Ordering number : EN※4433

No. ※4433

DM2023

20 Characters × 2 Lines Liquid Crystal Dot Matrix Display Module

Preliminary

Overview

The DM2023 is an LCD dot matrix display module that consists of an LCD panel and controller/driver circuits. It is capable of displaying two lines of 20 characters. The DM2023 module incorporates the control circuits, data RAM, and character generator ROM required for display. The DM2023 provides both 8-bit and 4-bit parallel interfaces, and allows the controlling microprocessor to read and write data directly.

General Specifications

1. Drive method: 1/16 duty, 1/5 bias (1/4 bias for the STN version)
2. Display size: 20 characters × 2 lines
3. Character structure: 5 × 8 dots
4. Display data RAM: 80 characters (80 × 8 bits)
5. Character generator ROM: 192 characters (See table 1.)
6. Character generator RAM: 8 characters (64 × 8 bits)
7. Instruction function: See table 2.
8. Circuit structure: See the block diagram.

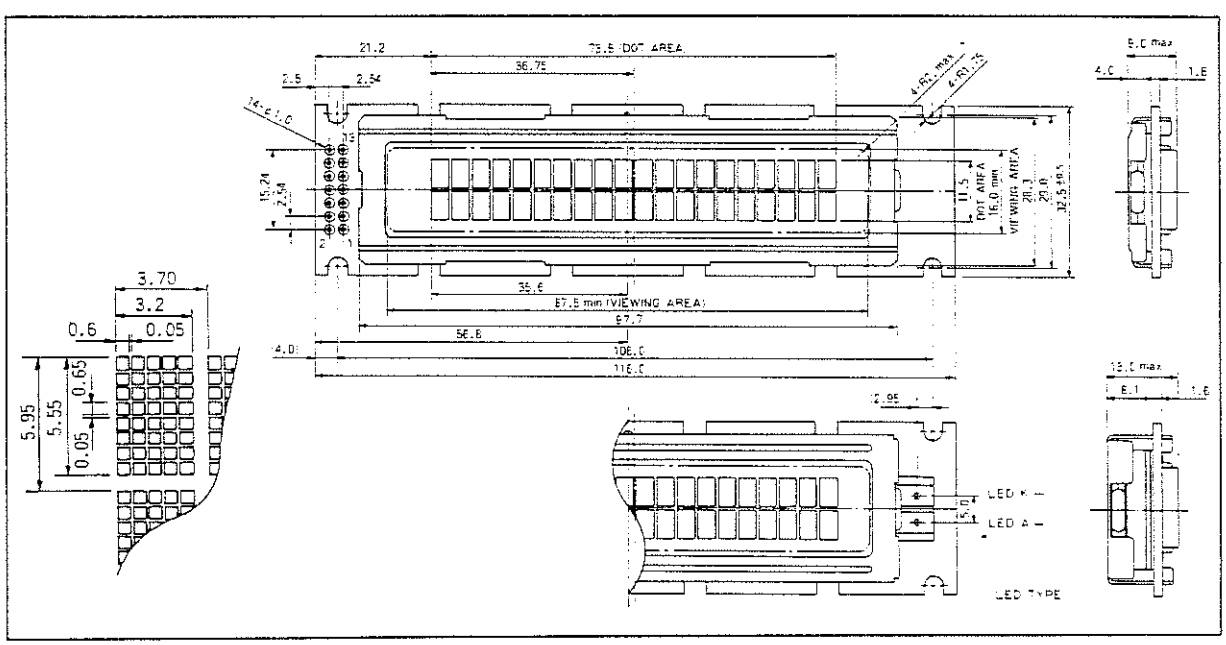
Mechanical Characteristics

Parameter	Dimension	Unit
Outline	116.0 (W) × 32.5 (H) × 9.0 (T): reflective	mm
	116.0 (W) × 32.5 (H) × 13.0 (T): LED version	mm
Min. viewing area	87.5 (W) × 16.0 (H)	mm
Character size	3.20 (W) × 4.85 (H)	mm
Dot pitch	0.65 (W) × 0.70 (H)	mm
Dot size	0.60 (W) × 0.65 (H)	mm
Weight	Reflective: about 36, LED: about 49	g

Module Dimensions

unit: mm

5015



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Specifications

Module Option Catalog Numbers

DM2023—1 2 3 4 □△OO

(□: first line) Liquid Crystal Characteristics

	LCD type	LCD operating temperature range	Supply specification	Viewing angle
0	TN	0 to +50°C	Single voltage supply	6 o'clock
1	TN	0 to +50°C	Single voltage supply	12 o'clock
7	STN	0 to +50°C	Single voltage supply	—

(△: second line) Polarizers

	TN type	LCD mode	STN type
S	Positive	Reflective type	Yellow
A	Positive	Transflective type	Yellow
B	Positive	Transmissive type	Yellow
G		Reflective type	Grey
H		Transflective type	Grey
J		Transmissive type	Grey

(OO: third and fourth lines) Backlighting

	Backlighting
L3	LED illumination (ultra-green)
L7	LED illumination (pure-green)

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Rating	Unit
Logic supply voltage	$V_{DD} - V_{SS}$	−0.3 to +7.0	V
LCD supply voltage	$V_{DD} - V_O$	−0.3 to +13.5	V
Input voltage	V_I	−0.3 to V_{DD} + 0.3	V
Operating temperature range	T_{opg}	0 to +50	°C
Storage temperature range	T_{stg}	−20 to +70	°C

Electro-Optical Characteristics at Ta = 25°C, $V_{DD} - V_{SS}$ = 5.0 ±0.25 V (unless otherwise specified)

Parameter	Symbol	Condition	Rating			Unit
			min	typ	max	
Input high level voltage	V_{IH}		2.2		V_{DD}	V
Input low level voltage	V_{IL}		0		0.6	V
Output high level voltage	V_{OH}	$-I_{OH}$ = 0.2 mA	2.4		V_{DD}	V
Output low level voltage	V_{OL}	I_{OL} = 1.2 mA	0		0.4	V
Supply current	I_{DD}			1.5	3.0	mA

(1) TN type (Optical characteristics listed are for the reflective type, 6 o'clock viewing angle version as an example.)

Parameter		Symbol	Condition		Rating			Unit	Note
					min	typ	max		
LCD drive voltage (reference values)		$V_{DD} - V_O$	θ = 20°, φ = 180°	Ta = 0°C		4.85		V	
				Ta = 25°C	4.2	4.3	4.4	V	
				Ta = 50°C		3.75		V	
Response time	Rise time	t_r	θ = 20°, φ = 180°	Ta = 0°C		300	600	ms	Figures 1 and 2
				Ta = 25°C		100	200	ms	
	Fall time	t_f	θ = 20°, φ = 180°	Ta = 0°C		350	700	ms	
				Ta = 25°C		150	300	ms	
Contrast ratio		K	θ = 20°	φ = 180°	3	5			Figures 2 and 3
Viewing angle range		θ2 − θ1	φ = 180°	K > 1.4	20	40		Degrees	

(2) STN type (Optical characteristics listed are for the yellow mode reflective type as an example.)

Parameter		Symbol	Condition		Rating			Unit	Note
					min	typ	max		
LCD drive voltage (reference values)		$V_{DD} - V_O$	θ = 0°	Ta = 0°C		4.7		V	
				Ta = 25°C	4.0	4.4	4.8	V	
				Ta = 50°C		4.3		V	
Response time	Rise time	t_r	θ = 0°	Ta = 0°C		300	600	ms	Figures 1 and 2
				Ta = 25°C		100	200	ms	
	Fall time	t_f	θ = 0°	Ta = 0°C		350	700	ms	
				Ta = 25°C		150	300	ms	
Contrast ratio		K	θ = 0°		7	10			Figures 2 and 3
Viewing angle range		θ2 − θ1	K > 1.4		60	70		Degrees	

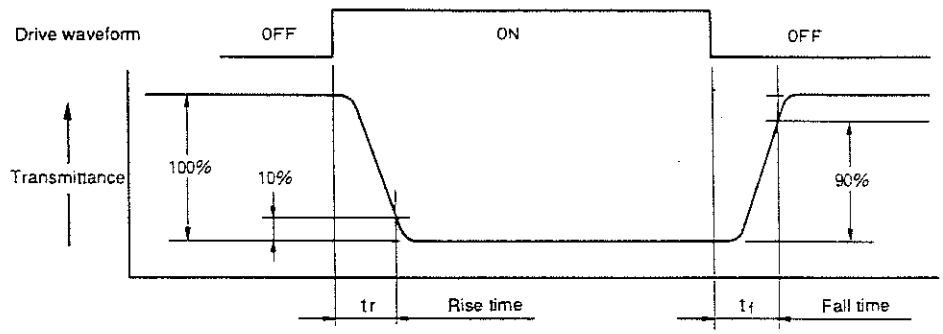


Figure 1 Response Time (positive display)

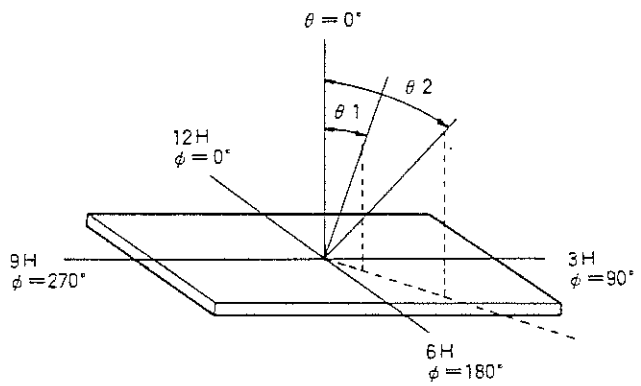


Figure 2 Viewing Angle Definition

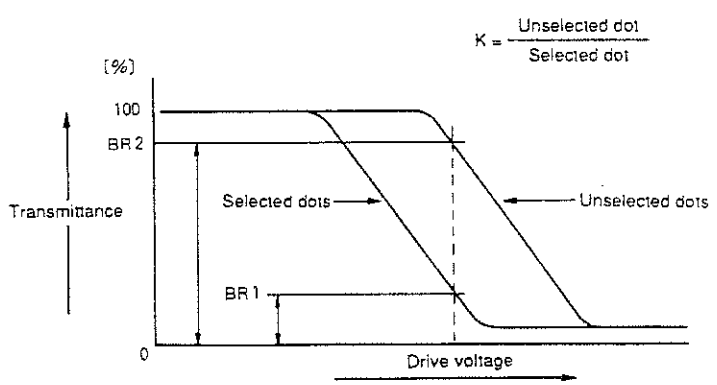


Figure 3 Contrast Definition

● LED Backlight Characteristics (Note: Measured at the LED backlight element.)

Absolute Maximum Ratings

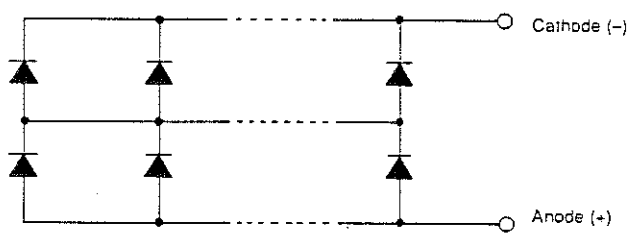
Parameter	Symbol	Condition	Rating	Unit
Forward current	I_F	Ta = 25°C	675	mA
Reverse breakdown voltage	V_R	Ta = 25°C	6	V
Power dissipation	P_D	Ta = 25°C	3600	mW
Operating temperature range	T_{opg}		−20 to +60	°C

Electro-Optical Characteristics at Ta = 25°C

Parameter		Forward voltage		Condition	Luminescence wavelength (peak)	Condition	Brightness			Condition
		V_F		I_F	λP	I_F	L			I_F
Type	Color	typ	max	—	typ	—	min	typ	max	—
L3	Ultra-green	4.2 V	5.6 V	270 mA	567 nm	270 mA	—	75 cd/m²	—	270 mA
L7	Pure green	4.0 V	5.6 V	270 mA	558 nm	270 mA	12 cd/m²	30 cd/m²	80 cd/m²	270 mA

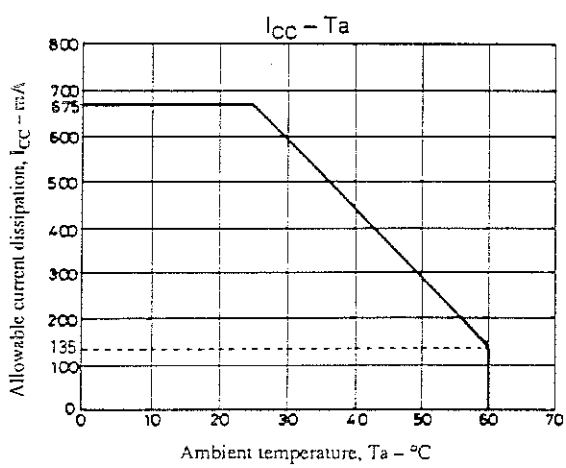
Note: The maximum brightness values are reference values.

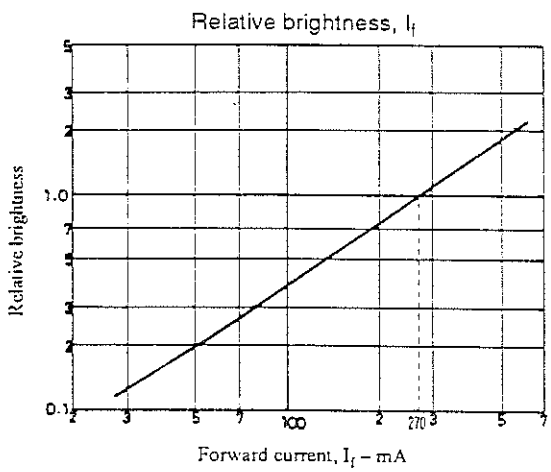
LED Backlight Wiring Diagram



Consists of 27 units of 2 chips in series, for a total of 54 chips.

Characteristics Figure (representative sample) Note: L3 type



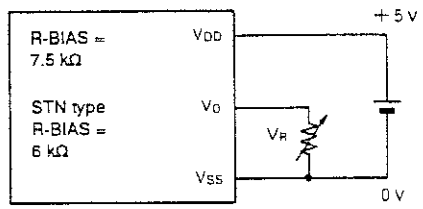


Display Position and DD.RAM Addresses

	Left side		(Display position)			Right side	
	1	2		10	11	19	20
First line	00H	01H	.....	09H	0AH	..... 12H	13H
Second line	40H	41H	.....	49H	4AH	..... 52H	53H

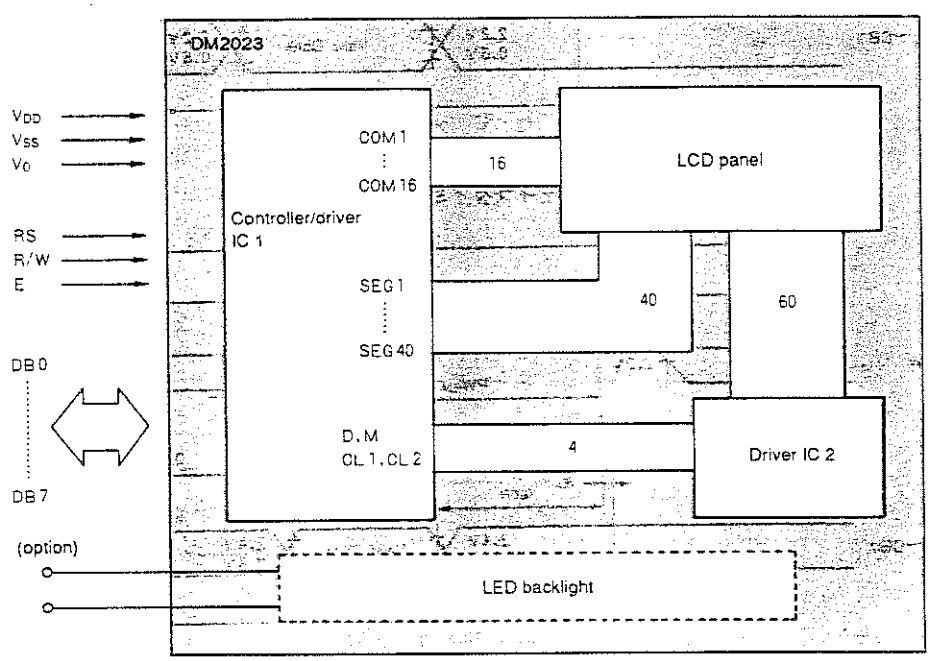
Note: The return home instruction resets the cursor to location 00H.

Supply Circuit Examples



Note: When the V_R is set to 5 kΩ for TN versions or 4 kΩ for STN versions, the LCD drive voltage can be varied over a range of from 3 to 5 V.

Block Diagram



IC 1: HD44780 or LC7985NA-8733
IC 2: SED1181FLA or NJU6417

Timing Characteristics at Ta = 25°C, $V_{DD} - V_{SS}$ = 5.0 ±0.25 V (unless otherwise specified)

Parameter	Symbol	Reference figure	Rating			Unit
			min	typ	max	
Enable cycle time	t_{cyc} E	Figures 4 and 5	1000			ns
Enable pulse width	PW_{EH}	Figures 4 and 5	450			ns
Enable rise and fall times	t_{Er}, t_{Ef}	Figures 4 and 5			25	ns
Address setup time	t_{AS}	Figures 4 and 5	140			ns
Address hold time	t_{AH}	Figures 4 and 5	10			ns
Data setup time	t_{DSW}	Figure 4	195			ns
Data delay time	t_{DDR}	Figure 5			320	ns
Data hold time (write)	t_H	Figure 4	10			ns
Data hold time (read)	t_{DHR}	Figure 5	20			ns

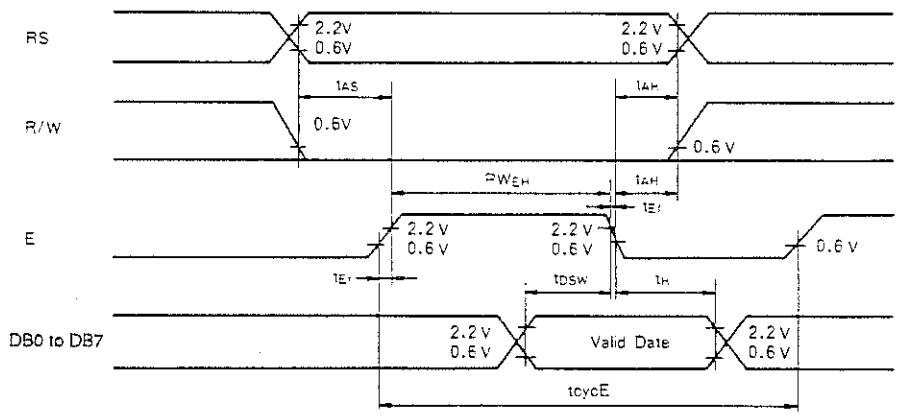


Figure 4 Interface Timing (write)

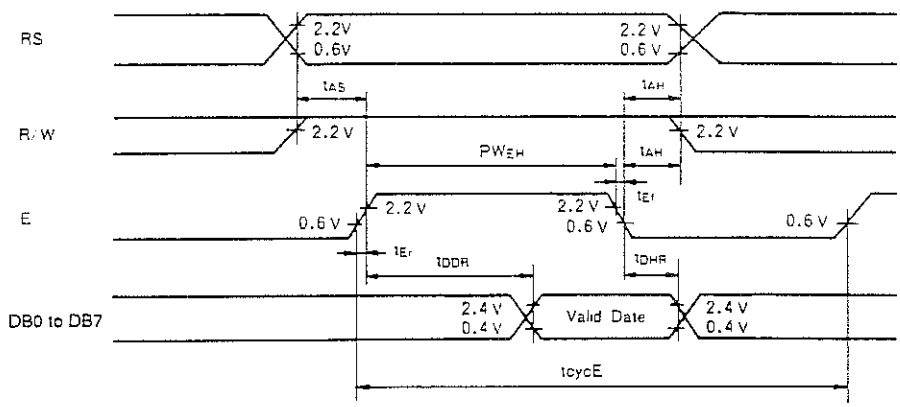


Figure 5 Interface Timing (read)

Pin Functions

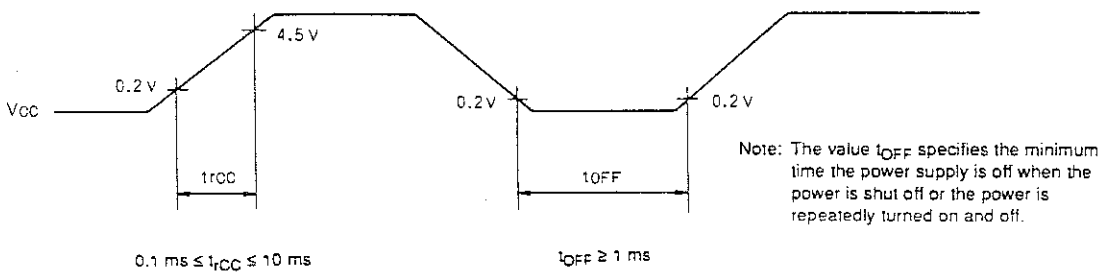
Pin No.	Symbol	Function
1	V_{SS}	0 V (GND)
2	V_{DD}	+5 V
3	V_O	LCD drive supply
4	RS	Register select pin 0: Instruction register (write) Busy flag and address counter (read) 1: Data register (read/write)
5	R/W	Read/write pin 0: Write; MPU → LCD module 1: Read; LCD module → MPU
6	E	Enable flag
7 to 10	DB0 to DB3	Data bus (tristate bidirectional pins) Used as the lower 4 bit pins when an 8-bit interface is used. Unused when a 4-bit interface is used.
11 to 14	DB4 to DB7	Data bus (tristate bidirectional pins) Used as the upper 4 bit pins when an 8-bit interface is used. Used as the 4 data bits when a 4-bit interface is used. DB7 is also be used as the busy flag.

Note: This module is designed so that it can be used with 4-bit and 8-bit microprocessors. In 4-bit mode data is transferred in two 4-bit cycles, and in 8-bit mode data is transferred in one 8-bit cycle.

Supply conditions when the built-in reset circuit is used.

Parameter	Symbol	Rating			Unit
		min	typ	max	
Supply rise time	t_{rCC}	0.1		10	ms
Supply off time	t_{OFF}	1			ms

If the above conditions are not met the internal reset circuit may not function correctly. Therefore, instruction reset should be used in such cases.



Note: The value t_{OFF} specifies the minimum time the power supply is off when the power is shut off or the power is repeatedly turned on and off.

0.1 ms ≤ t_{rCC} ≤ 10 ms

t_{OFF} ≥ 1 ms

Table 1 Character Code/Character Pattern Correspondence Chart

Upper / Lower 4 bits	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
××××0000	CG RAM (1)												
××××0001	(2)												
××××0010	(3)												
××××0011	(4)												
××××0100	(5)												
××××0101	(6)												
××××0110	(7)												
××××0111	(8)												
××××1000	(1)												
××××1001	(2)												
××××1010	(3)												
××××1011	(4)												
××××1100	(5)												
××××1101	(6)												
××××1110	(7)												
××××1111	(8)												

Note: The CG RAM is a character generator RAM that stores character patterns that may be freely rewritten by the user.

Table 2 Instruction Functions

Instruction	Code										Description	Execution time (when f_{OSC} = 250 kHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Display clear	0	0	0	0	0	0	0	0	0	1	Clears the whole display and then returns the cursor to the home position (location 0).	82 μs to 1.64 ms
Cursor home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position. Also restores a shifted display. The contents of DD RAM are not changed.	40 μs to 1.6 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor advance position and whether the display shifts. These operations are performed when data is read or written.	40 μs
Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets the display on/off state (D), the cursor on/off state (C), and the blinking state (B) of the character at the cursor position.	40 μs
Cursor/display shift	0	0	0	0	0	1	S/C	R/L	*	*	Performs cursor motion and display shift without changing the contents of DD RAM.	40 μs
Function set	0	0	0	0	1	DL	N	F	*	*	Sets the interface data length (DL), the number of display lines (N), and the character font (F).	40 μs
CG RAM address set	0	0	0	1	ACG						Sets the CG RAM address. The next data transmitted will be CG RAM data.	40 μs
DD RAM address set	0	0	1	ADD							Sets the DD RAM address. The next data transmitted will be DD RAM data.	40 μs
Busy flag/address readout	0	1	BF	AC							Reads out the busy flag (BF), which indicates the internal operation in progress state, and the contents of the address register.	1 μs
CG RAM/DD RAM data write	1	0	Write data								Writes to DD RAM or CG RAM.	40 μs
CG RAM/DD RAM data read	1	1	Read data								Reads data from DD RAM or CG RAM.	40 μs
	I/D = 1: Increment (+1) I/D = 0: Decrement (−1) S = 1: Display shift at the same time S/C = 1: Display shift S/C = 0: Cursor move R/L = 1: Right shift R/L = 0: Left shift DL = 1: 8 bits, DL = 0: 4 bits 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 accepted *: Invalid (don't care)											DD RAM: Display data RAM CG RAM: Character generator RAM ACG: A CG RAM address ADD: Corresponds to a DD RAM address AC: The address counter, which is used for both DD and CG RAMs.	The execution times will change if the internal oscillator frequency is changed. Example: If an f_{OSC} of 270 kHz is used, then a 40 μs time from this chart will become 40 μs × 250/270 = 37 μs.