

**Product Specification**

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# NHD-0216KZW-AY5

## OLED Display Module

<b>NHD-</b>	Newhaven Display
<b>0216-</b>	2 Lines x 16 Characters
<b>KZW-</b>	OLED
<b>A-</b>	Model
<b>Y-</b>	Emitting Color: Yellow
<b>5-</b>	5V Power Supply



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## Additional Resources

- **Support Forum:** <https://support.newhavendisplay.com/hc/en-us/community/topics>
- **GitHub:** <https://github.com/newhavendisplay>
- **Example Code:** <https://support.newhavendisplay.com/hc/en-us/categories/4409527834135-Example-Code/>
- **Knowledge Center:** [https://www.newhavendisplay.com/knowledge\\_center.html](https://www.newhavendisplay.com/knowledge_center.html)
- **Quality Center:** [https://www.newhavendisplay.com/quality\\_center.html](https://www.newhavendisplay.com/quality_center.html)
- **Precautions for using LCDs/LCMs:** <https://www.newhavendisplay.com/specs/precautions.pdf>
- **Warranty / Terms & Conditions:** <https://www.newhavendisplay.com/terms.html>

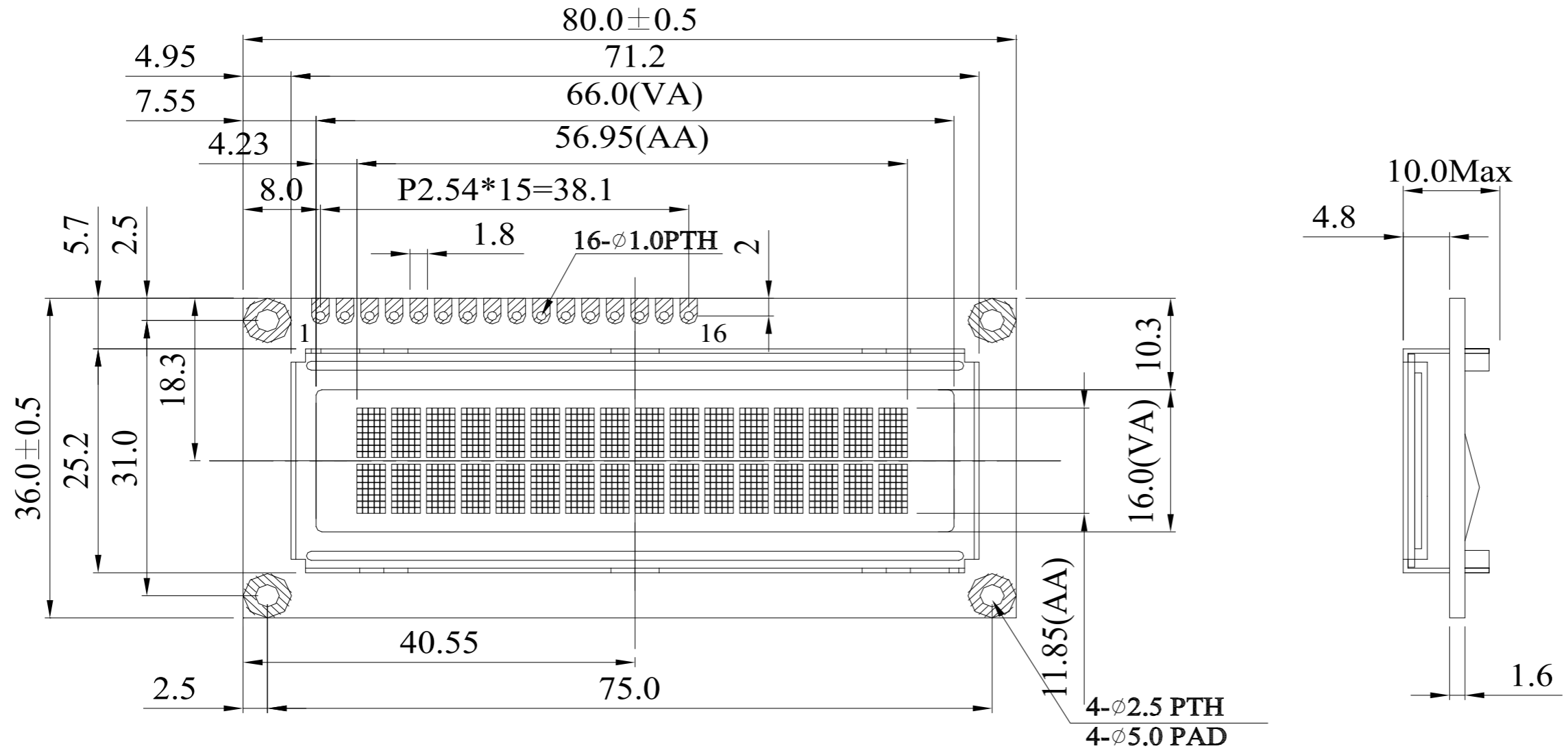


## Document Revision History

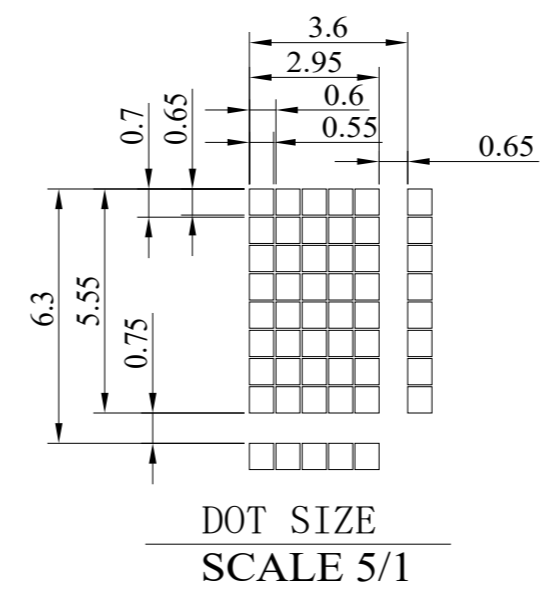
Revision	Date	Description	Changed By
0	04/01/2011	Initial Product Release	-
1	07/11/2011	Serial Interface Information Updated	AK
2	08/31/2011	Font Tables Updated	AK
3	10/18/2011	Jumper Selections Updated	AK
4	03/26/2012	Jumper Selections Updated	AK
5	02/08/2013	Optical Characteristics and Mechanical Drawing Updated.	JN
6	09/07/2013	Photo of Jumpers (solder pads) Added	AK
7	01/29/2015	Photo of Jumpers (solder pads) Updated	KA
8	08/30/2016	Supply Current & Brightness Updated	SB
9	03/02/2017	Electrical Characteristics Updated	TM
10	10/05/2018	Mechanical Drawing Reformat	SB
11	04/05/2019	Supply Voltage Updated	SB
12	03/25/2020	Label Added to Drawing	SB
13	02/25/2021	Controller IC Upgraded; Updated Supply Current, MAX Storage Temperature, Optical Characteristics & Quality Information Part Revision Upgraded from Rev1A to Rev1B	AS
14	09/07/2023	Part Revision Upgraded from Rev1B to Rev1C	KL
15	01/31/2024	Pin Description Table for Parallel Interface Updated	KL

# Mechanical Drawing

**Newhaven Display**  
 NHD-0216KZW-AY5\_Rev1C  
 Date Code  
 Part Label (type/format may vary)



PIN NO.	SYMBOL
1	Vss
2	Vdd
3	NC
4	RS
5	R/W
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7
15	NC
16	NC



- Product Description: 2x16 Character OLED**
- Driving Mode: 1/16 Duty
  - Interface: 4/8-bit 6800/8080 Parallel, SPI
  - Power Requirement: 5.0V OLED
  - Optical Features: Yellow Color, Anti-Glare, Full View
  - Recommended Pin Header: 1x16pin 2.54mm pitch

<b>Standard Tolerance:</b> (Unless otherwise specified)  Linear: ±0.3mm		
	Drawing/Part Number: <b>NHD-0216KZW-AY5</b>	Revision: <b>1C</b>
<b>Unless otherwise specified:</b> • Dimensions are in Millimeters • Third Angle Projection	Drawn By: K. Lewis	Approved By: K. Lewis
	Drawn Date: 09/07/2023	Approved Date: 09/07/2023
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## Pin Description

### Parallel Interface (default):

Pin No.	Symbol	External Connection	Function Description
1	V <sub>SS</sub>	Power Supply	Ground
2	V <sub>DD</sub>	Power Supply	Supply Voltage for OLED and logic
3	NC	-	No Connect
4	RS	MPU	Register select signal. RS=0: Command; RS=1: Data
5	R/W /WR	MPU	<b>6800 mode:</b> Read/Write select signal, R/W=1: Read; R/W: =0: Write <b>8080 mode:</b> Active LOW Write signal
6	E /RD	MPU	<b>6800 mode:</b> Operation enable signal. Falling edge triggered. <b>8080 mode:</b> Active LOW Read signal
7-10	DB0 – DB3	MPU	Four low order bi-directional three-state data bus lines. These four are not used during 4-bit operation.
11-14	DB4 – DB7	MPU	Four high order bi-directional three-state data bus lines.
15	NC	-	No Connect
16	NC	-	No Connect

### Serial Interface:

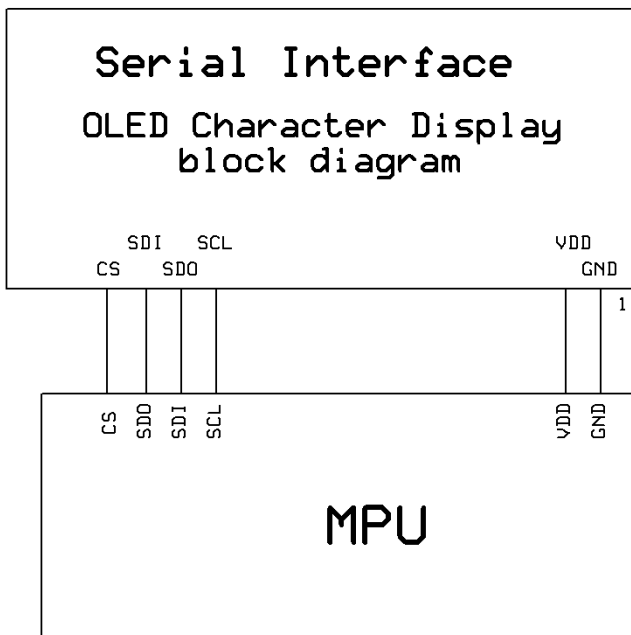
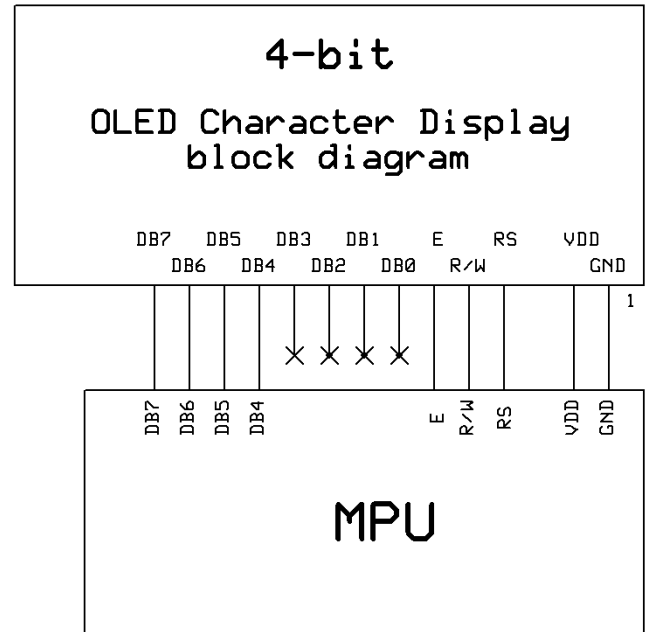
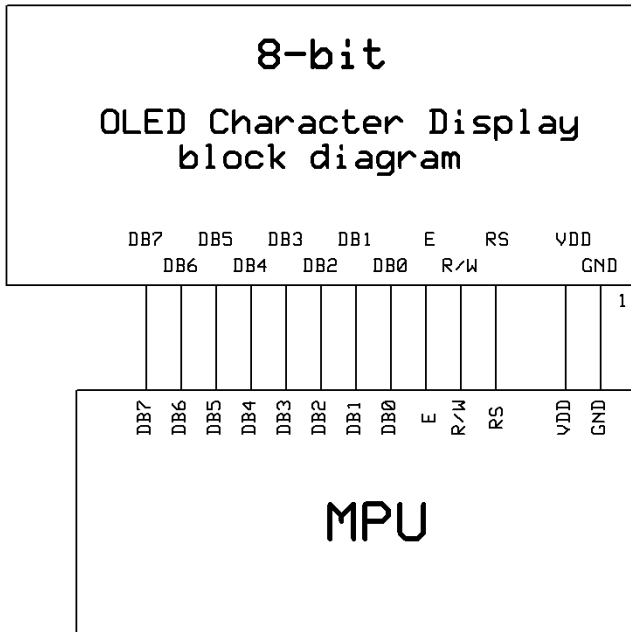
Pin No.	Symbol	External Connection	Function Description
1	V <sub>SS</sub>	Power Supply	Ground
2	V <sub>DD</sub>	Power Supply	Supply Voltage for OLED and logic
3-11	NC	-	No Connect
12	SCL	MPU	Serial Clock signal
13	SDO	MPU	Serial Data output signal
14	SDI	MPU	Serial Data input signal
15	NC	-	No Connect
16	/CS	MPU	Active LOW Chip Select signal

## Jumper Selection

MPU Interface	L_PS_H	J80_J68	L_CS_H	JCS	L_SHL_H
6800-MPU Parallel (default)	H	J68	L	X	H
8080-MPU Parallel	H	J80	L	X	H
Serial MPU	L	X	Open	Short	H

X = Don't care

## Wiring Diagrams



## Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	T <sub>OP</sub>	Absolute Max	-40	-	+80	°C
Storage Temperature Range	T <sub>ST</sub>	Absolute Max	-40	-	+85	°C
Supply Voltage	V <sub>DD</sub>	-	4.8	5.0	5.3	V
Supply Current	I <sub>DD</sub>	T <sub>OP</sub> =25°C, V <sub>DD</sub> =5.0V 50% Checkerboard	-	31	50	mA
"H" Level input	V <sub>IH</sub>	-	0.8 * V <sub>DD</sub>	-	V <sub>DD</sub>	V
"L" Level input	V <sub>IL</sub>	-	V <sub>SS</sub>	-	0.2 * V <sub>DD</sub>	V
"H" Level output	V <sub>OH</sub>	-	0.8 * V <sub>DD</sub>	-	V <sub>DD</sub>	V
"L" Level output	V <sub>OL</sub>	-	V <sub>SS</sub>	-	0.2 * V <sub>DD</sub>	V

## Optical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Optimal Viewing Angles	Top	-	80	-	-	°
	Bottom		80	-	-	°
	Left		80	-	-	°
	Right		80	-	-	°
Contrast Ratio	CR	-	10,000:1	-	-	-
Response Time	Rise	T <sub>R</sub>	-	10	-	μs
	Fall	T <sub>F</sub>	-	10	-	μs
Brightness <sup>2,3</sup>	L <sub>V</sub>	T <sub>OP</sub> =25°C, V <sub>DD</sub> =5.0V	100	120	-	cd/m <sup>2</sup>
Lifetime <sup>1</sup>	-	50% Checkerboard	80,000	100,000	-	Hrs.

### Note:

- 1) Lifetime at typical temperature is based on accelerated high-temperature operation. Lifetime is tested at average 50% pixels on and is rated as hours until half-brightness. The Display OFF command can be used to extend the lifetime of the display.
- 2) Luminance of active pixels will degrade faster than inactive pixels. Residual (burn-in) images may occur. To avoid this, every pixel should be illuminated uniformly. Using a screensaver is highly recommended.
- 3) Brightness is related to the VDD, the brightness will be dimmer if used with lower voltages.



## Table of Commands

Instruction	Code										Description	Max Execution Time	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Clear Display	0	0	0	0	0	0	0	0	0	0	1	Clears entire display. <b>Does not change DDRAM address.</b>	2ms
Return Home	0	0	0	0	0	0	0	0	0	1	0	Sets DDRAM Address to 0x00. Returns shifted display to original position.	600us
Entry Mode Set	0	0	0	0	0	0	0	0	1	I/D	S	Sets cursor to auto Increment or Decrement, and sets display shift.	600us
Display ON/OFF control	0	0	0	0	0	0	0	1	D	C	B	Sets Display (D) ON/OFF. Sets Cursor (C) ON/OFF. Sets Blinking (B) of cursor ON/OFF.	600us
Cursor/Display Shift	0	0	0	0	0	0	1	S/C	R/L	0	0	Moves cursor & shifts display without changing DDRAM contents.	600us
Function Set	0	0	0	0	1	DL	1	0	FT1	FT0		Set interface data length. Select Font Table.	600us
Set CGRAM address	0	0	0	1	ACG5	ACG4	ACG3	ACG2	ACG1	ACG0		Move to CGRAM address.	600us
Set DDRAM address	0	0	1	ADD6	ADD5	ADD4	ADD3	ADD2	ADD1	ADD0		Move to DDRAM address.	600us
Read Busy Flag & Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0		Read Busy Flag (BF) and Address Counter.	600us
Write data to CGRAM or DDRAM	1	0	<b>Write Data</b>								Write data to CGRAM or DDRAM	600us	
Read data from CGRAM or DDRAM	1	1	<b>Read Data</b>								Read data from CGRAM or DDRAM	600us	



## Instruction Descriptions

When an instruction is being executed, only the Busy Flag read instruction can be performed. During execution of an instruction, the Busy Flag = "1". When BF = "0" instructions can be sent to the controller.

### Clear Display

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

This instruction is used to clear the display by writing 0x20 in all DDRAM addresses. This instruction does not change the DDRAM Address.

### Return Home

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	0

This instruction is used to set the DDRAM Address to 0x00 and shifts the display back to the original state. The cursor (if on) will be at the first line's left-most character. The DDRAM contents on the display do not change.

### Entry Mode Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	I/D	S

I/D = Increment/Decrement

When I/D = "1", the DDRAM or CGRAM Address will automatically increment when a character code is written into or read from the DDRAM or CGRAM. The auto-increment will move the cursor one character space to the right.

When I/D = "0", the DDRAM or CGRAM Address will automatically decrement when a character code is written into or read from the DDRAM or CGRAM. The auto-decrement will move the cursor one character space to the left.

S = Shift Entire Display

When S = "1", the entire display is shifted to the right (when I/D = "0") or left (when I/D = "1").

#### I/D=1, S=1

		1	2	3	4	_		<b>Initial display</b>
	1	2	3	4	A	_		<b>Input new character "A"</b>
1	2	3	4	A	B	_		<b>Input new character "B"</b>
2	3	4	A	B	C	_		<b>Input new character "C"</b>
3	4	A	B	C	D	_		<b>Input new character "D"</b>

#### I/D=0, S=1

1	2	3	4	_				<b>Initial display</b>
	1	2	3	4	A			<b>Input new character "A"</b>
		1	2	3	B	A		<b>Input new character "B"</b>
			1	2	C	B		<b>Input new character "C"</b>
				1	D	C		<b>Input new character "D"</b>

### Display ON/OFF

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

D = Display ON/OFF

When D = "1", the display is turned ON. When D = "0", the display is turned OFF. Contents in DDRAM are not changed.

C = Cursor ON/OFF

When C = "1", the cursor is displayed. The cursor is displayed as 5 dots on the 8<sup>th</sup> line of a character. When C = "0", the cursor is OFF.

B = Blinking Cursor

When B = "1", the entire character specified by the cursor blinks at a speed of 409.6ms intervals. When B = "0", the character does not blink, the cursor remains on.

### Cursor/Display Shift

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	S/C	R/L	0	0

S/C	R/L	Shift Function
0	0	Shifts the cursor position to the left (AC is decremented by 1).
0	1	Shifts the cursor position to the right (AC is incremented by 1).
1	0	Shifts the entire display to the left. The cursor follows the display shift.
1	1	Shifts the entire display to the right. The cursor follows the display shift.

When the display is shifted repeatedly, each line moves only horizontally. The second line display does not shift into the first line.

The Address Counter does not change during a Display Shift.

### Function Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	1	0	FT1	FT0

DL = Interface Data Length

When DL = "1", the data is sent or received in 8-bit length via DB7...DB0.

When DL = "0", the data is sent or received in 4-bit length via DB7...DB4. When the 4-bit data length is used, the data must be sent or received in two consecutive writes/reads to combine the data into full 8-bits.

FT1, FT0 = Font Table Selection

FT1	FT0	Font Table
0	0	English / Japanese
0	1	Western European #1
1	0	English / Russian
1	1	Western European #2

**Note:** Changing the font table during operation will immediately change any data currently on the display to the corresponding character on the newly selected font table.

### Set CGRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	ACG5	ACG4	ACG3	ACG2	ACG1	ACG0

This instruction is used to set the CGRAM address into the Address Counter. Data can then be written to or read from the CGRAM locations. See section: “How to use CGRAM”.

ACG5...ACG0 is the binary CGRAM address.

### Set DDRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	ADD6	ADD5	ADD4	ADD3	ADD2	ADD1	ADD0

This instruction is used to set the DDRAM address into the Address Counter. Data can then be written to or read from the DDRAM locations.

ADD6...ADD0 is the binary DDRAM address.

Line 1 = Address 0x00 through 0x0F

Line 2 = Address 0x40 through 0x4F

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

### Read Busy Flag and Address Counter

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

This instruction is used to read the Busy Flag (BF) to indicate if the display controller is performing an internal operation.

The Address Counter is read simultaneously with checking the Busy Flag.

When BF = “1”, the controller is busy and the next instruction will be ignored.

When BF = “0”, the controller is not busy and is ready to accept instructions.

AC6...AC0 is the binary location of either the CGRAM or DDRAM current address.

### Write Data to CGRAM or DDRAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	Write Data							

This instruction is used to write 8-bits of data to the CGRAM or DDRAM at the current address counter. After the write is complete, the address is automatically incremented or decremented by 1 according to the Entry Mode.

### Read Data from CGRAM or DDRAM

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	Read Data							

This instruction is used to read 8-bits of data to the CGRAM or DDRAM at the current address counter. After the read is complete, the address is automatically incremented or decremented by 1 according to the Entry Mode.

The Set CGRAM Address or Set DDRAM Address Instruction must be executed before this instruction can be performed, otherwise the first Read Data will not be valid.

# Built-in Font Tables

English/Japanese (FT[1:0] = 00, default)

Upper 4bit Lower 4bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
LLLH	CG RAM (2)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
LLHL	CG RAM (3)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
LLHH	CG RAM (4)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
LHLL	CG RAM (5)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
LHLH	CG RAM (6)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
LHHL	CG RAM (7)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
LHHH	CG RAM (8)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HLLL	CG RAM (9)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HLLH	CG RAM (10)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HLHL	CG RAM (11)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HLHH	CG RAM (12)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HHLL	CG RAM (13)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HHLH	CG RAM (14)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HHHL	CG RAM (15)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
HHHH	CG RAM (16)	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒

Western European table 1 (FT[1:0] = 01)

Upper 4bit Lower 4bit	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	A	B	C
LLLH	CG RAM (2)		!	2	3	4	5	6	7	8	9	A	B	C	D	E
LLHL	CG RAM (3)		"	4	5	6	7	8	9	A	B	C	D	E	F	G
LLHH	CG RAM (4)		#	5	6	7	8	9	A	B	C	D	E	F	G	H
LHLL	CG RAM (5)		\$	6	7	8	9	A	B	C	D	E	F	G	H	I
LHLH	CG RAM (6)		%	7	8	9	A	B	C	D	E	F	G	H	I	J
LHHL	CG RAM (7)		&	8	9	A	B	C	D	E	F	G	H	I	J	K
LHHH	CG RAM (8)		'	9	A	B	C	D	E	F	G	H	I	J	K	L
HLLL	CG RAM (9)		(	A	B	C	D	E	F	G	H	I	J	K	L	M
HLLH	CG RAM (10)		)	B	C	D	E	F	G	H	I	J	K	L	M	N
HLHL	CG RAM (11)		*	C	D	E	F	G	H	I	J	K	L	M	N	O
HLHH	CG RAM (12)		+	D	E	F	G	H	I	J	K	L	M	N	O	P
HHLL	CG RAM (13)		,	E	F	G	H	I	J	K	L	M	N	O	P	Q
HHLH	CG RAM (14)		-	F	G	H	I	J	K	L	M	N	O	P	Q	R
HHHL	CG RAM (15)		.	G	H	I	J	K	L	M	N	O	P	Q	R	S
HHHH	CG RAM (16)		/	H	I	J	K	L	M	N	O	P	Q	R	S	T

English/Russian (FT[1:0] = 10)

Upper 4bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)	А	В	С	Д	Е	Ж	З	И	Й	К	Л	М	Н	О	П
LLLH	CG RAM (2)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
LLHL	CG RAM (3)	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
LLHH	CG RAM (4)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
LHLL	CG RAM (5)	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
LHLH	CG RAM (6)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
LHHL	CG RAM (7)	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
LHHH	CG RAM (8)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
HLLL	CG RAM (9)	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
HLLH	CG RAM (10)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
HLHL	CG RAM (11)	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
HLHH	CG RAM (12)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
HHLL	CG RAM (13)	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
HHLH	CG RAM (14)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
HHHL	CG RAM (15)	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
HHHH	CG RAM (16)	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о

Western European table 2 (FT[1:0] = 11)

Upper 4bit Lower 4bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)	±	⊗	⊗	P	°	P	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
LLLH	CG RAM (2)	≡	!	1	A	Q	S	9	G	⊗	⊗	⊗	J	+	Y	⊗
LLHL	CG RAM (3)	⊗	"	2	B	R	b	r	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
LLHH	CG RAM (4)	⊗	#	3	C	S	c	s	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
LHLL	CG RAM (5)	⊗	\$	4	D	T	d	t	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
LHLH	CG RAM (6)	⊗	%	5	E	U	e	u	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
LHHL	CG RAM (7)	⊗	&	6	F	V	f	v	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
LHHH	CG RAM (8)	⊗	'	7	G	W	g	w	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HLLL	CG RAM (9)	⊗	()	8	H	⊗	h	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HLLH	CG RAM (10)	⊗	)	9	I	Y	i	y	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HLHL	CG RAM (11)	⊗	*	:	J	Z	j	z	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HLHH	CG RAM (12)	⊗	+	;	K	⊗	k	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HHLL	CG RAM (13)	⊗	,	<	L	⊗	l	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HHLH	CG RAM (14)	⊗	-	=	M	⊗	m	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HHHL	CG RAM (15)	⊗	.	>	N	⊗	n	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
HHHH	CG RAM (16)	⊗	/	?	O	⊗	o	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗

## How to use CGRAM

The Character Generator RAM (CGRAM) is used to generate custom 5x8 character patterns. There are 8 available addresses: CGRAM Address 0x00 through 0x08.

Character Code DDRAM address on Font Table used to write CGRAM character to display	CGRAM Address						Character Patterns (CGRAM data)								Character Patterns (CGRAM data)
	5	4	3	2	1	0	7	6	5	4	3	2	1	0	
0x00	0	0	0	0	0	0	-	-	-	1	1	1	1	0	Character pattern #0
				0	0	1	-	-	-	1	0	0	0	1	
				0	1	0	-	-	-	1	0	0	0	1	
				0	1	1	-	-	-	1	1	1	1	0	
				1	0	0	-	-	-	1	0	1	0	0	
				1	0	1	-	-	-	1	0	0	1	0	
				1	1	0	-	-	-	1	0	0	0	1	
				1	1	1	-	-	-	0	0	0	0	0	Cursor position
0x01	0	0	1	0	0	0	-	-	-	1	0	0	0	1	Character pattern #1
				0	0	1	-	-	-	0	1	0	1	0	
				0	1	0	-	-	-	1	1	1	1	1	
				0	1	1	-	-	-	0	0	1	0	0	
				1	0	0	-	-	-	1	1	1	1	1	
				1	0	1	-	-	-	0	0	1	0	0	
				1	1	0	-	-	-	0	0	1	0	0	
				1	1	1	-	-	-	0	0	0	0	0	Cursor position
0x02..0x06	.	.	.	.	.	.	-	-	-	.	.	.	.	.	
	.	.	.	.	.	.	-	-	-	.	.	.	.	.	
	.	.	.	.	.	.	-	-	-	.	.	.	.	.	
	.	.	.	.	.	.	-	-	-	.	.	.	.	.	
	.	.	.	.	.	.	-	-	-	.	.	.	.	.	
0x07	1	1	1	0	0	0	-	-	-	0	0	0	0	0	Character pattern #7
				0	0	1	-	-	-	0	1	0	1	0	
				0	1	0	-	-	-	0	0	0	0	0	
				0	1	1	-	-	-	0	0	0	0	0	
				1	0	0	-	-	-	1	0	0	0	1	
				1	0	1	-	-	-	0	1	1	1	0	
				1	1	0	-	-	-	0	0	1	0	0	
				1	1	1	-	-	-	0	0	0	0	0	Cursor position

Notes:

“-“ = Not used

The cursor line position can be used, it will be displayed as a logic-OR if the cursor is turned ON.

CGRAM is stored in positions 0x00 through 0x07 of the font table. Therefore, to write the first CGRAM character to the display, you would move the cursor to the desired DDRAM location on the display and write character data 0x00.



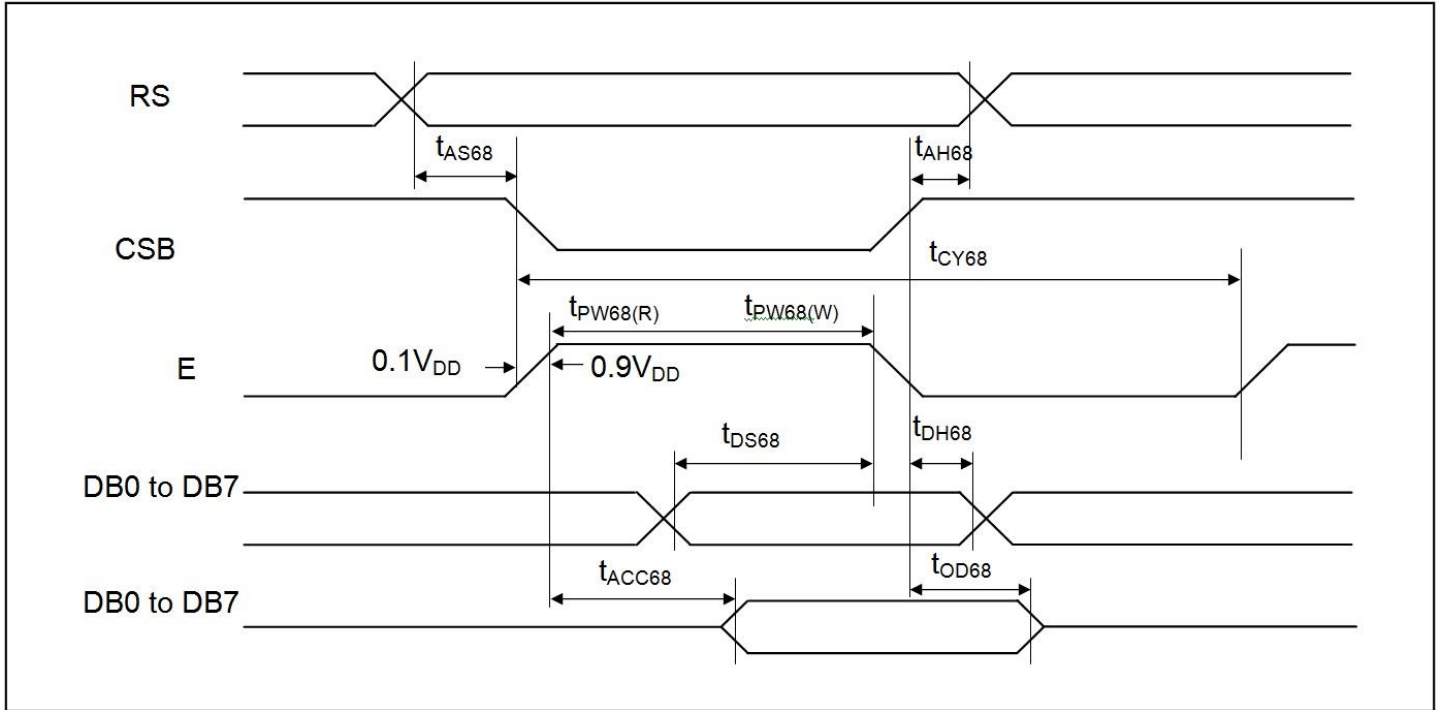
## Timing Characteristics

### MPU Interface

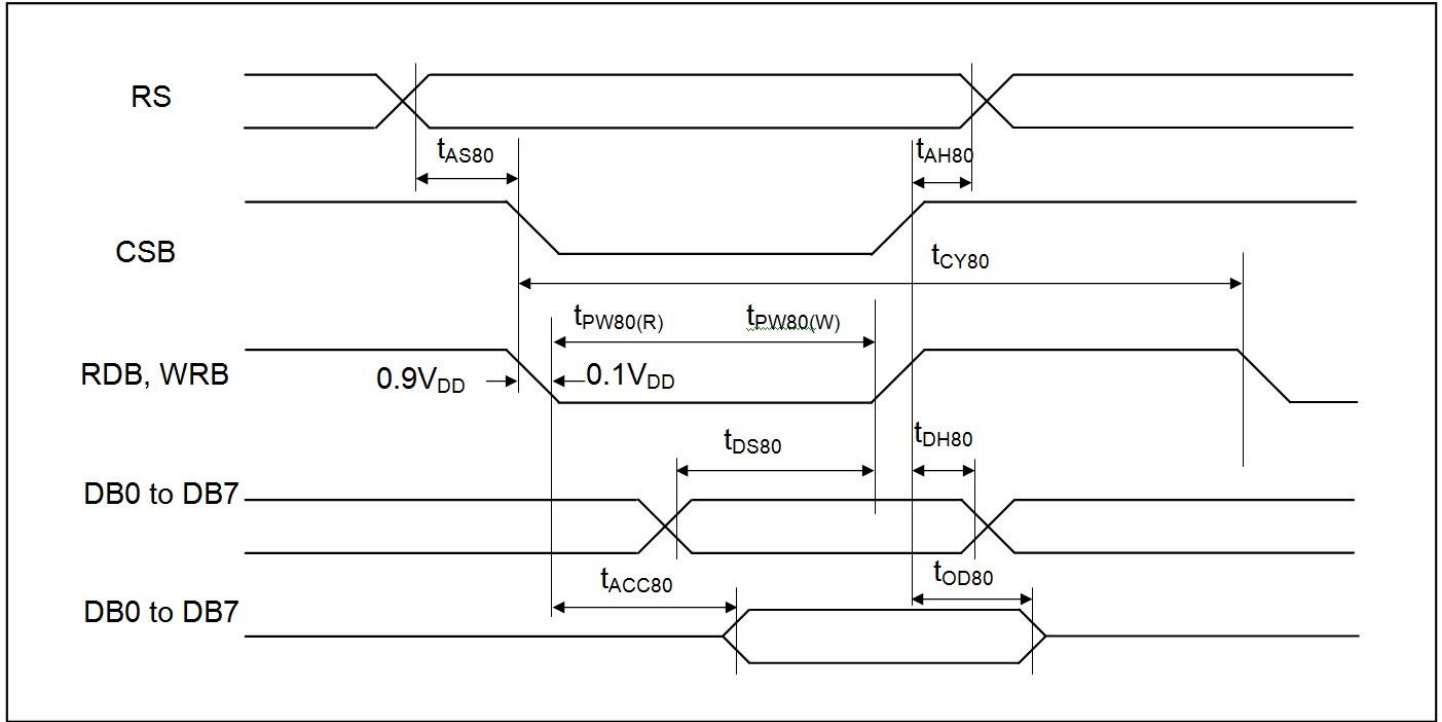
When DL is set for 8-bit mode, the display interfaces with the MPU with DB7...DB0 (DB7 is the MSB).

When DL is set for 4-bit mode, the display interfaces with the MPU with only DB7...DB4 (DB7 is the MSB). Each instruction must be sent in two operations, the 4 high-order bits first, followed by the 4 low-order bits. The Busy Flag must be checked after completion of the entire 8-bit instruction.

### 6800-MPU Parallel Interface (default)



Item	Signal	Symbol	Min.	Typ.	Max.	Unit	Note
Address setup time	RS	$t_{AS68}$	20	-	-	ns	
Address hold time	RS	$t_{AH68}$	0	-	-	ns	
System cycle time		$t_{CY68}$	500	-	-	ns	
Pulse width (write)	E	$t_{PW68(W)}$	250	-	-	ns	
Pulse width (read)	E	$t_{PW68(R)}$	250	-	-	ns	
Data setup time	DB7...DB0	$t_{DS68}$	40	-	-	ns	
Data hold time	DB7...DB0	$t_{DH68}$	20	-	-	ns	
Read access time	DB7...DB0	$t_{ACC68}$	-	-	180	ns	CL=100pF
Output disable time	DB7...DB0	$t_{OD68}$	10	-	-	ns	

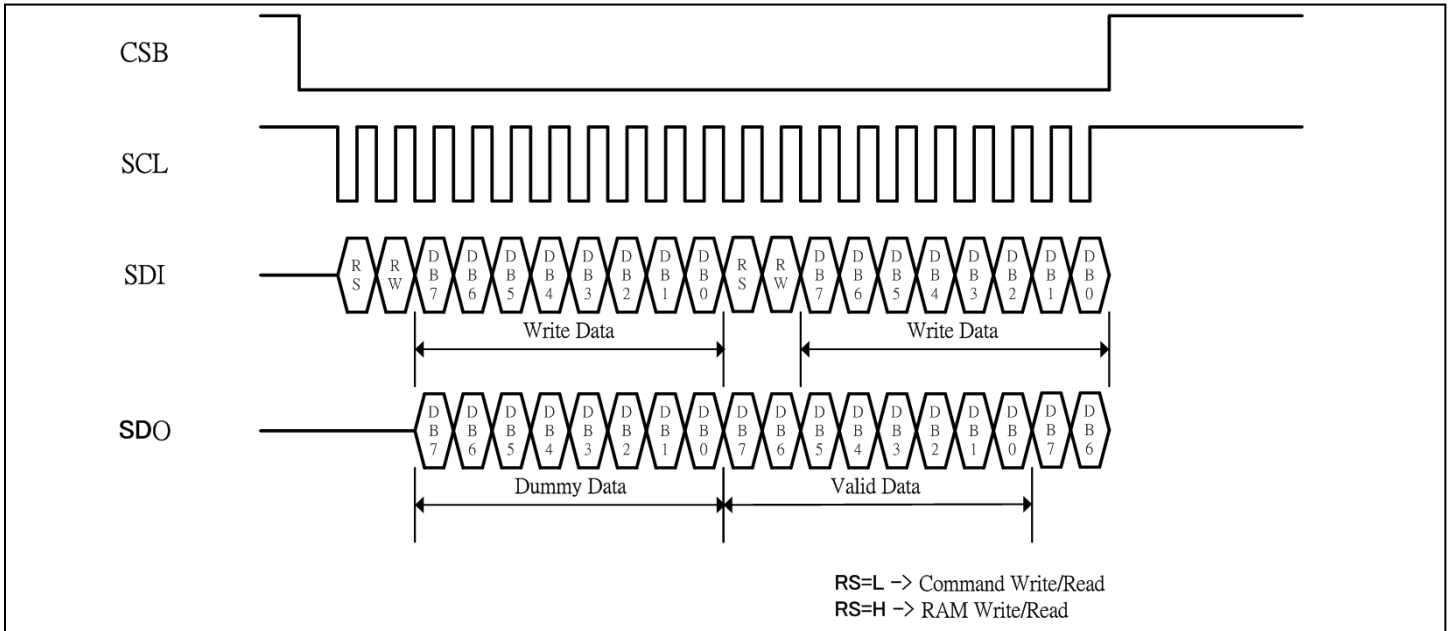
**8080-MPU Parallel Interface**


Item	Signal	Symbol	Min.	Typ.	Max.	Unit	Note
Address setup time	RS	$t_{AS80}$	20	-	-	ns	
Address hold time	RS	$t_{AH80}$	0	-	-	ns	
System cycle time		$t_{CY80}$	500	-	-	ns	
Pulse width (write)	/WR	$t_{PW80(W)}$	250	-	-	ns	
Pulse width (read)	/RD	$t_{PW80(R)}$	250	-	-	ns	
Data setup time	DB7...DB0	$t_{DS80}$	40	-	-	ns	
Data hold time	DB7...DB0	$t_{DH80}$	20	-	-	ns	
Read access time	DB7...DB0	$t_{ACC80}$	-	-	180	ns	CL=100pF
Output disable time	DB7...DB0	$t_{OD80}$	10	-	-	ns	

### Serial Interface

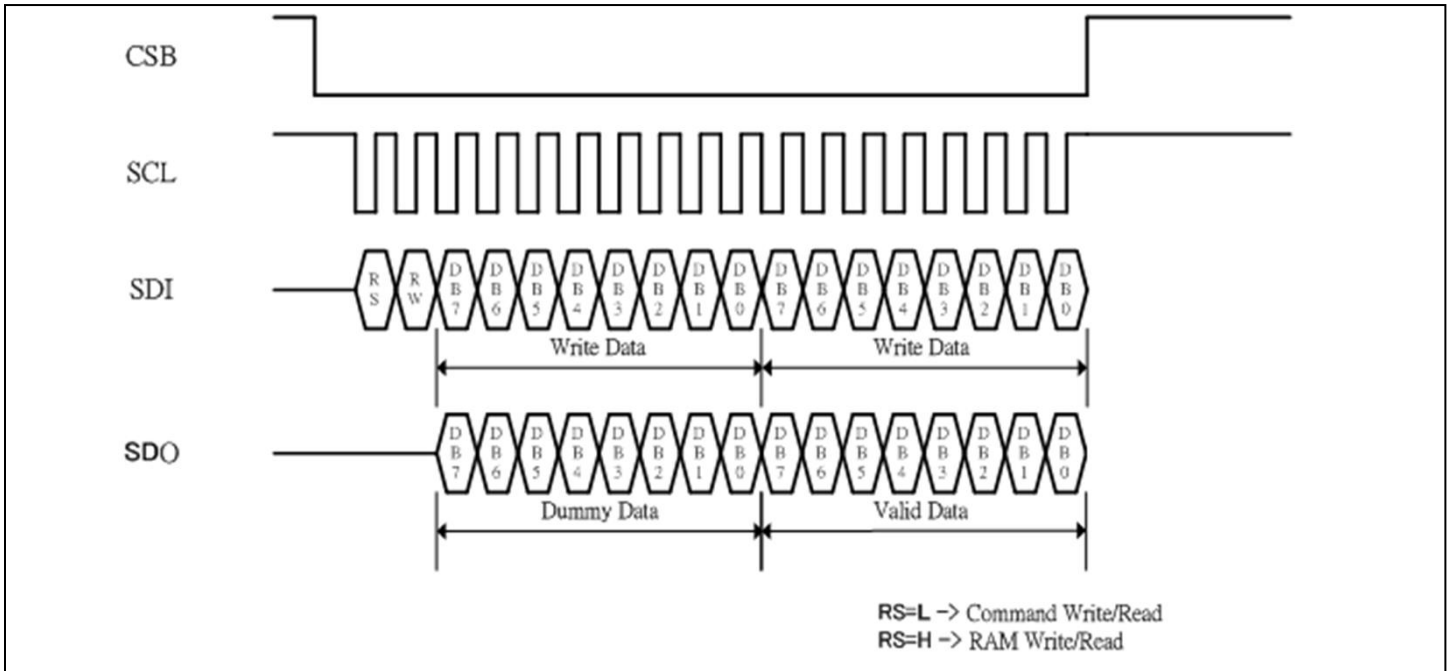
In serial interface mode, instructions and data are both sent on the SDI line and clocked in with the SCL line. /CS must go LOW before transmission, and must go HIGH when switching between writing instructions and writing data. The data on SDI is clocked into the LCD controller on the rising edge of SCL in the following format:

#### Instruction transmission:

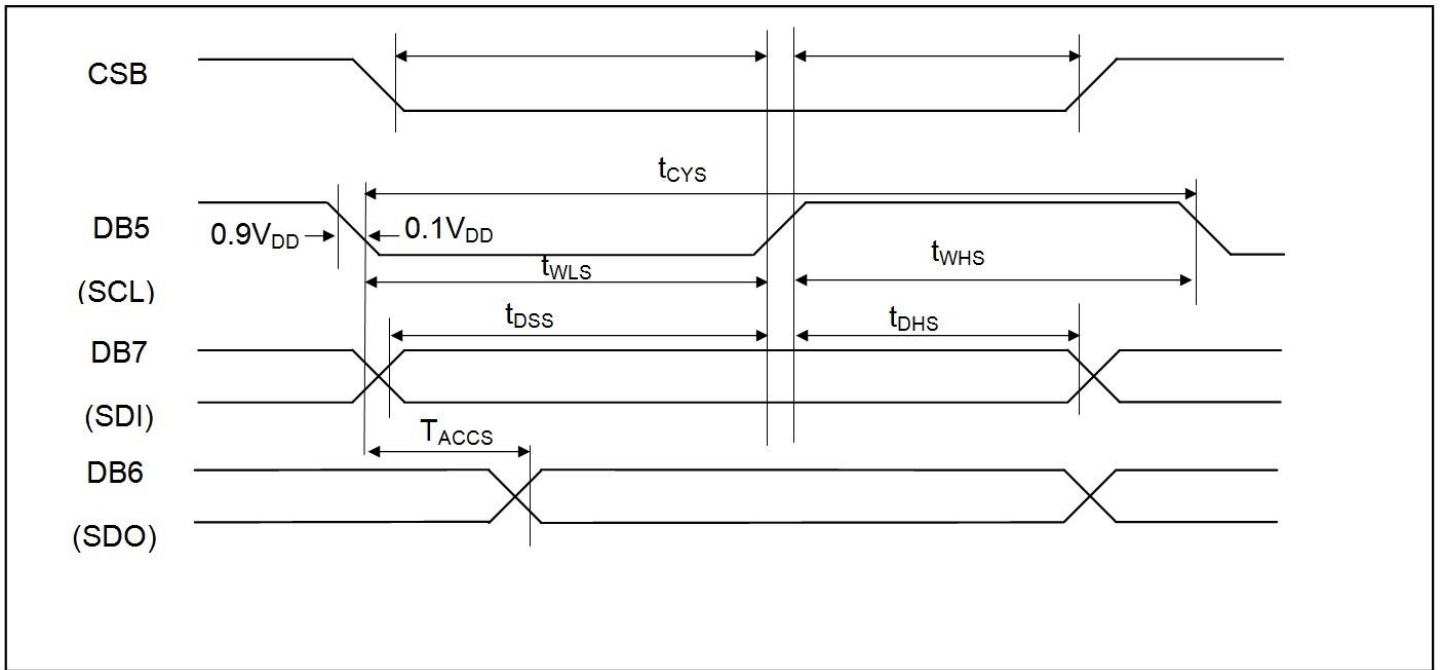


\*Note: RS and RW should be used between each instruction.

#### Data transmission:



\*Note: RS and RW only need to be set at the start of continuous data transmission.



Item	Signal	Symbol	Min.	Typ.	Max.	Unit	Note
Serial clock cycle	DB5 (SCL)	$t_{CYS}$	300	-	-	ns	
SCL high pulse width	DB5 (SCL)	$t_{WHS}$	100	-	-	ns	
SCL low pulse width	DB5 (SCL)	$t_{WLS}$	100	-	-	ns	
CSB setup time	CSB	$t_{CSS}$	150	-	-	ns	
CSB hold time	CSB	$t_{CHS}$	150	-	-	ns	
Data setup time	DB7 (SDI)	$t_{DSS}$	100	-	-	ns	
Data hold time	DB7 (SDI)	$t_{DHS}$	100	-	-	ns	
Read access time	DB6 (SDO)	$t_{ACCS}$	-	-	80	ns	

# Initialization Sequence

## 8-bit mode:

Power ON									
Wait for power stabilization: $\geq 1\text{ms}$									
Function Set:									
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	1	0	X	X
Check BUSY flag									
Display OFF:									
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	0	X	X
Check BUSY flag									
Display Clear:									
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1
Check BUSY flag									
Entry Mode Set:									
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	1	0
Check BUSY flag									
Home Command:									
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	0
Check BUSY flag									
Display ON:									
RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	1	X	X
Initialization End									

**4-bit mode:**

Power ON

 Wait for power stabilization:  $\geq 1\text{ms}$ 

Function Set:

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	0
0	0	0	0	1	0
0	0	1	0	X	X

Check BUSY flag

Display OFF:

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	0	0
0	0	1	0	X	X

Check BUSY flag

Display Clear:

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	0	0
0	0	0	0	0	1

Check BUSY flag

Entry Mode Set:

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	0	0
0	0	0	1	1	0

Check BUSY flag

Home Command:

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	0	0
0	0	0	0	1	0

Check BUSY flag

Display ON:

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	0	0
0	0	1	1	X	X

Initialization End

## Quality Information

Test Item	Content of Test	Test Condition	Note
High Temperature storage	Test the endurance of the display at high storage temperature.	+85°C , 240hrs	2
Low Temperature storage	Test the endurance of the display at low storage temperature.	-40°C , 240hrs	1,2
High Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at high temperature.	+80°C 240hrs	2
Low Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at low temperature.	-40°C , 240hrs	1,2
High Temperature / Humidity Storage	Test the endurance of the display by applying electric stress (voltage & current) at high temperature with high humidity.	+60°C , 90% RH , 240hrs	1,2
Thermal Shock resistance	Test the endurance of the display by applying electric stress (voltage & current) during a cycle of low and high temperatures.	-40°C,30min -> 25°C,5min -> 80°C,30min = 1 cycle 30 cycles	
Vibration test	Test the endurance of the display by applying vibration to simulate transportation and use.	10-55Hz, 1.5mm amplitude. 30min in each of 3 directions X,Y,Z	3
Static electricity test	Test the endurance of the display by applying electric static discharge.	Air: ±4kV, 10 Times	

**Note 1:** No condensation to be observed.

**Note 2:** Conducted after 2 hours of storage at 25°C, 0%RH.

**Note 3:** Test performed on product itself, not inside a container.

**Evaluation Criteria:**

- 1: Display is fully functional during operational tests and after all tests, at room temperature.
- 2: No observable defects.
- 3: Luminance >50% of initial value.
- 4: Current consumption within 50% of initial value