Part Numbering ~ LCD ~ Glass Only (without drivers)

				Ⓐ				Ⓑ					Ⓒ	Ⓓ	Ⓔ	Ⓕ
L	C	D	-	S	4	0	1	C	4	0			T	F	-	1
LIQUID	CRYSTAL	DISPLAY		OPERATING	TEMPERATURE			MODEL	NUMBER				FLUID TYPE	POLARIZER	DISPLAY MODE	VIEWING DIR

Ⓐ= OPERATING TEMPERATURE

S = Standard (0° TO 50° C)
H = High Temp (-30° to 75° C)
UH = Ultra High Temp (-40° to 85° C)

Ⓑ= MODEL NUMBER

FOR: ALPHANUMERIC AND NUMERIC
A = Alphanumeric <1.0”
B = Alphanumeric ≥1.0”
C = Numeric <1.0”
D = Numeric ≥1.0”
M = Custom Display <1.0”
N = Custom Display ≥1.0”
401C40 = 4 Character x 1 line, 0.40”
4x1C45 = 4.5 Character x 1 line, 0.45”
x - represents 1/2 column
101D23 = 1 Character x 1 Line, 2.3”
101D40 = 1 Character x 1 Line, 4.0”

FOR: MATRIX AND GRAPHIC MODEL
01602D = 16 Characters x 2 Lines, Dot Matrix
12864G = 128 Columns x 64 Rows, Graphics

Ⓒ= FLUID TYPE

T = Twisted Nematic (TN)
S = Super Twisted Nematic (STN)

Ⓓ= POLARIZER MODE

R = Reflective
F = Transflective
M = Transmissive

*** ADDITIONAL PART NUMBERING SEQUENCE FOR NON DEFAULT SETTING***

Ⓔ= DISPLAY MODE

Default = Positive image (no letter), or if more Description follows, use “-”
N = Negative image

Ⓕ= VIEWING DIRECTION

DEFAULT = 6 O’CLOCK (NO NUMBER)
1 = 12 O’CLOCK

Part Numbering ~ LCM ~ Character and LCD Modules ~ Graphic

				Ⓐ				Ⓑ			Ⓒ	Ⓓ	Ⓔ	Ⓕ	Ⓖ
L	C	M	-	S	0	1	6	0	2		D	T	F	-	1
LIQUID	CRYSTAL	MODULE		OPERATING	TEMPERATURE	MODEL	NUMBER				DISPLAY TYPE	FLUID TYPE	POLARIZER	DISPLAY MODE	VIEWING DIR

Ⓐ= OPERATING TEMPERATURE

S = Standard (0° to 50° C)
H = High Temp (-20° to 70° C)

Ⓑ= MODEL NUMBER

FOR: DOT MATRIX AND GRAPHIC MODEL
01602 = 16 Character x 2 Lines
12864 = 128 Columns x 64 Rows

FOR: ALPHANUMERIC AND NUMERIC
401C40 = 4 Character x 1 line, 0.40”
4x1C45 = 4.5 Character x 1 line, 0.45”
x - represents 1/2 column

Ⓒ= DISPLAY TYPE

D = Dot Matrix
G = Graphic
M = Custom

Ⓓ= FLUID TYPE

T = Twisted Nematic (TN)
S = Super Twisted Nematic (STN)
W = Film Compensated (FSTN)

Ⓔ= POLARIZER MODE

R = Reflective
F = Transflective
M = Transmissive

*** ADDITIONAL PART NUMBERING SEQUENCE FOR NON DEFAULT SETTING***

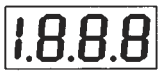
Ⓕ= DISPLAY MODE

Default = Positive Image (NO Letter), or if more Description follows use “-”
N = Negative Image

Ⓖ= VIEWING DIRECTION

DEFAULT = 6 O’CLOCK (NO NUMBER)
1 = 12 O’CLOCK

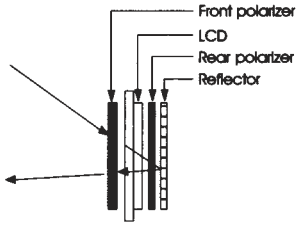
Types of Display

Positive Type 

Negative Type 

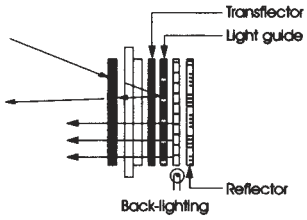
Lighting Methods

(1) Reflective Mode



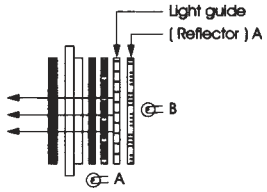
* It is necessary to use type under ambient light condition.

(2) Transflective Mode



* Ambient light is taken from the outside during day or in the dark and a back light is used in the dark.

(3) Transmissive Mode



Back-lighting only. In case of B, no reflector is used.

*A back light is always used.

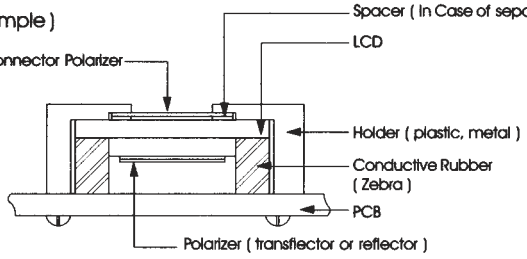
Connector and LCD Mounting Method

To connect LCD to the drive circuit, following connectors are available.

Rubber Connector

LCD Mounting Method (example)

Structure:
Alternate Lamination of conductive rubber and insulting rubber.
Connecting Method :
Mechanical compression.
Pitch (mm) :
Min 0.4

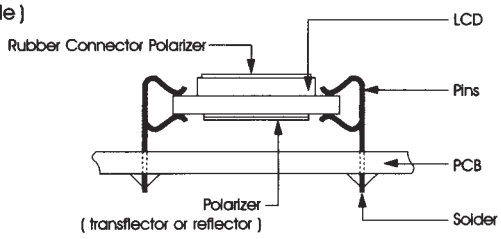


- Easy to assemble.
- Adopted for many year.
- Applicable even to narrow pads.
- Printed circuit boards need gold plating or graphite coating.

Pin Connector

LCD Mounting Method (example)

Structure:
Metal pins fit onto the panel terminal pads.
Connecting Method :
Soldering.
Pitch (mm) :
1.5, 1.8, 2.0, 2.54



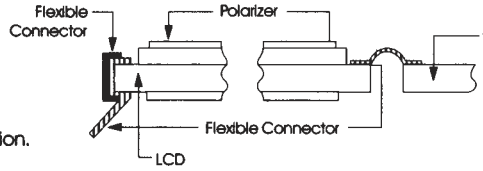
- Suitable for small production runs.

Flexible Connector

LCD Mounting Method (example)

* Resin on connecting point.

Structure:
Film with electroconductive thin film or printed graphite.
Connecting Method :
Heat and pressure fitting, Soldering or mechanical compression.
Pitch (mm) :
Anisotropic Type : Min 1.25



- A thin structure can be achieved.
- Possible to bend.
- Free trimming possible.

LCD Panels ~ Custom Design Guidelines

Reliability Test

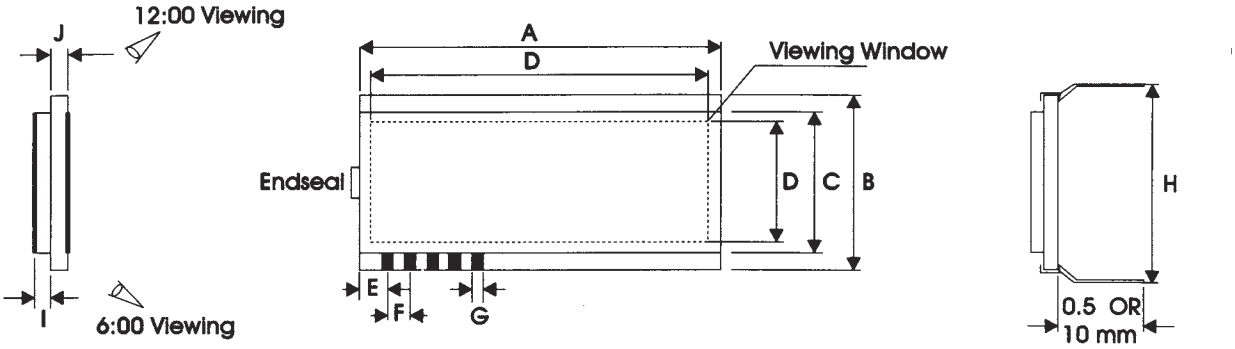
Item	Temperature		Test Condition	Judgement
Storage temperature upper spec. limit lower spec. limit	Special 100°C -40°C	Normal 70°C -10°C		
Operation temperature upper spec. limit lower spec. limit	85°C -40°C	50°C 0°C		
Low temperature / test			Lower spec. limit of storage temp. for 4hr	LCD can be used normally
High temperature / test High temp & humidity			Upper spec. limit of operation temp. 60~65°C, 90~95% RH 240HR	LCD can be used normally LCD can be used normally after test
Temperature Cycling Test	100°C -40°C	70°C -10°C	LSL of storage temp. for 30 min 1°C/1 min increase to USL of storage temp. for 30 min 1°C/ 1 min decrease to LSL of storage temp. for 30 min 5 cycle	LCD can be used normally after test
Thermal shock upper spec. limit lower spec. limit	100°C -40°C	70°C -10°C	LSL of storage temp. for 30 min USL of storage temp. within 10s USL of storage temp. for 30 min Reach LSL of storage temp. within 10s 5 cycle	LCD can be used normally after test

Typical Operating Characteristics

Classification of specification: Drive Duty / Temp. Grade				Static		1/2 Duty		1/3 Duty		1/4 Duty	1/8 Duty	1/16 Duty	1/32 Duty	1/64 Duty	1/80 Duty
				Commercial	High Temp.	Commercial	High Temp.	Commercial	High Temp.	Commercial	Commercial	Commercial	Commercial	Commercial	Commercial
Operating Voltage			Vop	3.0	5.0	3.0	5.0	3.0	5.0	3.0	4.5	5.0	8.0	10.0	13.0
Operating Frequency			Hz	32-100	32-100	32-100	32-100	32-100	32-100	32-100	32-100	32-100	32-100	32-100	32-100
Power Consumption			nA/mm²	5	10	5	10	5	10	5	5	5	5	5	5
Capacitance			PF/mm²	18	18	18	18	18	18	18	18	18	18	18	18
Response Time	Turn on Time	0°C	ms	300	150	300	150	300	150	300	300	300	300	300	300
		25°C	ms	100	50	100	50	100	50	100	100	100	100	100	100
	Turn off Time	0°C	ms	350	200	350	200	350	200	350	350	350	350	350	350
		25°C	ms	150	100	150	100	150	100	150	150	150	150	150	150
Viewing Angle	Vertical		degree	+15 -30	+15 -30	+15 -30	+15 -30	+15 -30	+15 -30	+15 -30	+10 -30	+0 -30	+0 -30	+0 -30	+0 -30
	Horizontal		degree	±45	±45	±45	±45	±45	±45	±45	±45	±45	±45	±45	±45
Operating Temp.			°C	-5~60	-20~80	-5~60	-20~80	-5~60	-20~80	-5~60	-5~50	-0~50	-5~50	-5~50	-0~50
Storage Temp.			°C	-20~80	-40~85	-20~80	-40~85	-20~80	-40~85	-20~80	-20~80	-20~80	-20~80	-20~80	-20~80
Contrast Ratio				20:1	20:1	20:1	20:1	20:1	20:1	20:1	20:1	10:1	10:1	10:1	10:1

Note: Data shown above can be tailored to customer specification.

Custom Display Guidelines



DESCRIPTION	DIMENSION	DESIGN PARAMETER
A. Overall glass length		Optimum length 6.8", 4.5", 3.4", 2.7", 2.25", 1.94" ...
B. Overall glass width		Optimum width 3.3", 2.2", 1.65", 1.1" ...
C. Back plane glass width (smaller glass plate)		When determining back plane glass dimension, always allow a minimum of 0.10" on each side of the contact ledge for a pin type display and 0.075" or more for elastomeric configuration.
D. Viewing window	Height	Viewing window should be located a minimum of 0.05" away from the image area and 0.10" inside of the back plane glass.
	Width	
E. Glass edge to centre of 1st contact pad		Avoid placing contact pad at glass corners.
F. Pitch of contacts		0.10" for standard pin package.
G. Contact pad width		Pad width should approximately equal pad spacing.
I. Back glass thickness		
J. Front glass thickness		

OPERATIONAL SPECIFICATIONS

1. Viewing angle:	Most common viewing angle is 6 o'clock position. Viewing angle is determined by the direction of the line of sight to the display. The viewing angle is the angle at which maximum contrast is achieved. Keep in mind that maximum contrast is normally achieved off angle but not at the perpendicular axis of the display.				
2. Operating temp:	°C to °C				
3. Storage temp:	°C to °C				
4. Drive method:	Static / Mux.				
5. Drive voltage:					
6. Number of:	A) digit	B) 14 or 16 Alphanumeric	C) Dot matrix char	D) Dot matrix graphic	E) Others (symbols)
7. Viewing mode:	Reflective / transflective / Transmissive				

LCD General Information

LCD Modules — TN type ~ Twisted Nematic

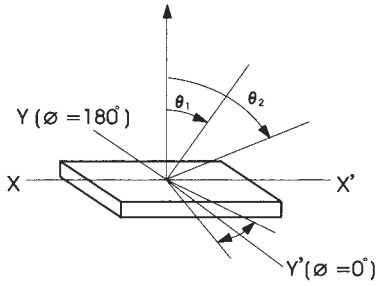
Item	Symbol	Min.	Typ.	Max.	Unit	Condition	Note
Viewing Angle	$\frac{\theta_2 - \theta_1}{\varnothing}$	40	–	–	deg.	Cr = 2.0	1 , 2
Contrast Ratio	Cr	–	4	–	–	θ = 20° $\varnothing$ = 0°	3
Response Time (rise)	Tr	–	110	–	ms	θ = 20° $\varnothing$ = 0°	4
Response Time (fall)	Tf	–	110	–	ms	θ = 20° $\varnothing$ = 0°	4

STN type ~ Super Twisted Nematic

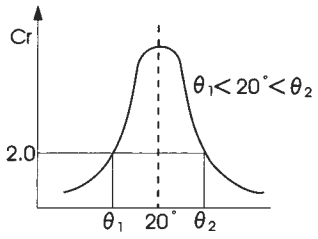
Item	Symbol	Min.	Typ.	Max.	Unit	Condition	Note
Viewing Angle	$\frac{\theta_2 - \theta_1}{\varnothing}$	70 -90	–	+90	deg.	Cr = 2.0	1 , 2
Contrast Ratio	Cr	–	4	–	–	θ = 20° $\varnothing$ = 0°	3
Response Time (rise)	Tr	–	110	–	ms	θ = 20° $\varnothing$ = 0°	4
Response Time (fall)	Tf	–	110	–	ms	θ = 20° $\varnothing$ = 0°	4

Definitions

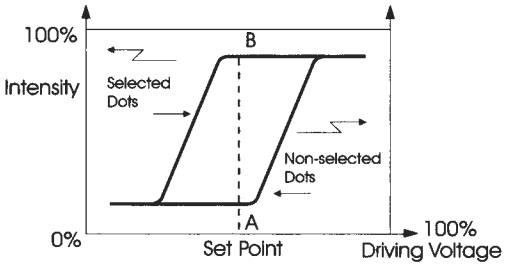
1 - Definition of angle θ & $\varnothing$



2 - Definition of viewing angle θ_1 & $\varnothing_2$

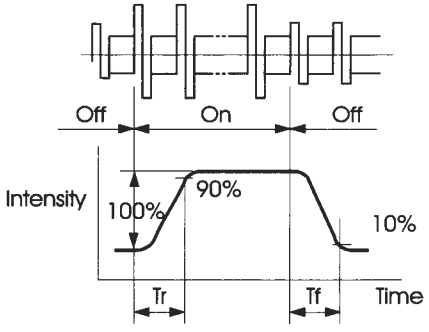


3 - Definition of contrast Cr



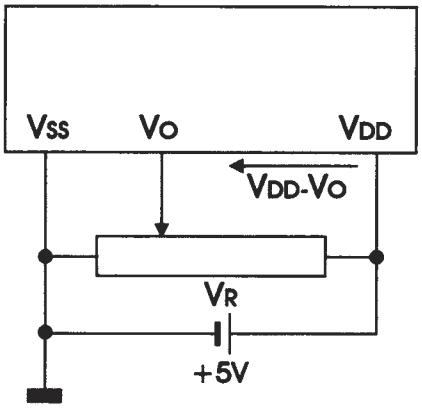
$Cr=(A/B)^P$ Negative : P= -1
Positive : P=+1

4 - Definition of Optical Response



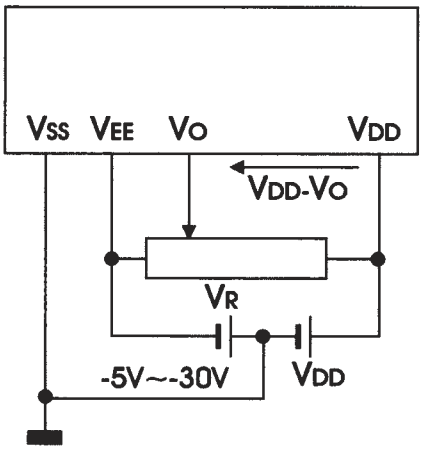
LCD Modules ~ Power Supply Schematics

Single Source



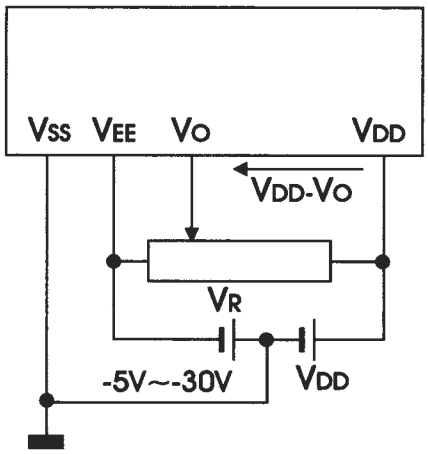
VDD-VO : LCD DRIVING VOLTAGE
VR : 10k-20k

Double Source



VDD-VO : LCD DRIVING VOLTAGE
VR : 10k-20k

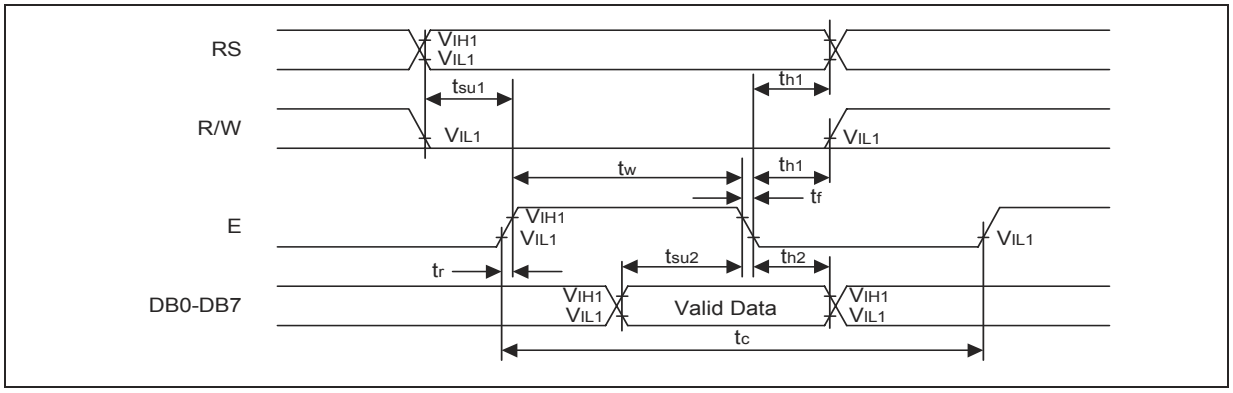
Negative Power Supply Included



VDD-VO : LCD DRIVING VOLTAGE
VR : 10k-20k

LCD Modules ~ Timing Characteristics

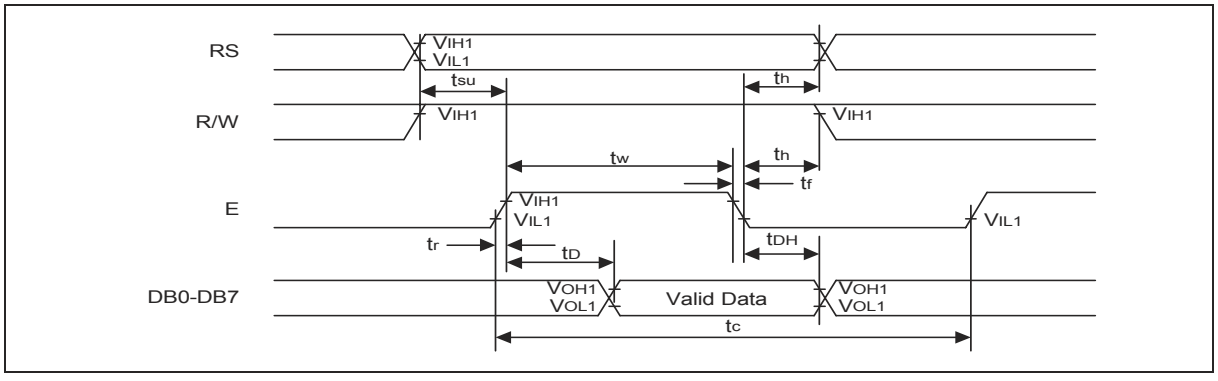
Writing Data from MPU to Controller



(V_{DD} = 4.5 to 5.5V, Ta = -30 to +85° C)

Mode	Characteristics	Symbol	Min	Typ	Max	Unit
Write Mode	E Cycle Time	tc	500	-	-	ns
	E Rise / Fall Time	t_R, t_F	-	-	20	
	E Pulse Width (High, Low)	tw	230	-	-	
	R/W and RS Setup Time	tsu1	40	-	-	
	R/W and RS Hold Time	t_{H1}	10	-	-	
	Data Setup Time	tsu2	80	-	-	
	Data Hold Time	t_{H2}	10	-	-	

Reading Out Data from MPU to Controller



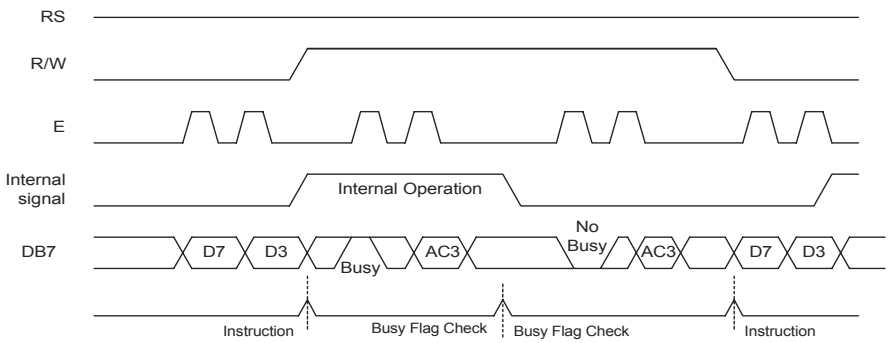
(V_{DD} = 4.5 to 5.5V, Ta = -30 to +85° C)

Mode	Characteristics	Symbol	Min	Typ	Max	Unit
Read Mode	E Cycle Time	tc	500	-	-	ns
	E Rise / Fall Time	t_R, t_F	-	-	20	
	E Pulse Width (High, Low)	tw	230	-	-	
	R/W and RS Setup Time	tsu	40	-	-	
	R/W and RS Hold Time	t_H	10	-	-	
	Data Output Delay Time	tD	-	-	120	
	Data Hold Time	tDH	5	-	-	

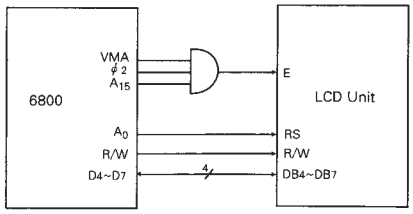
LCD Modules ~ MPU Interface

Interface to 4-Bit MPU

When interfacing data length is 4-bit, only 4 ports, from DB4 to DB7, are used as data bus. At first higher 4-bit (in case of 8-bit bus mode, the contents of DB4 - DB7) are transferred, and then lower 4-bit (in case of 8-bit bus mode, the contents of DB0 - DB3) are transferred. So transfer is performed by two times. Busy Flag outputs “High” after the second transfer are ended.

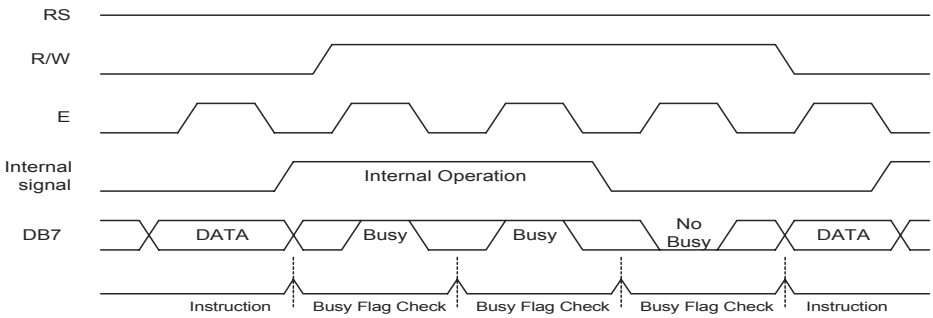


Connection to 6800

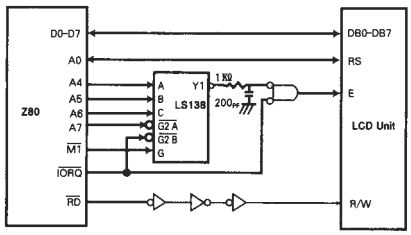


Interface to 8-Bit MPU

When interfacing data length is 8-bit, transfer is performed at a time through 8 ports, from DB0 to DB7.



Connection to Z80



LCD Modules ~ Initialization Instructions — 4 and 8 Bit Interface

8- Bit Interface

Power On

Wait for more than 30ms after V_{DD} rises to 4.5 V.
Wait for more than 40ms after V_{DD} rises to 2.7 V.

Function Set

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

Wait for more than 39μs

Display ON/OFF Control

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

Wait for more than 39μs

Display Clear

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

Wait for more than 1.53ms

Entry Mode Set

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

Initialization End

4- Bit Interface

Power On

Wait for more than 30ms after V_{DD} rises to 4.5 V.
Wait for more than 40ms after V_{DD} rises to 2.7 V.

Function Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	X	X	X	X
0	0	0	0	1	0	X	X	X	X
0	0	N	F	X	X	X	X	X	X

Wait for more than 39μs

Display ON/OFF Control

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

Wait for more than 39μs

Display Clear

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

Wait for more than 1.53ms

Entry Mode Set

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

Initialization End

D/L	0	4-bit mode
	1	8-bit mode

D	0	Display off
	1	Display on

I/D	0	Decrement mode
	1	Increment mode

N	0	1-line mode
	1	2-line mode

C	0	Cursor off
	1	Cursor on

SH	0	Entire shift off
	1	Entire shift on

F	0	Display off
	1	Display on

B	0	Blink off
	1	Blink on

LCD Modules ~ Initialization Instructions — Instruction Codes

Instruction	Instruction Code										Description Instruction Code	Execution time (fsoc=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 "20H" to DDRAM. and set DDRAM address to "00H" from AC.	1.53ms
Return Home	0	0	0	0	0	0	0	0	1	X	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	1	I/D	SH	Assign cursor moving direction and make shift of entire display enable.	39μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Set display(D), cursor(C), and blinking of cursor(B) on/off control bit.	39μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	X	X	Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	39μs
Function Set	0	0	0	0	1	DL	N	F	X	X	Set interface data length (DL : 4-bit/8-bit), numbers of display line (N : 1-line/2-line), display font type(F : 5 X 8 dots/ 5 X 11 dots)	39μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	39μs
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.	0μs
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43μs

NOTE: When an MPU program with checking the Busy Flag (DB7) is made, it must be necessary 1/2 fosc is necessary for executing the next instruction by the falling edge of the 'E' signal after the Busy Flag (DB7) goes to "LOW".

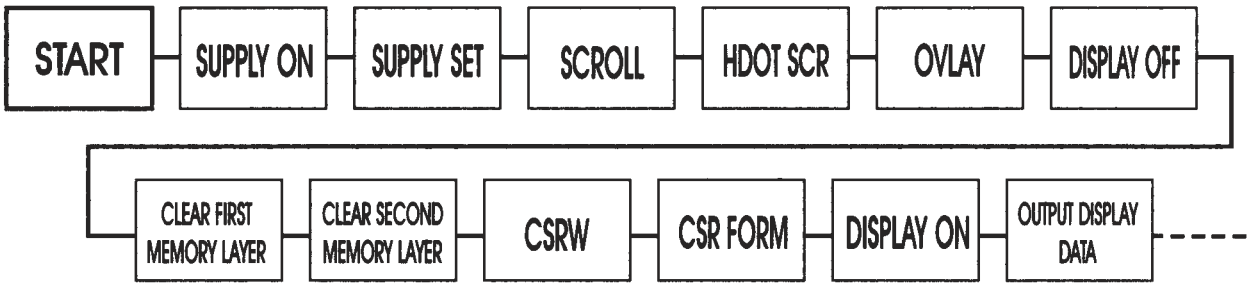
LCD Modules ~ Codes and Patterns

Higher 4 Bits / Lower 4 Bits	0000 (NOTE 1)	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110 (NOTE 1)	1111 (NOTE 1)	0001 (NOTE 2)
XXXX 0000	CG RAM (1)													
XXXX 0001	(2)													
XXXX 0010	(3)													
XXXX 0011	(4)													
XXXX 0100	(5)													
XXXX 0101	(6)													
XXXX 0110	(7)													
XXXX 0111	(8)													
XXXX 1000	(1)													
XXXX 1001	(2)													
XXXX 1010	(3)													
XXXX 1011	(4)													
XXXX1100	(5)													
XXXX 1101	(6)													
XXXX 1110	(7)													
XXXX 1111	(8)													

* NOTE 1 : FOR CHARACTER TYPE ONLY
* NOTE 2 : FOR GRAPHIC TYPE ONLY

Initialization Example

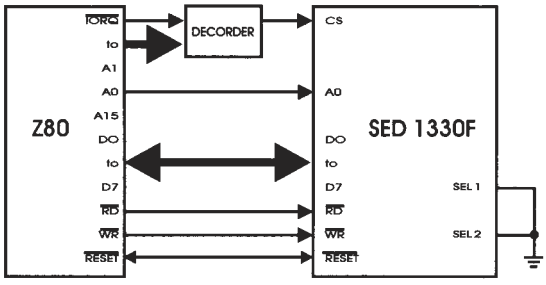
The Initialization example shown in figure is for a SED 1330F with an 8-bit microprocessor interface bus an Epson EG 4810-AR Display Unit(512x128 Pixels)



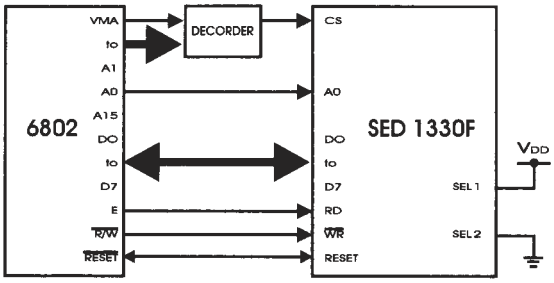
INITIALIZATION PROCEDURE

Interface to MPU

Z80 TO SED 1330F INTERFACE



6802 TO SED 1330F INTERFACE



Class		CODE												Command Description	Number of Read Bytes
		RD	WR	AO	D7	D6	D5	D4	D3	D2	D1	D0	Hex		
System Control	SYSTEM SET	1	0	1	0	1	0	0	0	0	0	0	40	Initialize device and display	8
	SLEEP IN	1	0	1	0	1	0	1	0	0	1	1	53	Enter standby mode	0
Display Control	DISPLAY ON/OFF	1	0	1	0	1	0	1	1	0	0	D	58 59	Enable and disable display and display flashing(D=0:Display OFF, D=1: Display ON)	1
	SCROLL	1	0	1	0	1	0	0	0	1	0	0	44	Set display start address and display regions	10
	CSRFORM	1	0	1	0	1	0	1	1	1	0	1	5D	Set cursor type	2
	CGRAM ADR	1	0	1	0	1	0	1	1	1	0	0	5C	Set start address of character generator RAM	2
	CSRDIR	1	0	1	0	1	0	0	1	1	C2	C1	4C to 4F	Set direction of cursor movement C C2 C1 Shift Direction 4CH 0 0 Right 4DH 0 1 Left 4EH 1 0 Up 4FH 1 1 Down	0
	HDOT SCR	1	0	1	0	1	0	1	1	0	1	0	5A	Set horizontal scroll position	1
	OVLAY	1	0	1	0	1	0	1	1	0	1	1	5B	Set display overlay format	1
Drawing Control	CSRW	1	0	1	0	1	0	0	0	1	1	0	46	Set cursor address	2
	CSRR	1	0	1	0	1	0	0	0	1	1	1	47	Read cursor address	2
Memory Control	MWRITE	1	0	1	0	1	0	0	0	0	1	0	42	Write to display memory	-
	MREAD	1	0	1	0	1	0	0	0	0	1	1	43	Read from display memory	-

[Notes]

1. In general, the internal registers of the SED1330F are modified as each command parameter is input.
   However, the microprocessor does not have to set all the parameters of a command and may send a new command before all parameters have been input.
   The internal registers for the parameters that have been input will have been changed but the remaining parameter registers are unchanged.
   2byte parameters (where two bytes are treated as 1 data item) are handled as follows:
   a. CSRW, CSRR:Each byte is processed individually. The microprocessor may read or write just the low byte of the cursor address.
   b. SYSTEM SET, SCROLL, CGRAM ADR:Both parameter bytes are processed together.
   If the command is changed after half of the parameter has been input, the single byte is ignored.