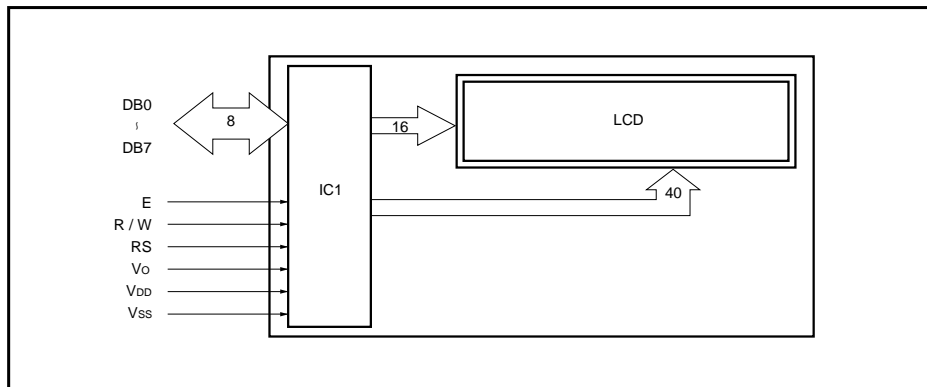




## Liquid Crystal Displays

## ●Block diagram



## ●Pin assignments

Pin No.	Symbol	Pin No.	Symbol
1	DB7	8	DB0
2	DB6	9	E
3	DB5	10	R / W
4	DB4	11	Rs
5	DB3	12	Vo
6	DB2	13	V <sub>DD</sub>
7	DB1	14	V <sub>SS</sub>

## ●Power supply example

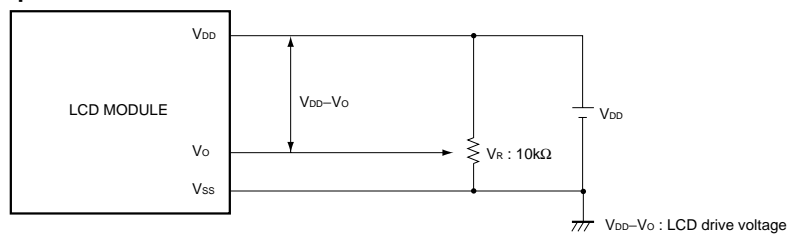


Fig.1

●Absolute maximum ratings ( $T_a=25^\circ\text{C}$ )

Parameter	Symbol	Min.	Max.	Unit
Power voltage for logics	$V_{DD}-V_{SS}$	-0.3	6.0	V
Power voltage for driving LCD	$V_{DD}-V_o$	-0.3	6.0	V
Input voltage	$V_{IN}$	-0.3	$V_{DD}+0.3$	V
Operating temperature	$T_{opr}$	0	50	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-20	70	$^\circ\text{C}$

Liquid Crystal Displays

●Electrical characteristics (V<sub>DD</sub>=5.0V, T<sub>a</sub>=25°C)

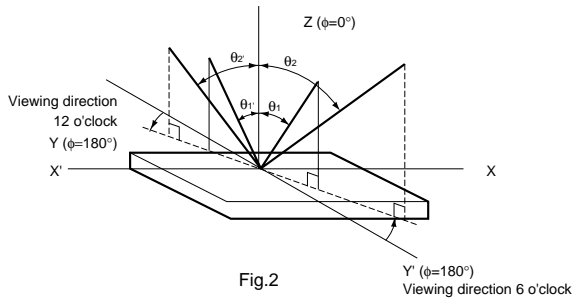
Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Logic power voltage	V <sub>DD</sub>	4.75	5.0	5.25	V	
LCD driving voltage	V <sub>DD</sub> -V <sub>O</sub>	3.0	-	V <sub>DD</sub>	V	
"H" input voltage (1)	V <sub>IH1</sub>	2.3	-	V <sub>DD</sub>	V	RS, R/W, CS
"L" input voltage (1)	V <sub>IL1</sub>	0	-	0.8	V	
"H" input voltage (2)	V <sub>IH2</sub>	0.8V <sub>DD</sub>	-	V <sub>DD</sub>	V	E
"L" input voltage (2)	V <sub>IL2</sub>	0	-	0.2V <sub>DD</sub>	V	
"H" output voltage	V <sub>OH</sub>	2.4	-	-	V	I <sub>OH</sub> =-0.205mA
"L" output voltage	V <sub>OL</sub>	-	-	0.4	V	I <sub>OL</sub> =1.6mA
Clock frequency	f <sub>osc</sub>	190	270	350	kHz	
Current consumption	I <sub>DD</sub>	-	1.4	3.6	mA	V <sub>DD</sub> =5.0V, f <sub>osc</sub> =270kHz check pattern

●Optical characteristics (T<sub>a</sub>=25°C)

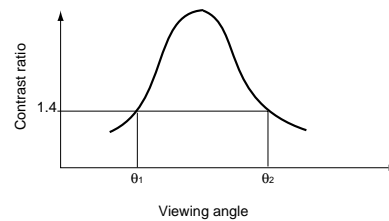
When viewing from below

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Response time	t <sub>r</sub>	-	100	200	ms	φ=0°, θ=10° V <sub>lcd</sub> =5.0V
Response time	t <sub>d</sub>	-	150	250	ms	φ=0°, θ=10° V <sub>lcd</sub> =5.0V
Contrast ratio	K	1.4	2.0	-	-	φ=0°, θ=10° V <sub>lcd</sub> =5.0V
Viewing angle	θ <sub>1</sub>	-	-	10	deg	K≥1.4, φ=0° V <sub>lcd</sub> =4.8V
	θ <sub>2</sub>	30	-	-	deg	
	φ	±30	-	-	-	deg

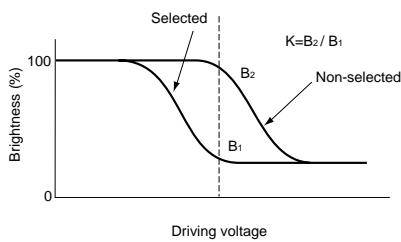
(1) Definition θ and φ



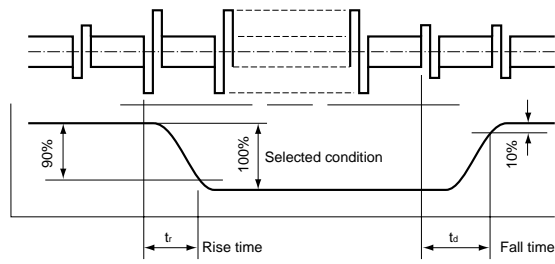
(2) Definition of viewing angles θ<sub>1</sub> and θ<sub>2</sub>



(3) Definition of contrast ratio "K"



(4) Definition of optical response



## Liquid Crystal Displays

## ●Terminal function

Symbol	Level	I/O Terminal	Function
DB7~DB4	H / L	Input / Output	Upper 4line of data-bus. DB7 can be used as busy flag.
DB3~DB0	H / L	Input / Output	Lower 4line of data-bus.
E	H, H / L	Input	Data read / Write enable signal (active H)
R / W	H / L	Input	Read / Write select signal L : Write H : Read
RS	H / L	Input	Register selected signal L : Instruction register (at write) L : Busy flag / address counter (at read) H : Data register (at write & read)
Vo	-	-	3.0~5.0V (V <sub>DD</sub> -Vo) LCD driving voltage input terminal
V <sub>DD</sub>	-	-	V <sub>DD</sub> =+5V
V <sub>SS</sub>	-	-	V <sub>SS</sub> =0V

## ●Timing chart

(1) Writing

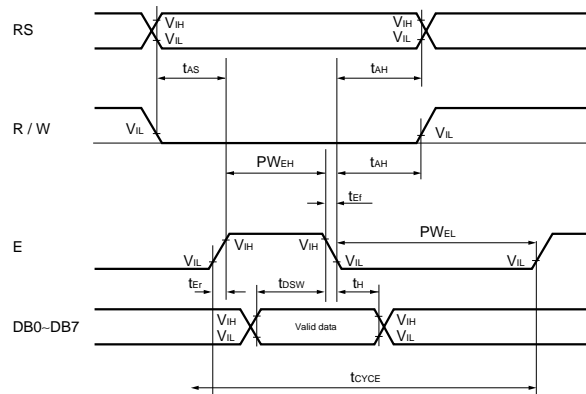


Fig.6

Parameter	Symbol	Min.	Max.	Unit	Conditions
"E" cycle time	t <sub>CYCE</sub>	500	-	ns	Fig.6
"E" pulse width H level	PW <sub>EH</sub>	220	-	ns	Fig.6
"E" pulse width L level	PW <sub>E_L</sub>	280	-	ns	Fig.6
"E" rise/fall time	t <sub>ER</sub> , t <sub>EF</sub>	-	20	ns	Fig.6
Setup time "RS, R/W to E"	t <sub>AS</sub>	40	-	ns	Fig.6
Address hold time	t <sub>AH</sub>	10	-	ns	Fig.6
Data setup time	t <sub>DSW</sub>	60	-	ns	Fig.6
Data hold time	t <sub>H</sub>	10	-	ns	Fig.6

## Liquid Crystal Displays

## (2) Reading

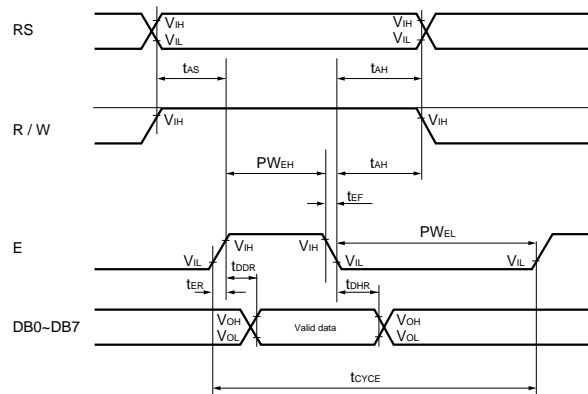


Fig.7

Parameter	Symbol	Min.	Max.	Unit	Conditions
"E" cycle time	$t_{CYCE}$	500	–	ns	Fig.7
"E" pulse width H level	$PW_{EH}$	220	–	ns	Fig.7
"E" pulse width L level	$PW_{EL}$	280	–	ns	Fig.7
"E" rise/fall time	$t_{ER}, t_{EF}$	–	20	ns	Fig.7
Setup time "RS, R/W to E"	$t_{AS}$	40	–	ns	Fig.7
Address hold time	$t_{AH}$	10	–	ns	Fig.7
Data decay time	$t_{DDR}$	–	240	ns	Fig.7
Data hold time	$t_{DHR}$	20	–	ns	Fig.7

## Liquid Crystal Displays

## ●Instruction

Instruction	Code											Description	Execution time(Max.)	
	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0				
Clear display	0	0	0	0	0	0	0	0	0	0	1	Cursor is returned to home position (address 0) after entire display clear.	4.4ms	
Cursor at home	0	0	0	0	0	0	0	0	0	1	*	Cursor is returned to home position (address 0). Shifted display is also returned to the original position. Contents of DDRAM are not changed.	4.4ms	
Entry mode	0	0	0	0	0	0	0	1	I / D	S		Cursor advance direction and display shift are set. These operation are performed during data write and read modes.	106μs	
Display ON / OFF control	0	0	0	0	0	0	1	D	C	B		Entire display ON / OFF (D), cursor ON / OFF (C), and character blink (B) at cursor position are set.	106μs	
Cursor / Display shift	0	0	0	0	0	1	S/C	R/L	*	*		Cursor and display are shifted without changing the contents of DDRAM.	160μs	
Function set	0	0	0	0	1	DL	A	*	*	*		Interface data length (DL), Addressing mode of DDRAM (A) are set.	106μs	
CG RAM address set	0	0	0	1	*	ACG						CGRAM address is set. After this what is transmitted and received is the data of CGRAM.	106μs	
DD RAM address set	0	0	1	ADD								DDRAM address is set. After this what is transmitted and received is the data of DDRAM.	106μs	
Busy flag / Address read	0	1	BF	ACDD			ACCG						Busy flag (BF) showing internal operation and contents of address counter are read.	0μs
CG RAM / DD RAM data read	1	0	Write Data (DD RAM)				Write Data (CG RAM)					Data are written in of DDRAM or CGRAM	106μs	
			*	*	*	*	*	*	*	*	*			*
CG RAM / DD RAM data read	1	1	Read Data (DD RAM)				Read Data (CG RAM)					Data are read out of DDRAM or CGRAM	160μs	
			*	*	*	*	*	*	*	*	*			*
I / D=1 : Increment I / D=0 : Decrement S=1 : With display shift S / C=1 : With display shift S / C=0 : Cursor movement R / L=1 : Shift to the right R / L=0 : Shift to the left DL=1 : 8bits A=0 : Addressing mode 1 A=1 : Addressing mode 2 BF=1 : Internal operation is being performed BF=0 : Instruction acceptable * Don't care											DD RAM : Display data RAM CG RAM : Character generator RAM ACG : Address of CGRAM ADD : Address of DDRAM These correspond to cursor address. AC : Address counter used for both DDRAM and CGRAM.			

\* DL=1

Liquid Crystal Displays

●Character code and corresponding character pattern

		Upper 4bit (HEX)															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Lower 4bit (HEX)	0	CGRAM (01)			0	a	P	`	P				—	9	3	6	
	1	(02)	!	1	A	Q	a	9				8	7	+	4	8	
	2	(03)	"	2	B	R	b	r				T	4	W	X	△	8
	3	(04)	#	3	C	S	c	s				J	0	+	+	△	0
	4	(01)	\$	4	D	T	d	t				\	1	+	+	△	0
	5	(02)	%	5	E	U	e	u				#	7	+	1	△	0
	6	(03)	&	6	F	V	f	v				9	0	+	3	△	0
	7	(04)	'	7	G	W	g	w				7	+	+	+	△	8
	8	(01)	(	8	H	X	h	x				4	0	+	U	△	2
	9	(02)	)	9	I	Y	i	y				9	7	U	△	2	
	A	(03)	*	#	J	Z	j	z				+	0	U	△	△	△
	B	(04)	+	;	K	⌋	k	⌋				+	7	U	△	△	△
	C	(01)	,	<	L	*	l	l				+	0	U	△	△	△
	D	(02)	—	=	M	⌋	m	⌋				+	7	U	△	△	△
	E	(03)	.	>	N	^	n	+				3	7	U	△	△	△
	F	(04)	/	?	O	_	o	+				W	U	U	△	△	△

## Liquid Crystal Displays

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### ●Operation note

#### (1) Handling precautions

- Protect the module from strong shocks as they can cause damage or defective operation.
- The polarizing plate on the surface of the module is soft and can easily be scratched. Wipe away dirt and dust using an alcohol-based cleanser.
- If the liquid crystal panel is damaged and the liquid crystal contacts your clothing or body, wash immediately with soap and water.
- If the module is to be used for long periods subjected to direct sunlight, employ a filter to block the ultraviolet rays.
- Do not use the module in areas of high temperature or high humidity. Do not use the module locations exposed to direct sunlight or fluorescent light.
- A protective film (polyethylene) is pasted over ROHM liquid crystal modules to protect the panel surfaces. When peeling this film off, be sure to peel as slow as possible in order to minimize the generation of static electricity.

#### (2) Precautions during operation

- Do not connect or disconnect the module while the power supply is turned on.
- Input the input signal after the module power supply is turned on. When turning it off, turn off the input signal first. Otherwise the IC may be damaged by the latch-up phenomenon.

#### (3) Precautions during installation

- Be sure to use a grounded soldering iron when performing any installation procedures.
- Be careful to avoid damage from static electricity. A CMOS-IC is used in the modules circuitry that can be easily damaged by static electricity.

#### (4) Precautions during unit assembly

- In order to protect the polarizing plate from dirt or scratches, it is recommended to use a protective cover on the front surface.

#### (5) Precautions for COG module

- Do not subject the front and back surface of the IC to light. Doing so may cause defective operation.
- When peeling off the protective film of the panel, use of an ion blower or other device to reduce the generation of static electricity is recommended.
- No special measures are taken to prevent the generation of static electricity on the module. Therefore, be sure to take the appropriate measures to prevent the generation of electrical charge on the LCD module by the design of the product itself.