

**SANYO**

No. ※4331

**DM1640****16 Characters × 4 Lines  
Liquid Crystal Dot Matrix Display Module****Preliminary****Overview**

The DM1640 is an LCD dot matrix display module that consists of an LCD panel and controller/driver circuits. It is capable of displaying four lines of 16 characters. The DM1640 module incorporates the control circuits, data RAM, and character generator ROM required for display. The DM1640 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: 16 characters × 4 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.

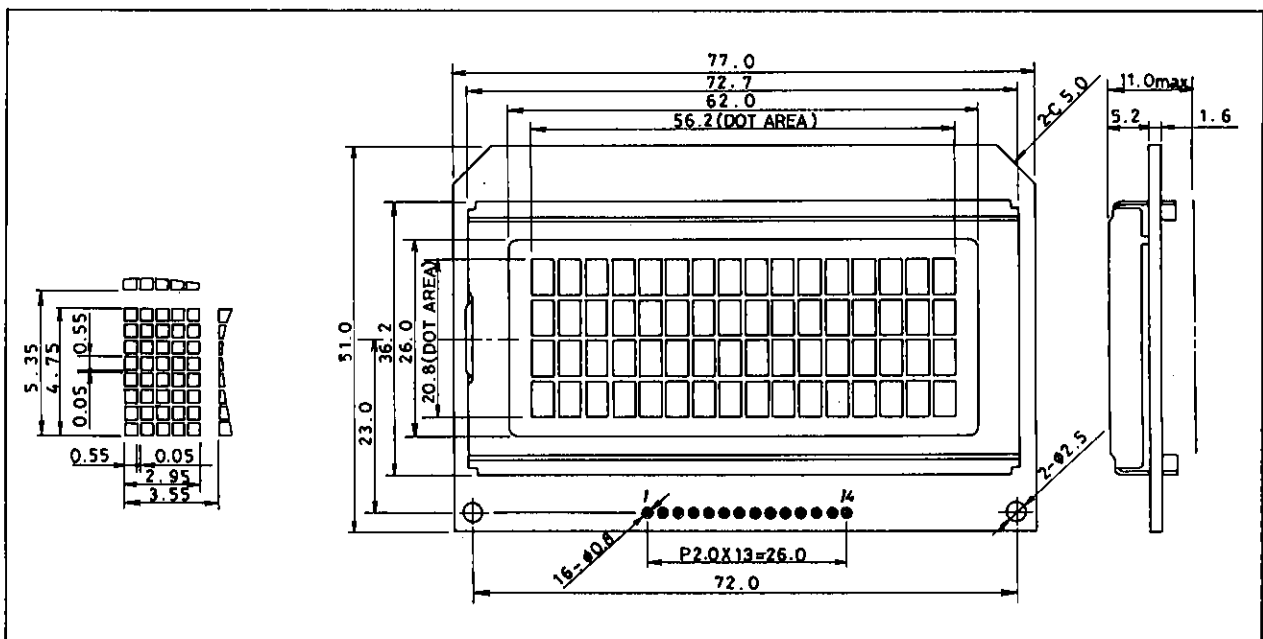
**Mechanical Characteristics**

Parameter	Dimension	Unit
Outline	77.0 (W) × 51.0 (H) × 11.0 (T)	mm
Min. viewing area	62.0 (W) × 26.0 (H)	mm
Character size	2.95 (W) × 4.15 (H)	mm
Dot pitch	0.60 (W) × 0.60 (H)	mm
Dot size	0.55 (W) × 0.55 (H)	mm
Weight	about 37	g

**Module Dimensions**

(unit: mm)

5011

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## Specifications

### Options

No.	Type number	LCD mode	Operating temperature range	Supply specs.	Viewing angle
1	DM1640-0S	TN, positive, reflective type	0 to +50°C	Single voltage supply	6 o'clock
2	DM1640-1S	TN, positive, reflective type	0 to +50°C	Single voltage supply	12 o'clock
3	DM1640-2S	TN, positive, reflective type	-20 to +70°C	Dual voltage supply	6 o'clock
4	DM1640-3S	TN, positive, reflective type	-20 to +70°C	Dual voltage supply	12 o'clock
5	DM1640-7S	STN, yellow, positive, reflective type	0 to +50°C	Single voltage supply	—

### 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
General purpose temperature range specifications	Operating temperature range	$T_{opr}$	0 to +50	°C
	Storage temperature range	$T_{stg}$	-20 to +70	°C
Wide temperature range specifications (TN type)	Operating temperature range	$T_{opr}$	-20 to +70	°C
	Storage temperature range	$T_{stg}$	-30 to +80	°C

### Electro-Optical Characteristics at Ta = 25°C, $V_{DD} - V_{SS} = 5.0 \pm 0.25$ 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 · General purpose temperature range specifications (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)		$V_{DD} - V_O$	$\theta = 20^\circ$ , $\phi = 180^\circ$	$T_a = 0^\circ\text{C}$		4.85		V	
				$T_a = 25^\circ\text{C}$	4.2	4.3	4.4	V	
				$T_a = 50^\circ\text{C}$		3.75		V	
Response time	Rise time	$t_r$	$\theta = 20^\circ$ , $\phi = 180^\circ$	$T_a = 0^\circ\text{C}$		300	600	ms	Figures 1 and 2
				$T_a = 25^\circ\text{C}$		100	200	ms	
	Fall time			$T_a = 0^\circ\text{C}$		350	700	ms	
				$T_a = 25^\circ\text{C}$		150	300	ms	
Contrast ratio		K	$\theta = 20^\circ$ , $\phi = 180^\circ$	$\alpha = 180^\circ$	3	5		Figures 2 and 3	
Viewing angle range		$\theta_2 - \theta_1$	$\phi = 180^\circ$	$K > 1.4$	20	40		Degrees	

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(2) TN type · Wide temperature range specifications (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)		$V_{DD} - V_O$	$\theta = 20^\circ$ , $\phi = 180^\circ$	$T_a = -20^\circ\text{C}$		7.9		V	
				$T_a = 25^\circ\text{C}$	6.8	6.9	7.0	V	
				$T_a = 70^\circ\text{C}$		5.4		V	
Response time	Rise time	$t_r$	$\theta = 20^\circ$ , $\phi = 180^\circ$	$T_a = -20^\circ\text{C}$		400	800	ms	Figures 1 and 2
				$T_a = 0^\circ\text{C}$		200	400	ms	
				$T_a = 25^\circ\text{C}$		100	200	ms	
	Fall time	$t_f$	$\theta = 20^\circ$ , $\phi = 180^\circ$	$T_a = -20^\circ\text{C}$		550	1000	ms	
				$T_a = 0^\circ\text{C}$		250	500	ms	
				$T_a = 25^\circ\text{C}$		150	300	ms	
Contrast ratio		K	$\theta = 20^\circ$ $\phi = 180^\circ$	3	5			Figures 2 and 3	
Viewing angle range		$\theta_2 - \theta_1$	$\phi = 180^\circ$ $K > 1.4$	30	40		Degrees		

(3) 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)		$V_{DD} - V_O$	$\theta = 0^\circ$	$T_a = 0^\circ\text{C}$		4.7		V	
				$T_a = 25^\circ\text{C}$	4.0	4.4	4.8	V	
				$T_a = 50^\circ\text{C}$		4.3		V	
Response time	Rise time	$t_r$	$\theta = 0^\circ$	$T_a = 0^\circ\text{C}$		300	600	ms	Figures 1 and 2
				$T_a = 25^\circ\text{C}$		100	200	ms	
	Fall time	$t_f$	$\theta = 0^\circ$	$T_a = 0^\circ\text{C}$		350	700	ms	
				$T_a = 25^\circ\text{C}$		150	300	ms	
Contrast ratio		K	$\theta = 0^\circ$	7	10			Figures 2 and 3	
Viewing angle range		$\theta_2 - \theta_1$	$K > 1.4$	60	70		Degrees		

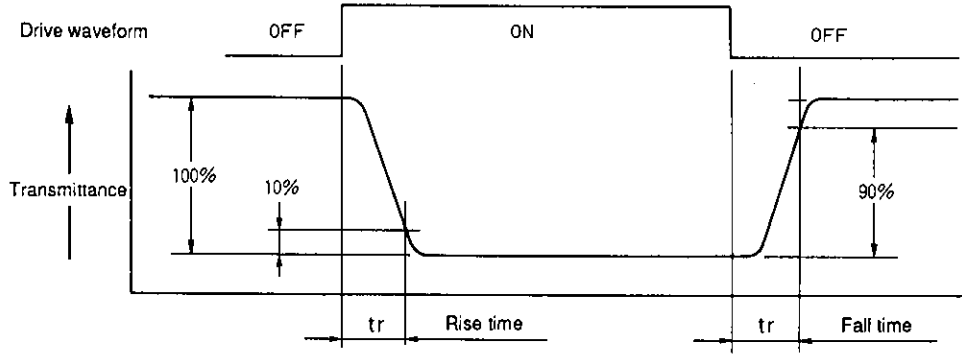


Figure 1 Response Time (positive display)

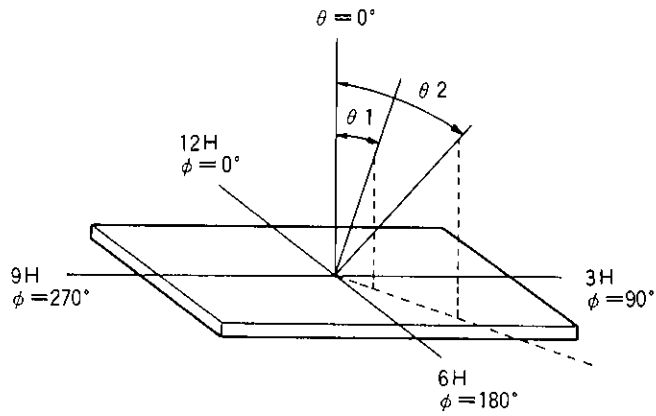


Figure 2 Viewing Angle Definition

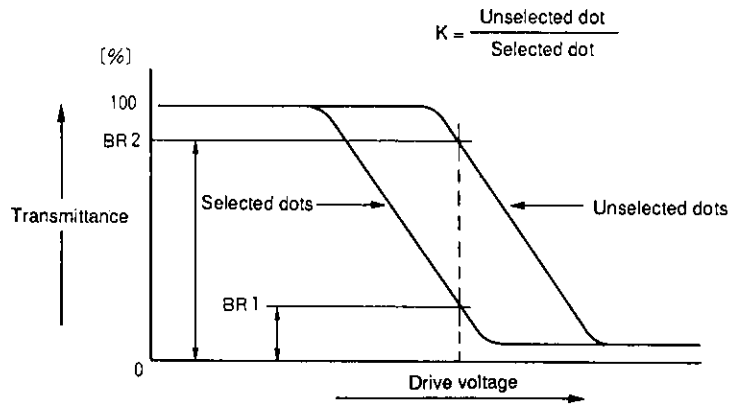


Figure 3 Contrast Definition

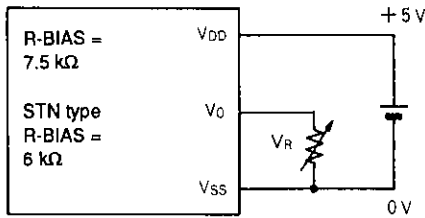
Display Position and DD.RAM Addresses

	Left side		(Display position)		Right side	
	1	2	10	11	15	16
First line	00H	01H.....09H	0AH	.....0EH	0FH	
Second line	40H	41H.....49H	4AH	.....4EH	4FH	
Third line	10H	11H.....19H	1AH	.....1EH	1FH	
Fourth line	50H	51H.....59H	5AH	.....5EH	5FH	

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

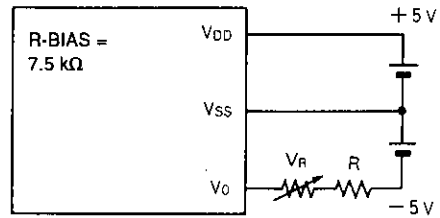
Supply Circuit Examples

- Single voltage supply specifications (general purpose temperature range versions)



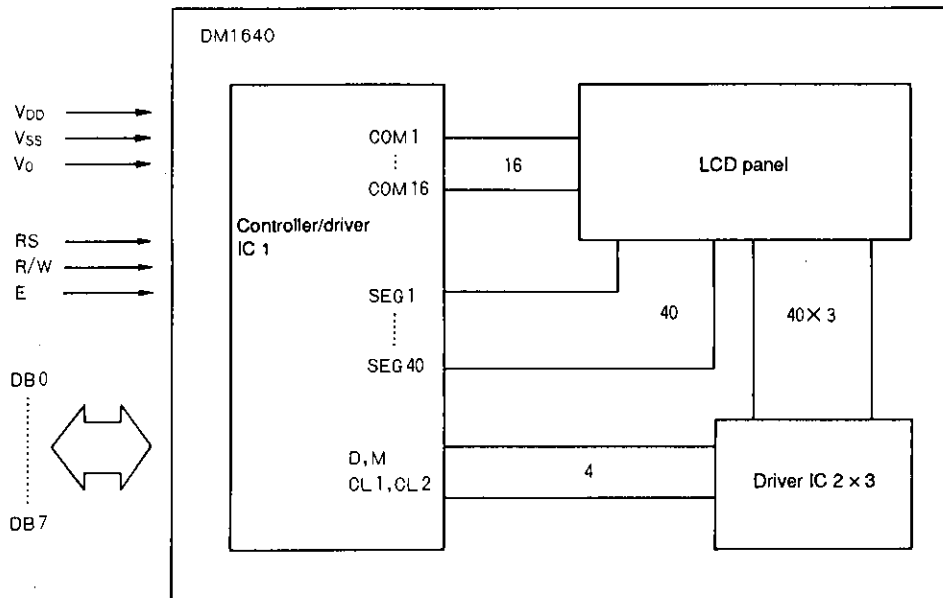
Note: When the  $V_R$  is set to 5 k $\Omega$  for TN versions, the LCD drive voltage can be varied over a range of from 3 to 5 V. For STN versions, the LCD drive voltage can be varied between 2.7 and 5 V.

- Dual voltage supply specifications (wide temperature range versions)



Note: When  $V_R = 5$  k $\Omega$  and  $R = 1$  k $\Omega$ , the LCD drive voltage can be varied over a range of from 5.6 to 8.8 V.

Block Diagram



IC 1: HD44780 or LC7985NA-8733  
 IC 2: MSM5839C or NJU6407 x 3

Timing Characteristics at  $T_a = 25^\circ\text{C}$ ,  $V_{DD} - V_{SS} = 5.0 \pm 0.25\text{ V}$  (unless otherwise specified)

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

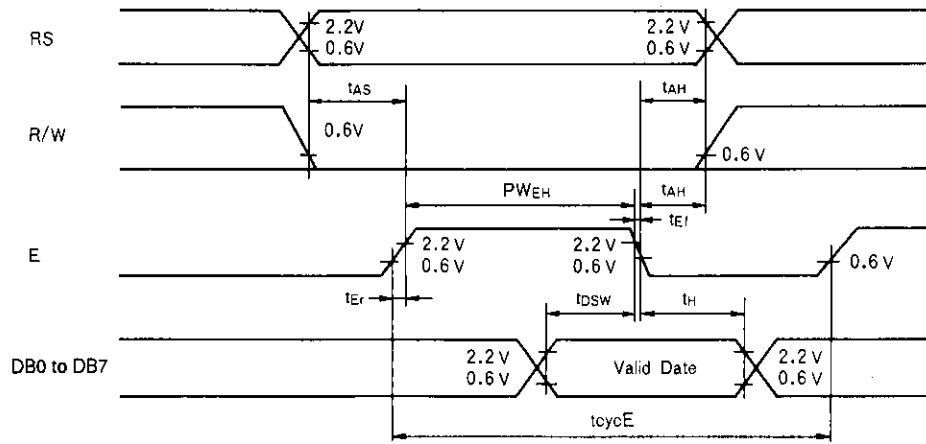


Figure 4 Interface Timing (write)

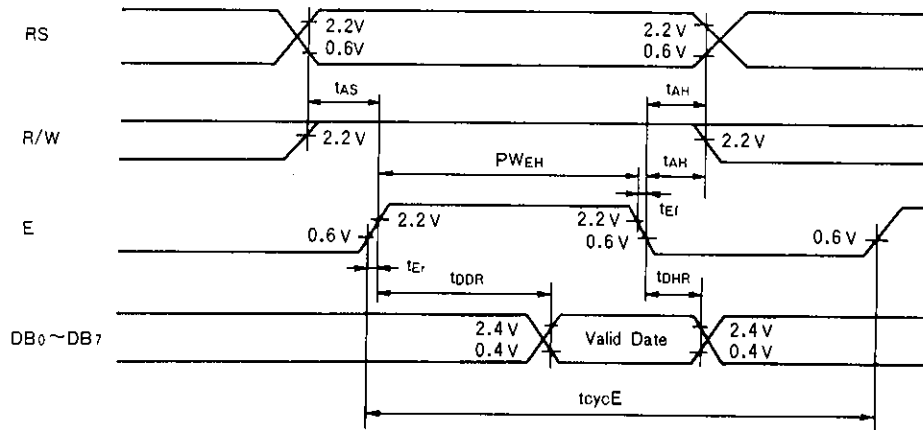


Figure 5 Interface Timing (read)

## Pin Functions

Pin No.	Symbol	Function
1	V <sub>SS</sub>	0 V (GND)
2	V <sub>DD</sub>	+5 V
3	V <sub>O</sub>	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 <sub>rCC</sub>	0.1		10	ms
Supply off time	t <sub>OFF</sub>	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.

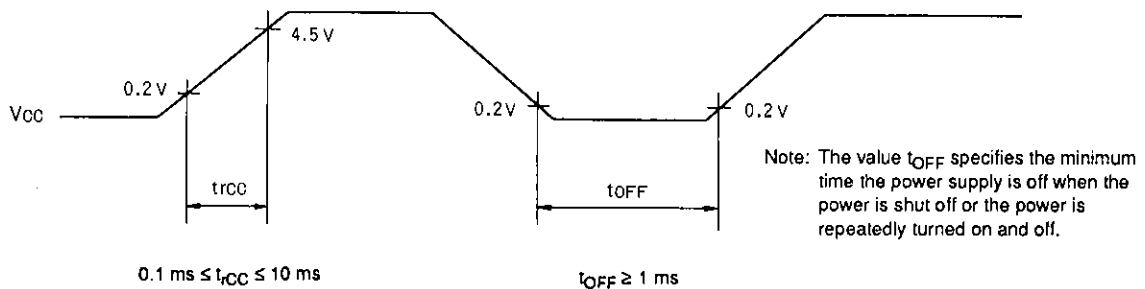


Table 1 Character Code/Character Pattern Correspondence Chart

Lower 4 bits	Upper 4 bits	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	1	2	3	4	5	6	7	8	9	A	B
	(2)	!	1	A	a	2	B	b	3	C	c	4	D	d
xxxx0010	(3)	"	2	B	b	3	C	c	4	D	d	5	E	e
	(4)	#	3	C	S	c	a	4	7	7	E	e	8	8
xxxx0100	(5)	\$	4	D	T	t	5	5	6	6	7	7	8	9
	(6)	%	5	E	U	e	u	6	7	7	8	8	9	0
xxxx0110	(7)	&	6	F	V	f	v	7	8	8	9	9	0	1
	(8)	7	7	G	W	g	w	8	9	9	0	0	1	2
xxxx1000	(1)	<	8	H	X	h	x	9	0	0	1	1	2	3
	(2)	>	9	I	Y	i	y	0	1	1	2	2	3	4
xxxx1010	(3)	*	0	J	Z	j	z	1	2	2	3	3	4	5
	(4)	+	1	K	L	k	l	2	3	3	4	4	5	6
xxxx1100	(5)	,	<	L	*	l	3	4	4	5	5	6	6	7
	(6)	-	=	M	I	m	i	5	6	6	7	7	8	9
xxxx1110	(7)	.	>	N	^	n	6	7	7	8	8	9	9	0
	(8)	/	?	O	_	o	7	8	8	9	9	0	0	1

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 $f_{OSC} = 250 \text{ kHz}$ )
	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 $\mu\text{s}$ 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 $\mu\text{s}$ 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 $\mu\text{s}$
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 $\mu\text{s}$
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 $\mu\text{s}$
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 $\mu\text{s}$
CG RAM address set	0	0	0	1	ACG					Sets the CG RAM address. The next data transmitted will be CG RAM data.	40 $\mu\text{s}$	
DD RAM address set	0	0	1	ADD					Sets the DD RAM address. The next data transmitted will be DD RAM data.	40 $\mu\text{s}$		
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 $\mu\text{s}$		
CG RAM/DD RAM data write	1	0	Write data					Writes to DD RAM or CG RAM.	40 $\mu\text{s}$			
CG RAM/DD RAM data read	1	1	Read data					Reads data from DD RAM or CG RAM.	40 $\mu\text{s}$			
	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 $\times$ 10 dots, F = 0: 5 $\times$ 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 $\mu\text{s}$ time from this chart will become 40 $\mu\text{s} \times 250/270 = 37 \mu\text{s}$ .

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