

FEATURES

- Display Format: 240 × 64
- Overall Dimensions:
180.0 (W) × 65.0 (H) × 10.5 (D) mm
- Active Area: 132.6 (W) × 39 (H) mm
- Dot Pitch: 0.48 (W) × 0.48 (H) mm
- Panel Type/Viewing Mode:
STN/Reflective

DESCRIPTION

The SHARP LM24014W Dot Matrix LCD consists of a 240 × 64 full dot graphic display unit. It also consists of an STN-type, reflective, positive panel, with a T6963C LCD Controller and a CG-ROM.

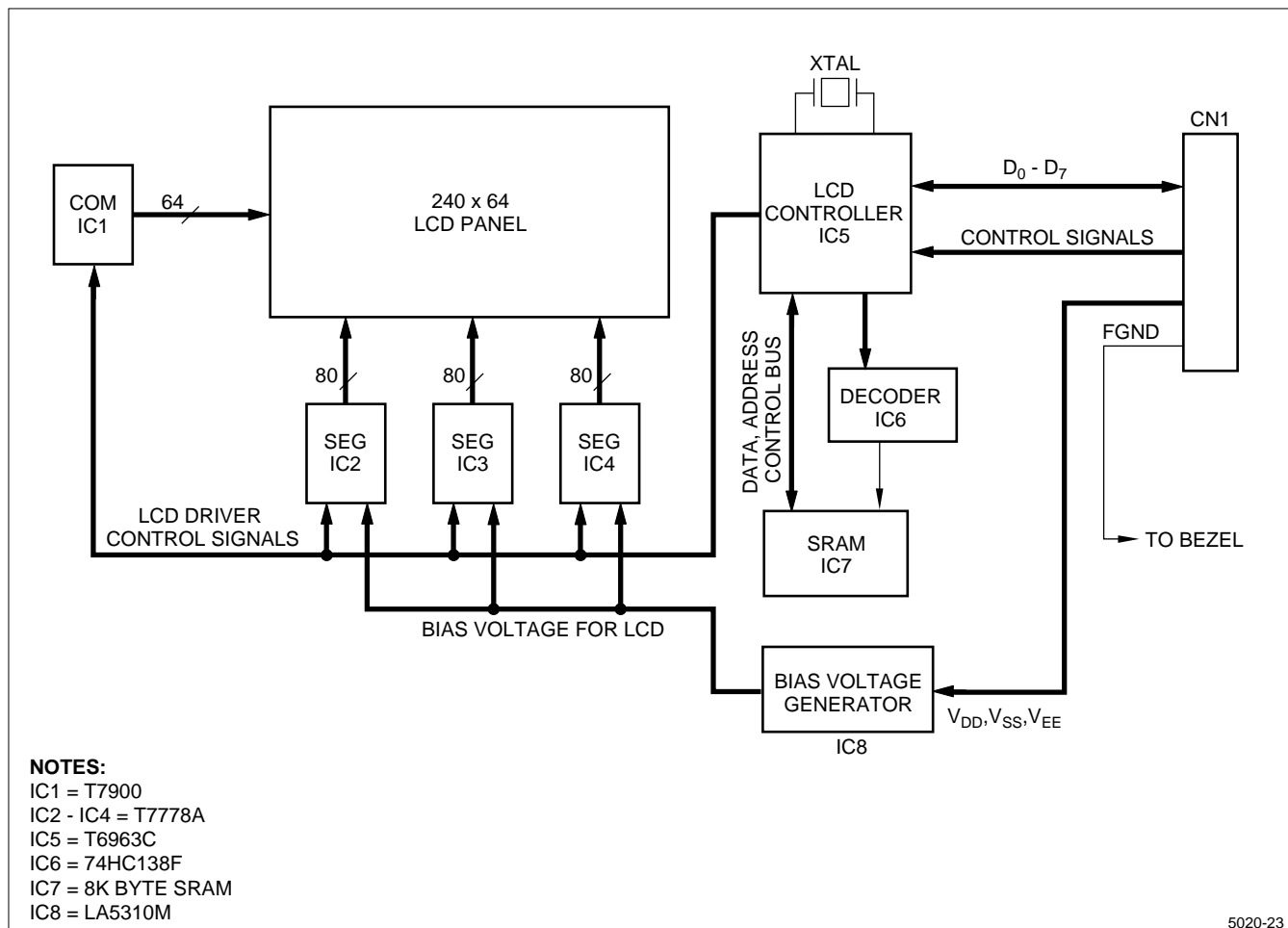


Figure 1. LM24014W Block Diagram

MECHANICAL SPECIFICATIONS

PARAMETER	SPECIFICATIONS	UNIT	NOTE
Outline Dimensions	180 (W) × 65 (H) × 10.5 max (D)	mm	1
Active Area	132.6 (W) × 39 (H)	mm	–
Display Format	240 (W) × 64 (H) Full Dot	–	–
Dot Size	0.48 (W) × 0.48 (H)	mm	–
Dot Spacing	0.05	mm	–
Dot Color	Dark Blue	–	2
Background Color	Yellow Green	–	2
Weight	Approximately 120	g	–

NOTES:

1. Excludes oscillator. See Outline Dimensions diagram.
2. Due to the characteristics of the LC material, the colors vary with environmental temperature.

ABSOLUTE MAXIMUM RATINGS ($t_A = 25^\circ\text{C}$)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$V_{DD} - V_{SS}$	Supply Voltage (Logic)	0	6.0	V
$V_{DD} - V_{EE}$	Supply Voltage (LCD Drive)	0	18.0	V
V_{IN}	Input Voltage	0	V_{DD}	V

ENVIRONMENTAL CONDITIONS

ITEM	Tstg		Topr		CONDITION	NOTE
	MIN.	MAX.	MIN.	MAX.		
Ambient Temperature	-25°C	+60°C	-0°C	+45°C	–	1
Humidity	–		–		No condensation	2
Vibration	–		–		3 Directions (X/Y/Z)	3
Shock	–		–		6 Directions ($\pm X/\pm Y/\pm Z$)	4

NOTES:

1. Do not subject the LCD unit to temperatures out of this specification.
2. $t_A \leq 40^\circ\text{C}$, 95% RH maximum.
 $t_A > 40^\circ\text{C}$, Absolute humidity less than $t_A = 40^\circ\text{C}$ at 95% RH.
3. These test conditions are in accordance with the following table (two hours for each direction of X/Y/Z (six hours total)):

Frequency	10 Hz to 55 Hz
Vibration Width	1.5 mm
Interval	10 Hz to 55 Hz to 10 Hz (1 min.)

4. Acceleration: 100 G
Pulse width: 6 ms
Three times for each direction of $\pm X/\pm Y/\pm Z$.

ELECTRICAL CHARACTERISTICS ($t_A = 25^\circ\text{C}$, $V_{DD} = 5.0\text{ V} \pm 5\%$)

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
$V_{DD} - V_{SS}$	Supply Voltage (Logic)	—	4.75	5.0	5.25	V	—
$V_{EE} - V_{SS}$	Supply Voltage (LCD Drive)	$V_{DD} = 5.0\text{ V}$	-12.0	—	-6.0	V	1
V_{IN}	Input Signal Voltage	'H' Level	$V_{DD} - 2.2$	—	V_{DD}	V	—
		'L' Level	0	—	0.8	V	—
V_{OUT}	Output Signal Voltage	'H' Level	$V_{DD} - 0.3$	—	V_{DD}	V	—
		'L' Level	0	—	+0.3	V	—
I_{DD}	Supply Current (Logic)	$V_{DD} = 5.0\text{ V}$ $V_{EE} = -10.0\text{ V}$	—	12	15	mA	—
I_{EE}	Supply Current (LCD Drive)		—	1.5	2.0	mA	
P_D	Power Consumption		—	75	95	mW	

NOTE:

- The maximum contrast of viewing angle θ can be set by adjusting $V_{EE} - V_{SS}$. Refer to Figure 21 for the definition of θ .
The typical value of LCD supply voltage ($\pm 0.5\text{ V}$ in each unit) normally means the optimum rating when viewing angle θ is set at 15° .

CONTRAST ADJUSTMENT

Use the external adjustable resistor (VR) to adjust the LCD display contrast for the change in viewing angle or power supply voltage.

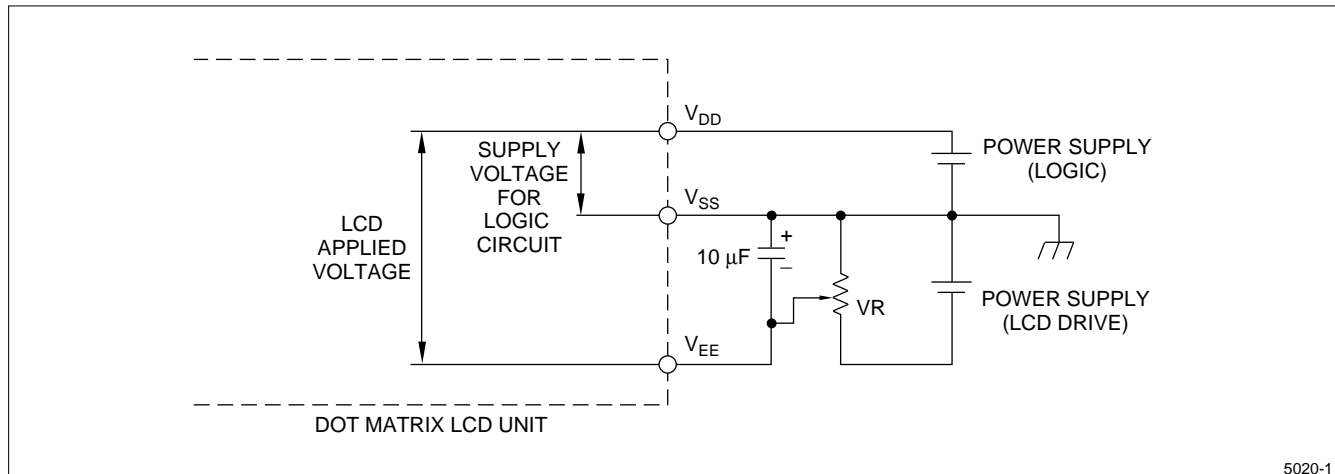


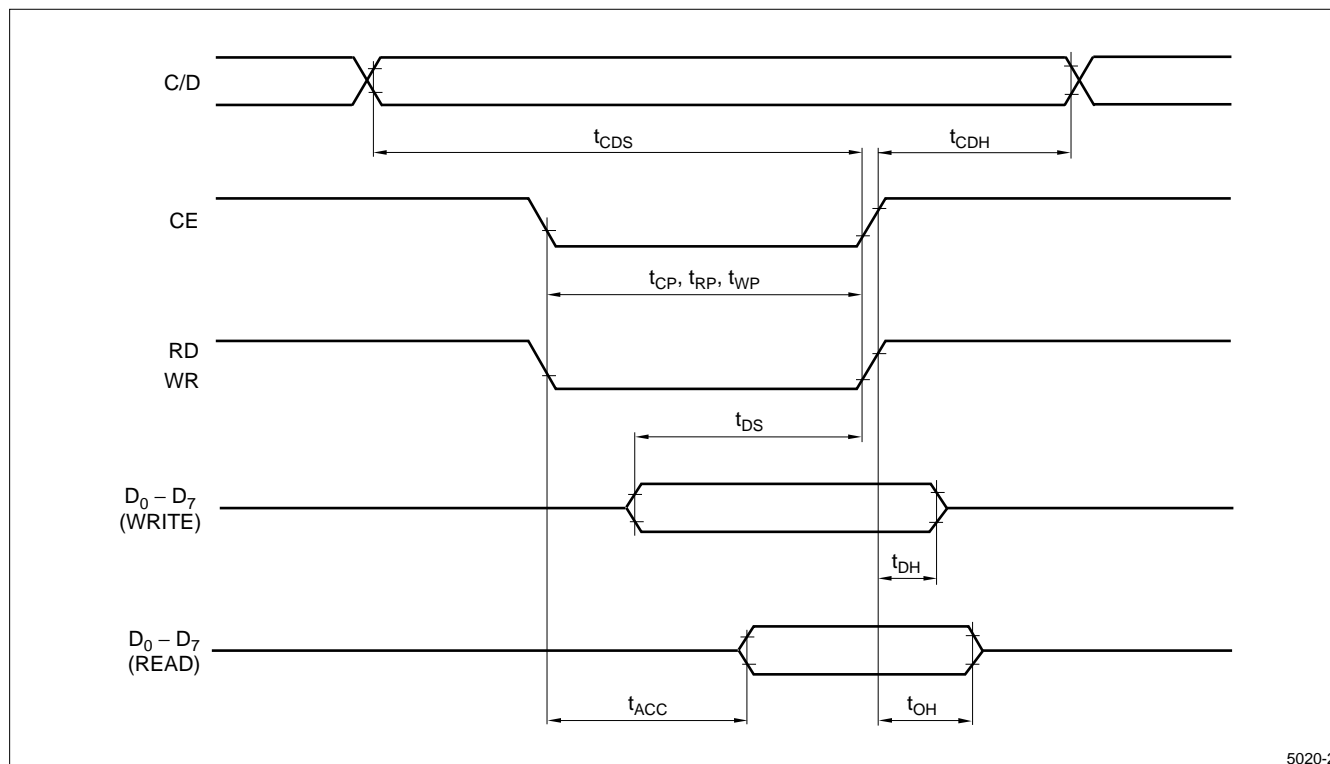
Figure 2. Connecting the Adjustable Resistor

INTERFACE SIGNALS

PIN NUMBER ¹	SYMBOL	PARAMETER	I/O	NOTE
1	FGND	Frame Ground (Connected to Bezel)	–	–
2	V _{SS}	Ground Potential (Logic)	–	–
3	V _{DD}	Power Supply to Logic and LCD (+)	–	–
4	V _{EE}	Power Supply to LCD (–)	–	–
5	WR	Data Write	Input	–
6	RD	Data Read	Input	–
7	CE	Chip Enable	Input	–
8	C/D	Code/Data	Input	–
9	NC	No Connection	–	–
10	RESET	Controller Reset	Input	–
11	D ₀	Data Bus (LSB)	I/O	–
12	D ₁	Data Bus	I/O	–
13	D ₂			–
14	D ₃			–
15	D ₄			–
16	D ₅			–
17	D ₆			–
18	D ₇	Data Bus (MSB)	I/O	–
19	FS	Font Select	Input	2
20	NC	No Connection	–	–

NOTES:

- Pin number and its location are shown in the Outline Dimensions diagram.
- If FS = 'H': 6 × 8 Character font.
If FS = 'L': 8 × 8 Character font.



5020-2

Figure 3. Interface Timing Chart

INTERFACE TIMING RATINGS

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
t_{CDS}	C/D Setup Time	100	—	ns
t_{CDH}	C/D Hold Time	10	—	ns
t_{CP}, t_{RP}, t_{WP}	CE, RD, WR Clock Width	80	—	ns
t_{DS}	Data Setup Time	80	—	ns
t_{DH}	Data Hold Time	40	—	ns
t_{ACC}	Access Time	—	150	ns
t_{OH}	Data Output Hold Time	10	50	ns

HIGH-ORDER LOW-ORDER 4 BIT	HIGH-ORDER													
	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111	
xxxx0000	CG RAM (1)		0	a	P	\	P	-	9	E	0	*		
xxxx0001	(2)	!	1	A	Q	a	9	0	7	7	4	ä	*	
xxxx0010	(3)	"	2	B	R	b	r	r	イ	ウ	×	*	0	
xxxx0011	(4)	#	3	C	S	c	s	、	ウ	テ	テ	e	0	
xxxx0100	(5)	\$	4	D	T	d	t	、	工	ト	ト	*	0	
xxx0101	(6)	%	5	E	U	e	u	、	オ	ト	工	0	0	
xxx0110	(7)	&	6	F	V	f	v	マ	カ	ニ	ヨ	*	Σ	
xxxx0111	(8)	'	7	G	W	g	w	マ	キ	又	ウ	*	π	
xxxx1000	(1)	(0	H	X	h	x	、	0	本	リ	、	又	
xxxx1001	(2))	9	I	Y	i	y	ウ	ケ	リ	ル	、	*	
xxxx1010	(3)	*	#	J	Z	j	z	工	コ	ン	ル	*	キ	
xxxx1011	(4)	+	;	K	L	k	l	、	オ	サ	ヒ	0	、	
xxxx1100	(5)	,	<	L	*	l	l	ト	ヨ	フ	ワ	0	、	
xxxx1101	(6)	-	=	M	I	m	i	、	ユ	ズ	、	ト	÷	
xxxx1110	(7)	.	>	N	^	n	÷	ヨ	セ	ホ	、	、		
xxxx1111	(8)	/	?	O	_	o	←	ウ	リ	マ	、	0	*	

NOTES:

1. CG RAM is character generator RAM in which user-definable character patterns are stored.
2. X mark: prohibition of input.

Figure 4. Character Generator Pattern

EXAMPLES OF RAM ADDRESS SET (In Case FS = 'H')

Example of Relation Between Text Mode and RAM Address

Text Home Position: 0000H 40 Characters
Text Area: 0028H 8 Lines

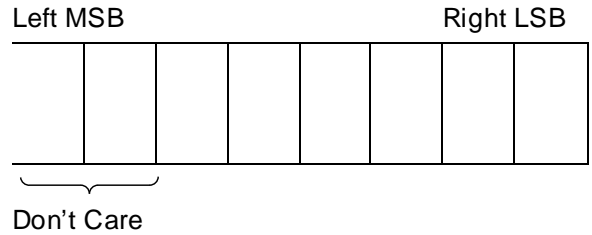
0000H	0001H	...	0026H	0027H
0028H	0029H	...	004EH	004FH
0050H	0051H	...	0076H	0077H
•	•	...	•	•
•	•	•••	•	•
•	•		•	•
0118H	0119H	...	013EH	013FH

In Text mode, display pattern is memorized by 6 × 8 character font. The character in the Status Data table is displayed for data code.

Example of Relation Between Graphic Mode and RAM Address

Graphic Home Position: 1000H
Graphic Area: 0028H 240 × 64 Dots

1000H	1001H	...	1026H	1027H
1028H	1029H	...	104EH	104FH
1050H	1051H	...	1076H	1077H
•	•	...	•	•
•	•	•••	•	•
•	•		•	•
19DBH	19DCH	...	19FEH	19FFH



In Graphic mode, display pattern is memorized by pattern of 6 × 1 dots. The screen of this unit is divided into 40 bytes (horizontal) × 64 bytes (vertical). 1 byte of data is translated to binary code. '1' is 'ON,' and '0' is 'OFF.' The upper 2 bits cannot be displayed.

NOTES:

1. Display memory size is 8 Kbytes. RAM address is from 0000H to 1FFFH.
2. In Text mode, display format is 40 character 8 lines, and character font is 6 × 8 dot in case FS = 'H.'
3. It is possible to classify freely to ranges of Text/Graphic in internal display RAM.
4. In case of setting Text/Graphic area bigger than real screen, it is possible to transfer the position of the display window by transferring the home position (Window function).
5. It is possible to overlay the Text screen and the Graphic screen.

INSTRUCTIONS

Instruction Table

SYMBOL	FUNCTION	CODE										
		C/D	RD	WR	D7	D6	D5	D4	D3	D2	D1	D0
WTRM	Write Memory	1	1	0	0	1	0	0	0	0	← N1 →	
WTRG	Write Resistor	1	1	0	0	0	1	0	0	AR	OR	CP
DSPM	Display Mode Set	1	1	0	1	0	0	1	GD	TD	CD	CB
CSRP	Cursor Pattern Select	1	1	0	1	0	1	0	0	← N2 →		
DR/W	Data Read/Write	1	1	0	1	1	0	0	0	← N3 →		
AS/R	Auto Mode	1	1	0	1	0	1	1	0	0	← N4 →	
MDST	Mode Set	1	1	0	1	0	0	0	CG	← N5 →		
PEEK	Screen Peeking	1	1	0	1	1	1	0	0	0	0	0
COPY	Screen Copy	1	1	0	1	1	1	0	1	0	0	0
BS/R	Bit Set/Reset	1	1	0	1	1	1	1	S/R	← BIT →		
–	Status Read	1	0	1	← STATUS DATA →							
–	Data (Write)	0	1	0	← WRITE DATA →							
–	Data (Read)	0	0	1	← READ DATA →							

Functions

SYMBOL	DESCRIPTION
MDST	AND/OR/EX-OR Functions of screen data between Text and Graphic
DR/W, PEEK, COPY	Read and Copy the data of display screen
WTRM	Software programmable of Text/Graphic ranges in display memory
DSPM	Cursor ON/OFF/Blink
CSRP	Cursor pattern selectable
MDST	Character ON/OFF/Inverse/Blink
BS/R	Bit set and bit reset of display memory
WTRG, MDST	Programmable CG-RAM

COMMAND EXPLANATION

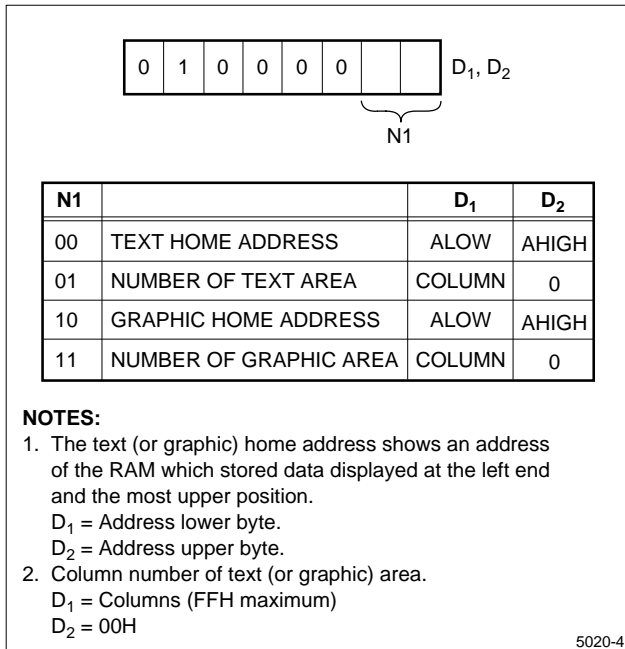


Figure 5. Internal RAM Write (WTRM)

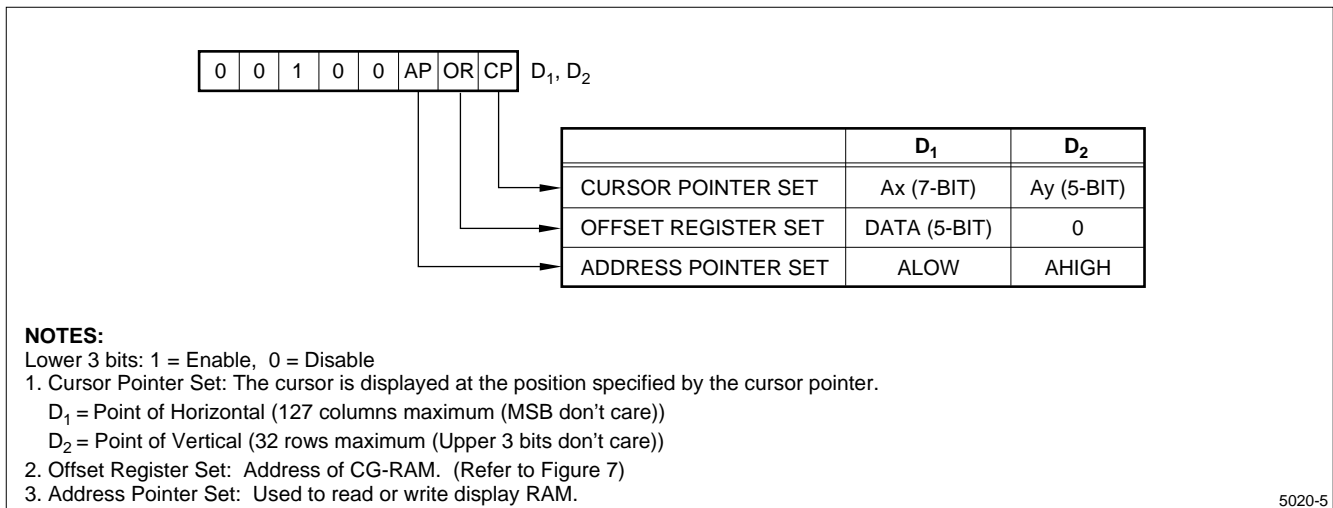


Figure 6. Internal Register Write (WTRG)

COMMAND EXPLANATION (cont'd)

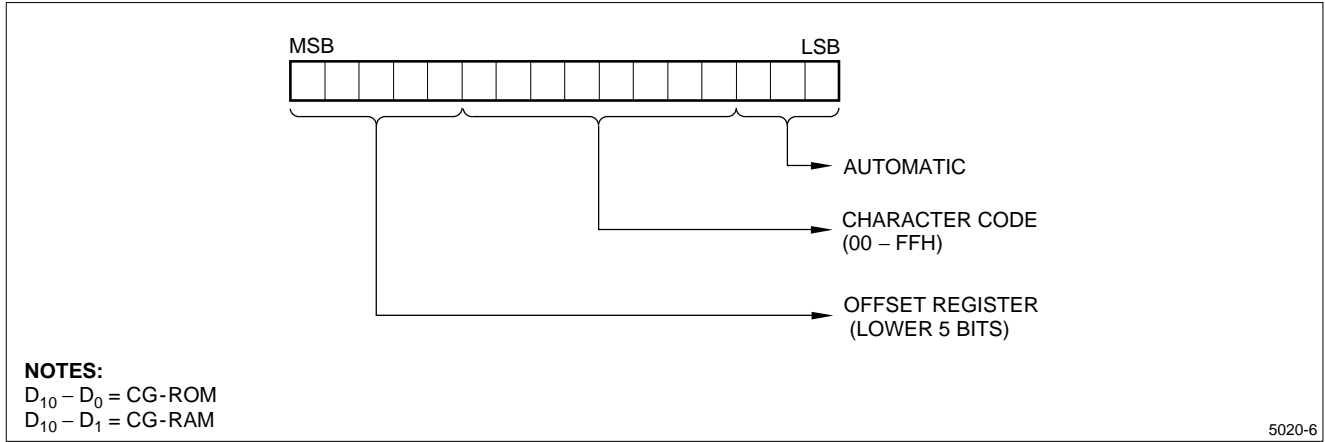


Figure 7. Offset Register Set Address of CG-RAM

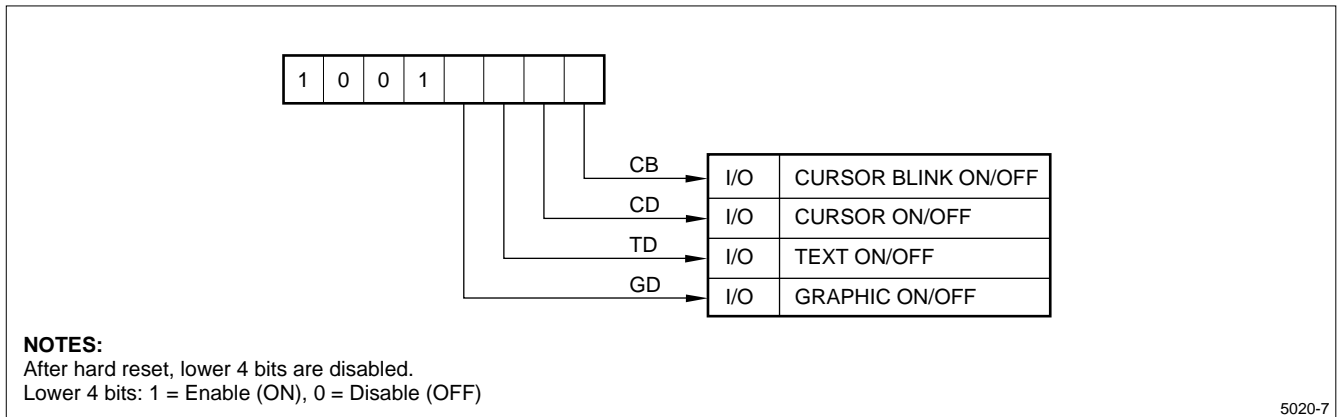
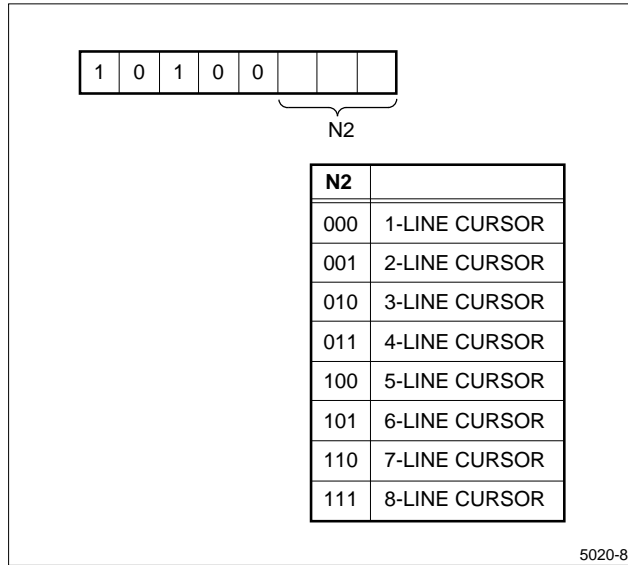


Figure 8. Display Mode Set (DSPM)

COMMAND EXPLANATION (cont'd)

Cursor Pattern Select



8
7
6
5
4
3
2
1

Figure 9. Cursor Pattern Select (CSRP)

Data Read/Write (DR/W)

Write this command after address pointer set.
Write this command after set data in case of 'Data Write.'

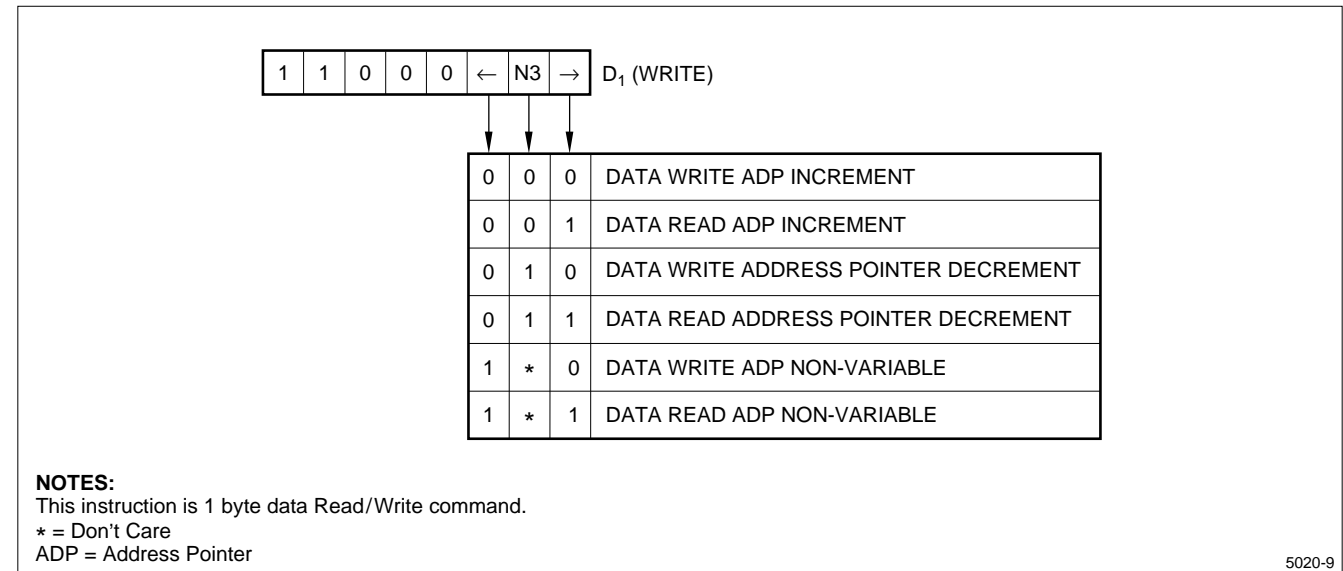


Figure 10. Data Read/Write (DR/W)

COMMAND EXPLANATION (cont'd)

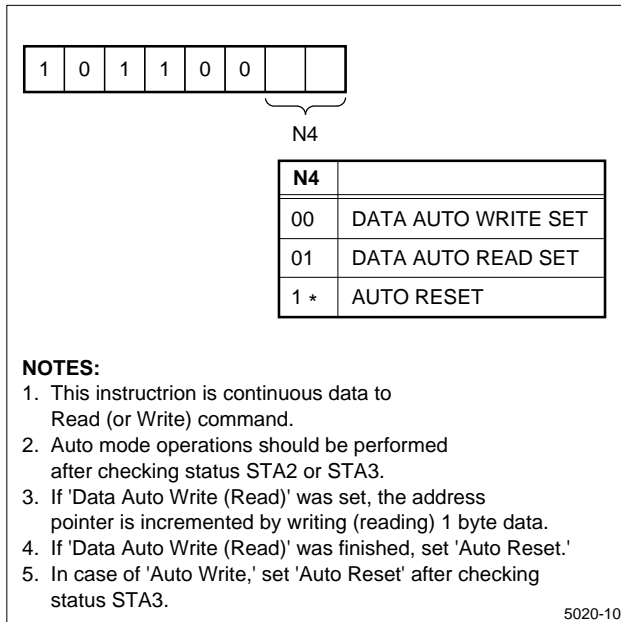


Figure 11. Auto Mode (AS/R)

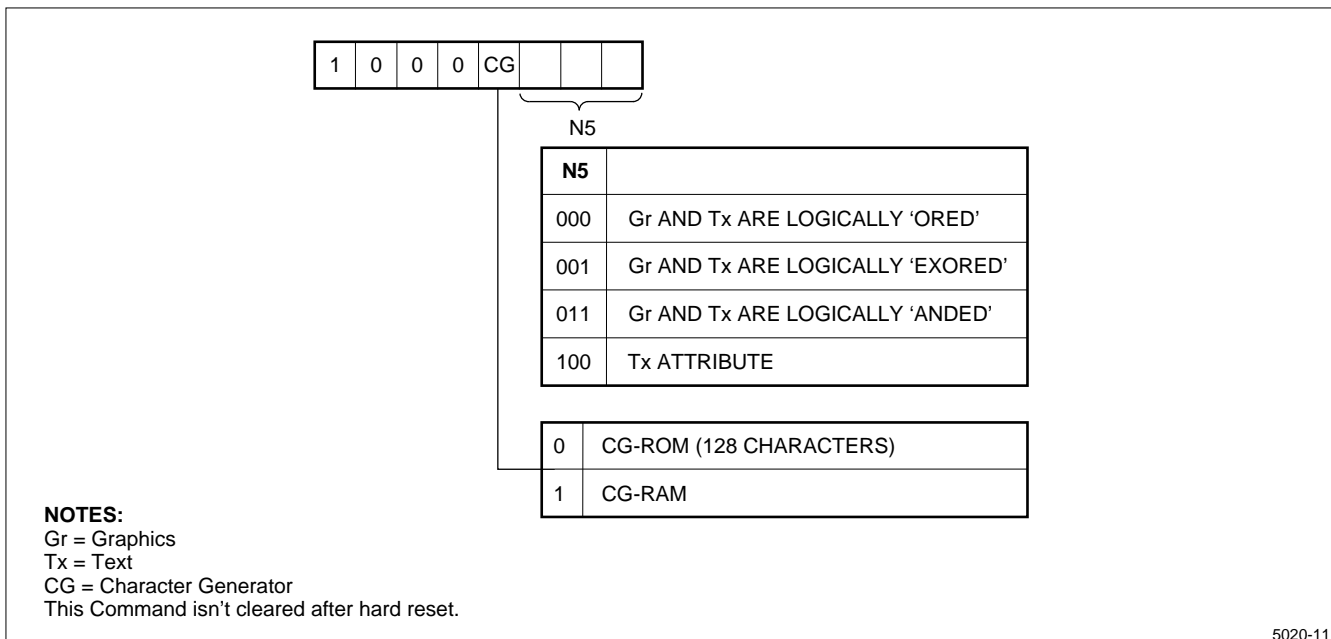


Figure 12. Mode Set (MDST)

COMMAND EXPLANATION (cont'd)

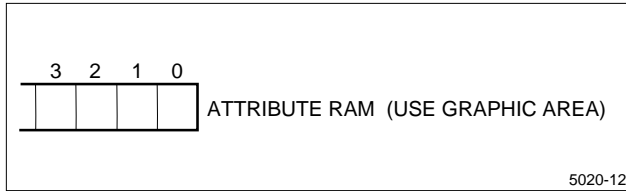


Figure 13. Attribute RAM

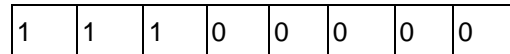
0	0	0	0	Normal
	1	0	1	Inverse
	0	1	1	Display Disable
1	0	1	1	Blinking

NOTES:

1. If CG-ROM mode was set, character code '80-FFH' is selected automatically.
2. Only text attribute.
3. Use graphic area for attributes.
4. If 'Attribute' was used, Graphic is OFF.
5. Method of programming:

Graphic	'10010***,' Write
Write Attribute Area	
Write Home Address	
Mode Set	'1000 (1/0)**,' Write
Graphic ON	'10011***,' Write

Screen Peeking (PEEK)



This instruction is used to read displayed data. It is possible to read logical combination data. If the address was not in the Graphic RAM area, this instruction is ignored and a status flag (STA6) is set.

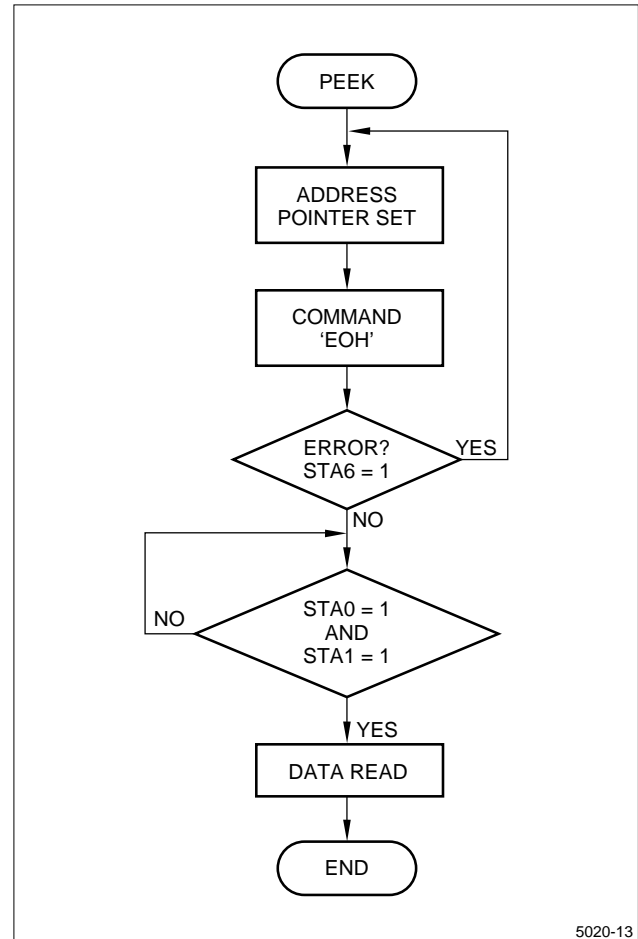


Figure 14. Screen Peeking Flow Chart

COMMAND EXPLANATION (cont'd)

Screen Copy (COPY)

1	1	1	0	1	0	0	0
---	---	---	---	---	---	---	---

If the address pointer accorded with graphic pointer, LCDC writes the displayed data of one line after according position in Graphic RAM area. If the address was not in the Graphic RAM area, this instruction is ignored and a status flag (STA6) is set.

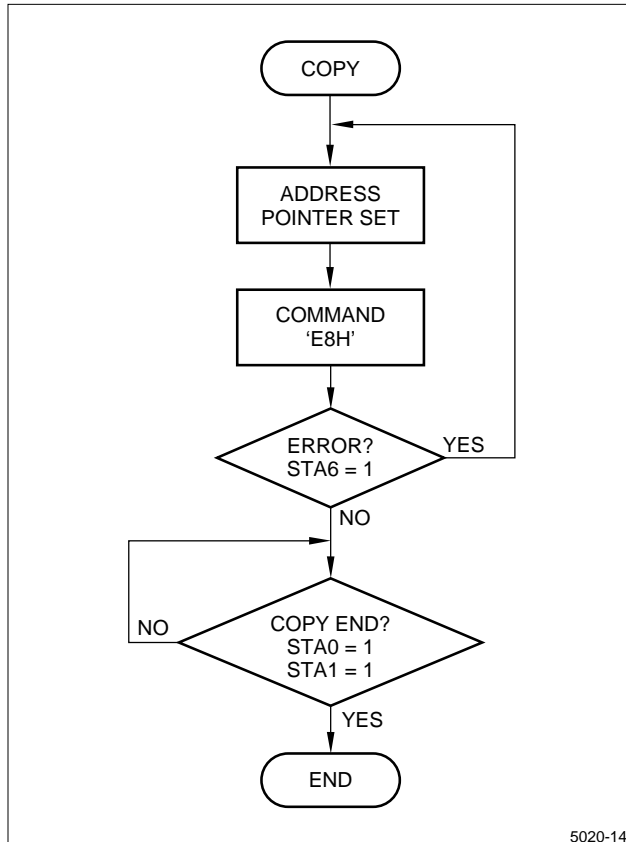


Figure 15. Screen Copy Flow Chart

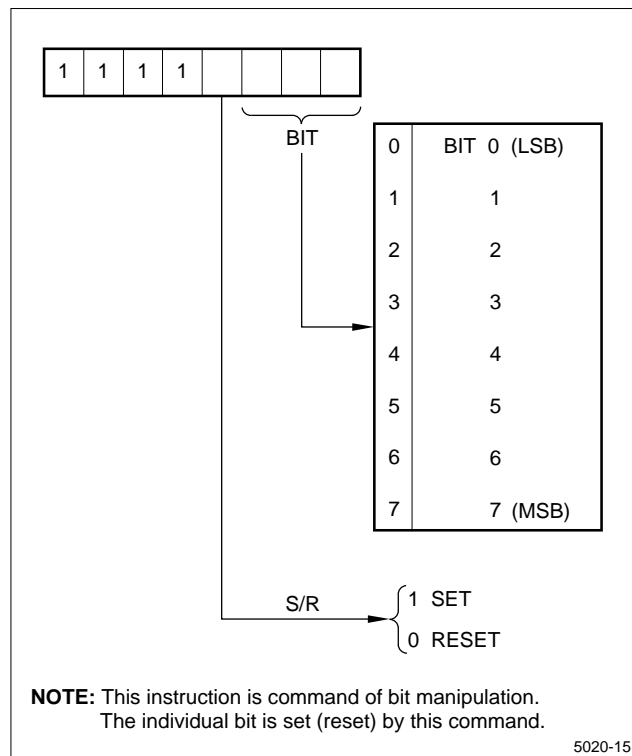


Figure 16. Bit Set Register (BS/R)

METHOD OF INITIALIZATION

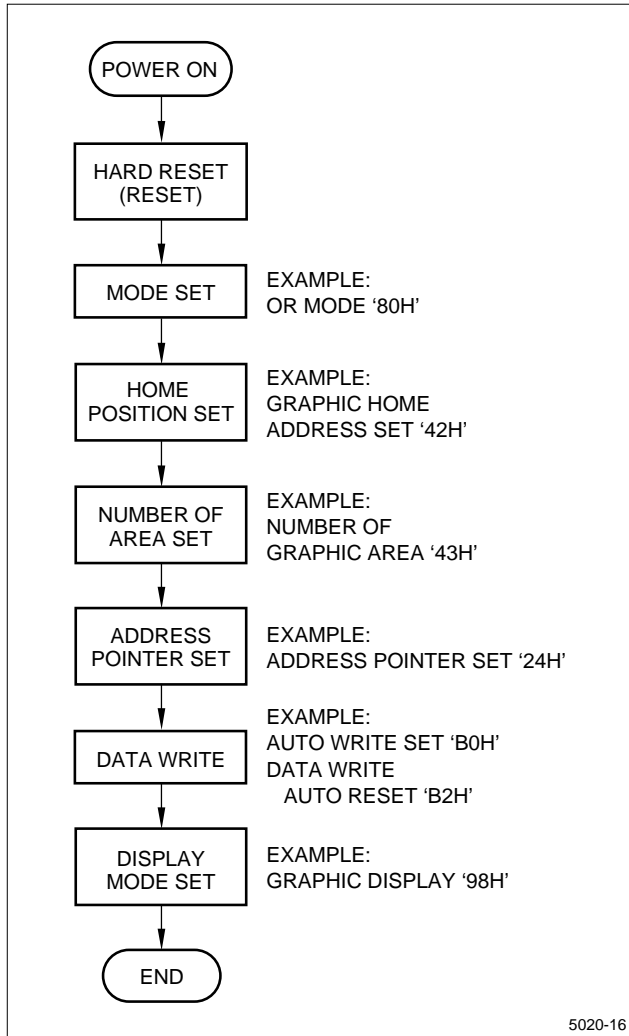


Figure 17. Initialization Flow Chart

PROGRAMMING FLOW CHARTS

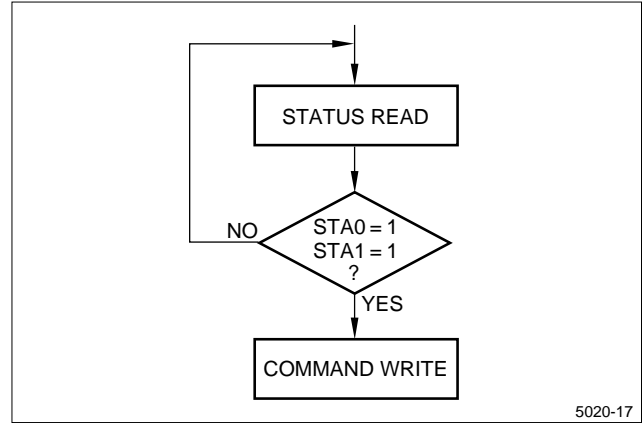


Figure 18. Command Write Flow Chart

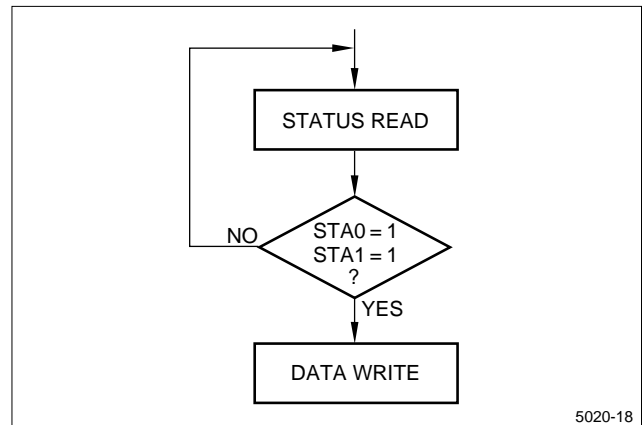


Figure 19. Data Write Flow Chart

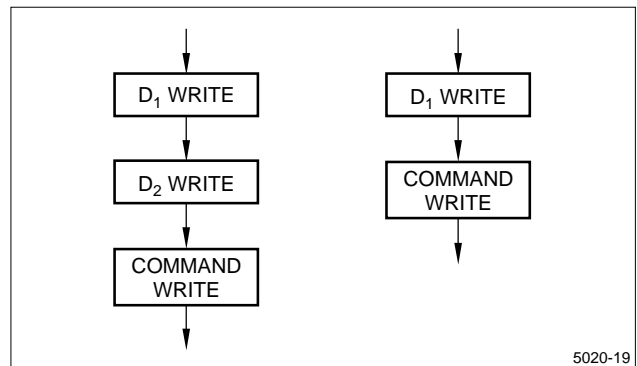


Figure 20. 'Command Write' and 'Data Write' Relationship

STATUS DATA

STATUS	DESCRIPTION	CONDITION		NOTE
STA0	Instruction	1: Ready	0: Busy	–
STA1	Data Read/Write	1: Ready	0: Busy	–
STA2	Auto Read	1: Ready	0: Busy	1
STA3	Auto Write	1: Ready	0: Busy	1
STA4	Don't Care	–	–	–
STA5	Reset	1: Disable	0: Enable	2
STA6	Error Flag	1: Error	0: Right	3
STA7	Blink Status	1: Disp. ON	0: Disp. OFF	–

MSB							LSB
STA7	STA6	STA5	STA4	STA3	STA2	STA1	STA0

NOTES:

1. Only under 'Auto Mode.'
2. This unit cannot enable 1 – 2 ms since power ON, because clock is unstable.
3. If the address was set out of Graphic RAM area, this flag is set. After writing next command, this flag is reset. (See Figures 14 and 15.)

OPTICAL CHARACTERISTICS (t_A = 25°C, V_{DD} = 5.0 V)

SYMBOL	PARAMETER	CONDITION		MIN	TYP	MAX	UNIT	NOTE
θ ₂ - θ ₁	Viewing Angle Range	φ = 0° θ ₁ < θ ₂	C ₀ ≥ 2.0	60	-	-	degrees	1
θ ₁			C ₀ = 2.0	-	-	-30		
θ ₂		φ = 45° 315° θ ₁ < θ ₂	C ₀ ≥ 2.0	60	-	-		
θ ₂ - θ ₁			C ₀ = 2.0	-	-	-30		
θ ₁				-	-	-		
θ ₂				25	-	-		
C ₀	Contrast Ratio	θ = 0°		5	7	-	-	2
t _R	Response Time – Rise	θ = 0°		-	150	250	ms	3
t _D	Response Time – Decay	θ = 0°		-	300	450	ms	

NOTES:

- The viewing angle range is defined as shown in Figure 21.
θ₁ (<0°) θ = 0°
- Contrast ratio is defined as follows:
Contrast ratio is calculated by using the following formula when the waveform voltage (Figure 23) is applied in the optical characteristics test method (Figure 22).

$$\text{Contrast Ratio} = \frac{\text{Photodetector output voltage with non-select waveform being applied}}{\text{Photodetector output voltage with select waveform being applied}}$$
- The Response characteristics of photodetector output are measured as shown in Figure 22, assuming that input signals are applied to select and deselect the dots to be measured, in the optical characteristics test method shown in Figure 23.
- The Optical Characteristics table shows optical characteristics detected when the LCD applied voltage waveforms are in the highest frequency (the most critical condition of the LCD characteristics).

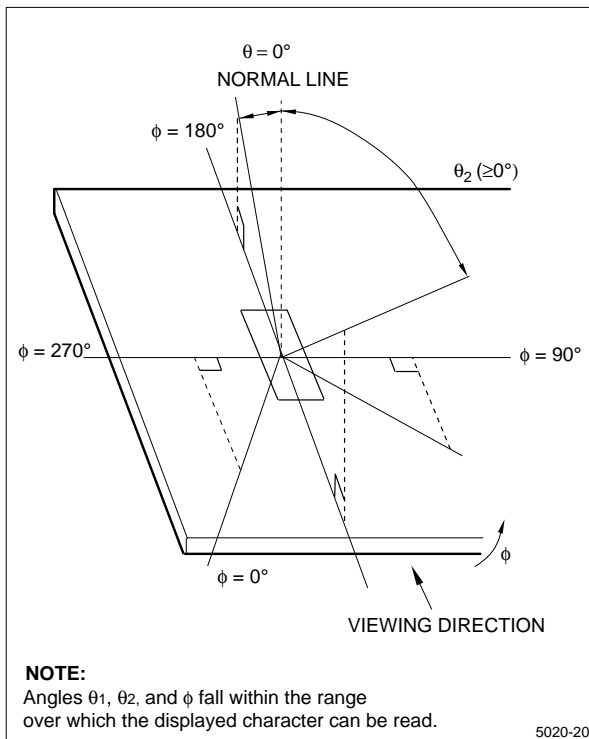


Figure 21. Definition of Viewing Angle

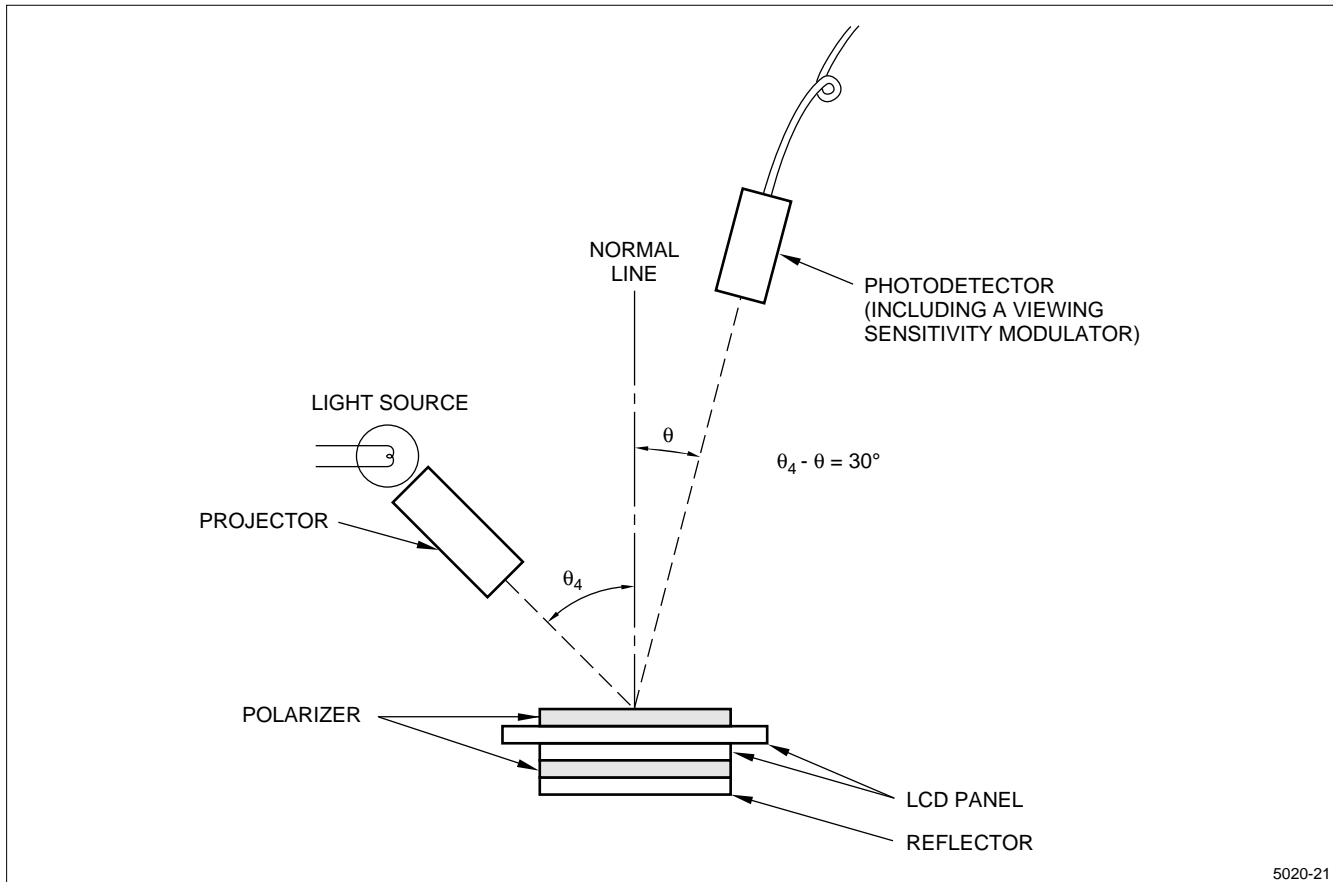


Figure 22. Optical Characteristics Test Method

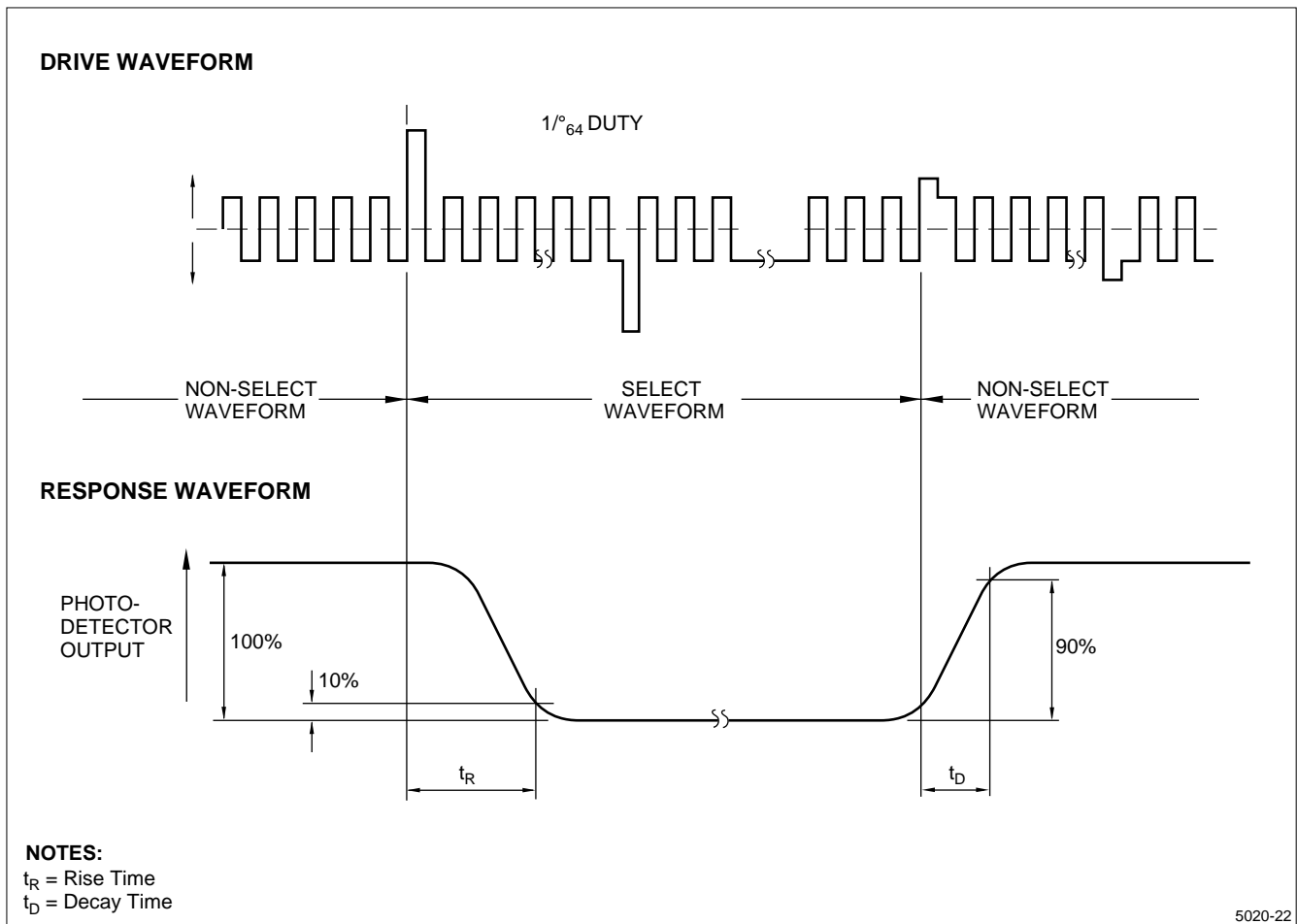


Figure 23. Definition of Response Time

PRECAUTIONS

- This unit's viewing angle is illustrated in Figure 24 and as follows:
 - $\theta_1 < \text{viewing range} < \theta_2$
 ($\theta_1 < 0^\circ, \theta_2 \geq 0^\circ$)
 (For the specific values of θ_1 and θ_2 , refer to Optical Characteristics table.) Consider the optimum viewing conditions according to the purpose when installing the unit.

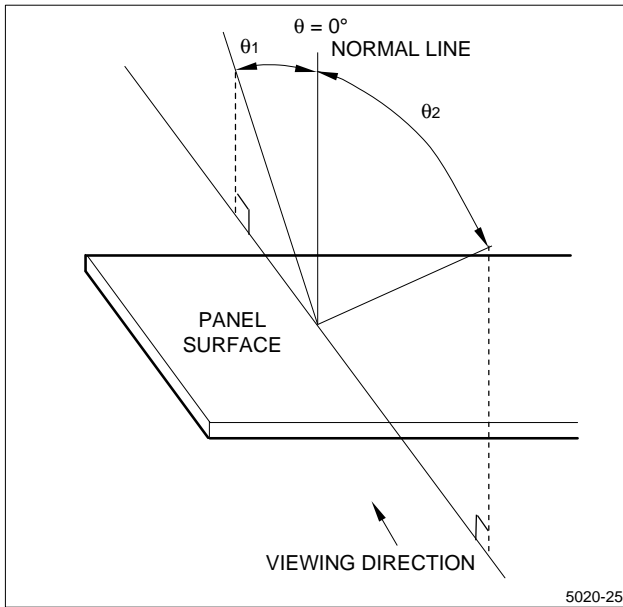


Figure 24. Dot Matrix LCD Viewing Angle

- This unit is installed using mounting tabs at the four corners of PCB or bezel. During installation, avoid undue stress on the unit such as twisting or bending. A transparent acrylic resin board or other type of protective panel should be attached to the front of the unit to protect the polarizer, LCD cells, etc.
- Since the front polarizer is easily damaged, use care to not scratch the face.
- If the surface of the LCD cells need cleaning, wipe it with a soft cloth.
- Wipe liquid off immediately since it can cause color changes and staining.
- The LCD is made of glass plates. Use care when handling it to avoid breakage.
- This unit contains CMOS LSIs which are sensitive to electrostatic charges. The following measures should be taken to protect the unit from electrostatic discharge:
 - Ground the metallic case of the main system (contact of the unit and main system).
 - Insulate the unit and main system by attaching insulating washers made of bakelite or nylon.
- Do not expose the unit to direct sunlight, strong ultraviolet light, etc. for prolonged periods.
- Store the unit at normal room temperature to prevent the LC from converting to liquid (due to excessive temperature changes).
- Do not disassemble the unit.

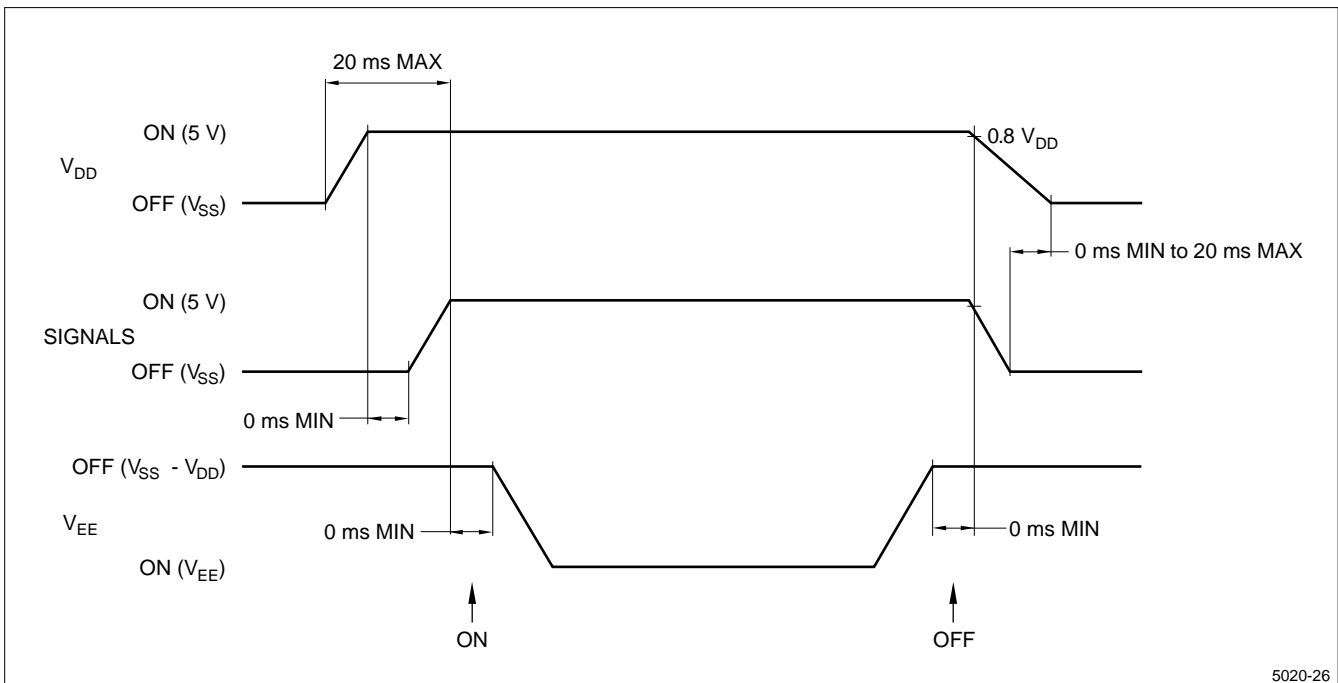
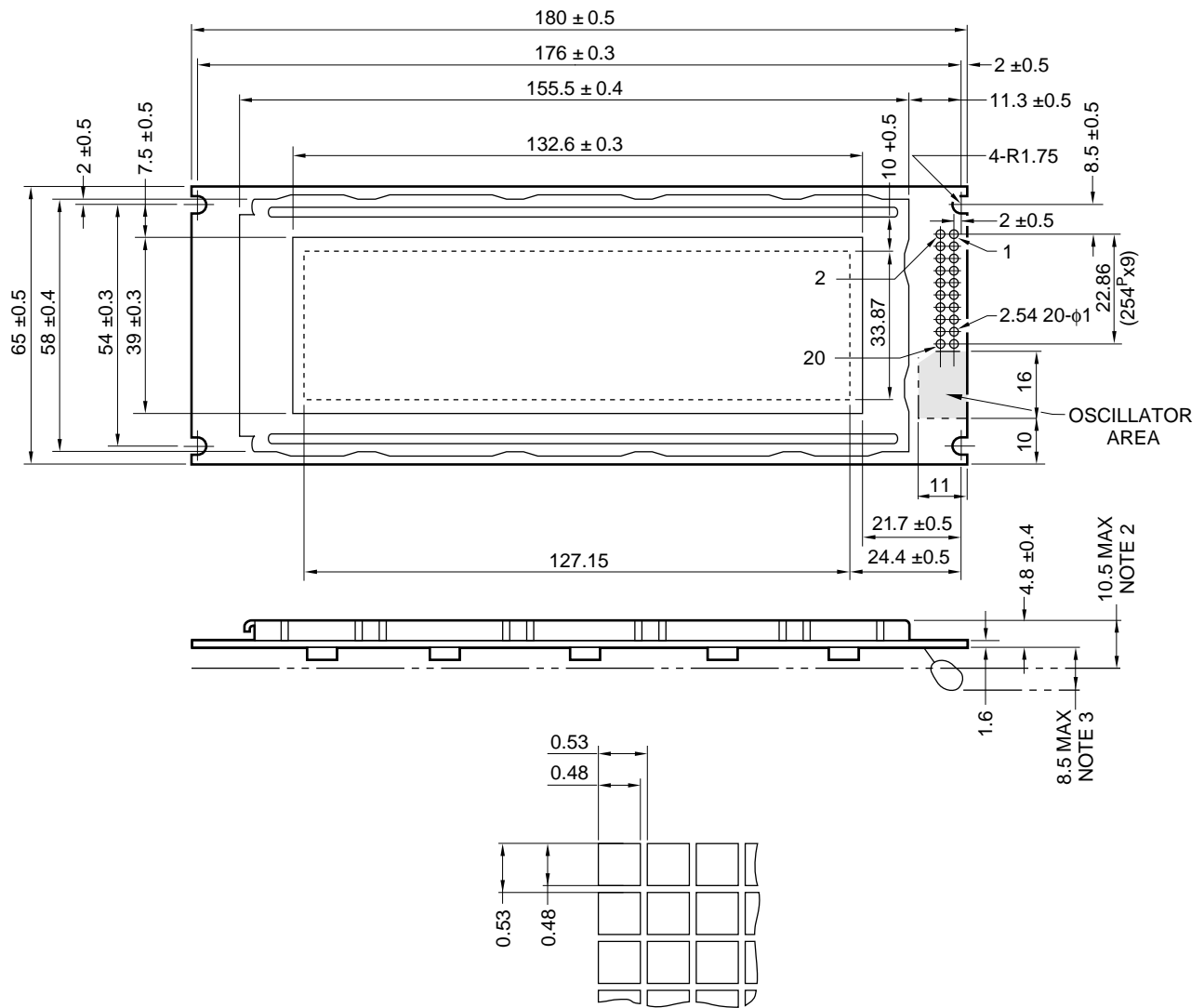


Figure 25. Power ON/OFF Sequence

OUTLINE DIMENSIONS



NOTES:

1. The bezel (metal frame) is galvanized with white zinc.
2. Maximum thickness (except oscillator).
3. Height of mounted oscillator.

DOT SIZE (S = 20/1)