

**DM2423**

24 Characters × 2 Lines Liquid Crystal Dot Matrix Display Module

Preliminary

Overview

The DM2423 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 24 characters. The DM2423 module incorporates the control circuits, data RAM, and character generator ROM required for display. The DM2423 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: 24 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	118.0 (W) × 36.0 (H) × 10.0 (T): reflective	mm
	118.0 (W) × 36.0 (H) × 13.0 (T): LED version	mm
Min. viewing area	93.5 (W) × 15.8 (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 40, LED: about 50	g

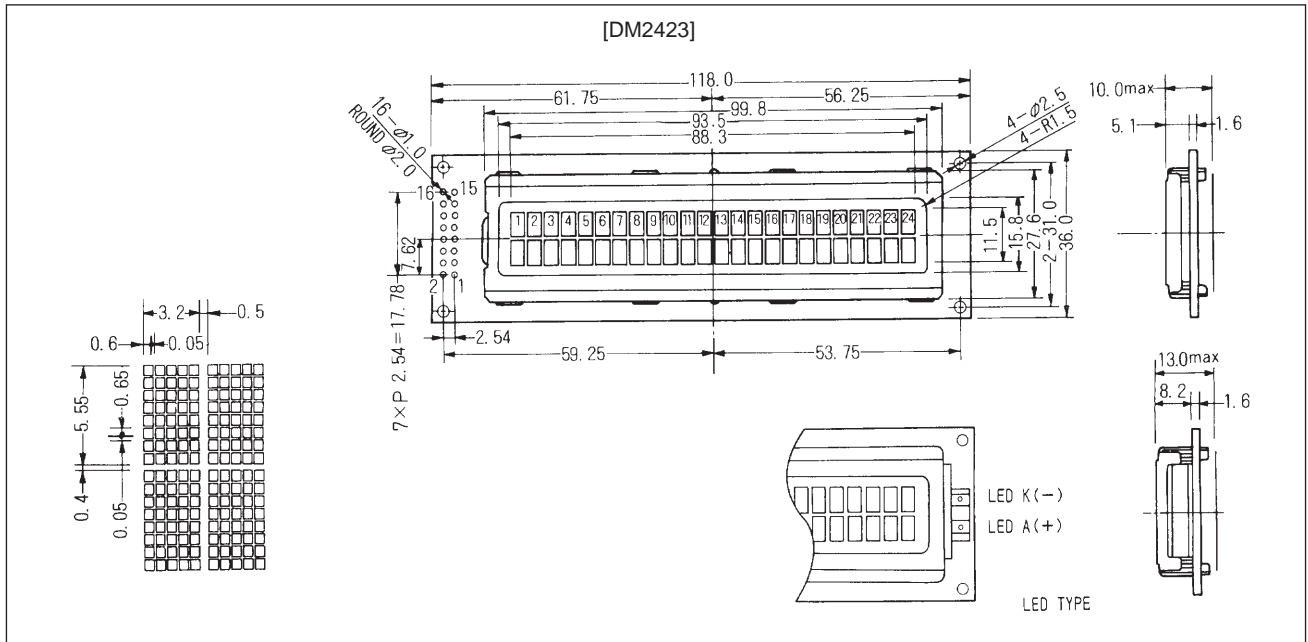
■ Any and all SANYO products described or contained herein do not have specifications that can handle applications that require extremely high levels of reliability, such as life-support systems, aircraft's control systems, or other applications whose failure can be reasonably expected to result in serious physical and/or material damage. Consult with your SANYO representative nearest you before using any SANYO products described or contained herein in such applications.

■ SANYO assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO products described or contained herein.

Module Dimensions

unit: mm

5012



Specifications

Module Option Catalog Numbers

DM2423—¹□²△³△⁴○○

(□: 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

(○○: 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	Ratings	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	Topr	0 to +50	°C
Storage temperature range	Tstg	-20 to +70	°C

DM2423

Electro-Optical Characteristics at Ta = 25°C, VDD – VSS = 5.0 ±0.25 V (unless otherwise specified)

Parameter	Symbol	Conditions	Ratings			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	Conditions		Ratings			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	Conditions		Ratings			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		θ ₂ – θ ₁	K > 1.4	60	70		Degrees		

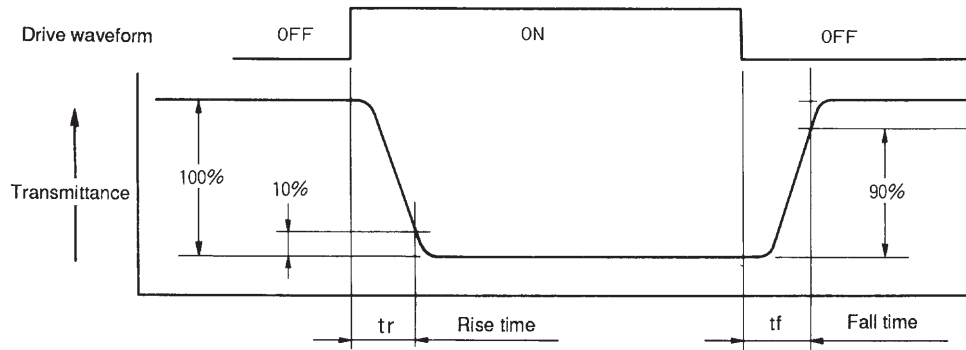


Figure 1 Response Time (positive display)

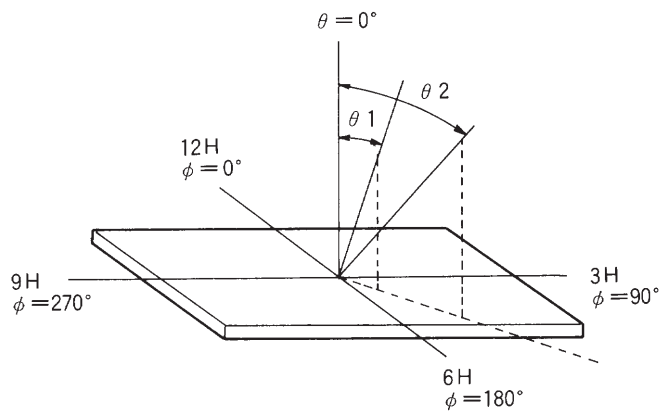


Figure 2 Viewing Angle Definition

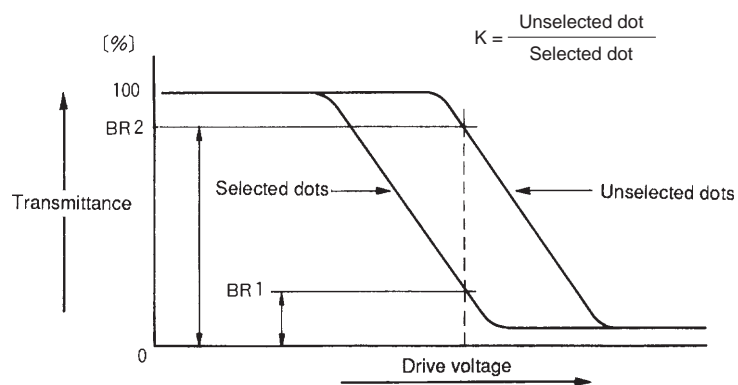


Figure 3 Contrast Definition

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

Absolute Maximum Ratings

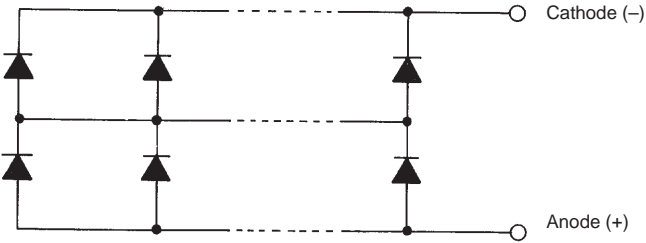
Parameter	Symbol	Conditions	Ratings	Unit
Forward current	I_F	$T_a = 25^{\circ}\text{C}$	675	mA
Reverse breakdown voltage	V_R	$T_a = 25^{\circ}\text{C}$	6	V
Power dissipation	P_D	$T_a = 25^{\circ}\text{C}$	3700	mW
Operating temperature range	T_{opr}		-20 to +60	$^{\circ}\text{C}$

Electro-Optical Characteristics

Parameter		Forward voltage			Luminescence wavelength (peak)		Brightness			
		V_F		Condition	λ_P	Condition	L			Condition
Type	Color	typ	max	—	typ	—	min	typ	max	—
L3	Ultra-green	4.0 V	5.6 V	270 mA	567 nm	270 mA	32 cd/m ²	75 cd/m ²	—	270 mA
L7	Pure green	4.2 V	5.6 V	270 mA	557 nm	270 mA	8 cd/m ²	25 cd/m ²	75 cd/m ²	270 mA

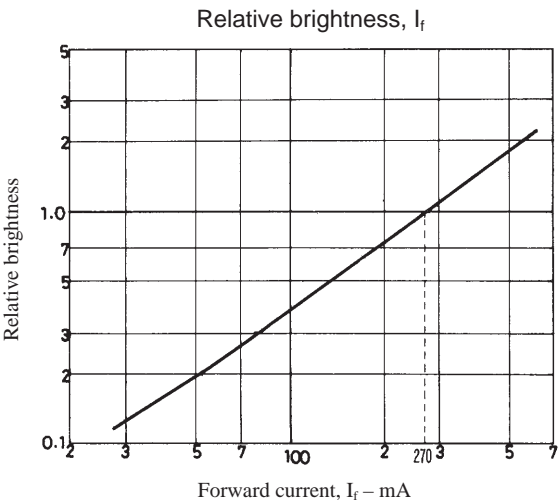
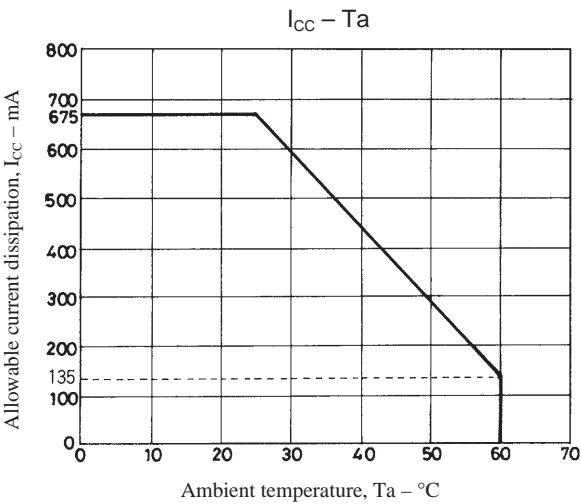
Note: The maximum brightness values are reference values.

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

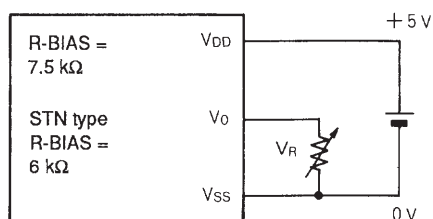


Display Position and DD.RAM Addresses

	Left side		(Display position)		Right side	
	1	2	10	11	23	24
First line	00H	01H.....09H	0AH	.....16H	17H	
Second line	40H	41H.....49H	4AH	.....56H	57H	

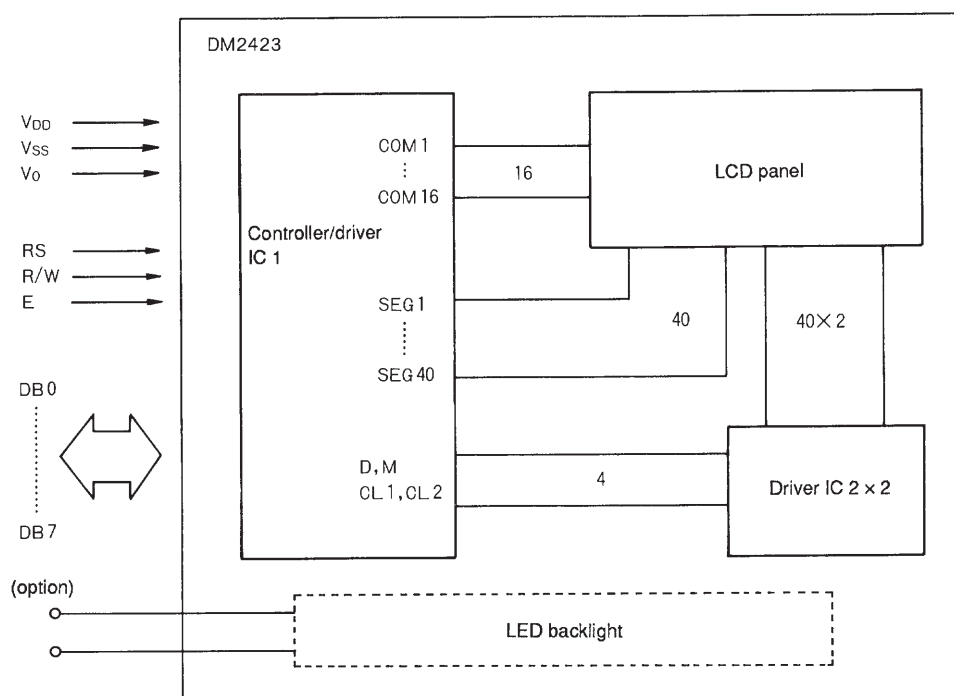
Note: The return home instruction resets the cursor to location 00H.

Supply Circuit Examples



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

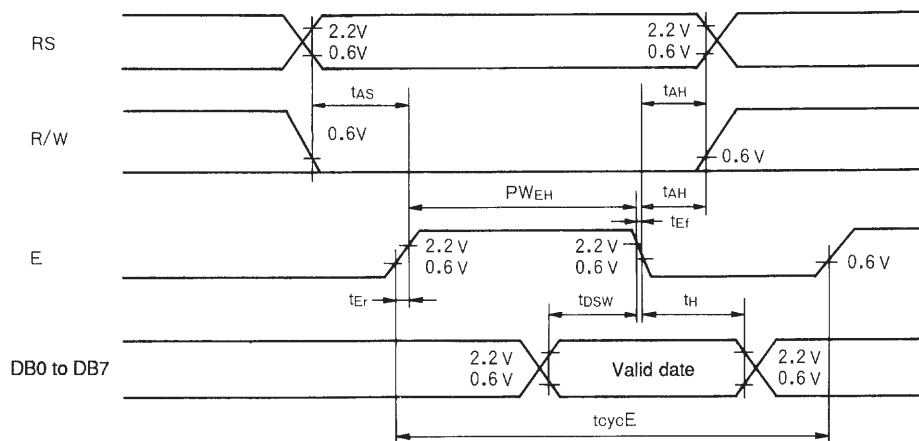
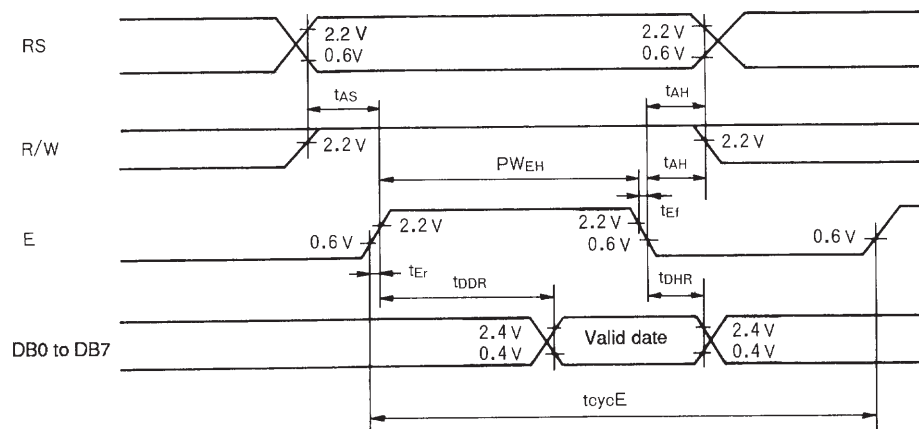
Block Diagram



IC 1: HD44780 or LC7985NA-8733
IC 2: LC7930N x 2

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	Ratings			Unit
			min	typ	max	
Enable cycle time	$t_{\text{cyc E}}$	Figures 4 and 5	1000			ns
Enable pulse width	PW_{EH}	Figures 4 and 5	450			ns
Enable rise and fall times	$t_{\text{Er}}, t_{\text{Ef}}$	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.
15	NC	Option pin (LED A: For use as the anode side (+) power supply pin.)
16	NC	Option pin (LED K: For use as the cathode side (–) power supply pin.)

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	Ratings			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.

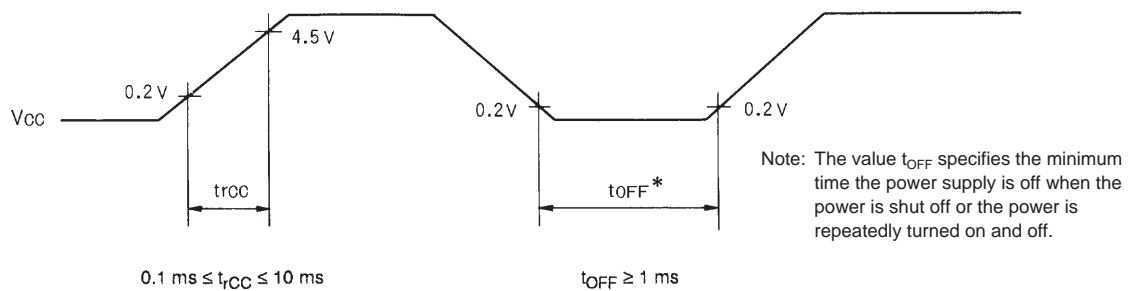


Table 1 Character Code/Character Pattern Correspondence Chart

Upper 4 bits Lower 4 bits	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	a	P	`	P	-	9	E	a	P	
xxxx0001	(2)	!	1	A	Q	a	9	a	7	7	4	a	q
xxxx0010	(3)	"	2	B	R	b	r	"	4	U	X	P	Q
xxxx0011	(4)	#	3	C	S	c	s	,	9	7	E	e	∞
xxxx0100	(5)	\$	4	D	T	d	t	,	I	t	†	μ	Q
xxxx0101	(6)	%	5	E	U	e	u	*	†	†	†	Q	Q
xxxx0110	(7)	&	6	F	V	f	v	9	†	†	†	P	Z
xxxx0111	(8)	'	7	G	W	g	w	7	†	†	†	g	π
xxxx1000	(1)	(	8	H	X	h	x	4	9	†	†	r	X
xxxx1001	(2)	)	9	I	Y	i	y	9	†	†	†	'	y
xxxx1010	(3)	*	:	J	Z	j	z	†	†	†	†	j	†
xxxx1011	(4)	+	:	K	[	k	(†	†	†	†	*	†
xxxx1100	(5)	,	<	L	†	†	†	†	†	†	†	†	†
xxxx1101	(6)	-	=	M	†	†	†	†	†	†	†	†	†
xxxx1110	(7)	.	>	N	^	n	†	†	†	†	†	†	†
xxxx1111	(8)	/	?	O	_	o	†	†	†	†	†	†	†

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.

- Specifications of any and all SANYO products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.
- SANYO Electric Co., Ltd. strives to supply high-quality high-reliability products. However, any and all semiconductor products fail with some probability. It is possible that these probabilistic failures could give rise to accidents or events that could endanger human lives, that could give rise to smoke or fire, or that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO products (including technical data, services) described or contained herein are controlled under any of applicable local export control laws and regulations, such products must not be exported without obtaining the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written permission of SANYO Electric Co., Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production. SANYO believes information herein is accurate and reliable, but no guarantees are made or implied regarding its use or any infringements of intellectual property rights or other rights of third parties.

This catalog provides information as of September, 1999. Specifications and information herein are subject to change without notice.