

# 16 characters × 2 lines COG module

## RCM2090R

The RCM2090R is a reflective TN type liquid crystal module with a built-in controller / driver LSI and a display capacity of 16 characters × 2 lines.

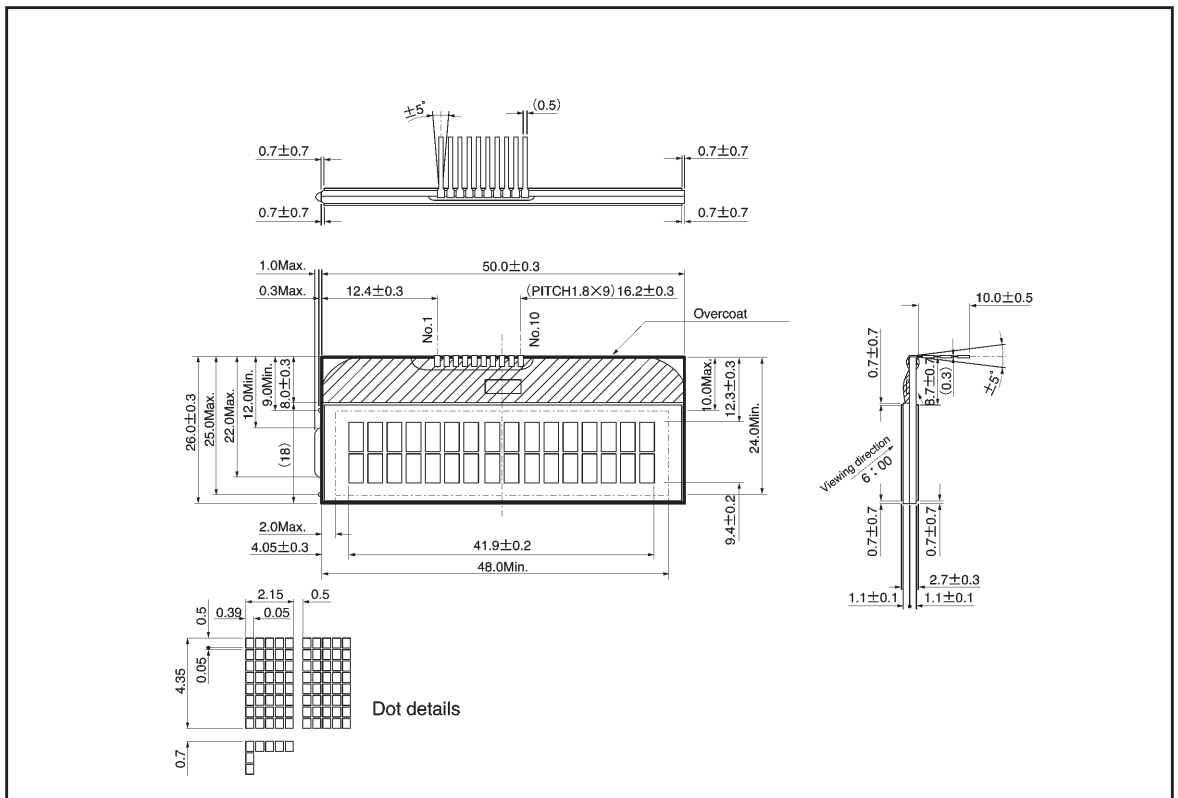
●Applications

Printers, copiers, facsimiles, etc.

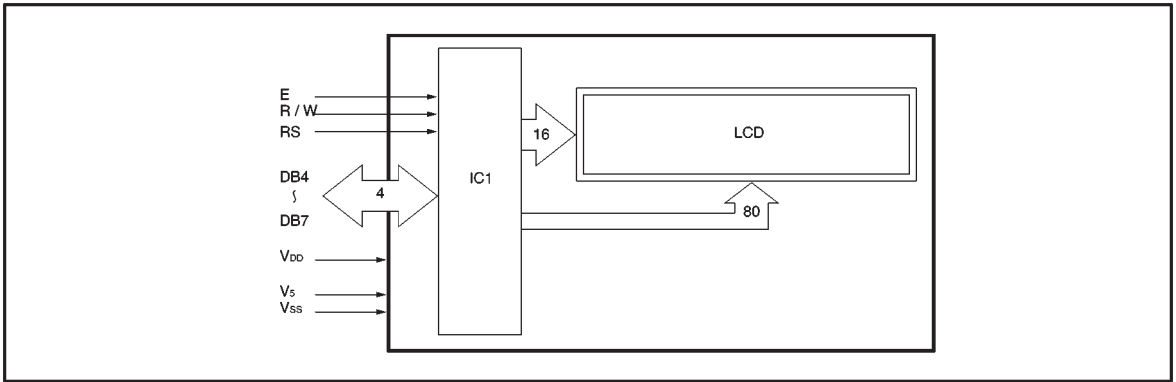
●Features

- 1) Wide viewing angle and high contrast.
- 2) 5 × 7 dot character matrix with cursor.
- 3) Interfaces with 4-bit MPUs.
- 4) Displays up to 237 characters and special symbols
- 5) Custom character patterns are displayed with the character RAM.
- 6) Abundant instruction set including clear display, cursor on / off, and character blinking.
- 7) Compact and lightweight for easy assembly to the host instrument.
- 8) Operable on single 5V power supply.
- 9) Low power consumption.

●External dimensions (Units: mm)



●Block diagram



●Pin assignments

Pin No.	Signal	Pin No.	Signal
1	RS	6	DB6
2	R / W	7	DB7
3	E	8	VSS
4	DB4	9	VDD
5	DB5	10	V5

●Power supply example

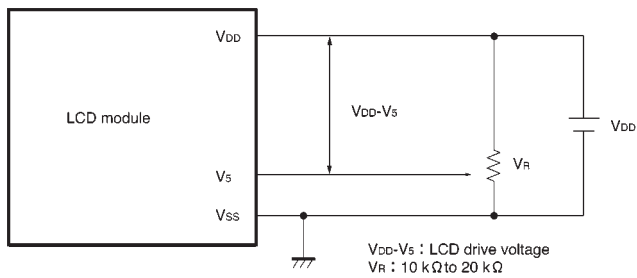


Fig.1

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Min.	Max.	Unit
Logic power supply voltage	$V_{DD}-V_{SS}$	-0.3	6.0	V
LCD drive voltage	$V_{DD}-V_5$	-0.3	6.0	V
Input voltage	$V_i$	-0.3	$V_{DD}+0.3$	V
Operating temperature	$T_{opr}$	0	50	°C
Storage temperature	$T_{stg}$	-20	70	°C

●Electrical characteristics ( $V_{DD} = 5.0V \pm 0.25V$ ,  $T_a = 25^\circ C$ )

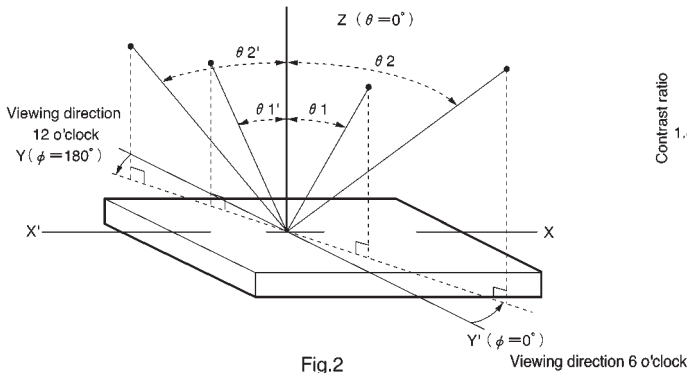
Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
High level input voltage	$V_{IH}$	$0.7V_{DD}$	—	—	V	—
Low level input voltage	$V_{IL}$	—	—	$0.2V_{DD}$	V	—
High level output voltage	$V_{OH}$	$0.75V_{DD}$	—	—	V	$I_{OH} = -0.1mA$
Low level output voltage	$V_{OL}$	—	—	$0.2V_{DD}$	V	$I_{OL} = 0.1mA$
Operating voltage	$V_{LCD}$	3.0	—	5.0	V	1 / 4Bias
Power supply current	$I_{DD}$	—	1.5	2.5	mA	$V_{DD} = 5.0V$

●Optical characteristics ( $T_a = 25^\circ C$ )

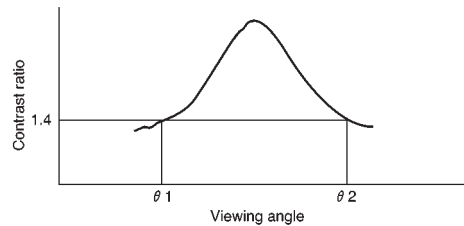
When viewing from below

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Rise time	$T_r$	—	100	250	ms	$\theta = 10^\circ$ , $\phi = 0^\circ$
Fall time	$T_d$	—	150	250	ms	$\theta = 10^\circ$ , $\phi = 0^\circ$
Contrast ratio	K	—	3	—	—	$\theta = 10^\circ$ , $\phi = 0^\circ$
Viewing angle	$\theta 1$	—	—	10	deg	$K \geq 1.4$
	$\theta 2$	40	—	—	deg	$\phi = 0^\circ$
	$\phi$	$\pm 30$	—	—	deg	$K \geq 1.4$ $\theta = 20^\circ$

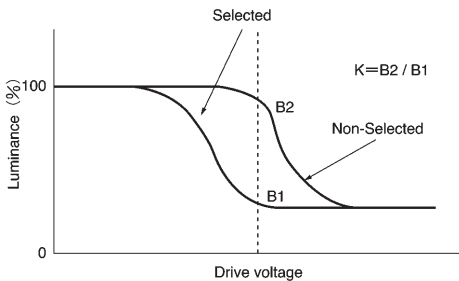
(1) Definition  $\theta$  and  $\phi$



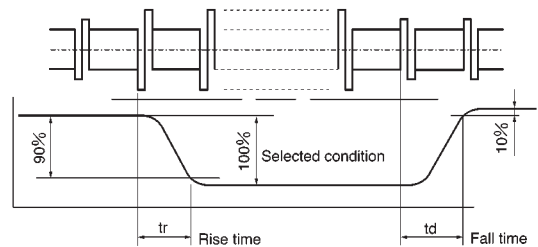
(2) Definition of viewing angles



(3) Definition of contrast ratio "K"



(4) Definition of optical response



## ● Pin functions

Symbol	Level	IN / OUT	Function	
V <sub>SS</sub>	—	—	0V	Earth
V <sub>DD</sub>	—	—	5.0V	Power supply voltage
V <sub>5</sub>	—	—	3.0~5.0V (V <sub>DD</sub> -V <sub>5</sub> )	The V <sub>5</sub> pin is for the liquid crystal contrast adjustment should be kept within the range V <sub>DD</sub> ≥ V <sub>5</sub> ≥ V <sub>SS</sub> .
RS	H / L	IN	Register selection signal. 0: Instruction register (writing) Busy flag, address counter (reading) 1: Data register (reading / writing)	
R / W	H / L	IN	Reading (R) and writing (W) selection signal. 0: Writing MPU→LCD module 1: Reading MPU←LCD module	
E	H, H / L	IN	Data reading and writing start signal.	
DB4 ? DB7	H / L	IN / OUT	The upper 4 line data buses are 3-state bi-directional. DB7 can also be used as a busy flag.	

## ● Timing chart

## (1) Writing

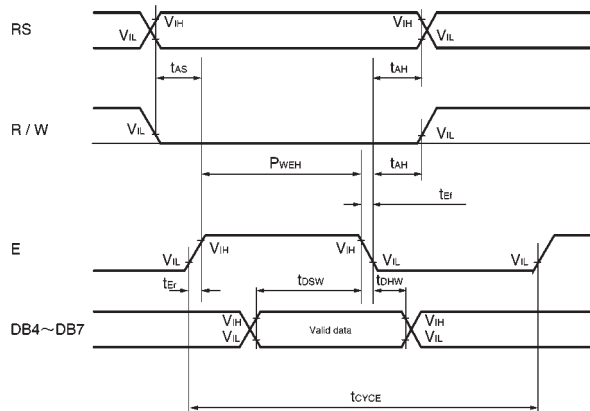


Fig.6

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Enable cycle time	t <sub>CYCE</sub>	500	—	—	ns	Fig.6
Enable pulse time	P <sub>WEH</sub>	250	—	—	ns	
Enable rise and fall time	t <sub>Er</sub> / t <sub>Erf</sub>	—	—	20	ns	
Address setup time	t <sub>AS</sub>	40	—	—	ns	
Address hold time	t <sub>AH</sub>	10	—	—	ns	
Data setup time	t <sub>DSW</sub>	60	—	—	ns	
Data hold time	t <sub>DHW</sub>	10	—	—	ns	

## (2) Reading

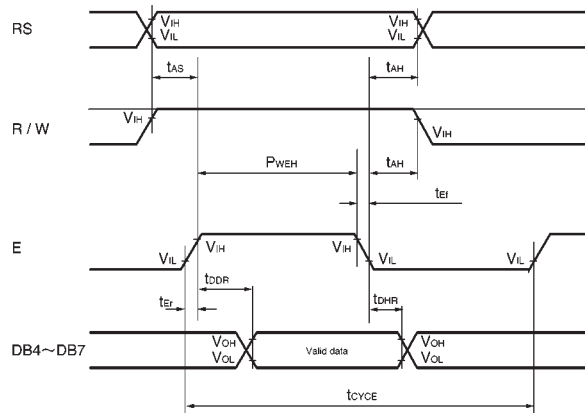


Fig.7

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Enable cycle time	t <sub>cyce</sub>	500	—	—	ns	Fig.7
Enable pulse time	P <sub>WEH</sub>	250	—	—	ns	
Enable rise and fall time	t <sub>ER</sub> / t <sub>EF</sub>	—	—	20	ns	
Address setup time	t <sub>AS</sub>	40	—	—	ns	
Address hold time	t <sub>AH</sub>	10	—	—	ns	
Data delay time	t <sub>DDR</sub>	—	—	250	ns	
Data hold time	t <sub>DHR</sub>	20	—	—	ns	

## ● Instructions

Instruction	Code										Description	Execution time Max.	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		fosc=250kHz	
Clear display	0	0	0	0	0	0	0	0	0	1	Clears display and sets address 0 of DD RAM to address counter.	1.64ms	
Home cursor	0	0	0	0	0	0	0	0	0	1	*	Sets address 0 of DD RAM to address counter and returns a shifted display to original position. The contents of DD RAM are unchanged.	1.64ms
Entry mode set	0	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and specifies whether or not to shift display. This operation occurs when reading or writing data.	40 μs
Display on / off control	0	0	0	0	0	0	0	1	D	C	B	Turns display on or off (D), turns cursor on or off (C), or blinks the character at the cursor position (B).	40 μs
Cursor / display shift	0	0	0	0	0	0	1	S/C	R/L	*	*	Moves cursor or shifts display without changing the DD RAM.	40 μs
Function set	0	0	0	0	1	DL	N	SD1	SD2	CD	CD	Sets the interface data length (DL), SEG data transfer direction (SD1,SD2), and COM data transfer direction (CD).	40 μs
CG RAM address set	0	0	0	1	ACG						Sets the CG RAM address. Data received after this is CG RAM data.	40 μs	
DD RAM address set	0	0	1	ADD						Sets the DD RAM address. Data received after this is DD RAM data.	40 μs		
Read busy flag address	0	1	BF	AC						Reads the busy flag signifying internal operations in progress and reads the contents of the address counter.	0 μs		
Write data to CG or DD RAM	1	0	Write Data						Data is written from the DD RAM or CG RAM.	40 μs tADD=6 μs			
Read data from CG or DD RAM	1	1	Read Data						Data is read to DD RAM or CG RAM.	40 μs tADD=6 μs			
	I/D=1: Increment, I/D=0: Decrement S=1: Accompanies display shift S/C=1: Display shift, S/C=0: Cursor movement R/L=1: Right shift, R/L=0: Left shift DL=1: 8 bit, DL=0: 4 bit N=1: 2 lines, N=0: 1 line CD=0: COM1→COM16 CD=1: COM16→COM1 SD1=0,SD2=0: SEG1→SEG50→SEG51→SEG100 SD1=1,SD2=0: SEG1→SEG50→SEG100→SEG51 SD1=0,SD2=1: SEG100→SEG51→SEG50→SEG1 SD1=1,SD2=1: SEG100→SEG51→SEG1→SEG50 BF=1: Internal operation in progress BF=0: Instructions can be received										DD RAM: Display data RAM CG RAM: Character generator RAM ACG: CG RAM address ADD: DD RAM address (corresponds to cursor address) AC: Address counter used for both DD and CG RAM.	Execution times will vary with frequency (See example 1)	

(Example 1) When fosc = 270kHz

$$40\mu\text{s} \times \frac{250}{270} = 37\mu\text{s}$$

●Character code and corresponding character pattern

Upper Lower	Lower															
	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	*1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
0001	*2	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^
0010	*3	_	`	a	b	c	d	e	f	g	h	i	j	k	l	m
0011	*4	n	o	p	q	r	s	t	u	v	w	x	y	z	{	
0100	*5	~	!	@	#	\$	%	&	'	(	)	*	+	=	>	
0101	*6	<	:	;	<	~	^	_	~	~	~	~	~	~	~	
0110	*7	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
0111	*8	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1000	*1	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1001	*2	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1010	*3	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1011	*4	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1100	*5	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1101	*6	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1110	*7	~	~	~	~	~	~	~	~	~	~	~	~	~	~	
1111	*8	~	~	~	~	~	~	~	~	~	~	~	~	~	~	

### ●Reset function

When you turn on the power supply, the module automatically returns to its initial (reset) settings. At the initial settings, the busy flag (BF) becomes "1." The busy status last 10 ms from when  $V_{DD}$  reaches 4.5V. At the initial settings, following instructions are carried out.

(1) Clear display	
(2) Function set	
8-bit interface data length	(DL = 1)
Two line display	(N = 1)
SEG signal transfer direction SEG1→SEG50→SEG51→SEG100	(SD1 = 0, SD2 = 0)
COM signal transfer direction COM1→COM16	(CD = 0)
(3) Display on / off control	
Display off	(D = 0)
Cursor off	(C = 0)
Blinking off	(B = 0)
(4) Entry mode set	
+ 1 (increment)	(I / D = 1)
No shift	(S = 0)

\* The internal reset circuit may not operate properly due to conditions with the power supply. If this is the case, use the appropriate instruction to reset the settings.

### ●Operation notes

#### (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 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 in 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 surfaces 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.



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