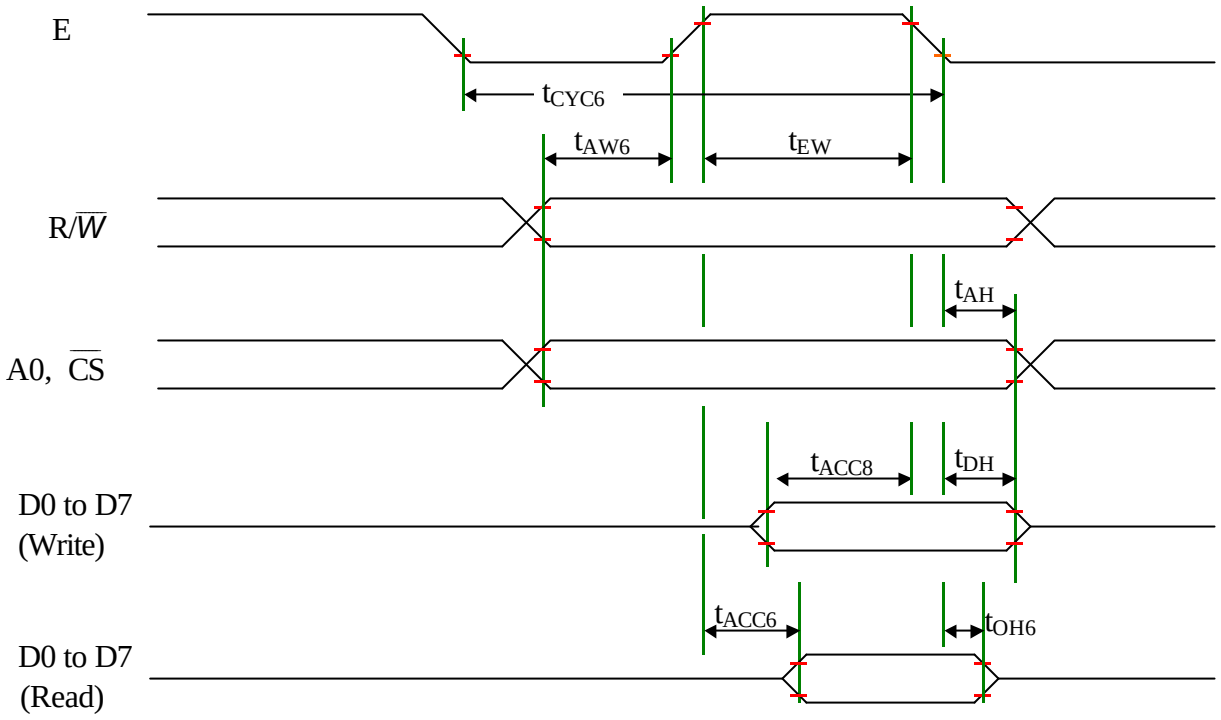
For memory control and system control commands:

$t_{CYC8} = 2t_C + t_{OC} + t_{CEA} + 75 > t_{ACV} + 245$

For all other commands:

$t_{CYC8} = 4t_C + t_{OC} + 30$

6800 family interface timing



Note

t_{CYC6} indicates the interval during which CS is LOW and E is HIGH.

SED1335F

Ta = -20 to 75 °C

Signal	*Symbol*	*Parameter*	*VDD = 4.5 to 5.5V*		*VDD = 2.7 to 4.5V*		*Unit*	*Condition*
			min	*max*	*min*	*max*		
A0, $\overline{CS}$ R/$\overline{W}$	t_{CYC6}	System cycle time	See note.	—	See note.	—	ns	CL = 100 pF
	t_{AW6}	Address setup time	0	—	10	—	ns	
	t_{AH6}	Address hold time	0	—	0	—	ns	
D0 to D7	t_{DS6}	Data setup time	100	—	120	—	ns	
	t_{DH6}	Data hold time	0	—	0	—	ns	
	t_{OH6}	Output disable time	10	50	10	75	ns	
	t_{ACC6}	Access time	—	85	—	130	ns	
E	t_{EW}	Enable pulsewidth	120	—	150	—	ns	

Note

For memory control and system control commands:

$t_{CYC6} = 2t_C + t_{EW} + t_{CEA} + 75 > t_{ACV} + 245$

For all other commands:

$t_{CYC6} = 4t_C + t_{EW} + 30$

8. Commands

8.1 The Command Set

Table 1. Command set

Class	Command	Code											Hex	Command description	Command read parameters	
		$\overline{RD}$	$\overline{WR}$	A0	D7	D6	D5	D4	D3	D2	D1	D0			Number of bytes	Section
System control	SYSTEM SET	1	0	1	0	1	0	0	0	0	0	0	40	Initialize device and display	8	8.2.1
	SLEEP IN	1	0	1	0	1	0	1	0	0	1	1	53	Enter standby mode	0	8.2.2
Display control	DISP ON/OFF	1	0	1	0	1	0	1	1	0	0	D	58, 59	Enable and disable display and display flashing	1	8.3.1
	SCROLL	1	0	1	0	1	0	0	0	1	0	0	44	Set display start address and display regions	10	8.3.2
	CSRFORM	1	0	1	0	1	0	1	1	1	0	1	5D	Set cursor type	2	8.3.3
	CGRAM ADR	1	0	1	0	1	0	1	1	1	0	0	5C	Set start address of character generator RAM	2	8.3.6
	CSRDIR	1	0	1	0	1	0	0	1	1	CD 1	CD 0	4C to 4F	Set direction of cursor movement	0	8.3.4
	HDOT SCR	1	0	1	0	1	0	1	1	0	1	0	5A	Set horizontal scroll position	1	8.3.7
	OVLAY	1	0	1	0	1	0	1	1	0	1	1	5B	Set display overlay format	1	8.3.5
Drawing control	CSRW	1	0	1	0	1	0	0	0	1	1	0	46	Set cursor address	2	8.4.1
	CSRR	1	0	1	0	1	0	0	0	1	1	1	47	Read cursor address	2	8.4.2
Memory control	MWRITE	1	0	1	0	1	0	0	0	0	1	0	42	Write to display memory	—	8.5.1
	MREAD	1	0	1	0	1	0	0	0	0	1	1	43	Read from display memory	—	8.5.2

Notes

1. In general, the internal registers of the SED1335 series are modified as each command parameter is input.

   However, the microprocessor does not have to set all the parameters of a command and may send a new command before all parameters have been input. The internal registers for the parameters that have been input will have been changed but the remaining parameter registers are unchanged.

   2-byte parameters (where two bytes are treated as 1 data item) are handled as follows:

   a. CSRW, CSRR: Each byte is processed individually. The microprocessor may read or write just the low byte of the cursor address.

   b. SYSTEM SET, SCROLL, CGRAM ADR: Both parameter bytes are processed together. if the command is changed after half of the parameter has been input, the single byte is ignored.

2. APL and APH are 2-byte parameters, but are treated as two 1-byte parameters.

8.2 System Control commands

8.2.1 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 SED1335 series, an incorrect SYSTEM SET command may cause other commands to operate incorrectly.

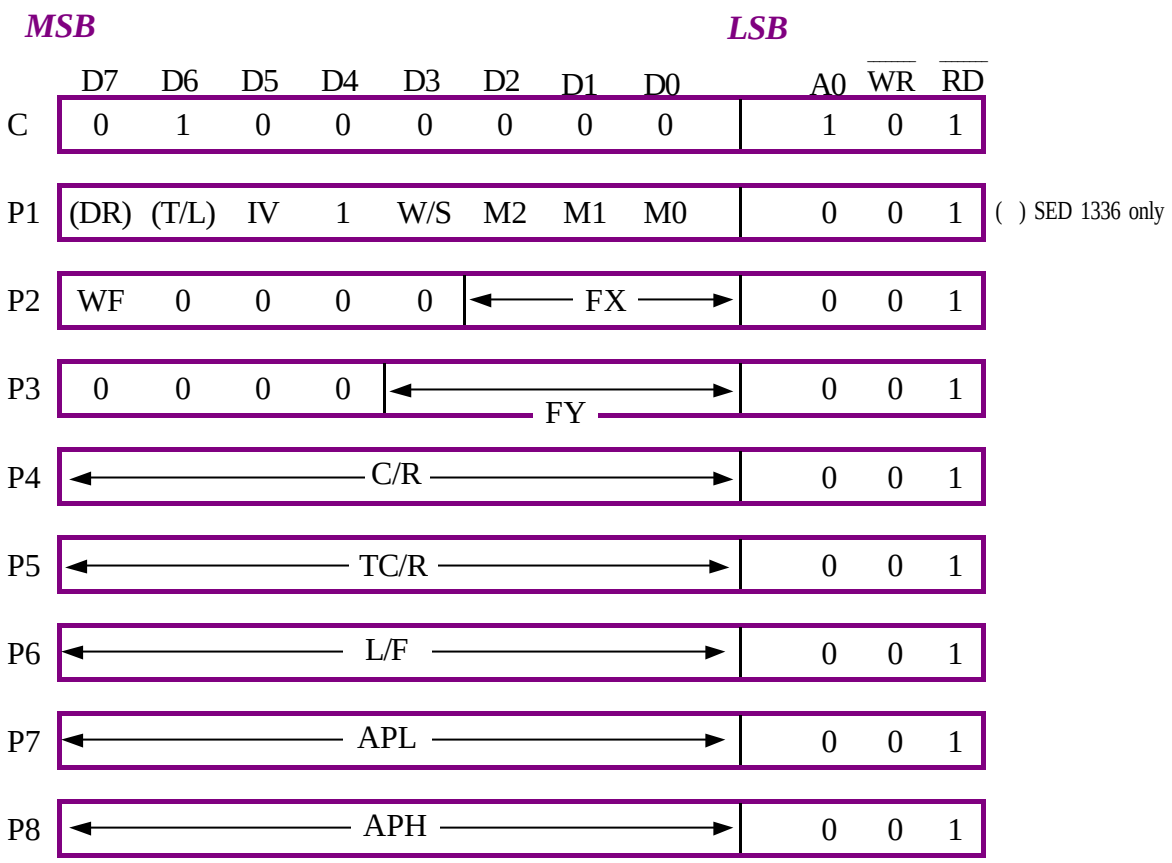


Figure 1. SYSTEM SET instruction

8.2.1.1. 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.

8.2.1.2. MO

Selects the internal or external character generator ROM. The internal character generator ROM contains 160, 5*7 pixel characters, as shown in figure 70. 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.

8.2.1.3. M1

Selects the memory configuration for user-definable characters. The CG RAM codes select one of the 64 codes shown in figure 46.

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.

8.2.1.4. M2

Selects 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 SED1335 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)

8.2.1.5. W/S

Selects the LCD drive method
W/S = 0: Single-panel drive
W/S = 1: Two-panel drive

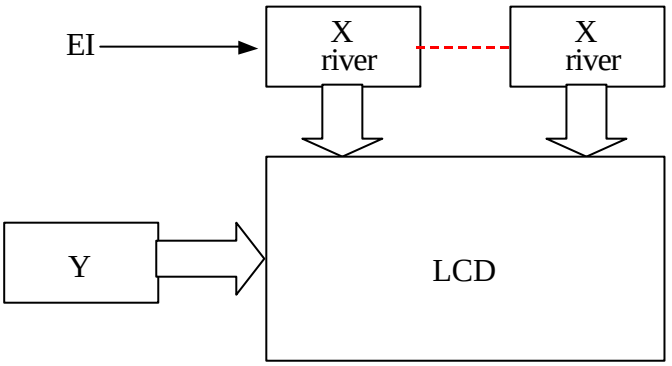


Figure 2. Single-panel display

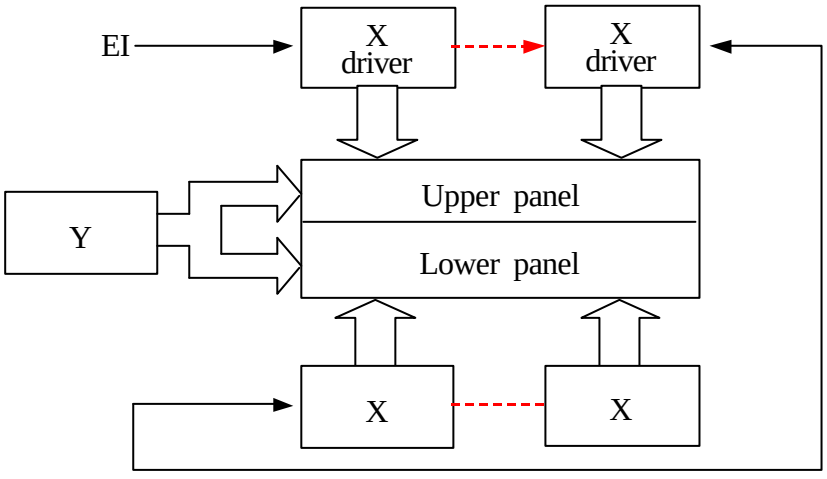


Figure 3. Above-and-below two-panel display

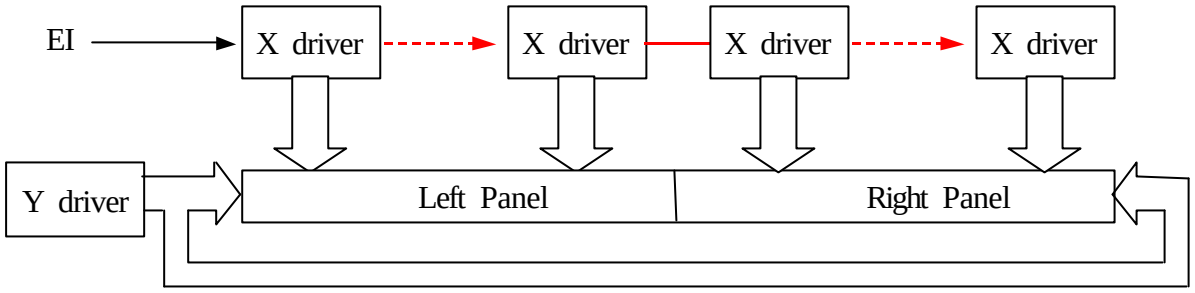


Figure 4. Left-and-right two-panel display

Table 2. LCD parameters

Parameter	*W/S = 0*		*W/S = 1*	
	IV = 1	*IV = 0*	*IV = 1*	*IV = 0*
C/R	C/R	C/R	C/R	C/R
TC/R	TC/R	TC/R (See ntoe 1.)	TC/R	TC/R
L/F	L/F	L/F	L/F	L/F
SL1	00H to L/F	00H to L/F + 1 (See Note 2.)	(L/F)/2	(L/F)/2
SL2	00H to L/F	00H to L/F + 1 (See Note 2.)	(L/F)/2	(L/F)/2
SAD1	First screen block	First screen block	First screen block	First screen block
SAD2	Second screen block	Second screen block	Second screen block	Second screen block
SAD3	Third screen block	Third screen block	Third screen block	Third screen block
SAD4	Invalid	Invalid	fourth screen block	fourth screen block
Cursor movement range	Continuous movement over whole screen		Above-and-below configuration: continuous movement over whole screen	

Notes

1. See table 26 for further details on setting the C/R and TC/R parameters when using the HDOT SCR command.
2. The value of SL when IV = 0 is equal to the value of SL when IV = 1, plus one.

8.2.1.6. 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 SED1335 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.

See section 10.5 for information on scrolling.

IV = 0: Screen top-line correction

IV = 1: No screen top-line correction

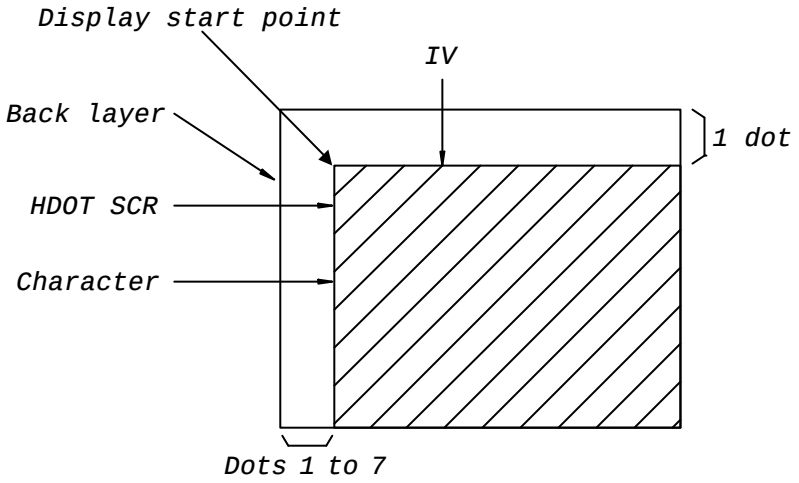


Figure 5. IV and HDOT SCR adjustment

8.2.1.7 FX

Defines 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. Note that the maximum character width in TV mode is eight pixels.

Table 3. Horizontal character size selection

FX					*[FX] character width (pixels)*
HEX	*D3*	*D2*	*D1*	*D0*	
00	0	0	0	0	1
01	0	0	0	1	2
↓	↓	↓	↓	↓	↓
07	0	1	1	1	8

Since the SED1335 series handles display data in 8-bit units, characters larger than 8 pixels wide must be formed from 8-pixel segments. As figure 6 shows, the remainder of the second eight bits are not displayed.

This also applies to the second screen layer.

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.

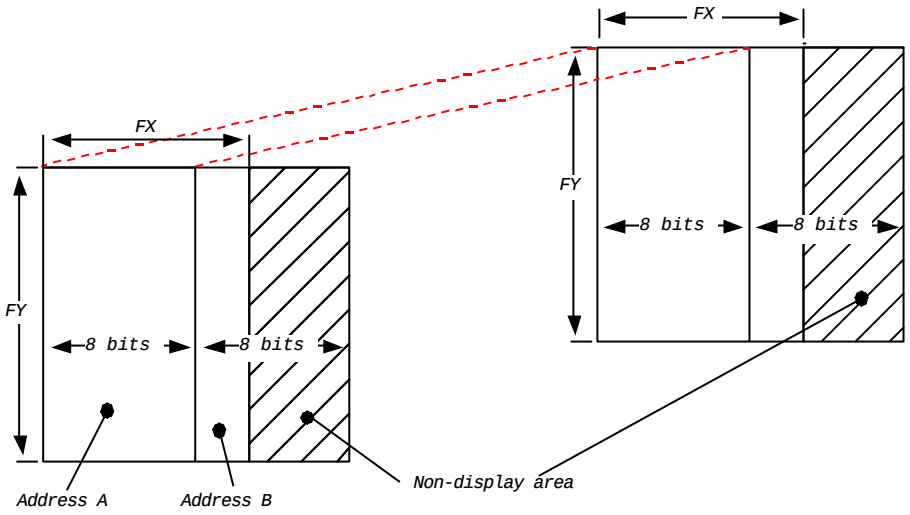


Figure 6. FX and FY display addresses

8.2.1.8. WF

Selects 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.

8.2.1.9 FY

Sets 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.

Table 4. Vertical character size selection

FY					*[F/Y] character height (Pixels)*
HEX	***D3***	***D2***	***D1***	***D0***	
00	0	0	0	0	1
01	0	0	0	1	2
↓	↓	↓	↓	↓	↓

FY					[F/Y] character height (Pixels)
HEX	D3	D2	D1	D0	
07	0	1	1	1	8
↓	↓	↓	↓	↓	↓
0E	1	1	1	0	15
0F	1	1	1	1	16

8.2.1.10 C/R

Sets 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.

Table 5. Display line address range

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

8.2.1.11. TC/R

Sets 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}.

Table 6. Line length selection

FY									[F/Y] 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

8.2.1.12. L/F

Sets 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.

Table 7. Frame height selection

FY									[F/Y] line 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

If W/S is set to 1, selection two-screen display, the number of lines must be even and L/F must,
therefore, be an odd number.

8.2.1.13. AP

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

APL	AP7	AP6	AP5	AP4	AP3	AP2	AP1	AP0
APH	AP15	AP14	AP13	AP12	AP11	AP10	AP9	AP8

Figure 7. AP parameters

Table 8 .Hrizontal address range

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

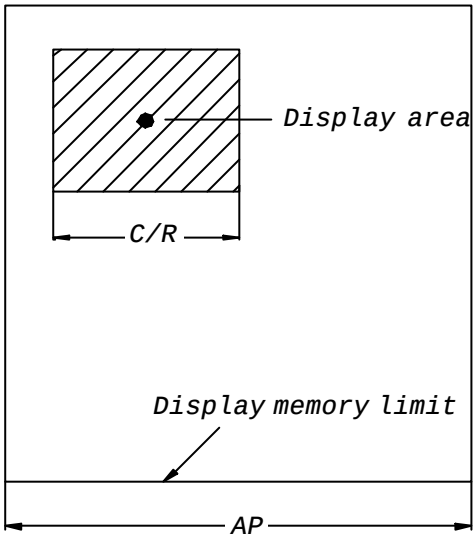


Figure 8. AP and C/R relationship

8.2.2 SLEEP IN

Puts the device into the sleep state. This command has no parameter bytes. At least one blank frame after receiving this command, the SED1330 series 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 SED1330 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 SED1330 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.

	MSB							LSB
C	0	1	0	1	0	0	1	1

Figure 9. SLEEP IN instruction

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 SED1335 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 pull-down resistors on the bus will force these lines to a known state.

8.3 Display Control Commands

8.3.1 DISP ON/OFF

Turns 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.

	MSB							LSB
C	0	1	0	1	1	0	0	D
P1	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0

Figure 10. DISP ON/OFF parameters

8.3.1.1. D

Turns 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

8.3.1.2 FC

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

Table 9 Cursor flash rage selection

FC1	*FC0*	*Cursor display*	
0	0	OFF (blank)	
0	1	ON	No flashing
1	0		Flash at f_{FR}/32 Hz (approx. 2 Hz)
1	1		Flash at f_{FR}/64 Hz (approx. 1 Hz)

Note

As the MWRITE command always enables the cursor, the cursor position can be checked even when performing consecutive writes to display memory while the cursor is flashing.

8.3.1.3. FP

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

The display attributes are as follows:

Table 10. Screen block attribute selection

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 f_{FR}/32 Hz (approx. 2 Hz)
1	1		Flash at f_{FR}/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.

8.3.2 SCROLL

8.3.2.1 C

Sets 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 figure 11.

	MSB							LSB	
C	0	1	0	0	0	1	0	0	
P1	A7	A6	A5	A4	A6	A2	A1	A0	(SAD 1L)
P2	A15	A14	A13	A12	A11	A10	A9	A8	(SAD 1H)
P3	L7	L6	L5	L4	L3	L2	L1	L0	(SL 1)
P4	A7	A6	A5	A4	A6	A2	A1	A0	(SAD 2L)
P5	A15	A14	A13	A12	A11	A10	A9	A8	(SAD 2H)
P6	L7	L6	L5	L4	L3	L2	L1	L0	(SL 2)
P7	A7	A6	A5	A4	A6	A2	A1	A0	(SAD 3L)
P8	A15	A14	A13	A12	A11	A10	A9	A8	(SAD 3H)
P9	A7	A6	A5	A4	A6	A2	A1	A0	(SAD 4L)
P10	A15	A14	A13	A12	A11	A10	A9	A8	(SAD 4H)

Figure 11. SCROLL instruction parameters

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.

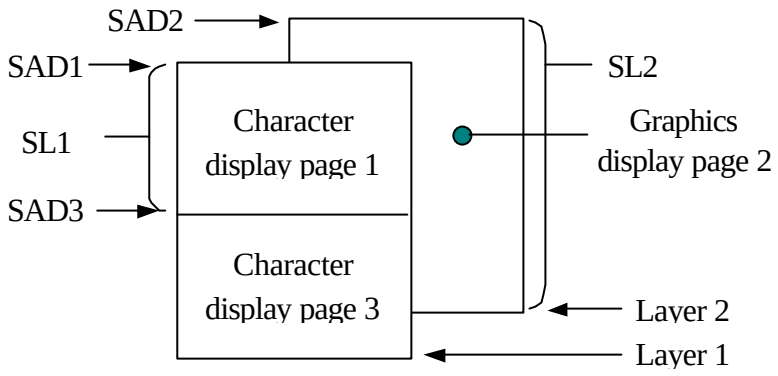
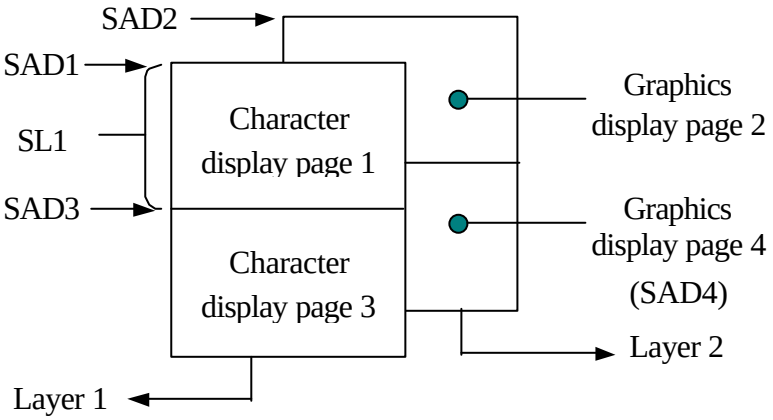
Table 11. Screen block start address selection

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

8.3.2.2 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.

Table 12. Text display mode

<table>
<tr><th>W/S</th><th>Screen</th><th>Fist layer</th><th>Second layer</th></tr>
<tr><td rowspan="4">0</td><td>First screen block</td><td>SAD1</td><td>SAD2</td></tr>
<tr><td>Second screen block</td><td>SL1</td><td>SL2</td></tr>
<tr><td>Third screen block (partitioned screen)</td><td colspan="2">SAD3 (See note 1.)
Set both SL1 and SL2 to L/F +1 if not using a partitioned screen</td></tr>
<tr><td colspan="3">Screen configuration example:
 
</td></tr>
<tr><td rowspan="4">1</td><td>Upper screen</td><td>SAD1, SL1</td><td>SAD2, SL2</td></tr>
<tr><td>Lower screen</td><td>SAD3 (See note 2.)</td><td>SAD4 (See note 2.)</td></tr>
<tr><td colspan="3">Set both SL1 and SL2 to ((L/F)/2 + 1))</td></tr>
<tr><td colspan="3">Screen configuration example:
 
</td></tr>
</table>

Notes

1. SAD3 has the same value as either SAD1 or SAD2, whichever has the least number of lines (set by SL1 and SL2).
2. Since the parameters corresponding to SL3 and SL4 are fixed by L/F, they do not have to be set in this mode.

Table 13. Graphics display mode

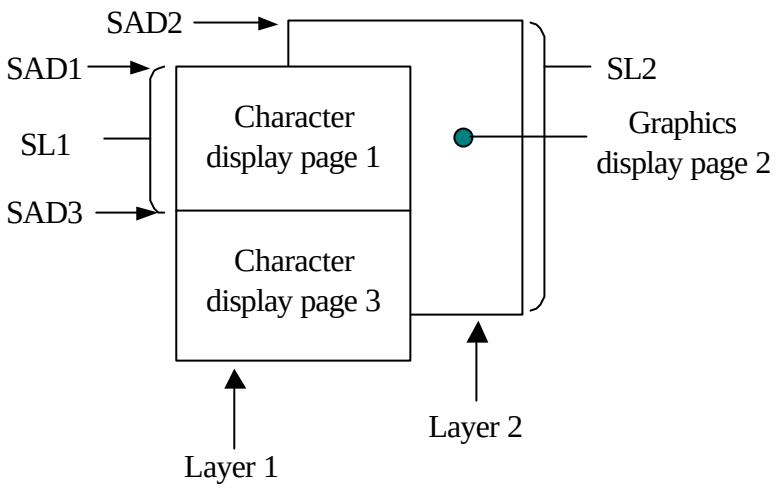
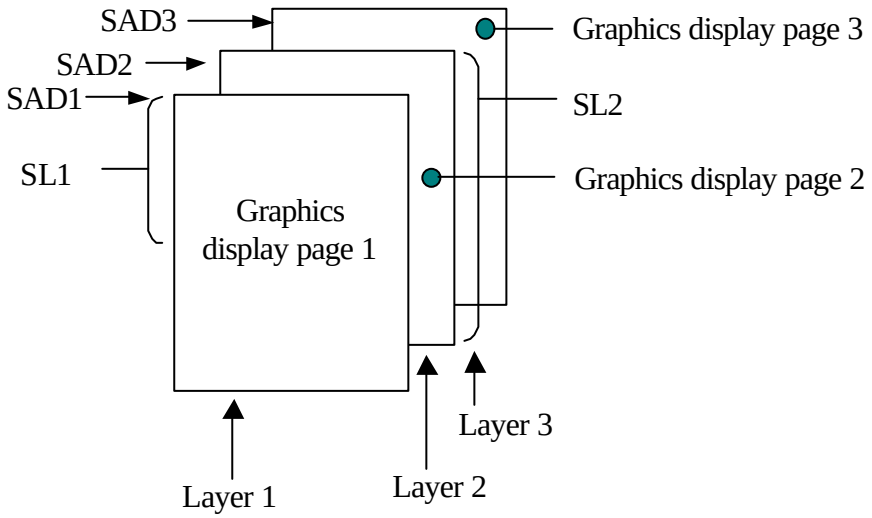
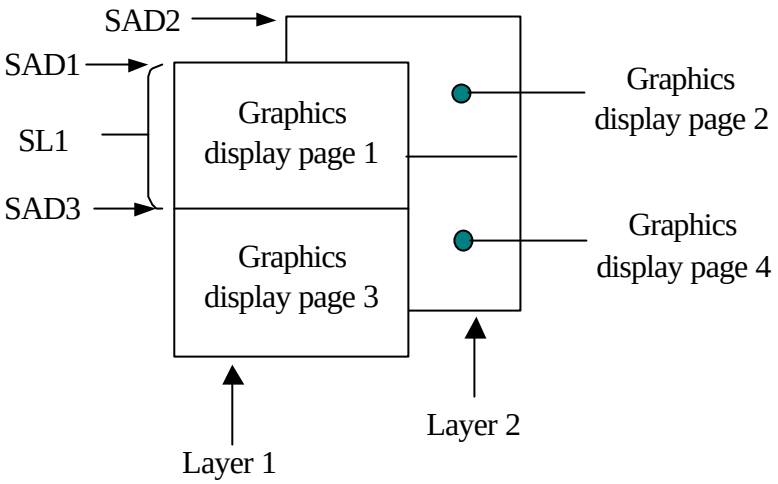
<table>
<tr><th>W/S</th><th>Screen</th><th>Fist layer</th><th>Second layer</th><th>Third layer</th></tr>
<tr><td rowspan="3">0</td><td>Two-layer composition</td><td>SAD1
SL1</td><td>SAD2
SL2</td><td></td></tr>
<tr><td>Upper screen</td><td colspan="2">SAD3 (See note 3.)
Set both SL1 and SL2 to L/F + 1 if not using a partitioned screen</td><td></td></tr>
<tr><td colspan="4">Screen configuration example:
 
</td></tr>
<tr><td rowspan="2">0</td><td>Three-layer configuration</td><td>SAD1
SL1 = L/F + 1</td><td>SAD2
SL2 = L/F + 1</td><td>SAD3
—</td></tr>
<tr><td colspan="4">Screen configuration example:
 
</td></tr>
</table>

Table 13. Graphics display mode (continued)

W/S	Screen	Fist layer	Second layer	Third layer
1	Upper screen	SAD1 SL1	SAD2 SL2	—
	Lower screen	SAD3 (See note 2.)	SAD4 (See note 2.)	—
	Set both SL1 and SL2 to ((L/F)/2 + 1)			
	Screen configuration example: (See note 3.)  			

Notes

1. SAD3 has the same value as either SAD1 or SAD2, whichever has the least number of lines (set by SL1 and SL2).
2. Since the parameters corresponding to SL3 and SL4 are fixed by L/F, they do not have to be set.
3. If, and only if, W/S = 1, the differences between SL1 and (L/F + 1)/2, and between SL2 and (L/F + 1)/2, are blanked.

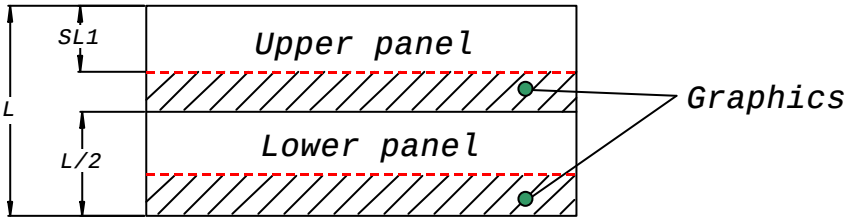


Figure 12. Two-panel display height

8.3.3 CSRFORM

Sets 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.

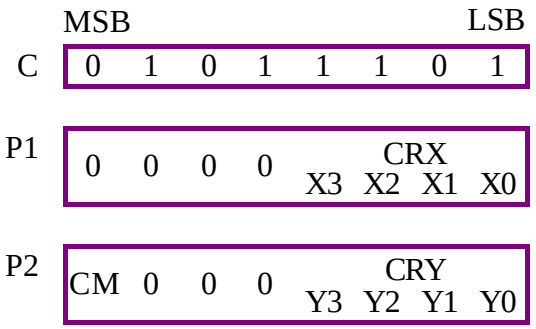


Figure 13. CSRFORM parameter bytes

8.3.3.1 CRX

Sets 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.

Table 14. Horizontal cursor size selection

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

8.3.3.2. CRY

Sets 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.

Table 15. Cursor height selection

CRY					[CRY] cursor height (lines)
HEX	Y3	Y2	Y1	Y0	
0	0	0	0	0	lllegal
1	0	0	0	1	2
↓	↓	↓	↓	↓	↓
8	1	0	0	0	9

CRY					[CRY] cursor height (lines)
HEX	Y3	Y2	Y1	Y0	
↓	↓	↓	↓	↓	↓
E	1	1	1	0	15
F	1	1	1	1	16

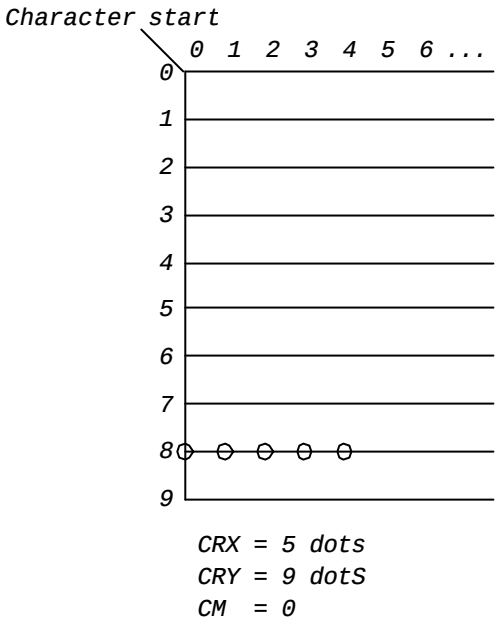


Figure 14. Cursor size and position

8.3.3.3. CM

Sets the cursor shape. Always set CM to 1 when in graphics mode.
CM = 0: Underscore cursor
CM = 1: Block cursor

8.3.4. CSRDIR

Sets 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.

	MSB							LSB
C	0	1	0	0	1	1	CD1	CD2

Figure 15. CSRDIR parameters

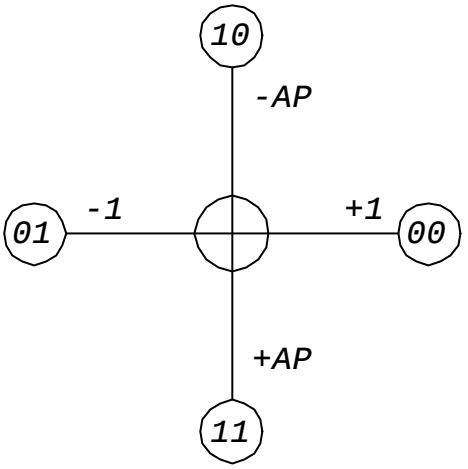


Figure 16. Cursor direction

Table 16 Cursor shift 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 ≥ 9, the cursor address increment must be preset for movement in character units. See section 9 .3.

8.3.5. OVLAY

Selects layered screen composition and screen text/graphics mode.

	MSB							LSB
C	0	1	0	1	1	0	1	1

P1	0	0	0	OV	DM2	DM1	MX1	MX0

Figure 17. OVLAY parameters

8.3.5.1. 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.

Table 17. Composition method selection

MX1	*MX0*	*Function*	*Composition method*	*Applications*
0	0	L1∪L2∪L3	OR	Underlining, rules, mixed text and graphics
0	1	(L1⊕L2)∪L3	Exclusive-OR	Inverted characters, flashing regions, underlining
1	0	(L1∩L2)∪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)

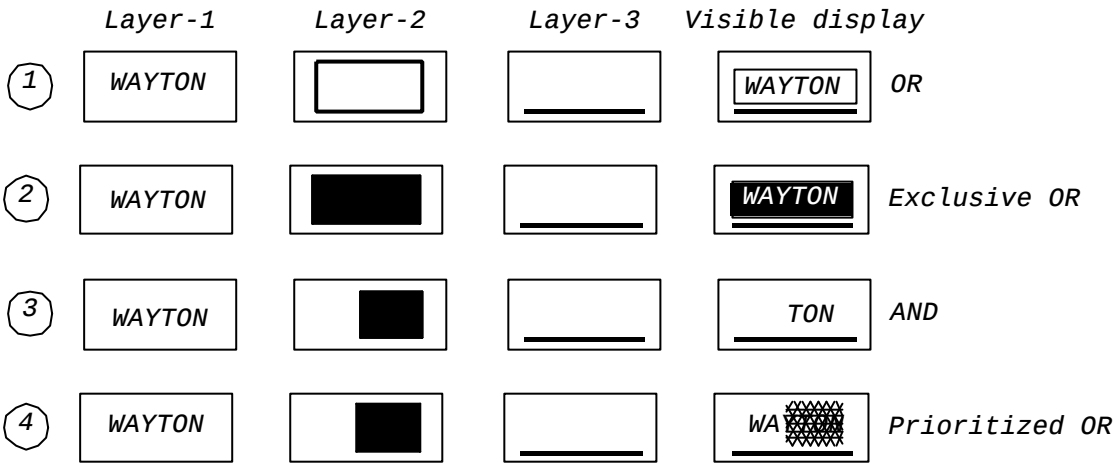


Figure 18. Combined layer display

Note

L1: Not flashing

L2: Flashing at 1 Hz

L3: Flashing at 2 Hz

8.3.5.2. 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.

8.3.5.3. 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.

8.3.6. CGRAM ADR

Specifies the CG RAM start address.

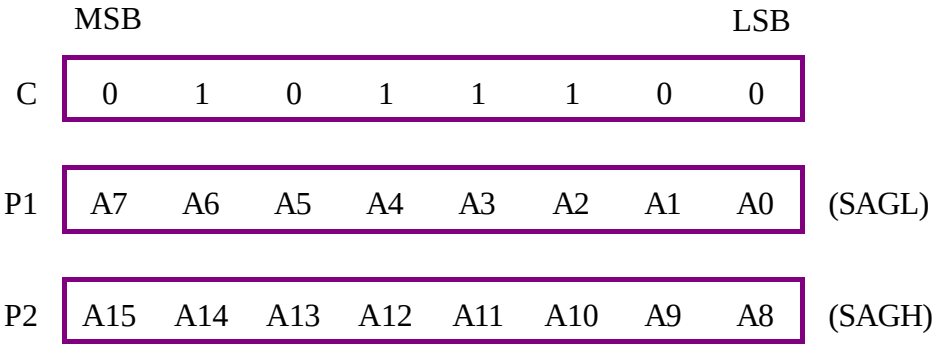


Figure 19. CGRAM ADR parameters

Note

See section 11 for information on the SAG parameters.

8.3.7. 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.

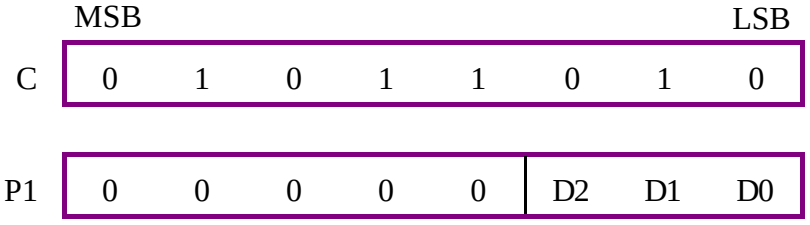


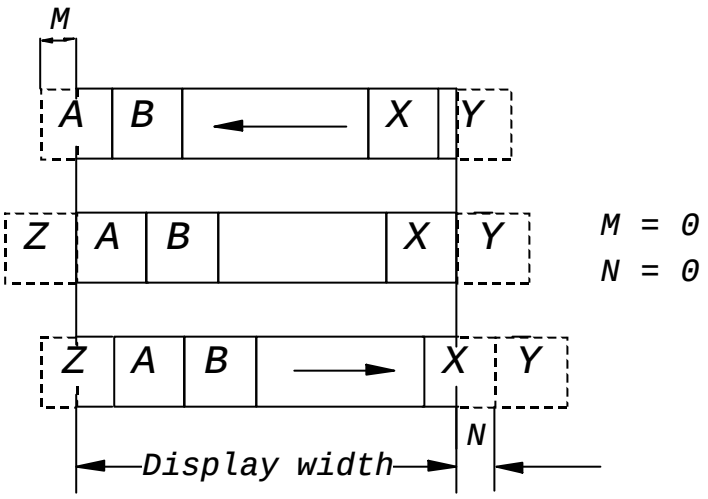
Figure 20. HDOT SCR parameters

8.3.7.1. 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 SED1335 series. See Section 9.5 for more information on scrolling the display.

Table 18. Scroll step selection (continued)

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 21. Horizontal scrolling

8.4 Drawing Control Commands

8.4.1. CSRW

The 16-bit cursor address register contains the display memory address of the data at the cursor position as shown in Figure 22.

Note that the microprocessor cannot directly access the display memory.

The MREAD and MWRITE commands use the address in this register.

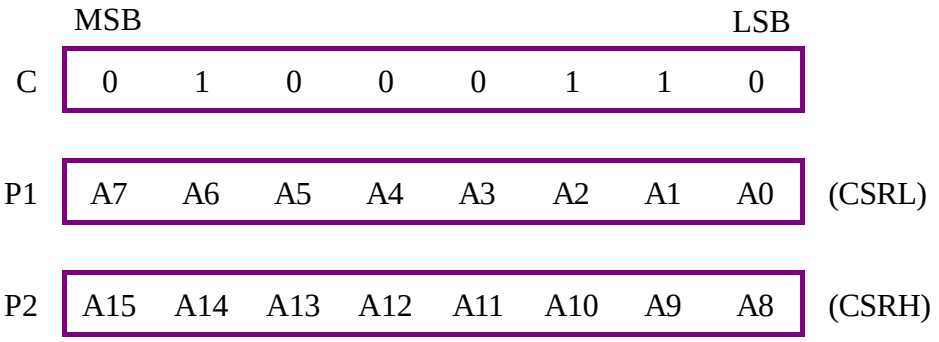


Figure 22. CSRW parameters

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.

8.4.2. CSRR

Reads 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.

If a new address is not set, display memory accesses will be from the last set address or the address after previous automatic increments.

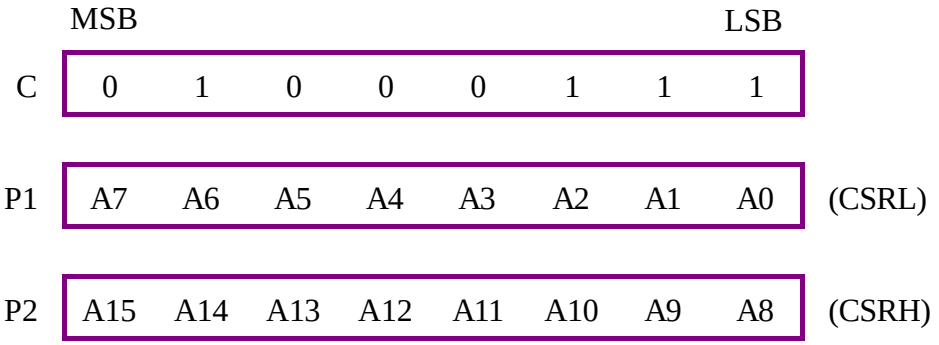


Figure 23. CSRR parameters

8.5. Memory Control Commands

8.5.1 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 SED1335 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.

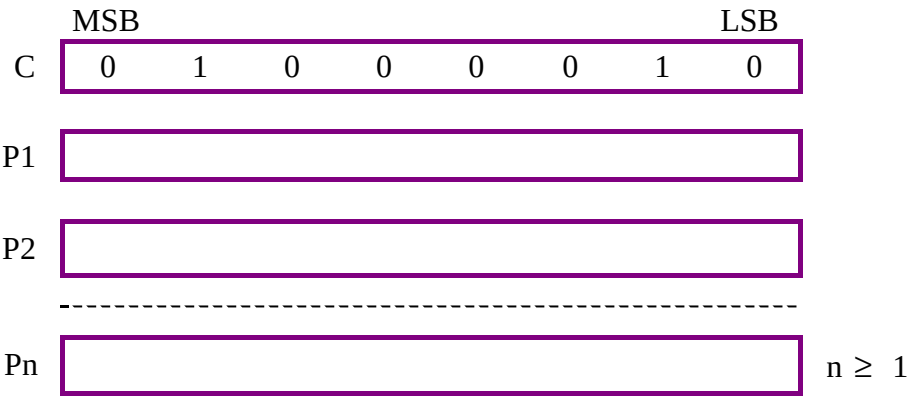


Figure 24. MWRITE parameters

Note

P1, P2,…, Pn: display data.

8.5.2. MREAD

Puts the SED1335 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.

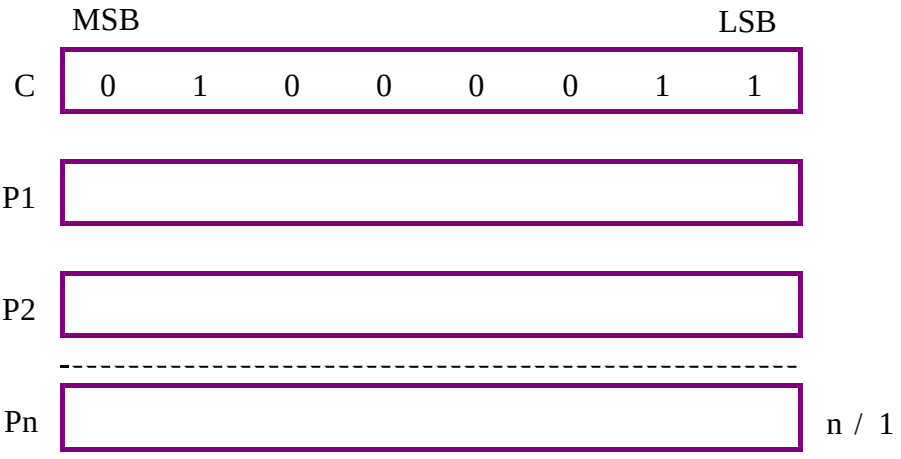


Figure 25. MREAD parameters

8.5.3 Status flag

The SED1335 series has a single bit status flag.

D6: X line standby

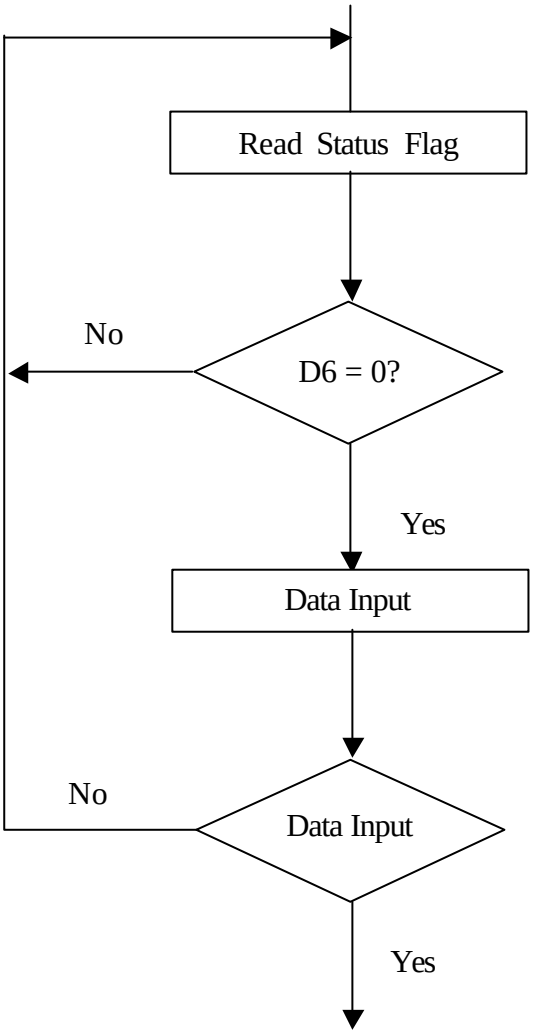
$\overline{RD}$	$\overline{WR}$	A0	D7							D0
0	1	0	X	D6	X	X	X	X	X	X

X: Don't care

If D6=0: Period of retrace lines

If D6=0: Period of retrace lines

The D6 status flag is HIGH for the TC/R-C/R cycles at the end of each line where the SED1335 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.



Flowchart for busy flag checking

<Timing To Be Observed For Avoiding SED 1330 Series Write Noise>

9. Display control Functions

9.1 Character Configuration

The origin of each character bitmap is in the top left corner as shown in Figure 29. Adjacent bits in each byte are horizontally adjacent in the corresponding character image.

Although the size of the bitmap is fixed by the character generator, the actual displayed size of the character field can be varied in both dimensions.

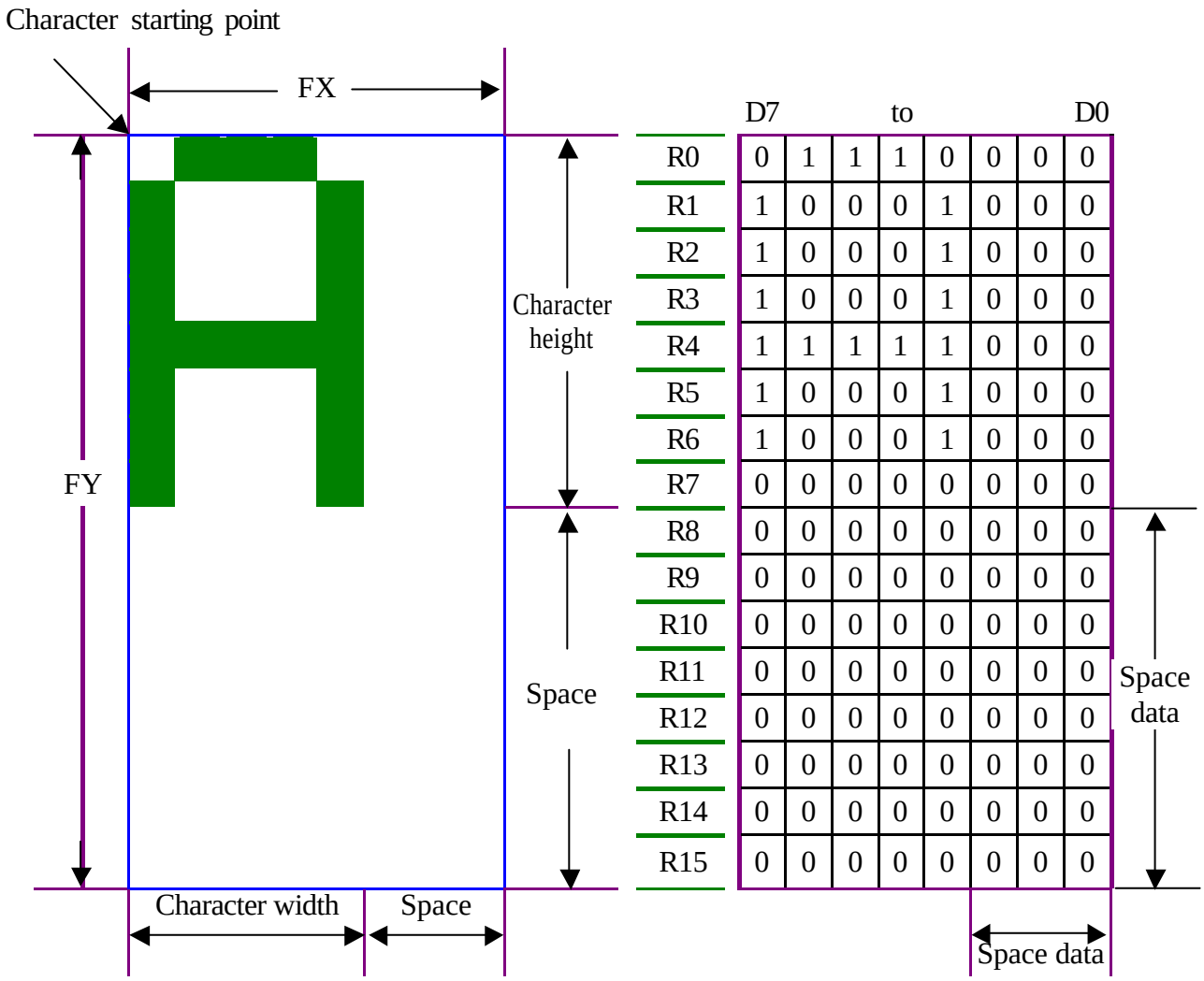


Figure 26. Example of character display ([FX] £ 8) and generator bitmap

If the area outside the character bitmap contains only zeros, the displayed character size can easily be increased by increasing FX and FY, as the zeros ensure that the extra space between displayed characters is blank.

The displayed character width can be set to any value up to 16 even if each horizontal row of the bitmap is two bytes wide.

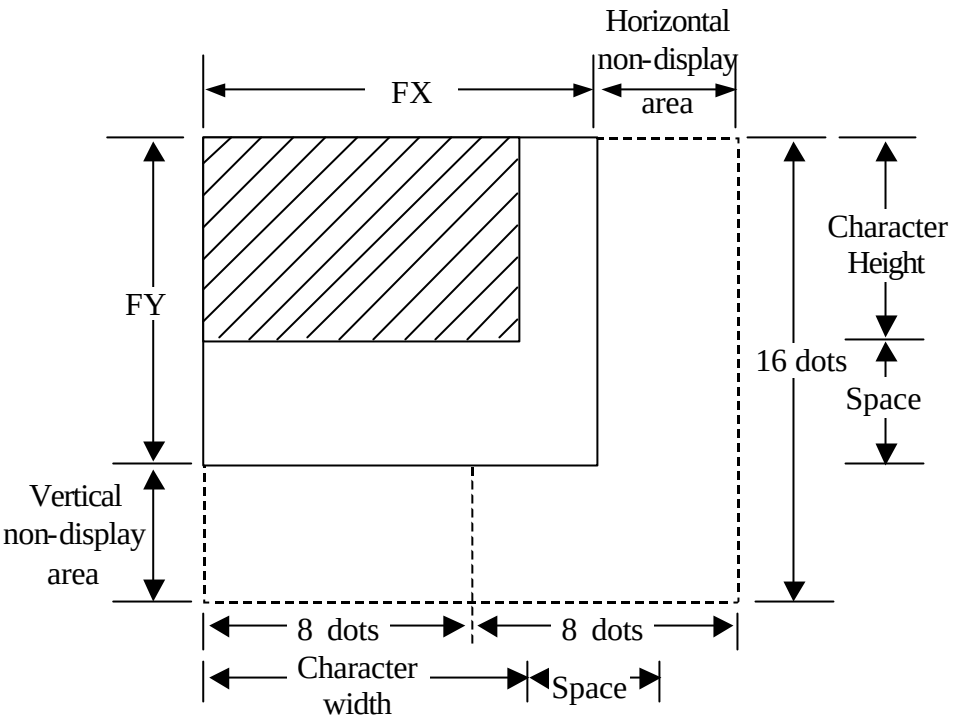


Figure 27. Character width greater than one byte wide ([FX] = 9)

Note

The SED1335 series does not automatically insert spaces between characters. If the displayed character size is 8 pixels or less and the space between character origins is nine pixels or more, the bitmap must use two bytes per row, even though the character image requires only one.

9.2. Screen Configuration

9.2.1. Screen Configuration

The basic screen configuration of the SED1335 series is as a single text screen or as overlapping text and graphics screens. The graphics screen uses eight times as much display memory as the text screen.

Figure 28 shows the relationship between the virtual screens and the physical screen.

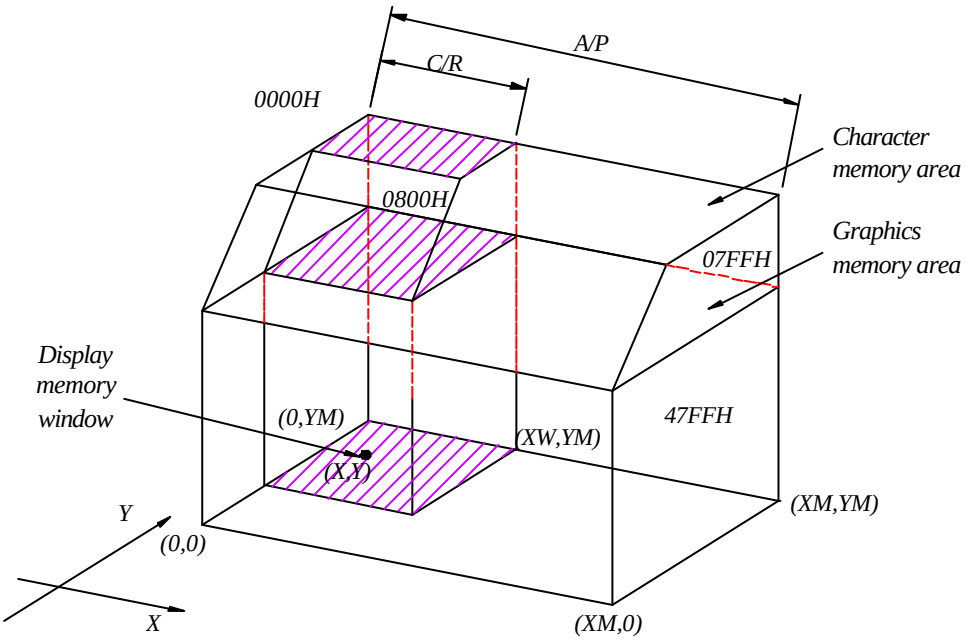


Figure 28. Virtual and physical screen

9.2.2. Display address scanning

The SED1335 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.

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.

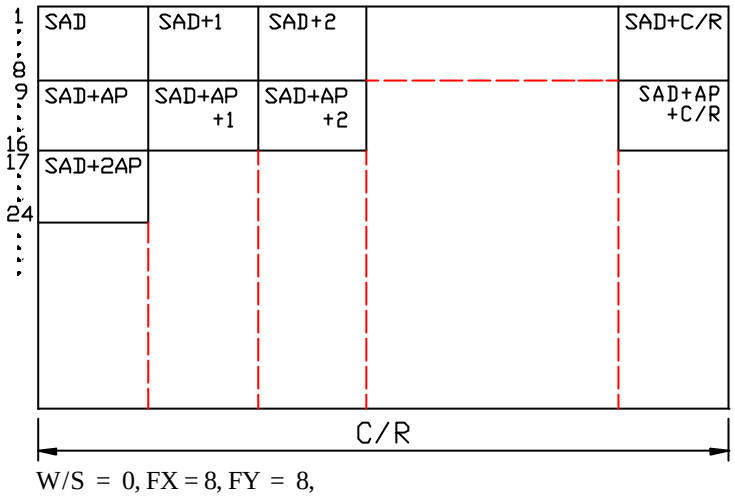


Figure 29. Character position parameters

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

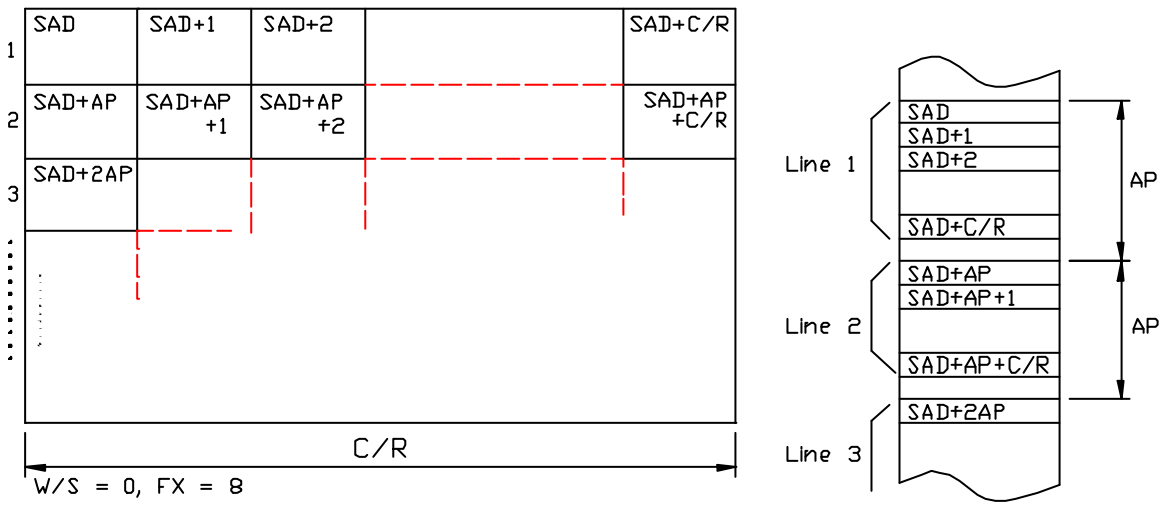


Figure 30. Character parameters VS. memory

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

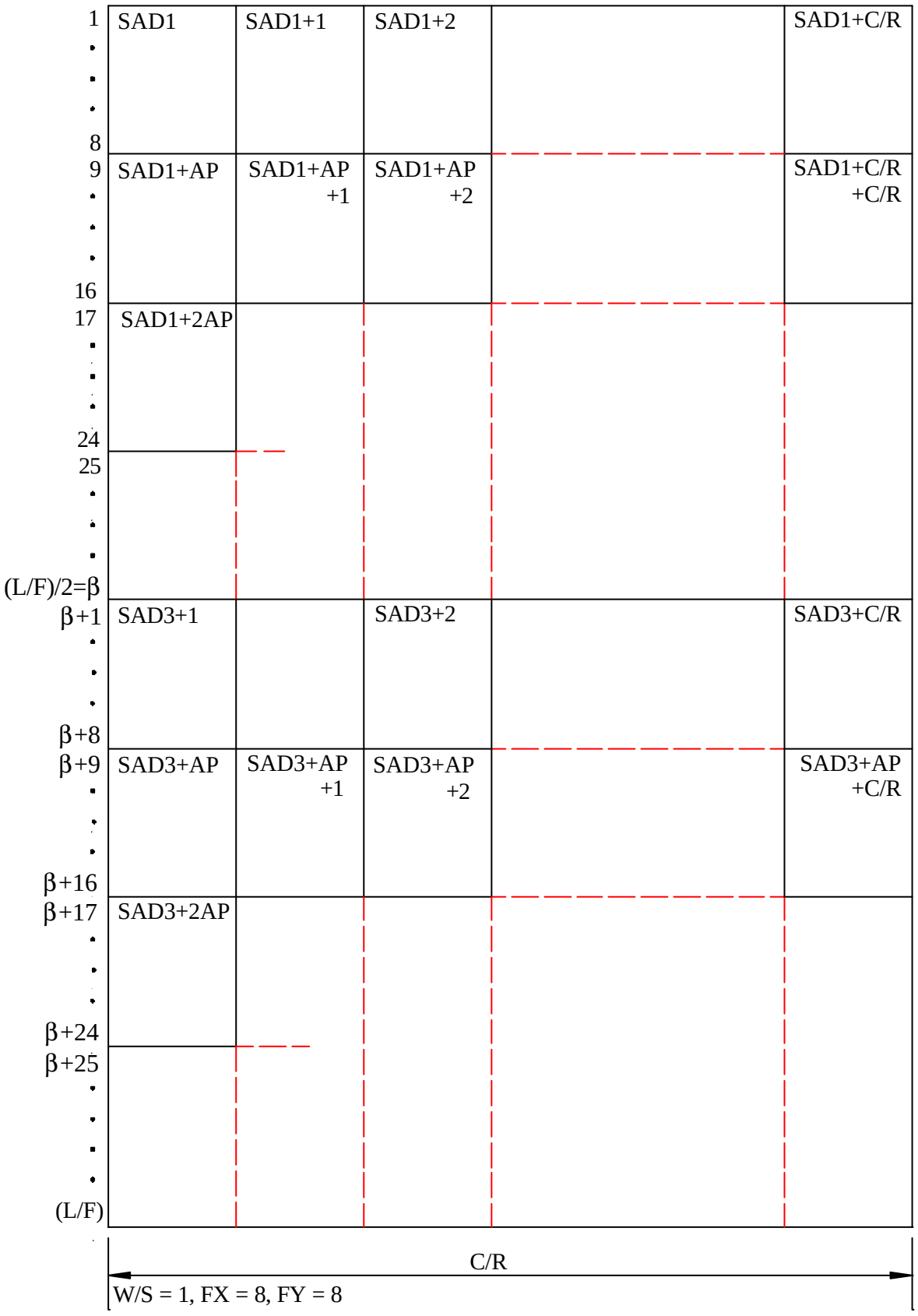


Figure 31. Two-panel display address indexing

Note: In two-panel drive, the SED1335 series reads line 1 and line β+1 as one cycle. The upper and lower panels are thus read alternately, one line at a time.

9.2.3. Display scan timing

Figure 32 shows the basic timing of the SED1335 series. One display memory read cycle takes nine periods of the system clock, Φ0(fosc). This cycle repeats (C/R+1) times per display line.

When reading, the display memory pauses at the end of each line for (TC/R-C/R) display memory read cycles, though the LCD drive signals are still generated. TC/R may be set to any value within the constraints imposed by C/R, fosc, $f_{FR,}$ and the size of the LCD panel, and it may be uaed to fine tune the frame frequency. The microprocessor may also use this pause to access the display memory data.

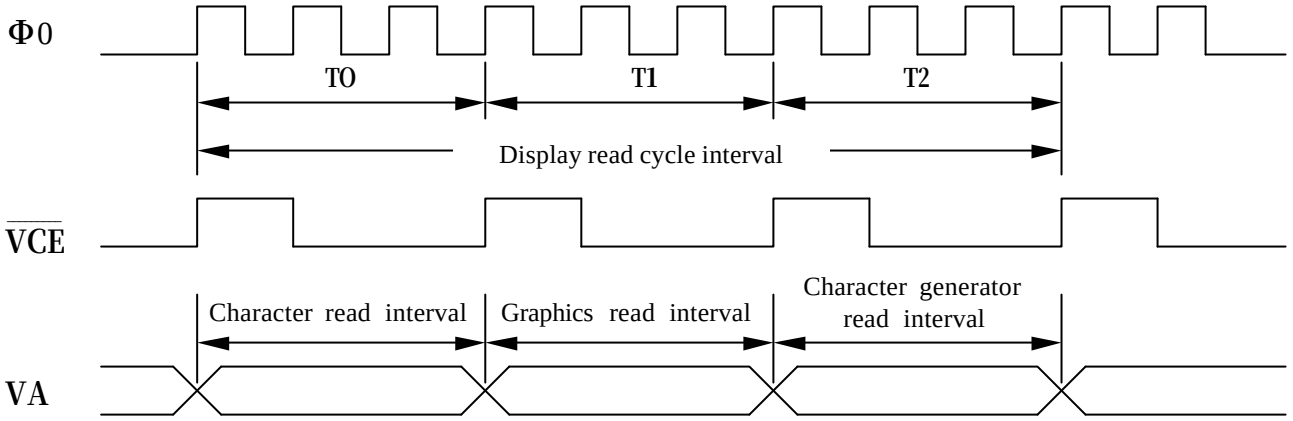


Figure 32. Display memory basic read cycle

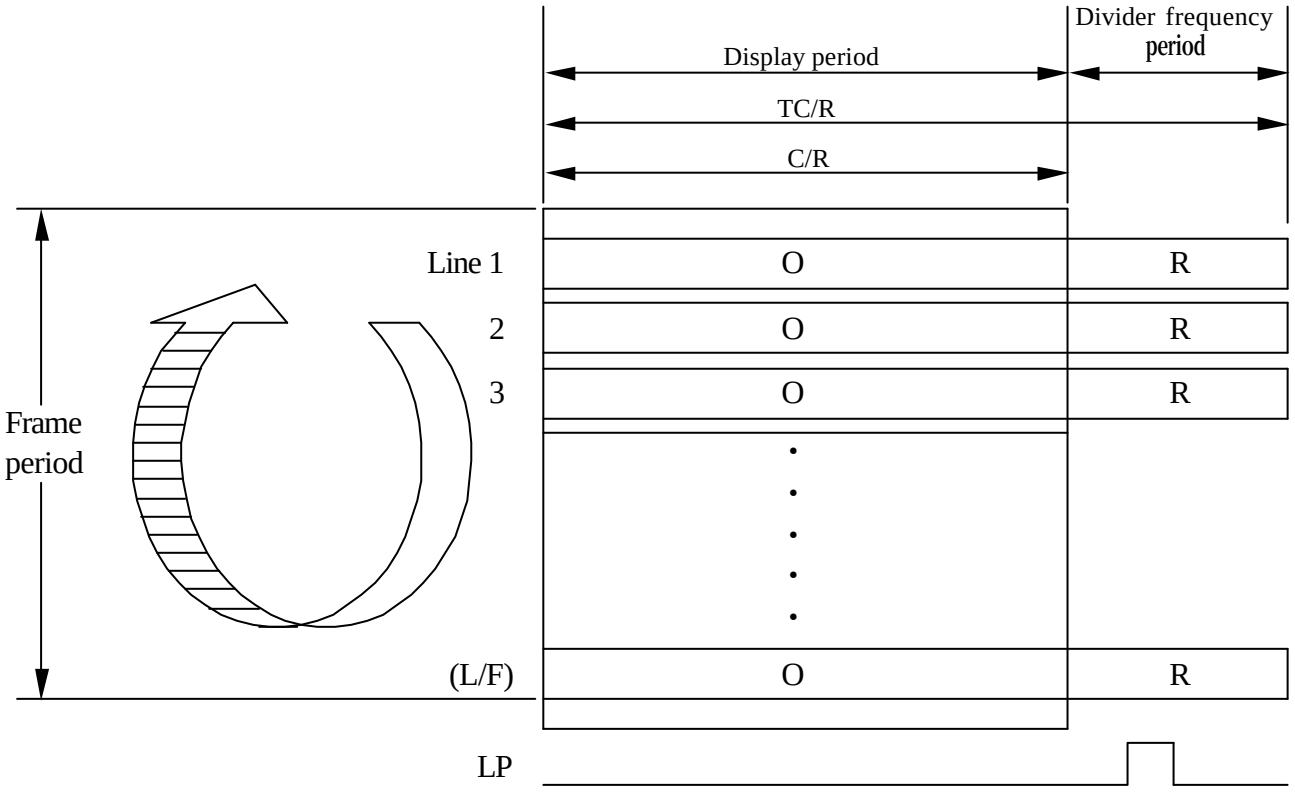


Figure 33. Relationship between TC/R and C/R

Note: The divider adjustment interval (R) applies to both the upper and lower screens even if W/S =1. In this case, LP is active only at the end of the lower screen' s display interval.

9.3 Cursor Control

9.3.1 Cursor register function

The SED1335 series cursor address register functions as both the displayed cursor position address register and the display memory access address register. When accessing display memory outside the actual screen memory, the address register must be saved before accessing the memory and restored after memory access is complete.

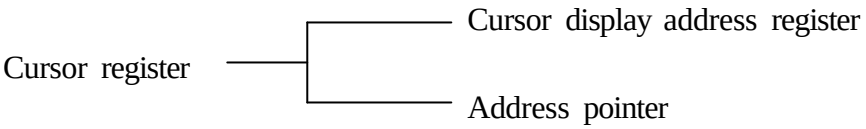


Figure 34. Cursor addressing

Note that the cursor may disappear from the display if the cursor address remains outside the displayed screen memory for more than a few hundred milliseconds.

9.3.2 Cursor movement

On each memory access, the cursor address register changes by the amount previously specified with CSRDIR, automatically moving the cursor to the desired location.

9.3.3 Cursor display layers

Although the SED1335 series can display up to three layers, the cursor is displayed in only one of these layers:

Two-layer configuration: First layer (L1)

Three-layer configuration: Third layer (L3)

The cursor will not be displayed if it is moved outside the memory for its layer, Layers may be swapped or the cursor layer moved within the display memory if it is necessary to display the cursor on a layer other than the present cursor layer.

Although the cursor is normally displayed for character data, the SED1335 series may also display a dummy cursor for graphical characters. This is only possible if the graphics screen is displayed, the text screen is turned off and the microprocessor generates the cursor control address.

D = 1 FC1 = 0 FC0 = 1	Cursor ON
FP1 = 0 FC0 = 0	Block screen 1 (character screen) OFF
FP3 = 0 FP2 = 1	Block screen 2 (graphics screen) ON

Figure 35 Cursor display layers

Consider the example of displaying Chinese characters on a graphics screen. To write the display data, the cursor address is set to the second screen block, but the cursor is not displayed. To display the cursor, the cursor address is set to an address within the blank text screen block.

Since the automatic cursor increment is in address units, not character units, the controlling microprocessor must set the cursor address register when moving the cursor over the graphical characters.

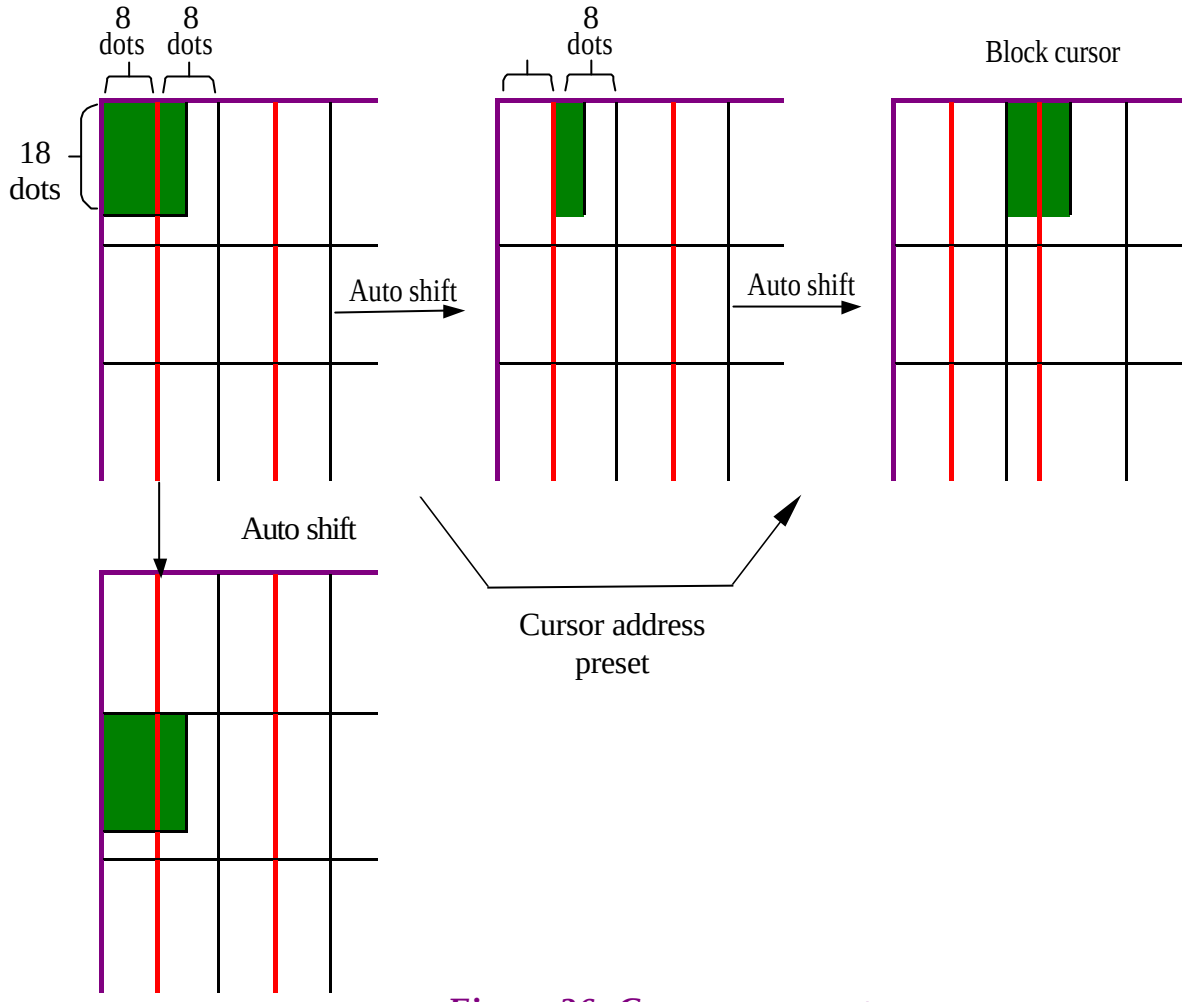


Figure 36. Cursor movement

If no text screen is displayed, only a bar cursor can be displayed at the cursor address.

If the first layer is a mixed text and graphics screen and the cursor shape is set to a block cursor, the SED1335 series automatically decides which cursor shape to display. On the text screen it displays a block cursor, and on the graphics screen, a bar cursor.

9.4 Memory to Display Relationship

The SED1335 series supports virtual screens that are larger than the physical size of the LCD panel address range, C/R. A layer of the SED1335 series can be considered as a window in the larger virtual screen held in display memory. This window can be divided into two blocks, with each block able to display a different portion of the virtual screen.

This enables, for example, one block to dynamically scroll through a data area while the other acts as a status message display area. See Figures 37 and 38.

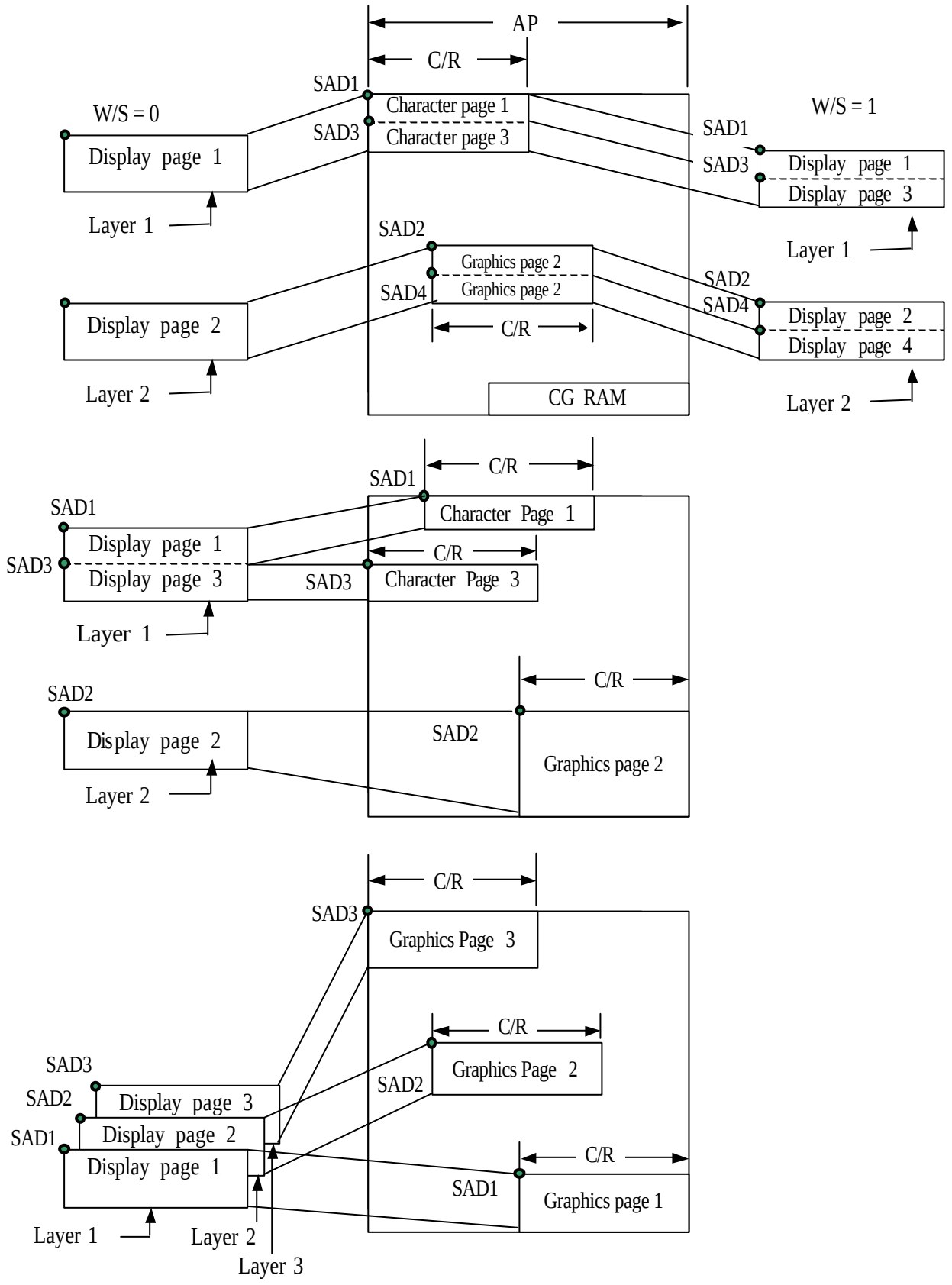


Figure 37. Display layers and memory

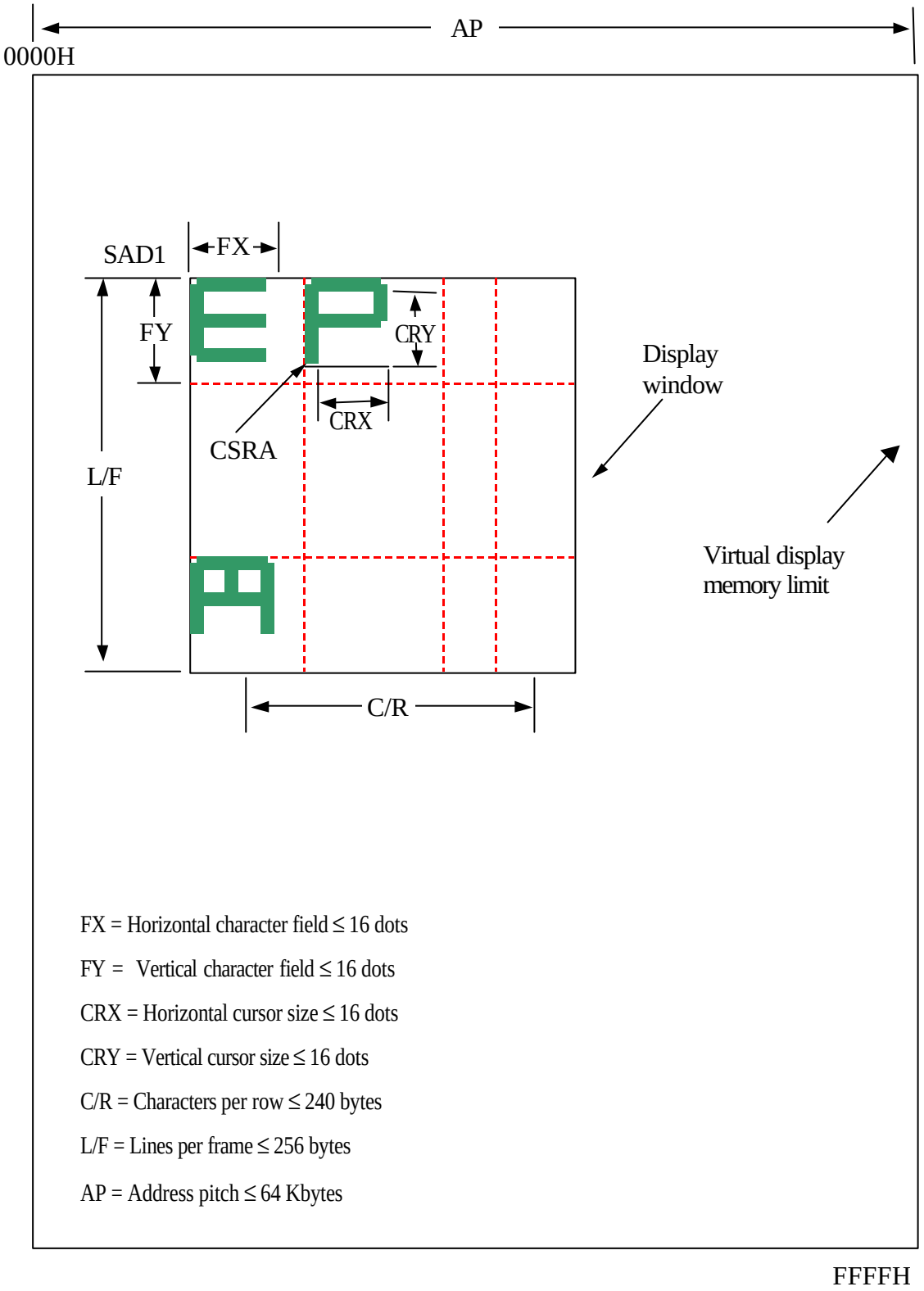


Figure 38. Display window and memory

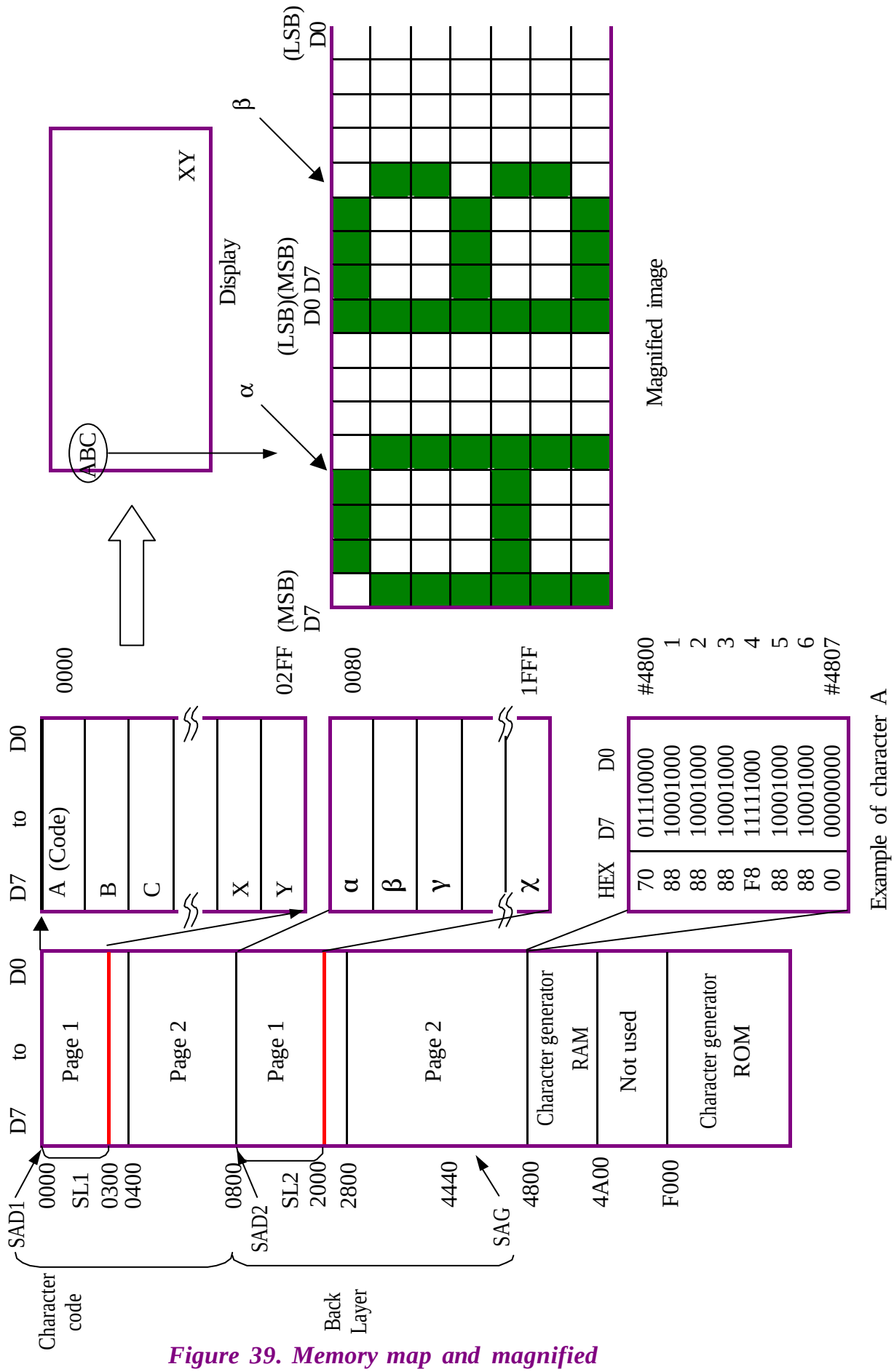


Figure 39. Memory map and magnified

9.5 Scrolling

The controlling microprocessor can set the SED1335 series scrolling modes by overwriting the scroll address registers SAD1 to SAD4, and by directly setting the scrolling mode and scrolling rate.

9.5.1 On-page scrolling

The normal method of scrolling within a page is to move the whole display up one line and erase the bottom line. Since the SED1335 series does not automatically erase the bottom line, it must be erased with blanking data when changing the scroll address register.

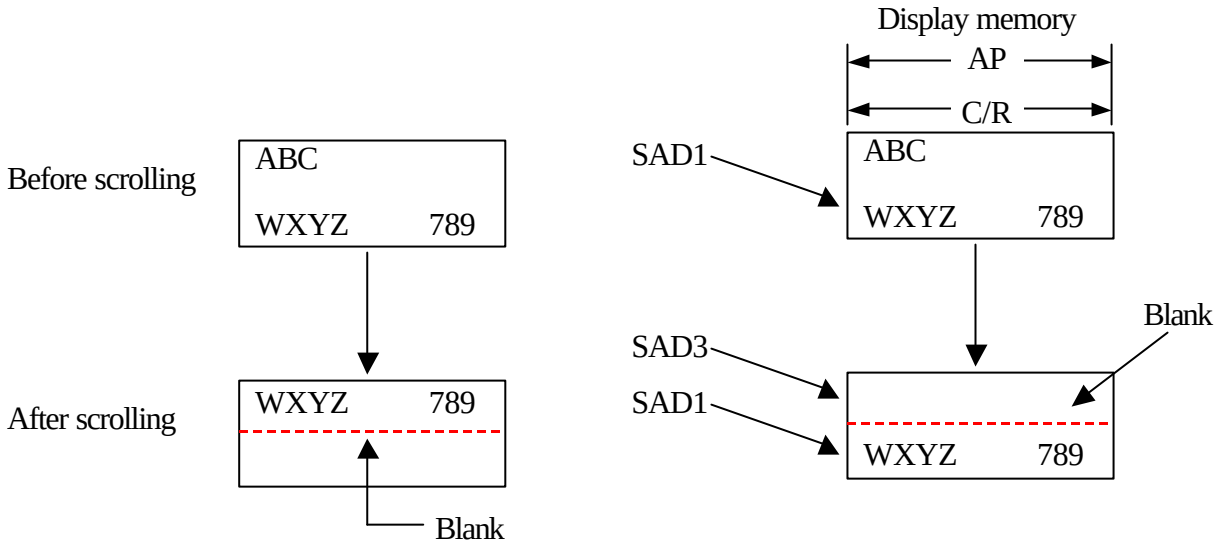


Figure 40. On-page scrolling

9.5.2 Inter-page scrolling

Scrolling between pages and page switching can be performed only if the display memory capacity is greater than one screen.

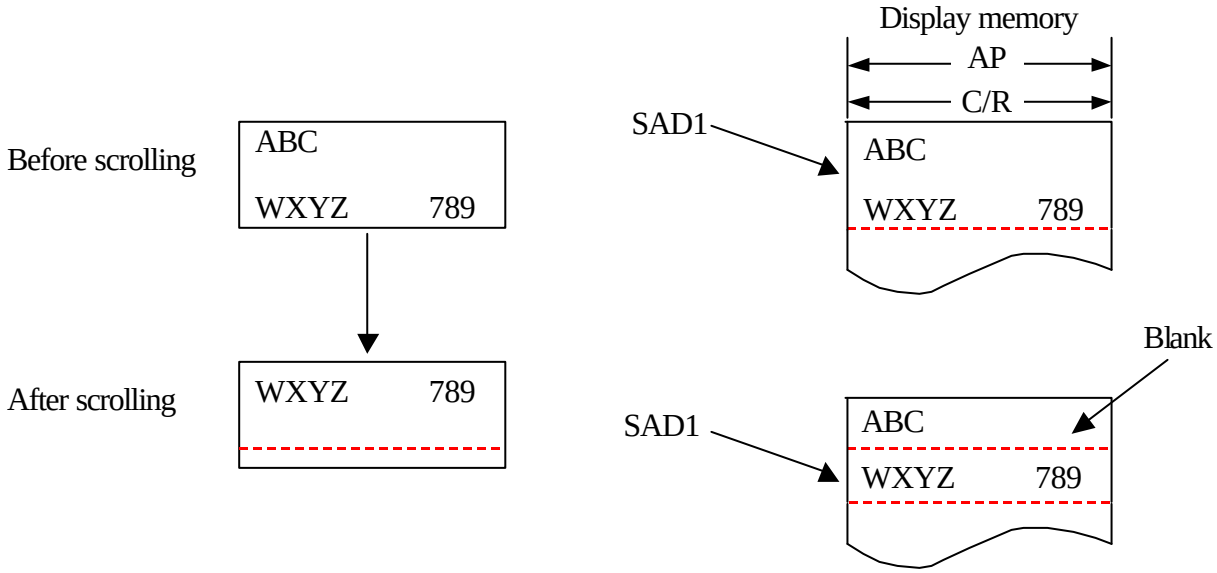


Figure 43. Inter-page scrolling

9.5.3 Horizontal scrolling

The display can be scrolled horizontally in one-character units, regardless of the display memory capacity.

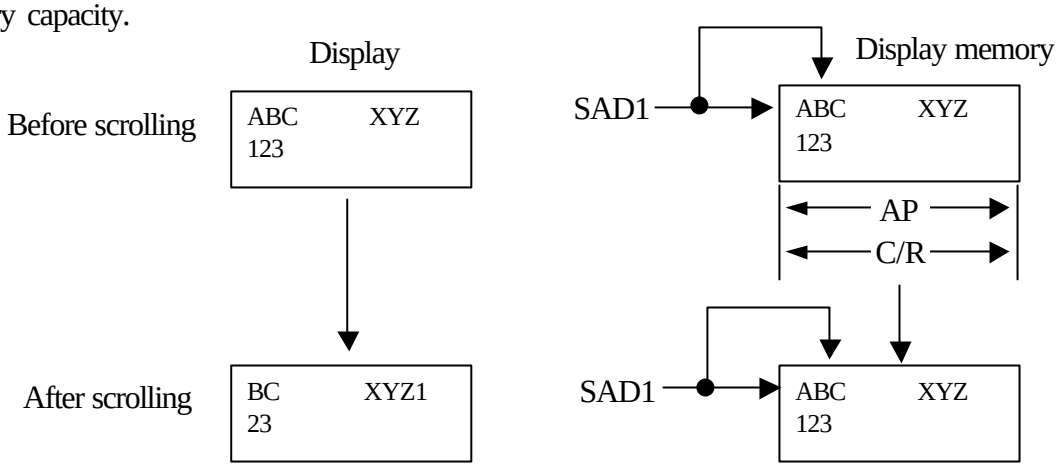


Figure 42. Horizontal Wraparound scrolling

9.5.4 Bidirectional scrolling

Bidirectional scrolling can be performed only if the display memory is larger than the physical screen both horizontally and vertically. Although scrolling is normally done in single-character units, the HDOT SCR command can be used to scroll horizontally in pixel units. Single-pixel scrolling both horizontally and vertically can be performed by using the SCROLL and HDOT SCR commands. See Section 16.4.

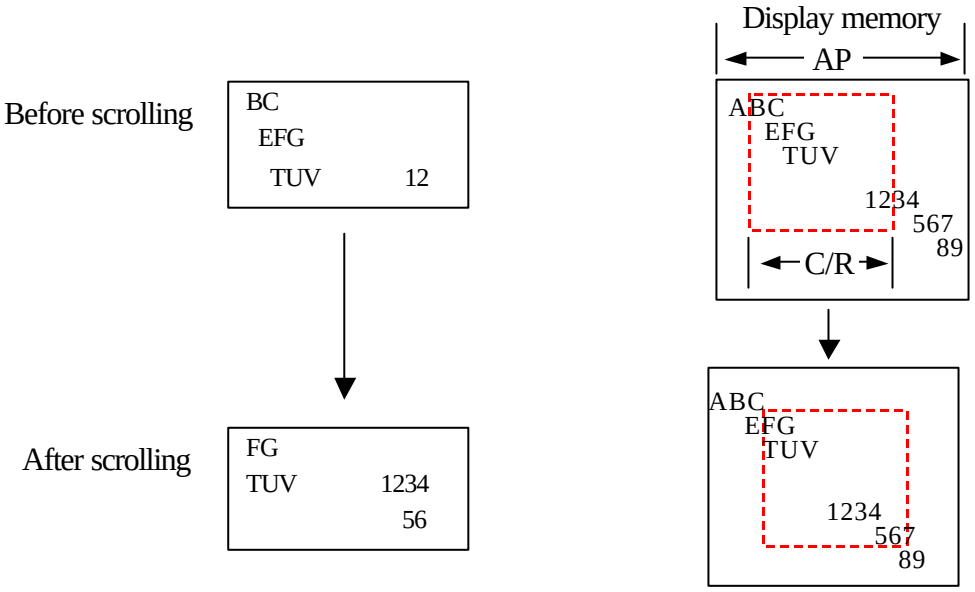


Figure 46. Bidirectional scrolling

9.5.5 Scroll units

Table 19 Scroll units

Mode	Vertical	Horizontal
Text	Characters	Pixels or characters
Graphics	Pixels	Pixels

Note that in a divided screen, each block cannot be independently scrolled horizontally in pixel units.

10.Character generator

10.1 CG Characteristics

10.1.1 Internal character generator

The internal character generator is recommended for minimum system configurations containing a SED1335 series, display RAM, LCD panel, single-chip microprocessor and power supply. Since the internal character generator uses a CMOS mask ROM, it is also recommended for low-power applications.

- ❒ 5 * 7-pixel font (See section 17.)
- ❒ 160 JIS standard characters
- ❒ Can be mixed with character generator RAM (maximum of 64 CG RAM characters)
- ❒ Can be automatically spaced out up to 8 * 16 pixels

10.1.2 External character generator ROM

The external CG ROM can be used when fonts other than those in the internal ROM are needed. Data is stored in the external ROM in the same format used in the internal ROM. (See section 10.3.)

- ❒ Up to 8 * 8-pixel characters (M2 = 0) or 8 * 16-pixel characters (M2 = 1)
- ❒ Up to 256 characters (192 if used together with the internal ROM)
- ❒ Mapped into the display memory address space at F000H to F7FFH (M2 = 0) or F000H to FFFFH (M2 =1)
- ❒ Characters can be up to 8 * 16-pixels, however excess bits must be set to zero.

10.1.3 Character generator RAM

The user can freely use the character generator RAM for storing graphics characters. The character generator RAM can be mapped by the microprocessor anywhere in display memory, allowing effective use of unused address space.

- ❒ Up to 8 * 8-pixel characters (M2 = 0) or 8 * 16 characters (M2 =1)
- ❒ Up to 256 characters if mapped at F000H to FFFFH (64 if used together with character generator ROM)
- ❒ Can be mapped anywhere in display memory address space if used with the character generator ROM
- ❒ Mapped into the display memory address space at F000H to F7FFH if not used with the character generator ROM (more than 64 characters are in the CG RAM). set SAG0 to F000H and M1 to zero when defining characters number 193 upwards.

10.2 CG Memory Allocation

Since the SED1335 series uses 8-bit character codes, it can handle no more than 256 characters at a time. However, if a wider range of characters is required, character generator memory can be bank-switched using the CGRAM ADR command.

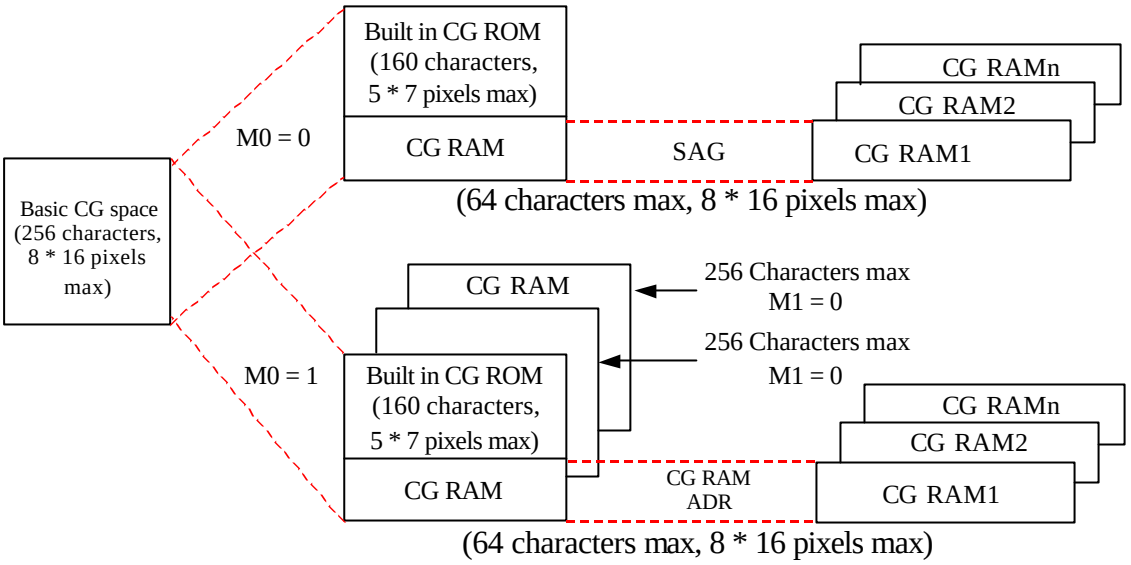


Figure 44. Internal and external character mapping

Note that there can be no more than 64 characters per bank.

Table 20. Character mapping

Item		***Parameter***	***Remarks***
Internal/external character generator selection		M0	
Character field height	1 to 8 pixels	M2 = 0	
	9 to 16 pixels	M2 = 1	
	Greater than 16 pixels	Graphics mode (8 bits * 1 line)	
Internal CG ROM/RAM select Extermall CG ROM/RAM select		Automatic	Determined by the character code
CG RAM bit 6 correction		M1	
CG RAM data storage address		specified with CGRAM ADR command	Can be moved anywhere in the display memory address space
External CG ROM address	192 characters or less	Other than the area of figure 49	
	More than 192 characters	Set SAG to F000H and overlay SAG and the CG ROM table.	

10.3 Setting the Character Generator Address

The CG RAM addresses in the VRAM address space are not mapped directly from the address in the SAG register. The data to be displayed is at a CG RAM address calculated from SAG + character code + ROW select address. This mapping is shown in tables 21 and 22.

Table 21 Character fonts, number of lines [8 (M2 = 0, M1 = 0)

SAG	*A15*	*A14*	*A13*	*A12*	*A11*	*A10*	*A9*	*A8*	*A7*	*A6*	*A5*	*A4*	*A3*	*A2*	*A1*	*A0*
Character code	0	0	0	0	0	D7	D6	D5	D4	D3	D2	D1	D0	0	0	0
+ROW select address	0	0	0	0	0	0	0	0	0	0	0	0	0	R2	R1	R0
CG RAM address	VA15	VA14	VA13	VA12	VA11	VA10	VA9	VA8	VA7	VA6	VA5	VA4	VA3	VA2	VA1	VA0

Table 22 Character fonts, 9 [number of lines [1 6 (M2 = 1 , M1 = 0)

SAG	*A15*	*A14*	*A13*	*A12*	*A11*	*A10*	*A9*	*A8*	*A7*	*A6*	*A5*	*A4*	*A3*	*A2*	*A1*	*A0*
Character code	0	0	0	0	D7	D6	D5	D4	D3	D2	D1	D0	0	0	0	0
+ROW select address	0	0	0	0	0	0	0	0	0	0	0	0	R3	R2	R1	R0
CG RAM address	VA15	VA14	VA13	VA12	VA11	VA10	VA9	VA8	VA7	VA6	VA5	VA4	VA3	VA2	VA1	VA0

Row	*R3*	*R2*	*R1*	*R0*
Row 0	0	0	0	0
Row 1	0	0	0	1
Row 2	0	0	1	0
↓	↓	↓	↓	↓
Row 7	0	1	1	1
Row 8	1	0	0	0
↓	↓	↓	↓	↓
Row 14	1	1	1	0
Row 15	1	1	1	1

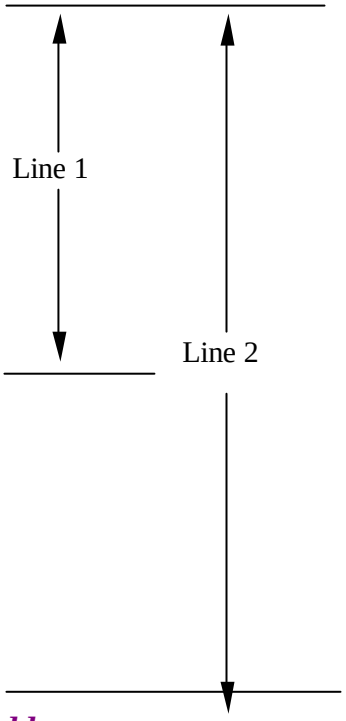


Figure 45. Row select address

Note

Lines = 1: lines in the character bitmap [8

Lines = 2: lines in the character bitmap 〈 9

10.3.1 M1 =1

The SED1335 series automatically coverts all bits set in bit 6 of character code for CG RAM 2 to zero Because of this, the CG RAM data areas become contiguous in display memory

When writing data to CG RAM:

- Calculate the address as for M1 = 0.
- Change bit 6 of the character code from "1" to "0".

10.3.2 CG RAM addressing example

- Define a pattern for the "A" in figure 26.
- The CG RAM table start address is 4800H.
- The character code for the defined pattern is 80H (the first character code in the CG RAM area).

As the character code table in figure 46 shows, codes 80H to 9FH and E0H to FFH are allocated to the CG RAM and can be used as desired. 80H is thus the first code for CG RAM. As characters cannot be used if only using graphics mode, there is no need to set the CG RAM data.

Table 23. Character data example

CGRAM ADR	***5CH***	
P1	00H	***Reverse the CG RAM address calculation to calculate SAG***
P2	40H	
CSRDIR	4CH	Set cursor shift direction to right
CSRW	46H	CG RAM start address is 4800H
P1	00H	
P2	48H	
MWRITE	42H	
P	70H	Write Row 0 data
P2	88H	Write Row 1 data
P3	88H	Write Row 2 data
P4	88H	Write Row 3 data
P5	F8H	Write Row 4 data
P6	88H	Write Row 5 data
P7	88H	Write Row 6 data
P8	00H	Write Row 7 data
P8	00H	Write Row 8 data
↓	↓	↓
P16	00H	Write Row 15 data

10.4 Character Codes

The following figure shows the character codes and the codes allocated to CG RAM All codes can be used by the CG RAM if not using the internal ROM.

	Upper 4 bits															
Lower 4 bits	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***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	←							

CG RAM1 CG RAM2

M1 = 0

M1 = 1

Figure 46. On-chip character codes

Internal character generator font

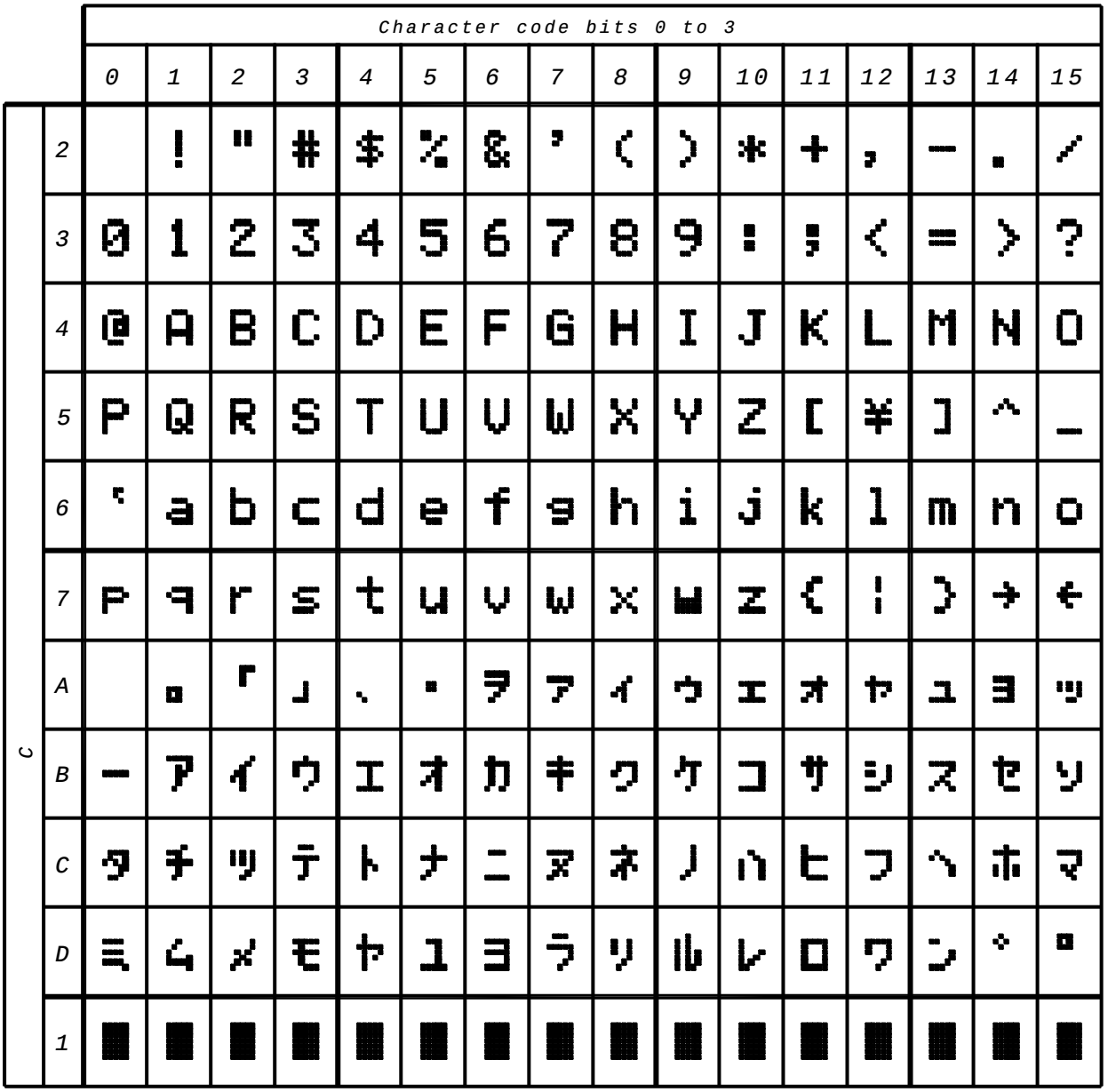


Figure 50. On-chip character set

Note

The shaded positions indicate characters that have the whole 6*8 bitmap blackened.