16 characters × 2 lines transflective character module with LED backlight
RCM2060M

The RCM2060M is a transflective TN type liquid crystal module with a yellow-green LED backlight, a built-in controller/driver LSI, and a display capacity of 16 characters × 2 lines.

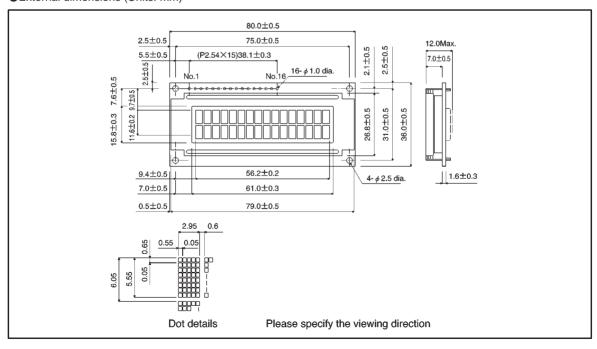●Applications
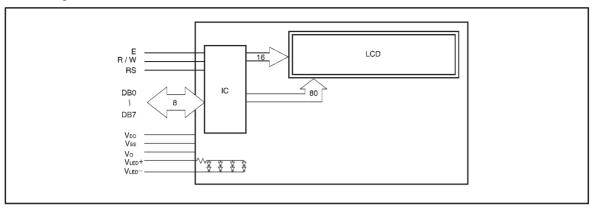Personal computers, word processors, facsimiles, telephones, etc.

●Features
1) Wide viewing angle and high contrast.
2) 5×7 dot character matrix with cursor.
3) Interfaces with 4-bit or 8-bit MPUs.
4) Displays up to 226 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 light weight for easy assembly to the host instrument.
8) Operable on single 5 V power supply.
9) Low power consumption.
10) Built-in extremely thin LED backlight with minimal power consumption.

●External dimensions (Units: mm)

Dot details   Please specify the viewing direction

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●Block diagram

●Pin assignments

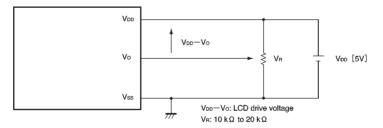| Pin no.	Signal	Pin no.	Signal
1	V_{SS}	9	DB2
2	V_{DD}	10	DB3
3	V_O	11	DB4
4	RS	12	DB5
5	R / W	13	DB6
6	E	14	DB7
7	DB0	15	$V_{LED}-$
8	DB1	16	$V_{LED}+$

●Power supply example

$V_{DD}-V_O$: LCD drive voltage
V_R: 10 kΩ to 20 kΩ

Fig.1

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Logic power supply voltage	$V_{DD}-V_{SS}$	0	—	6.5	V
LCD drive voltage	$V_{DD}-V_O$	0	—	6.5	V
Input voltage	V_{IN}	V_{SS}	—	V_{DD}	V
Operating temperature	Topr	0	—	50	℃
Storage temperature	Tstg	−20	—	70	℃

● Electrical characteristics (V_{DD} = 5.0 V ± 0.25 V, Ta = 25°C)

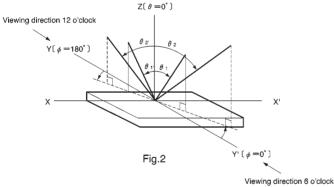| Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Input high level voltage	V_{IH}	2.2	—	V_{DD}	V	
Input low level voltage	V_{IL}	—	—	0.6	V	
Output high level voltage	V_{OH}	2.4	—	—	V	$-I_{OH}=0.205mA$
Output low level voltage	V_{OL}	—	—	0.4	V	$I_{OL}=1.2mA$
Power supply current	I_{DD}	—	1.0	3	mA	$V_{DD}=5V$
LED forward current	I_{LED}	—	60	—	mA	$V_{LED}=5V$

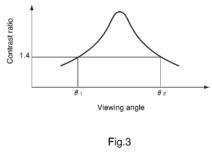● Optical characteristics (Ta = 25°C, ϕ = 0°)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Rise time	t_r	—	100	250	ms	$\theta=10°$, $\phi=0°$
Fall time	t_d	—	150	250	ms	$\theta=10°$, $\phi=0°$
Contrast ratio	K	—	3	—	—	$\theta=10°$, $\phi=0°$
Viewing angle	θ_1	—	—	10	deg	$\phi=0°$, K≧1.4
	θ_2	40	—	—	deg	$\phi=0°$, K≧1.4
	ϕ	±30	—	—	deg	$\theta_1=20°$, K≧1.4

(1) Definition of θ and ϕ

Fig.2

(2) Definition of viewing angles θ_1 and θ_2

Fig.3

(3) Definition of contrast ratio "K"

Fig.4

(4) Definition of optical response

Fig.5

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●Timing chart

(1) Writing

Fig. 6

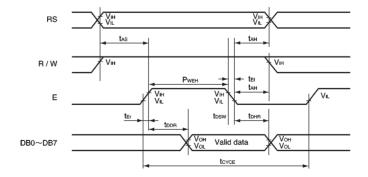| Parameter	Symbol	Min.	Typ.	Max.	Unit	
Enable cycle time	t_{CYCE}	500	—	—	ns	Fig.6
Enable pulse time	P_{WEH}	220	—	—	ns	Fig.6
Enable rise and fall time	t_{Er}, t_{Ef}	—	—	25	ns	Fig.6
Address setup time	t_{AS}	40	—	—	ns	Fig.6
Address hold time	t_{AH}	10	—	—	ns	Fig.6
Data setup time	t_{DSW}	60	—	—	ns	Fig.6
Data hold time	t_{DHW}	10	—	—	ns	Fig.6

(2) Reading

Fig. 7

Parameter	Symbol	Min.	Typ.	Max.	Unit	
Enable cycle time	t_{CYCE}	500	—	—	ns	Fig.7
Enable pulse time	P_{WEH}	220	—	—	ns	Fig.7
Enable rise and fall time	t_{Er}, t_{Ef}	—	—	25	ns	Fig.7
Address setup time	t_{AS}	40	—	—	ns	Fig.7
Address hold time	t_{AH}	10	—	—	ns	Fig.7
Data delay time	t_{DDR}	60	—	120	ns	Fig.7
Data hold time	t_{DHR}	20	—	—	ns	Fig.7

● Pin functions

Symbol	Level	Input / output	Function		
V_{SS}	—	—	GND : 0V	Power supply voltage	
V_{dd}	—	—	5V		
V_O	—	—			
RS	H / L	Input	Register selection signal. 0: Instruction register (writing) 　Busy flag, address counter (reading) 1: Data register (reading / writing)		
R / W	H / L	Input	Reading (R) and writing (W) selection signal. "0": Writing MPU → LCD module "1": Reading MPU ← LCD module		
E	H,H→L	Input	Data reading and writing start signal.		
DB0 ⟨ DB3	H / L	Input / output	The lower 4 line data buses are bi-directional and used for data transfer between the MPU and the module. They are not used during 4-bit operation.		
DB4 ⟨ DB7	H / L	Input / output	The upper 4 line data buses are bi-directional and used for data transfer between the MPU and the module. DB7 can also be used as a busy flag.		

Note: In order to be able to interface with 4-bit or 8-bit MPUs, the module supports data transfer with two
transmissions of 4 bits at a time or one transmission of 8 bits at once.
(1) When the interface data length is 4 bits, data is transferred along DB4 through DB7 buses and DB0
through DB3 buses are not used. Data transferal is completed after two transfers of 4 bit data. First the
upper nibble (contents of DB4 through DB7 during 8-bit interfacing) is transferred and then the lower
nibble (contents of DB0 through DB3 during 8-bit interfacing) is transferred.
(2) When the interface data length is 8 bits, the data DB0 through DB7 is transferred along the eight data
buses.

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●Instructions

Instruction	Code										Description	Execution time
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		f_{CP}=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	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	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.	42μs
Display on / off control	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].	42μs
Cursor / display shift	0	0	0	0	0	1	S/C	R/L	∗	∗	Moves cursor or shifts display without changing the DD RAM.	42μs
Function set	0	0	0	0	1	DL	N	F	∗	∗	Sets the interface data length [DL], number of lines displayed [N], and character font [F].	42μs
CG RAM address set	0	0	0	1			A_{CG}				Sets the CG RAM address. Data received after this is CG RAM data.	42μs
DD RAM address set	0	0	1				A_{DD}				Sets the DD RAM address. Data received after this is DD RAM data.	42μs
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.	0μs
Write data to CG or DD RAM	1	0				Write Data					Data is written from the DD RAM or CG RAM.	46μs
Read data from CG or DD RAM	1	1				Read Data					Data is read to DD RAM or CG RAM.	46μs

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
F = 1: 5 × 10 dots
F = 0: 5 × 7 dots
BF = 1: Internal operation in progress
BF = 0: Instructions can be received

DD RAM: Display data RAM
CG RAM: Character generator RAM
A_{CG}: CG RAM address
A_{DD}: DD RAM address (corresponds to cursor address)
AC: Address counter used for both DD and CG RAM.

Execution times will vary with frequency.

(Note) ∗ = Invalid

●Character code and corresponding character pattern

Character code and corresponding character pattern table

●Reset function

When you turn the power supply on using the internal re-
set circuit, the module automatically returns to its initial
(reset) settings. At the initial settings, the following
instructions are carried out.

(1) Clear display

The busy flag remains in the busy condition (BF = 1) until
initialization is completed. This takes 15 ms.

(2) Function set

  DL = 1: 8-bit interface data length

  N = 1

  F = 0: 5 × 7 dot matrix

(3) Display on/off control

  D = 0: Display off

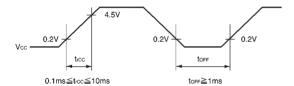 C = 0: Cursor off

  B = 0: Blinking off

(4) Entry mode set

  1/D = 1: +1 (increment)

  S = 0: No shift

(5) Select DD RAM

Depending on the power supply's rise and fall times when
it is turned on, there may be times when the initialization
cannot be completed. Therefore, be aware of the follow-
ing timing relationship.

V_{CC} — 4.5V — 0.2V

$0.1ms \leqq t_{rCC} \leqq 10ms$ $t_{OFF} \geqq 1ms$

t_{OFF} regulates the power supply breaks, or on and off
times.

Note) When the above power supply conditions are not met, the internal re-
      set circuit will not operate properly.