LCD Module Specification

1.0 Table of Contents

2.0 Record of revision

Rev	Date	Item	Page	Comment

3.0 General specification

Display format: 2 x 16

Character size: 5 x 7

View area: 61 x 15.8

General dimensions: 80 x 36

LCD type: ☐ STN Gray ☐ STN Yellow ☐ FSTN

Polarizer mode: ☐ Reflective ☐ Transflective
☐ Tansmissive ☐ Negative

View angle: ☐ 6 O'clock ☐ 12 O'clock ☐ Others_____

Backlight: ☐ LED ☐ EL ☐ CCFL

Backlight colour: ☐ Yellow green ☐ Amber ☐ Blue green
☐ White ☐ Others

Controller/Driver: KS0070B

Temperature range: ☐ Normal temperature ☐ Wide temperature
Operating 0 to 50 C Operating –25 to 70 C
Storage –20 to 70 C Storage –30 to 80 C

4.0 Absolute maximum rating

Vss = 0V, Ta = 25°C

NO	ITEM	SIMBOL	MIN	MAX	UNIT
1.	Power Supply voltage (Logic)	$V_{DD} - V_{SS}$	0	7	V
2.	Power Supply voltage (LCD Driver)	$V_{DD} - V_0$	-	12	V
3.	Operating Temperature	T_{op}	Refer page 3		°C
4.	Storage Temperature	T_{st}	Refer page 3		°C

5.0 Electrical characteristics

NO	ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
1.	Power Supply voltage (Logic)	$V_{DD} - V_{SS}$	-	2.75	-	5.5	V
2.	Power Supply voltage (V_{LCD})	V_{DD}-V_0	25°C	4.3	4.5	4.7	V
3.	Input Voltage (except OSC1)	V_{IH}	-	$0.7V_{DD}$	-	V_{DD}	V
		V_{IL}	-	-0.3	-	0.4	V
4.	Current Supply	I_{DD}	$V_{DD} - V_{SS} = 5V$	-	5	-	mA

6.0 Environmental requirements

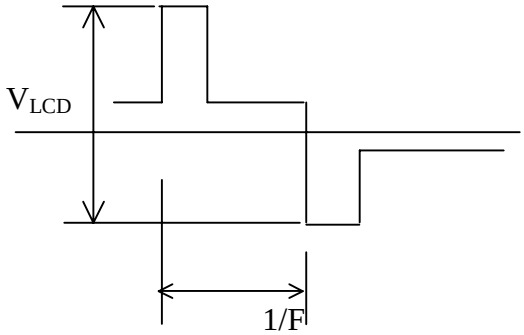
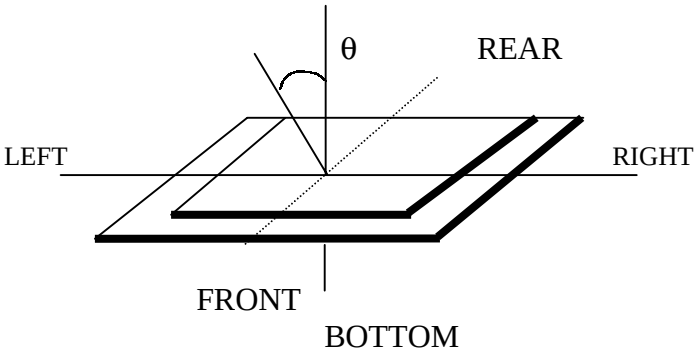
NO	ITEM	CONDITION
1.	Operating Temperature	Refer page 3
2.	Storage Temperature	Refer page 3
3.	Operating Humidity	5% to 95%RH
4.	Cycle Test	0 C @ 30 min to 50 C @ 30min for 1 cycle run for 10 cycles

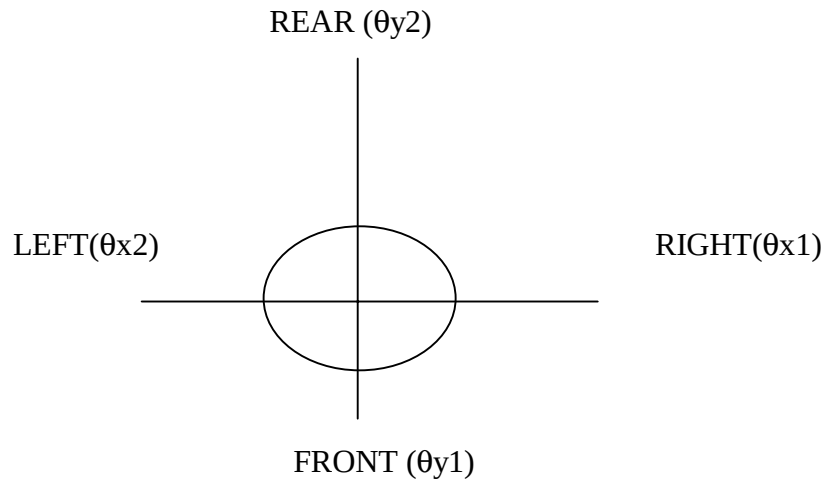
Note: The background on LCD has the possibility to be changed in different temperature range.

7.0 LCD specification

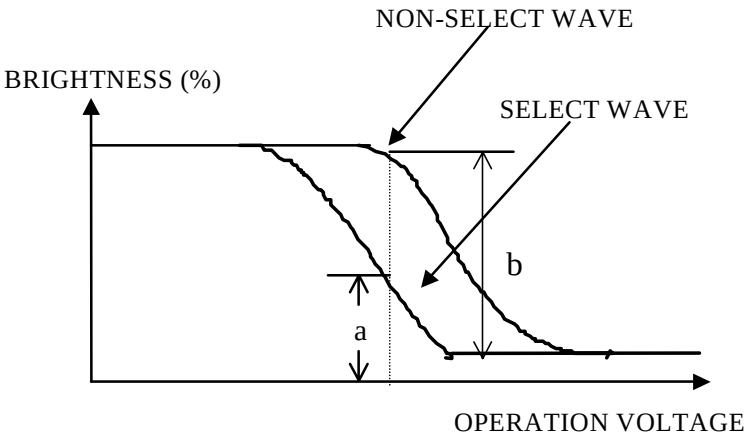
7.1 Electro-optical characteristics

NO	ITEM	SYMBOL	TEMP. °C	CONDITION	COMMERCIAL			UNIT	REF.
					MIN	TYP	MAX		
1	Operating Voltage	V_{LCD}	25	θ = 0 Cr = max	4.3	4.5	4.7	Volt	7.1.1
2	Viewing	θ x 1	25	CR ≥ 2 V_{LCD} = 4.5V	-	45	-	Deg	7.1.2
		θ x 2			-	45	-		
		θ y 1			-	50	-		
		θ y 2			-	45	-		
3	Contrast Ratio	Cr	25	θ = 0^0, V_{LCD} =4.5V	-	10	-		7.1.3

NO	CHARACTERISTICS	DEFINITIONS
7.1.1	***Definition of Operating Voltage (V_{LCD})***	 V_{LCD} : Operating Voltage F : Frame Frequency
7.1.2	***Definition of Viewing Angle***	



7.1.3 ***Definition of Contrast Ratio***



Contrast Ratio = Brightness of non-selected state (b) / Brightness of selected state (a)

Conditions

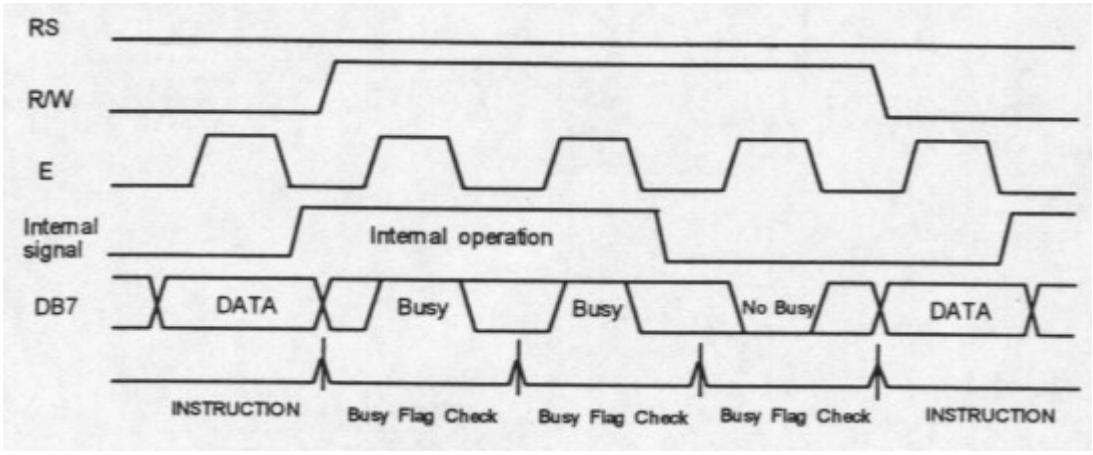
(a) Operating Voltage: V_{LCD}
(b) Temperature: 25°C
(c) Viewing Angle, $\theta = 0^o$

8.0 Interface

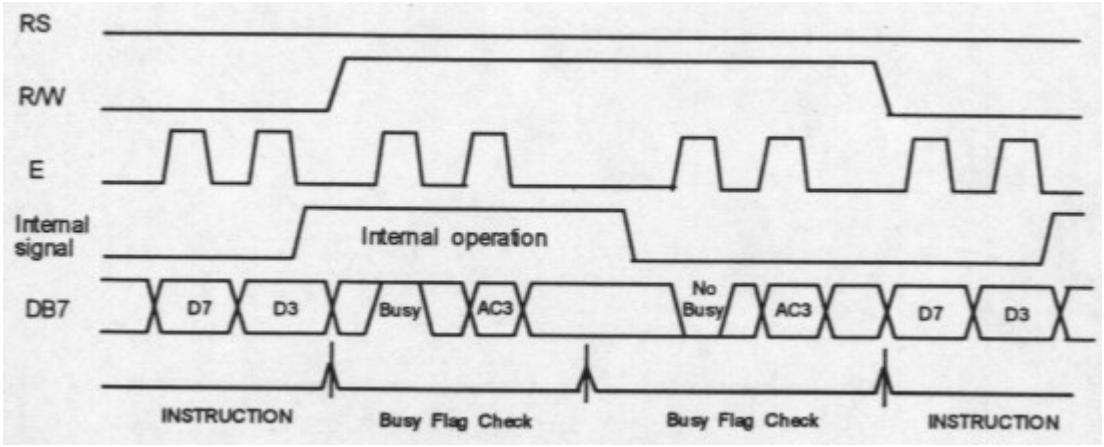
8.1	***Display Driver***	KS0070B	
8.2	***Duty Cycle***	1/16	
8.3	***Pin-out Assignments***		
	Pin No	**Symbol**	**Description**
	1	V_{SS}	Ground terminal of module
	2	V_{DD}	Supply terminal of module
	3	V_O	Power supply for Liquid Crystal Drive
	4	RS	Register Select: RS = 0 …. Instruction Register RS = 1 …. Data Register
	5	R/W	Read/Write: High = Read Low = Write
	6	E	Enable
	7 to 14	D0 to D7	Bi-directional Data Bus. Data Transfer is performed once, thru D0 to D7, in the case of interface data length is 8-bits.
	15	(BL -)	LED power supply terminals
	16	(BL +)	

9.0 TIMING CHARACTERISTICS/TIMING DIAGRAMS

9.1 Timing Characteristics for KS0070B

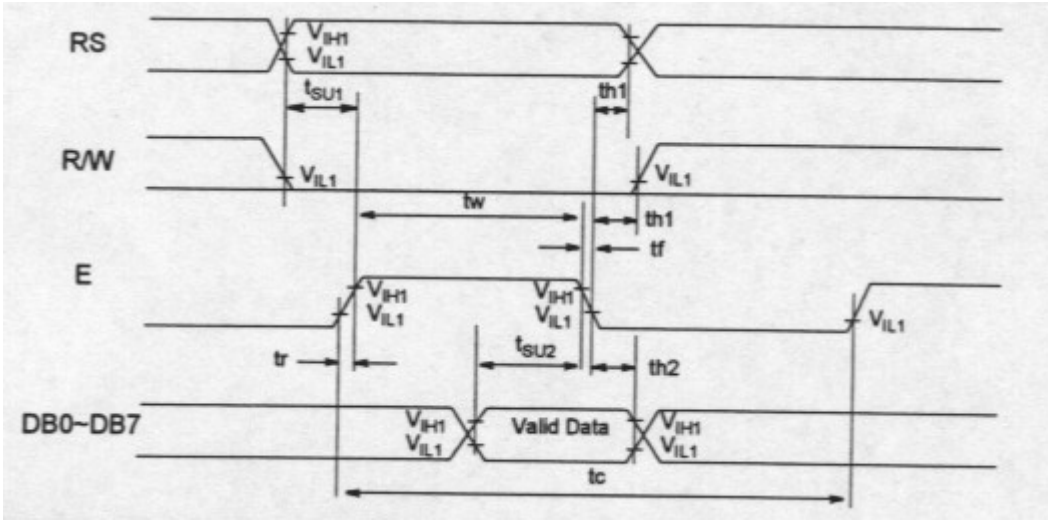


Example of 8-bitBus mode timing diagram



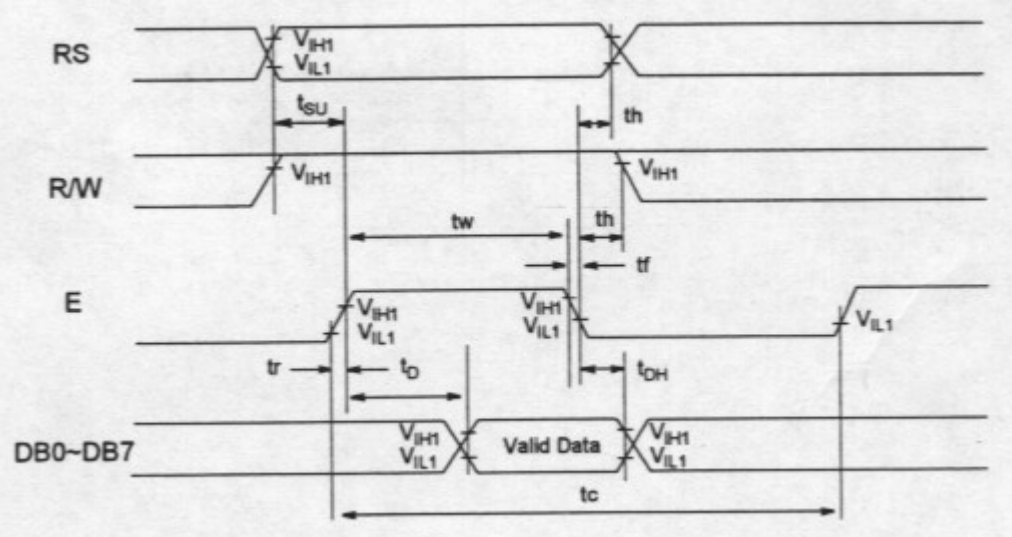
Example of 4-bit Bus mode timing diagram

9.2 Timing Diagrams for Write Mode and Read Mode (KS0070B)



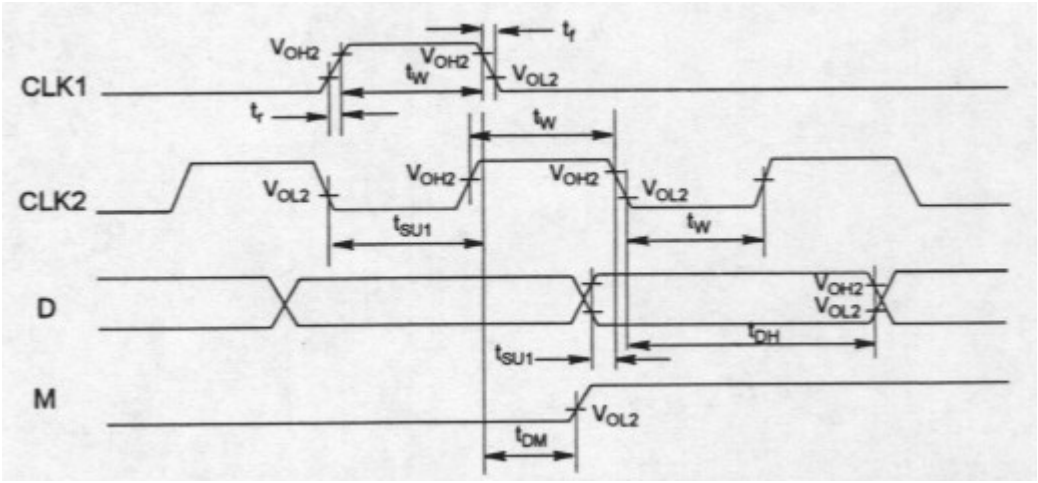
Write Mode Timing Diagram

Item	Symbol	Condition	Min	Max	Unit
Enable cycle time	t_c	V_{DD} = 4.5 to 5.5V Ta = -30 to +85C	500	-	ns
Enable rise/fall time	t_r, t_f		-	25	
Enable pulse width (high, low)	t_w		220	-	
R/W and RS setup time	t_{su1}		40	-	
R/W and RS hold time	t_{h1}		10	-	
Data setup time	t_{su2}		60	-	
Data hold time	t_{h2}		10	-	



Read Mode Timing Diagram

Item	Symbol	Condition	Min	Max	Unit
Enable cycle time	t_c	V_{DD} = 4.5 to 5.5V Ta = -30 to +85C	500	-	ns
Enable rise/fall time	t_r, t_f		-	25	
Enable pulse width (high, low)	t_w		220	-	
R/W and RS setup time	t_{su1}		40	-	
R/W and RS hold time	t_{h1}		10	-	
Data setup time	t_{su2}		-	120	
Data hold time	t_{h2}		20	-	



Interface mode with extension driver timing diagram

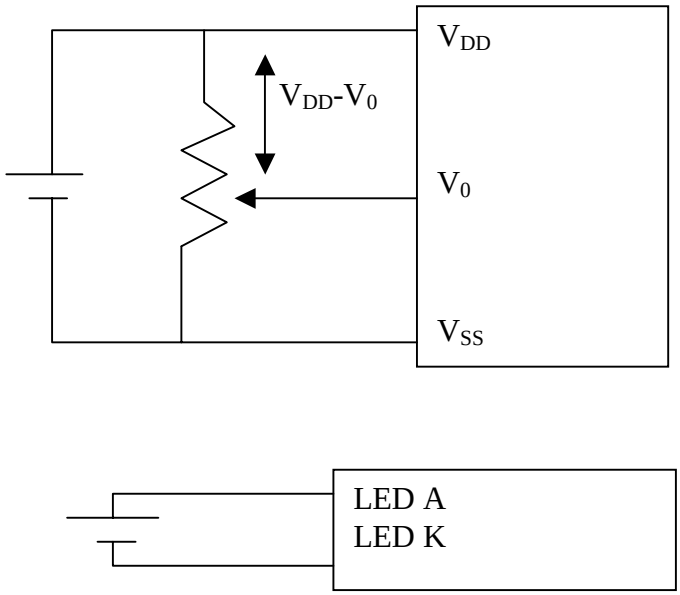
Item	Symbol	Min	Max	Unit
Clock pulse width (high, low)	t_W	800	-	ns
Clock rise/fall time	t_r/t_f	-	100	
Clock setup time	t_{SU1}	500	-	
Data setup time	t_{SU2}	300	-	
Data hold time	t_{DH}	300	-	
M delay time	t_{DW}	-1000	1000	

Relationship between character code (DDRAM) and character pattern (CGRAM)

Character Code (DDRAM data)								CGRAM Address						CGRAM Data								Pattern number
D7	D6	D5	D4	D3	D2	D1	D0	A5	A4	A3	A2	A1	A0	P7	P6	P5	P4	P3	P2	P1	P0	
0	0	0	0	×	0	0	0	0	0	0	0	0	0	×	×	×	0	1	1	1	0	pattern 1
											0	0	1				1	0	0	0	1	
											0	1	0				1	0	0	0	1	
											0	1	1				1	1	1	1	1	
											1	0	0				1	0	0	0	1	
											1	0	1				1	0	0	0	1	
											1	1	0				1	0	0	0	1	
											1	1	1				0	0	0	0	0	
0	0	0	0	×	1	1	1	0	0	0	0	0	0	×	×	×	1	0	0	0	1	pattern 8
											0	0	1				1	0	0	0	1	
											0	1	0				1	0	0	0	1	
											0	1	1				1	1	1	1	1	
											1	0	0				1	0	0	0	1	
											1	0	1				1	0	0	0	1	
											1	1	0				1	0	0	0	1	
											1	1	1				0	0	0	0	0	

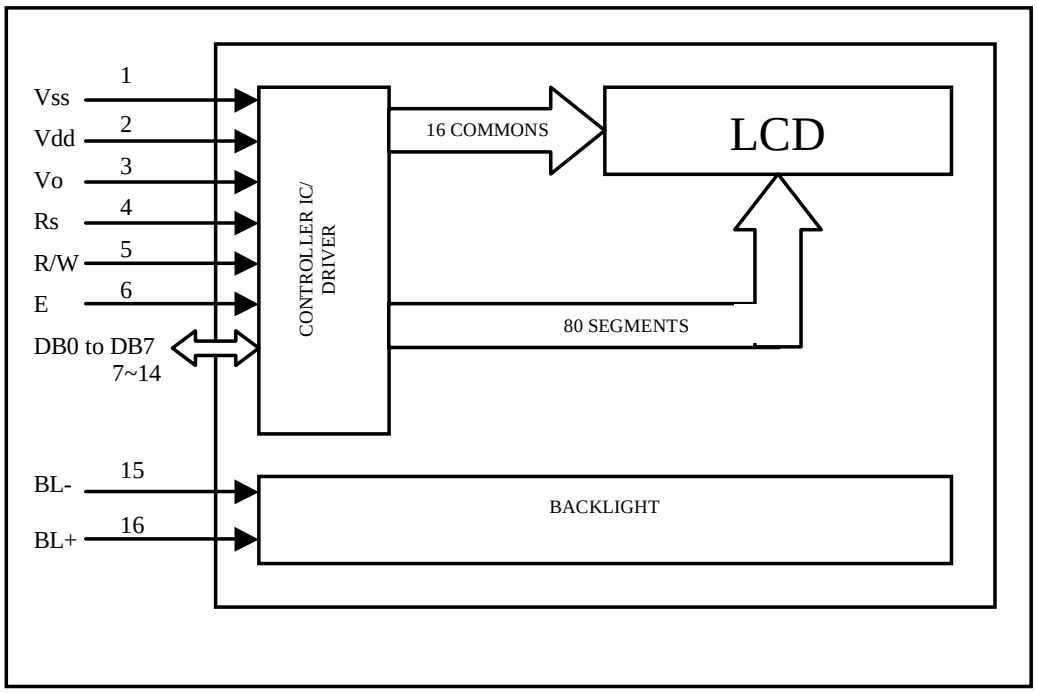
Character Generator ROM (KS0070)

10. Power Supply



Where V_{DD}-V_0 = LCD Driving voltage

11. Block Diagram



12. Instructions

Instruction	Code										Description	Executed time(max) fosc=270KHz
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clear all display and returns the cursor to the home position (Address 0)	1.53 ms
Cursor at home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (Address 0). Also return the display being shifted to the original position. DDRAM contents remain unchanged.	1.53 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and specifies or not to shift the display. These operations are performed during data write and read.	39 µs
Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets the ON/OFF of all display (D) cursor ON/OFF (C), and blink of cursor position character (B).	39 µs
Cursor/display shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DDRAM contents.	39 µs
Function set	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL), number of display lines (N) and character font (F).	39 µs
CGRAM address set	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Sets the CGRAM, data is sent and received after this setting.	39 µs
DDRAM address set	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set the DGRAM, data is sent and received after this setting.	39 µs
Busy Flag/ address read	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Recall Busy flag (FB) indicating internal operation is being performed and read address counter contents.	0 µs
CGRAM/DDRAM data write	1	0	WRITE DATA								Writes data into DDRAM or CGRAM	43 µs
CGRAM/DDRAM data read	1	1	READ DATA								Reads data into DDRAM or CGRAM	43 µs

Code		Description	Executed time (max)
I/D=1: Increment	DL= 0:4-bit	DDRAM: Display Data RAM	Fcp or fosc = 250KHz
I/D=0: Decrement	1/16 duty	CGRAM: Character Generator RAM	However, when frequency changes, execution
S=1: With display shift	1/8 duty, 1/11 duty	ACG: CGRAM Address	time also changes.
S/C=1: Display shift	F= 1:5x10 dots	ADD: DDRAM Address	
S/C=0: Cursor movement	F= 0: 5x7 dots	Corresponds to cursor address	Example
R/L=1: Shift to the right	BF=1: Internal operations is	AC: Address Counter, used for both DDRAM	If fcp or fosc is 270KHz
R/L=0: Shift to the left	being performed	and CGRAM	
DL=1: 8-bit	BF=0: Instruction acceptable	* : Invalid	

8 bit operation, 8 digit 2line display example.

Step	Instruction											
No	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Display	Operation
1	Power supply on											Initialized. No display
2	Function set											Sets to 8 bit operation and select 2 lines display and 5x8 dot character font.
	0	0	0	0	1	1	1	0	X	X		
3	Display on/off control										_	Turn on display and cursor. All display is in space mode because of initialisation.
	0	0	0	0	0	0	1	1	1	0		
4	Entry mode set										_	Sets mode to increment the address by one and to shift the cursor to the right at the time of write to the DD/CGRAM. Display is not shifted.
	0	0	0	0	0	0	0	1	1	0		
5	Write data to CGRAM/DDRAM										C_	Writes C. DDRAM has already been selected by initialisation when the power was turned on. The cursor is incremented by one and shifted to the right.
	1	0	0	1	0	0	0	0	1	1		
6												
7	Write data to CGRAM/DDRAM										CRYSTAL CLEAR_	Writes R
	1	0	0	1	0	1	0	0	1	0		
8	Set DDRAM address										CRYSTAL CLEAR _	Sets DDRAM address so that the cursor is positioned at the head of the second line.
	0	0	1	1	0	0	0	0	0	0		
9	Write data to CGRAM/DDRAM										CRYSTAL CLEAR T_	Writes T
	1	0	0	1	0	1	0	1	0	0		
10												
11	Write data to CGRAM/DDRAM										CRYSTAL CLEAR TECH_	Writes H
	1	0	0	1	0	0	1	0	0	0		
12	Entry mode set										CRYSTAL CLEAR TECH_	Sets mode to shift display at the time of write.
	0	0	0	1	0	0	0	1	1	1		
13	Write data to CGRAM/DDRAM										CRYSTAL CLEAR TECHNOLOGY	Writes Y. Display is shifted to the left. The first and second lines both shift at the same time.
	1	0	0	1	0	1	1	0	0	1		
14												
15	Return home										CRYSTAL CLEAR TECHNOLOGY	Returns both display and cursor to the original position (address 0)
	0	0	0	1	0	0	0	0	1	X		