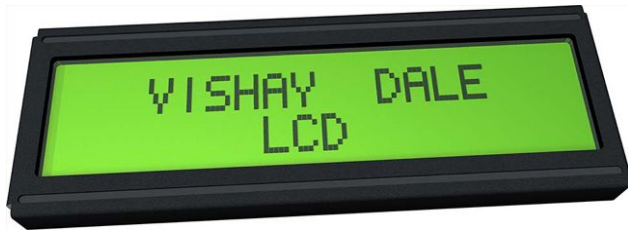


16 x 2 Character LCD



FEATURES

- Type: character
- Display format: 16 x 2 characters
- Built-in controller: ST7066 (or equivalent)
- Duty cycle: 1/16
- 5 x 8 dots includes cursor
- +5 V power supply
- LED can be driven by pin 1, pin 2, pin 15, pin 16 or A and K
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912


RoHS
COMPLIANT

MECHANICAL DATA		
ITEM	STANDARD VALUE	UNIT
Module dimension	84.0 x 44.0 x 13.2 (max.)	mm
Viewing area	66.0 x 16.0	
Active area	56.2 x 11.5	
Dot size	0.55 x 0.65	
Dot pitch	0.60 x 0.70	
Mounting hole	76.0 x 36.0	
Character size	2.95 x 5.55	

ABSOLUTE MAXIMUM RATINGS					
ITEM	SYMBOL	STANDARD VALUE			UNIT
		MIN.	TYP.	MAX.	
Supply voltage for logic	V_{DD} to V_{SS}	-0.3	-	7.0	V
Supply voltage for LCD	V_{DD} to V_0	-0.3	-	13.0	
Input voltage	V_I	V_{SS}	-	V_{DD}	
Operating temperature	T_{OP}	-20	-	+70	°C
Storage temperature	T_{ST}	-30	-	+80	°C

Note

- $V_{SS} = 0\text{ V}$, $V_{DD} = 5.0\text{ V}$

ELECTRICAL CHARACTERISTICS						
ITEM	SYMBOL	CONDITION	STANDARD VALUE			UNIT
			MIN.	TYP.	MAX.	
Supply voltage for logic	V_{DD} to V_{SS}	-	4.5	5.0	5.5	V
Supply voltage for LCD ⁽¹⁾	V_{DD} to V_0	-20 °C	-	-	5.2	V
		25 °C	-	3.8	-	
		70 °C	3.2	-	-	
Input high voltage	V_{IH}	-	0.7 V_{DD}	-	V_{DD}	V
Input low voltage	V_{IL}	-	V_{SS}	-	0.6	mA
Output high voltage	V_{OH}	-	3.9	-	-	V
Output low voltage	V_{OL}	-	-	-	0.4	mA
Supply current	I_{DD}	$V_{DD} = +5\text{ V}$	1.0	1.2	1.5	mA

Note

- Please design the VOP adjustment circuit on customer's main board

OPTIONS									
PROCESS COLOR						BACKLIGHT			
TN	STN GRAY	STN YELLOW	STN BLUE	FSTN B&W	STN COLOR	NONE	LED	EL	CCFL
yes	yes	yes	yes	yes	-	yes	yes	-	-

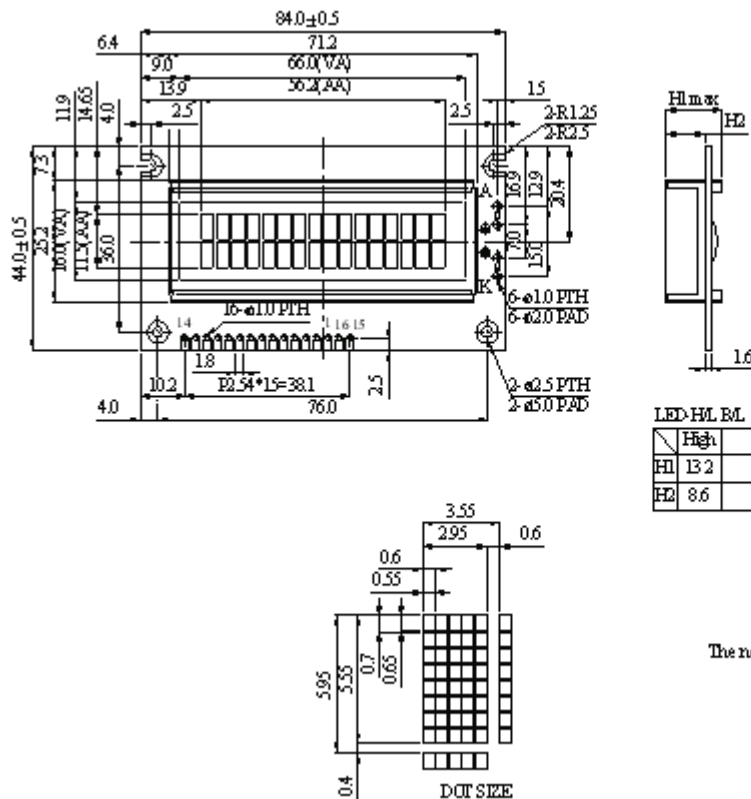
DISPLAY CHARACTER ADDRESS CODE

Display position

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
DD RAM address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

INTERFACE PIN FUNCTION

PIN NO.	SYMBOL	FUNCTION
1	V _{SS}	Ground
2	V _{DD}	Power supply voltage for logic (+5 V)
3	V _O	Operating voltage (variable)
4	RS	H / L; H: data / L: instruction code
5	R / \bar{W}	H / L; H: read (MPU → module) / L: write (MPU → module)
6	E	H, H → L chip enable signal
7	DB0	H / L data bus line
8	DB1	H / L data bus line
9	DB2	H / L data bus line
10	DB3	H / L data bus line
11	DB4	H / L data bus line
12	DB5	H / L data bus line
13	DB6	H / L data bus line
14	DB7	H / L data bus line
15	A	LED+
16	K	LED-

DIMENSIONS in millimeters


LED-HL-BL	High
H1	13.2
H2	8.6

The non-specified tolerance of dimension is ±0.3mm.



1. Module Classification Information

LCD- 016 N 002 A -Y Y H -ET

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

1. Brand : Vishay Intertechnology
2. Horizontal Format: 16 characters
3. Display Type : N→Character Type (RoHS), M→Character Type
4. Vertical Format: 2 lines
5. Model serials no.: A
6. Backlight Type :

N→Without backlight	T→LED, White
B→EL, Blue green	A→LED, Amber
D→EL, Green	R→LED, Red
W→EL, White	O→LED, Orange
F→CCFL, White	G→LED, Green
Y→LED, Yellow Green	B→LED, Blue
7. LCD Mode :

B→TN Positive, Gray	T→FSTN Negative
N→TN Negative,	
G→STN Positive, Gray	
Y→STN Positive, Yellow Green	
M→STN Negative, Blue	
F→FSTN Positive	
8. LCD Polarize Type/ Temperature range/ View direction

A→Reflective, N.T, 6:00	H→Transflective, W.T,6:00
D→Reflective, N.T, 12:00	K→Transflective, W.T,12:00
G→Reflective, W. T, 6:00	C→Transmissive, N.T,6:00
J→Reflective, W. T, 12:00	F→Transmissive, N.T,12:00
B→Transflective, N.T,6:00	I→Transmissive, W. T, 6:00
E→Transflective, N.T.12:00	L→Transmissive, W.T,12:00
9. Special Code ET : English and European standard font ; Fits in with the ROHS Directions and regulations



2. Precautions in use of LCD Modules

- (1) Avoid applying excessive shocks to the module or making any alterations or modifications to it.
- (2) Don't make extra holes on the printed circuit board, modify its shape or change the components of LCD module.
- (3) Don't disassemble the LCM.
- (4) Don't operate it above the absolute maximum rating.
- (5) Don't drop, bend or twist LCM.
- (6) Soldering: only to the I/O terminals.
- (7) Storage: please storage in anti-static electricity container and clean environment.

3. General Specification

Item	Dimension	Unit
Number of Characters	16 characters x 2 Lines	—
Module dimension	84.0 x 44.0 x 13.2(MAX)	mm
View area	66.0 x 16.0	mm
Active area	56.20 x 11.5	mm
Dot size	0.55 x 0.65	mm
Dot pitch	0.60 x 0.70	mm
Character size	2.95 x 5.55	mm
Character pitch	3.55 x 5.95	mm
LCD type	STN Positive, Transflective, Yellow Green	
Duty	1/16	
View direction	6 o'clock	
Backlight Type	LED Yellow green	



4. Absolute Maximum Ratings

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	T _{OP}	-20	—	+70	°C
Storage Temperature	T _{ST}	-30	—	+80	°C
Input Voltage	V _I	V _{SS}	—	V _{DD}	V
Supply Voltage For Logic	V _{DD} -V _{SS}	-0.3	—	7	V
Supply Voltage For LCD	V _{DD} -V ₀	-0.3	—	13	V

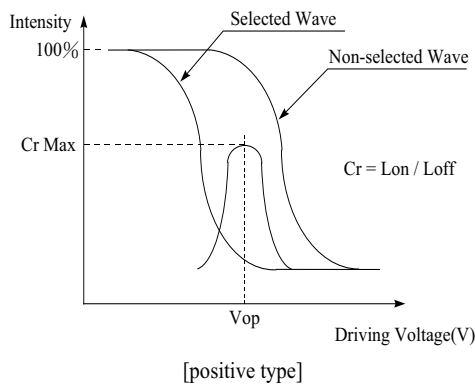
5. Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	V _{DD} -V _{SS}	—	4.5	5.0	5.5	V
Supply Voltage For LCD	V _{DD} -V ₀	T _a =-20°C	—	—	5.2	V
		T _a =25°C	—	3.8	—	V
		T _a =70°C	3.2	—	—	V
Input High Volt.	V _{IH}	—	0.7 V _{DD}	—	V _{DD}	V
Input Low Volt.	V _{IL}	—	V _{SS}	—	0.6	V
Output High Volt.	V _{OH}	—	3.9	—	—	V
Output Low Volt.	V _{OL}	—	—	—	0.4	V
Supply Current	I _{DD}	V _{DD} =5.0V	1.0	1.2	1.5	mA

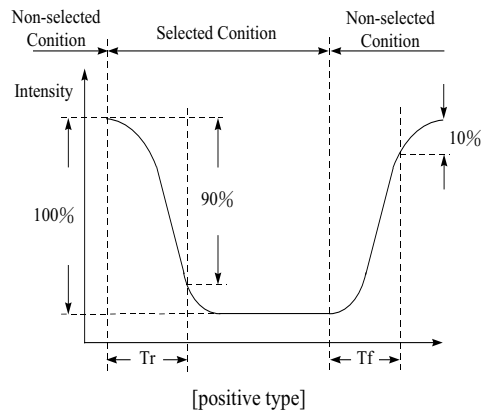
6. Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	$(V) \theta$	$CR \geq 2$	20	—	40	deg
	$(H) \varphi$	$CR \geq 2$	-30	—	30	deg
Contrast Ratio	CR	—	—	3	—	—
Response Time @25C	T rise	—	—	150	200	ms
	T fall	—	—	150	200	ms

Definition of Operation Voltage (Vop)



Definition of Response Time (Tr, Tf)



Conditions:

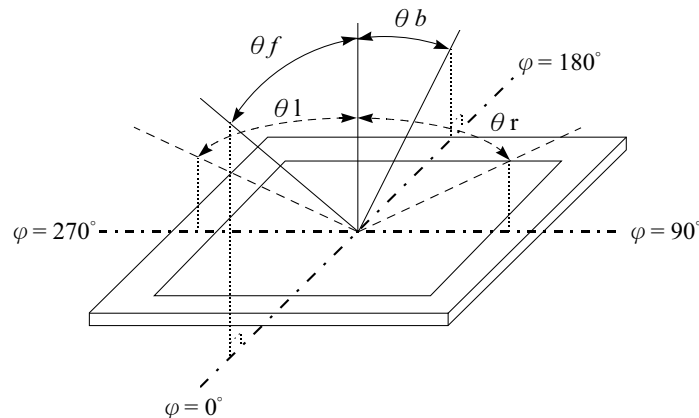
Operating Voltage: Vop

 Viewing Angle (θ , φ): 0° , 0°

Frame Frequency: 64 HZ

Driving Waveform: 1/N duty, 1/a bias

Definition of viewing angle($CR \geq 2$)

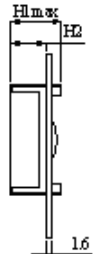
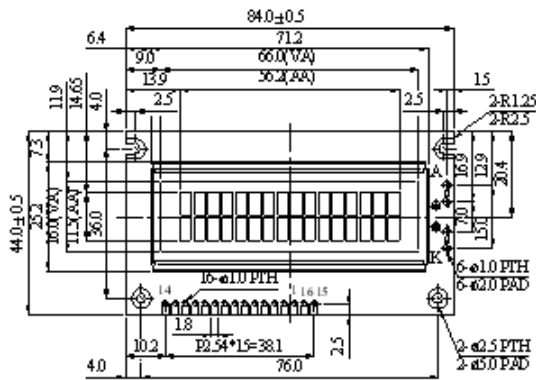




7. Interface Pin Function

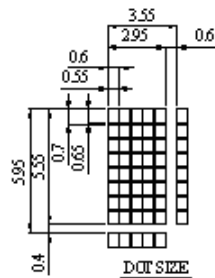
Pin No.	Symbol	Level	Description
1	V _{SS}	0V	Ground
2	V _{DD}	5.0V	Supply Voltage for logic
3	VO	(Variable)	Operating voltage for LCD
4	RS	H/L	H: DATA, L: Instruction code
5	R/W	H/L	H: Read(MPU→Module) L: Write(MPU→Module)
6	E	H,H→L	Chip enable signal
7	DB0	H/L	Data bus line
8	DB1	H/L	Data bus line
9	DB2	H/L	Data bus line
10	DB3	H/L	Data bus line
11	DB4	H/L	Data bus line
12	DB5	H/L	Data bus line
13	DB6	H/L	Data bus line
14	DB7	H/L	Data bus line
15	A	—	LED +
16	K	—	LED —

8. Contour Drawing & Block Diagram

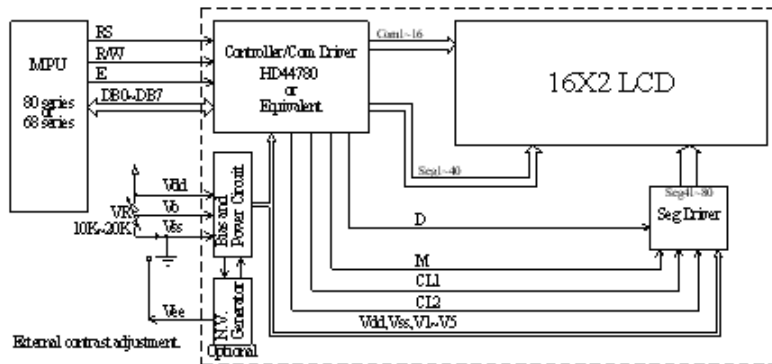


LED-H/L-B/L	
High	
H1	13.2
H2	8.6

PIN NO.	SYMBOL
1	V _{SS}
2	V _{DD}
3	V _O
4	R/S
5	R/W
6	E
7	DE0
8	DE1
9	DE2
10	DE3
11	DE4
12	DE5
13	DE6
14	DE7
15	A
16	K



The non-specified tolerance of dimension is ±0.3mm.



Character located	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DDRAM address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
DDRAM address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

9. Function Description

The LCD display Module is built in a LSI controller, the controller has two 8-bit registers, an instruction register (IR) and a data register (DR).

The IR stores instruction codes, such as display clear and cursor shift, and address information for display data RAM (DDRAM) and character generator (CGRAM). The IR can only be written from the MPU. The DR temporarily stores data to be written or read from DDRAM or CGRAM. When address information is written into the IR, then data is stored into the DR from DDRAM or CGRAM. By the register selector (RS) signal, these two registers can be selected.

RS	R/W	Operation
0	0	IR write as an internal operation (display clear, etc.)
0	1	Read busy flag (DB7) and address counter (DB0 to DB7)
1	0	Write data to DDRAM or CGRAM (DR to DDRAM or CGRAM)
1	1	Read data from DDRAM or CGRAM (DDRAM or CGRAM to DR)

Busy Flag (BF)

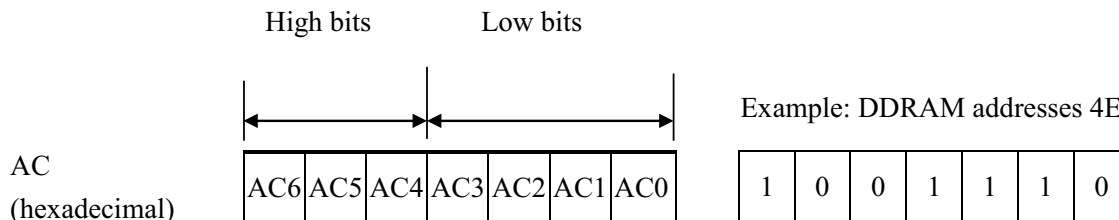
When the busy flag is 1, the controller LSI is in the internal operation mode, and the next instruction will not be accepted. When RS=0 and R/W=1, the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.

Address Counter (AC)

The address counter (AC) assigns addresses to both DDRAM and CGRAM

Display Data RAM (DDRAM)

This DDRAM is used to store the display data represented in 8-bit character codes. Its extended capacity is 80x8 bits or 80 characters. Below figure is the relationships between DDRAM addresses and positions on the liquid crystal display.





Display position DDRAM address

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

2-Line by 16-Character Display

Character Generator ROM (CGROM)

The CGROM generate 5x8 dot or 5x10 dot character patterns from 8-bit character codes. See Table 2.

Character Generator RAM (CGRAM)

In CGRAM, the user can rewrite character by program. For 5x8 dots, eight character patterns can be written, and for 5x10 dots, four character patterns can be written.

Write into DDRAM the character code at the addresses shown as the left column of table 1. To show the character patterns stored in CGRAM.

Relationship between CGRAM Addresses, Character Codes (DDRAM) and Character patterns
Table 1.

For 5 * 8 dot character patterns

Character Codes (DDRAM data)	CGRAM Address		Character Patterns (CGRAM data)		
7 6 5 4 3 2 1 0 High Low	5 4 3 2 1 0 High Low			7 6 5 4 3 2 1 0 High Low	
0 0 0 0 * 0 0 0	0 0 0	0 0 0	* * *	0	Character pattern(1)
		0 0 1	* * *	0 0 0	
		0 1 0	* * *	0 0 0	
		0 1 1	* * *	0	
		1 0 0	* * *	0 0 0	
		1 0 1	* * *	0 0 0	
		1 1 0	* * *	0 0 0 0	
		1 1 1	* * *	0 0 0 0	
0 0 0 0 * 0 0 1	0 0 1	0 0 0	* * *	0 0 0	Character pattern(2)
		0 1 0	* * *	0 0 0	
		0 1 1	* * *	0 0 0 0	
		1 0 0	* * *	0 0 0 0	
		1 0 1	* * *	0 0 0 0	Cursor pattern
		1 1 0	* * *	0 0 0 0	
		1 1 1	* * *	0 0 0 0	
		0 0 0	* * *		
		0 0 1	* * *		
0 0 0 0 * 1 1 1	1 1 1	1 0 0			
		1 0 1			
		1 1 0			
		1 1 1	* * *		

For 5 * 10 dot character patterns

Character Codes (DDRAM data)	CGRAM Address		Character Patterns (CGRAM data)		
7 6 5 4 3 2 1 0 High Low	5 4 3 2 1 0 High Low			7 6 5 4 3 2 1 0 High Low	
0 0 0 0 * 0 0 0	0 0	0 0 0 0	* * *	0 0 0 0 0	Character pattern
		0 0 0 1	* * *	0 0 0 0 0	
		0 0 1 0	* * *	0 0 0 0	
		0 0 1 1	* * *	0 0 0	
		0 1 0 0	* * *	0 0 0	
		0 1 0 1	* * *	0 0 0	
		0 1 1 0	* * *	0	
		0 1 1 1	* * *	0 0 0 0	
		1 0 0 0	* * *	0 0 0 0	
		1 0 0 1	* * *	0 0 0 0	
		1 0 1 0	* * *	0 0 0 0 0	Cursor pattern
		1 1 1 1	* * *	* * * * *	

■ : " High "

10. Character Generator ROM Pattern

Table 2.

Upper 4 bit Lower 4 bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
LLLH	CG RAM (2)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
LLHL	CG RAM (3)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
LLHH	CG RAM (4)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
LHLL	CG RAM (5)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
LHLH	CG RAM (6)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
LHHL	CG RAM (7)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
LHHH	CG RAM (8)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
HLLL	CG RAM (1)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
HLLH	CG RAM (2)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
HLHL	CG RAM (3)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
HLHH	CG RAM (4)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
HHLL	CG RAM (5)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
HHLH	CG RAM (6)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
HHHL	CG RAM (7)	0	1	2	3	4	5	6	7	8	9	:	;	<	=	~
HHHH	CG RAM (8)	!	"	#	\$	%	&	'	()	*	+	,	-	.	/

11. Instruction Table

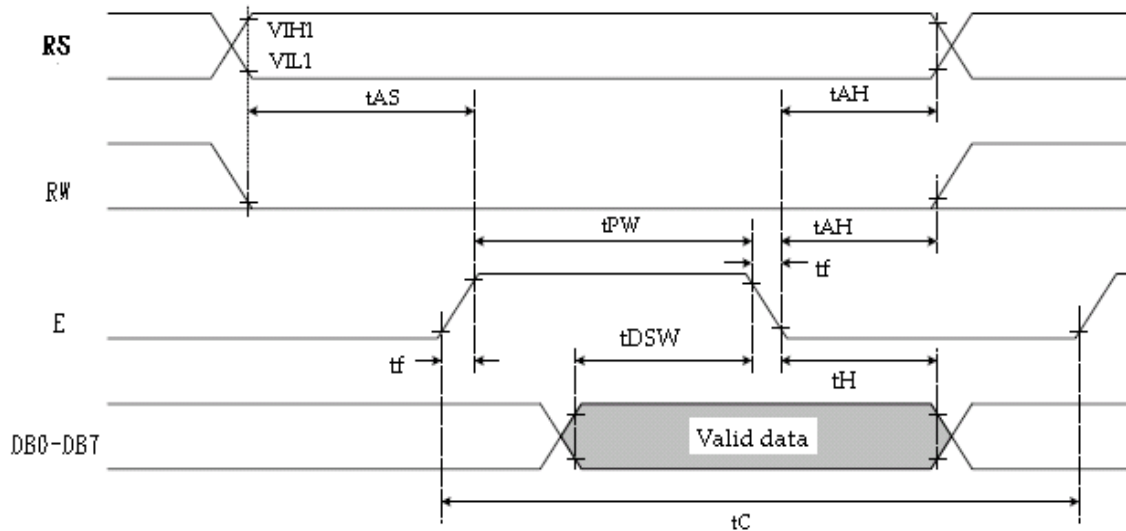
Instruction	Instruction Code										Description	Execution time (fosc=270Khz)	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "00H" to DDRAM and set DDRAM address to "00H" from AC	1.53ms	
Return Home	0	0	0	0	0	0	0	0	0	1	Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.53ms	
Entry Mode Set	0	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and enable the shift of entire display.	39 μ s
Display ON/OFF Control	0	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C), and blinking of cursor (B) on/off control bit.	39 μ s
Cursor or Display Shift	0	0	0	0	0	0	1	S/C	R/L	—	—	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.	39 μ s
Function Set	0	0	0	0	0	1	DL	N	F	—	—	Set interface data length (DL:8-bit/4-bit), numbers of display line (N:2-line/1-line)and, display font type (F:5x11 dots/5x8 dots)	39 μ s
Set CGRAM Address	0	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39 μ s
Set DDRAM Address	0	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	39 μ s
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0 μ s	
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43 μ s	
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43 μ s	

* "—" : don't care

12. Timing Characteristics

12.1 Write Operation

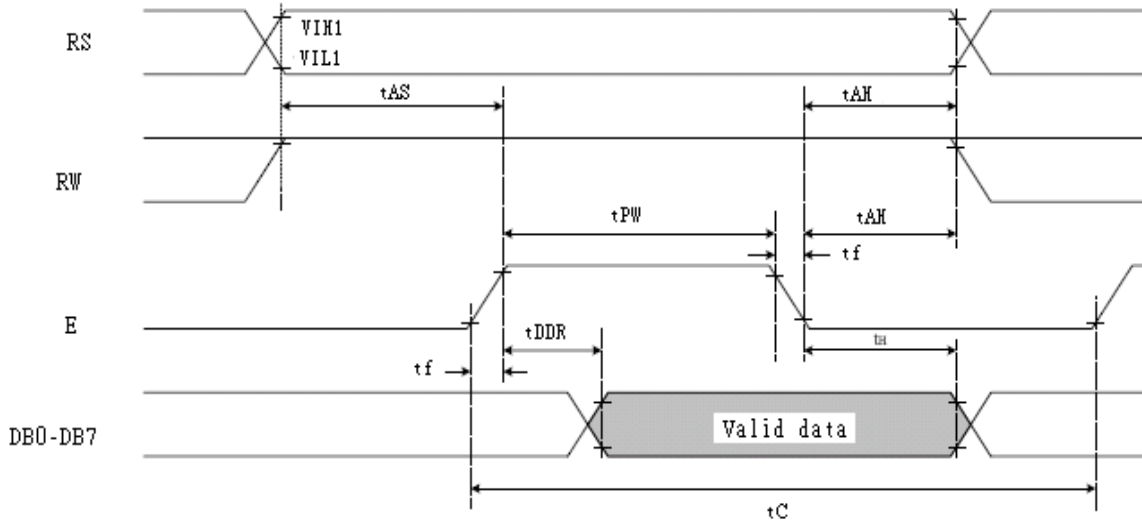
- Writing data from MPU



$T_a=25^{\circ}\text{C}$, $V_{DD}=5.0\text{V}$

Item	Symbol	Min	Typ	Max	Unit
Enable cycle time	T_C	1200	—	—	ns
Enable pulse width	T_{PW}	140	—	—	ns
Enable rise/fall time	T_R, T_F	—	—	25	ns
Address set-up time (RS, R/W to E)	t_{AS}	0	—	—	ns
Address hold time	t_{AH}	10	—	—	ns
Data set-up time	t_{DSW}	40	—	—	ns
Data hold time	t_H	10	—	—	ns

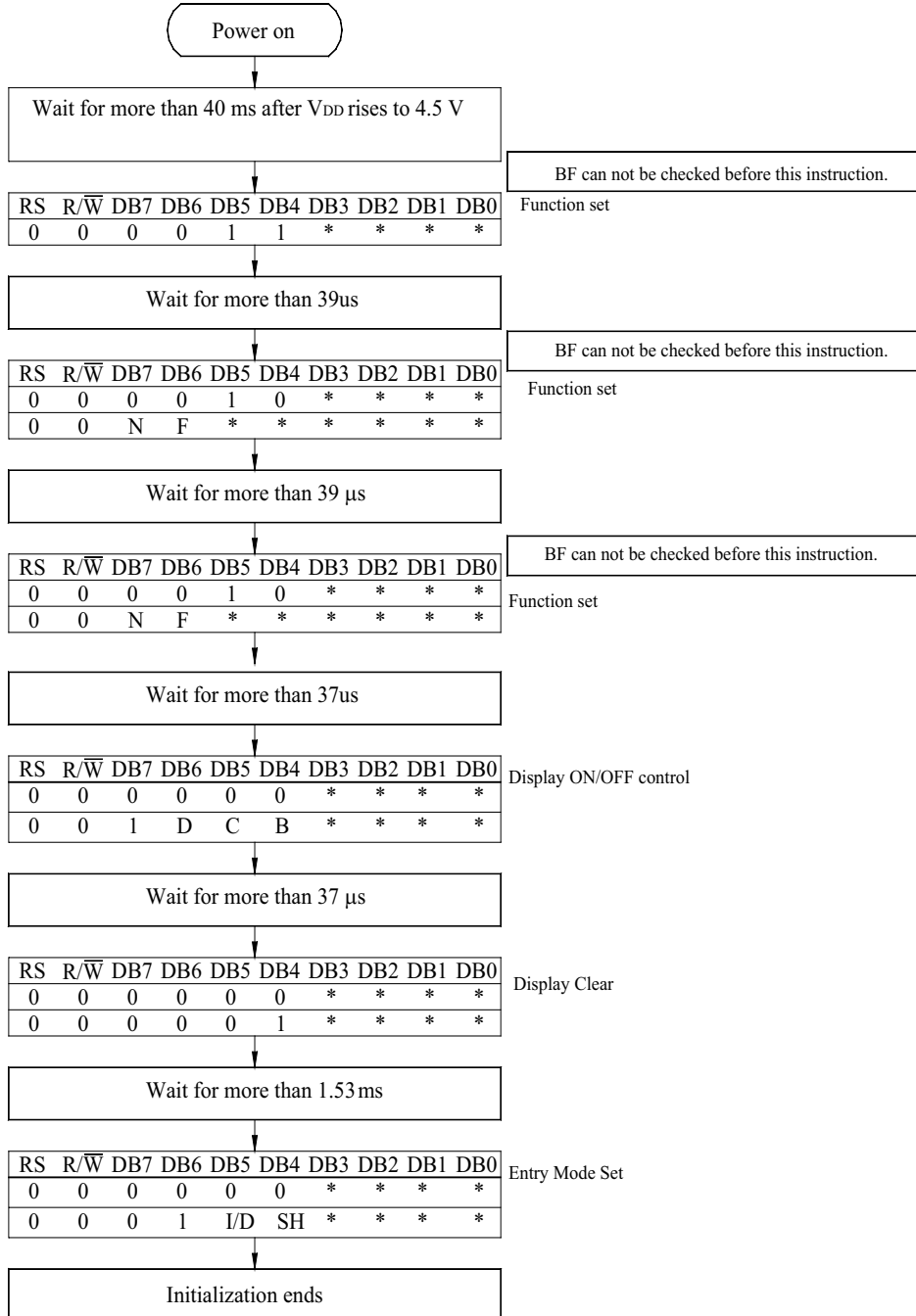
- Reading data from ST7066U



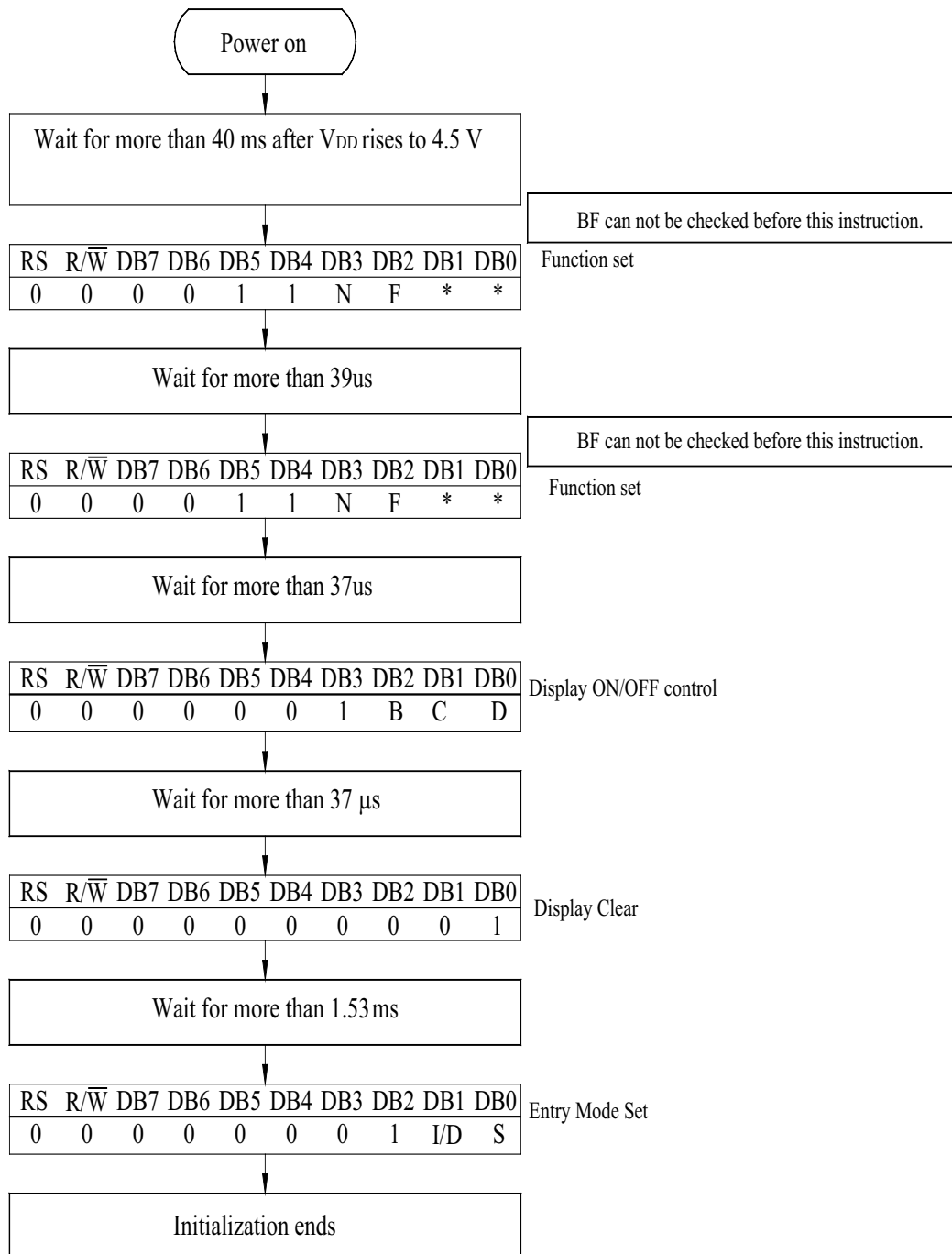
Ta=25°C, VDD=5V

Item	Symbol	Min	Typ	Max	Unit
Enable cycle time	T_C	1200	—	—	ns
Enable pulse width (high level)	T_{PW}	140	—	—	ns
Enable rise/fall time	T_R, T_F	—	—	25	ns
Address set-up time (RS, R/W to E)	t_{AS}	0	—	—	ns
Address hold time	t_{AH}	10	—	—	ns
Data delay time	t_{DDR}	—	—	100	ns
Data hold time	t_H	10	—	—	ns

13. Initializing of LCM



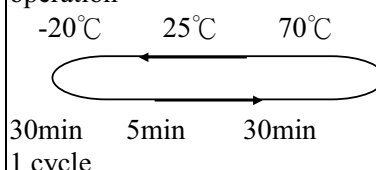
4-Bit Interface



8-Bit Ineterface

14. Reliability

Content of Reliability Test (wide temperature, -20°C~70°C)

Environmental Test			
Test Item	Content of Test	Test Condition	Note
High Temperature storage	Endurance test applying the high storage temperature for a long time.	80°C 200hrs	2
Low Temperature storage	Endurance test applying the high storage temperature for a long time.	-30°C 200hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	70°C 200hrs	—
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20°C 200hrs	1
High Temperature/ Humidity Operation	The module should be allowed to stand at 60°C, 90%RH max For 96hrs under no-load condition excluding the polarizer, Then taking it out and drying it at normal temperature.	60°C, 90%RH 96hrs	1,2
Thermal shock resistance	The sample should be allowed stand the following 10 cycles of operation  30min 5min 30min 1 cycle	-20°C/70°C 10 cycles	—
Vibration test	Endurance test applying the vibration during transportation and using.	Total fixed amplitude : 1.5mm Vibration Frequency : 10~55Hz One cycle 60 seconds to 3 directions of X, Y, Z for Each 15 minutes	3
Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V, RS=1.5kΩ CS=100pF 1 time	—

Note1: No dew condensation to be observed.

Note2: The function test shall be conducted after 4 hours storage at the normal Temperature and humidity after remove from the test chamber.

Note3: Vibration test will be conducted to the product itself without putting it in a container.

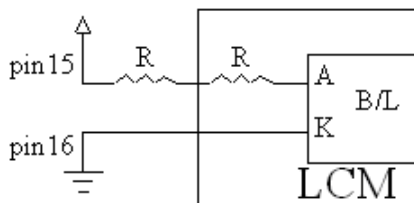
15. Backlight Information

Specification

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Supply Current	I _{LED}	104	130	150	mA	V=4.2V
Supply Voltage	V	4.0	4.2	4.4	V	—
Reverse Voltage	V _R	—	—	8	V	—
Luminous Intensity	I _V	60	80	—	CD/M ²	I _{LED} =130mA
Wave Length	λ _p	560	570	580	nm	I _{LED} =130mA
Life Time	—	—	100000	—	Hr.	I _{LED} ≤ 130mA
Color	Yellow Green					

Note: The LED of B/L is drive by current only, drive voltage is for reference only. drive voltage can make driving current under safety area (current between minimum and maximum).

2. Drive from pin15, pin16



(Will never get V_{ee} output from pin15)



Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.