OPTIONS & SELECTION GUIDES

TN (Twisted Nematic)
STN (Super Twisted Nematic)
- STN type offers high contrast and wide viewing angle.
- STN type is available with different background colors;
- Yellow-green w/black characters
- Silver-gray w/dark blue characters
- Dark blue w/white characters

FSTN (Film STN)
- Black and white STN with very high contrast ratio for large graphic panels.

TEMPERATURE RANGE

	OPPERATION (°C)	STORAGE (°C)
STANDARD	0 ~ +50	-20 ~ +70
EXTENDED	-20 ~ +70	-30 ~ +80

BACK LIGHT
EL (Electro- luminescent)
- Power efficient

LED with a choice of colors
- Bright and even back lighting
- Long life expectancy, more than 100,000 hours
- Simple to drive. Needs +5 volts only
- Brightness can be easily adjusted

CCFL (Cold Cathode Florescent Light)
- Paper white, best for large graphic displays
- Less power consumption than LED's

DISPLAY TYPE
- Positive image (Dark dots on light background)
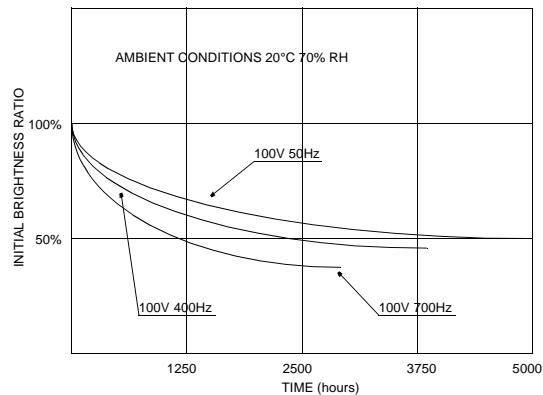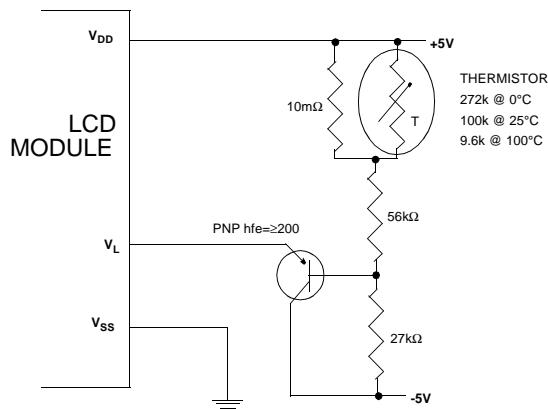- Negative image (Light dots on dark background)

VIEWING ANGLE
- 12:00 (Top) Display is below eye level
- 6:00 (Bottom) Display is above eye level

SELECTION GUIDE

DISPLAY/POLORIZER	DISPLAY DESCRIPTION	OUTDOORS	OFFICE LIGHT	SUBDUED LIGHT	VERY LOW LIGHT	COMMENTS
REFLECTIVE POSITIVE	DARK CHARACTERS ON A LIGHT GREY OR YELLOW BACKGROUND	EXCELLENT	VERY GOOD	POOR	UNUSABLE	CAN'T BE BACK LIT
TRANSFLECTIVE POSITIVE	DARK CHARACTERS ON A LIGHT GREY OR YELLOW BACKGROUND	EXCELLLENT	VERY GOOD	VERY GOOD	EXCELLENT	BEST CHOICE FOR GENERAL USE
TRANSMISSIVE NEGATIVE	LIGHT CHARACTERS ON A DARK BACKGROUND	POOR	GOOD	VERY GOOD	EXCELLENT	MUST BE USED WITH A BACK-LIGHT
TRANSMISSIVE POSITIVE	DARK CHARACTERS ON A LIGHT GRAY OR YELLOW BACKGROUND	GOOD	VERY GOOD	EXCELENT	EXCELLENT	HIGH CONTRAST DISPLAY

TEMPERATURE COMPENSATION & EL LIFE TIME

COMMANDS FOR CHARACTER MODULES

Command	Code										Description	Execution Time
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position (address 0).	82µs~1.64ms
Return Home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (address 0). Also returns a shifted display to the home position. DD RAM contents remain unchanged.	40µs~1.64ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and enables/disables the display.	40µs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Turns the display ON/OFF (D), or the cursor ON/OFF (C), and blink of the character at the cursor position (B).	40µs
Cursor & Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DD RAM contents.	40µs
Function Set	0	0	0	0	1	DL	N$	RE	*	#	Sets the data width (DL), the number of lines in the display (L), and the character font (F).	40µs
Set CG RAM Address	0	0	0	1	A_{CG}						Sets the CG RAM address. CG RAM data can be read or altered after making this setting.	40µs
Set DD RAM Address	0	0	1	A_{DD}							Sets the DD RAM address. Data may be written or read after making this setting.	40µs
Read Busy Flag & Address	0	1	BF	AC							Reads the BUSY flag (BF) indicating that an internal operation is being performed and reads the address counter contents.	1µs
Write Data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	46µs
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	46µs

I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift. S/C= 1: Display shift S/C = 0: cursor move R/L= 1: Shift to the right. R/L= 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line RE = 1: Ext. Reg. Ena. F = 0: 5 x 7 dots BF = 1: Busy BF = 0: Can accept data *# Set to 1 on 24x4 modules* *$ With KS0072 is Address Mode.*	DD RAM: Display data RAM CG RAM: Character generator RAM A_{CG}: CG RAM Address A_{DD}: DD RAM Address Corresponds to cursor address. AC: Address counter Used for both DD and CG RAM address.	Execution times are typical. If transfers are timed by software and the busy flag is not used, add 10% to the above times.

CHARACTER MODULE INITIALIZATION

Internal Reset Circuit

The module is automatically initialized when the power is applied. The following commands are executed during initialization. The busy flag is kept in the busy state until initialization is complete. The busy state lasts for 10 ms after V_{DD} reaches 4.5 volts.
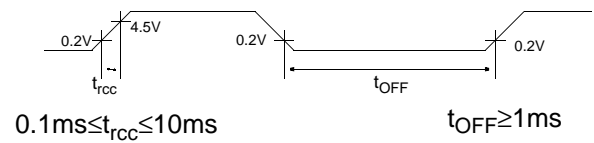
1) Clear Display
2) Function set
   - DL=1.......8-bit data length for interface
   - N=0.........Single-line display
   - F=0.........5x7 dot matrix character font
3) Display ON/OFF Control
   - D=0........Display OFF
   - C=0........Cursor OFF
   - B=0........Blink function OFF
4) Entry Mode Set
   - I/D=1......Increment Mode
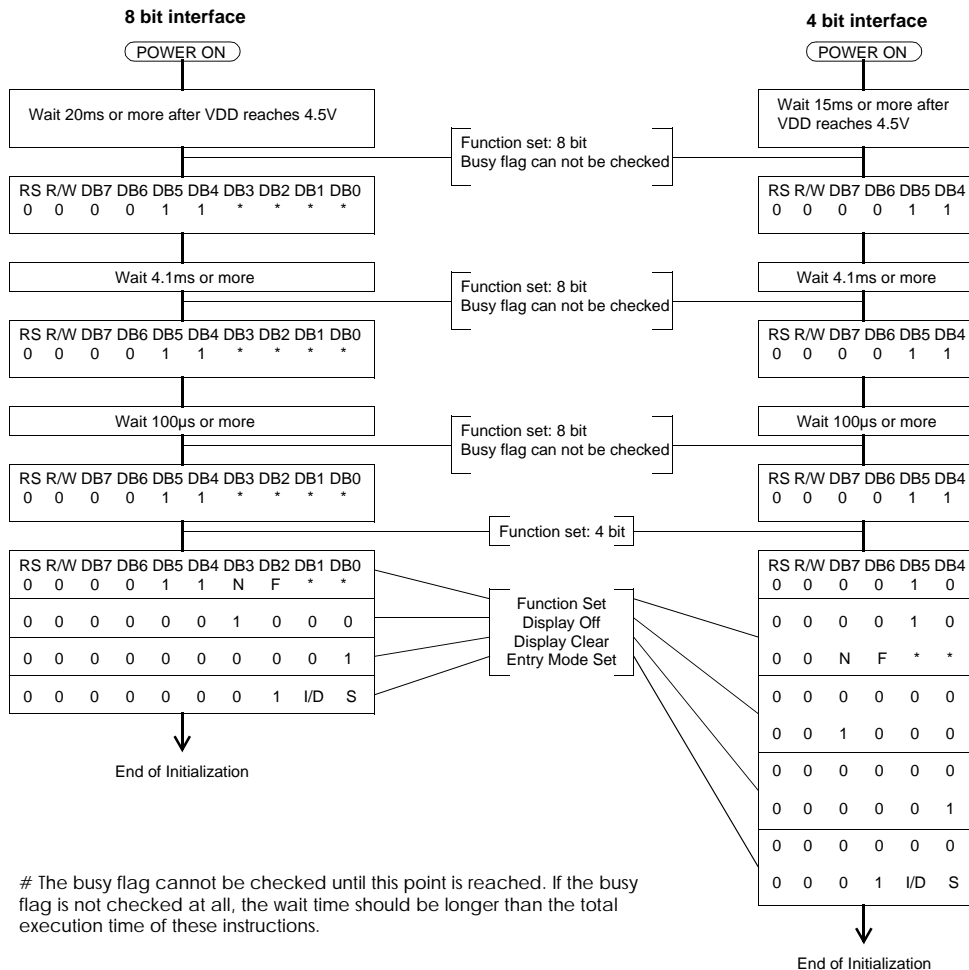   - S=0........Display shift OFF

NOTE:

If the following power conditions are not satisfied, the internal reset circuit does not function properly. In this case, the initialization should be executed by the series of instructions from outside the MPU (Software Initialization).

Power Conditions for Internal Reset

ITEM	SYMBOL	MIN	TYP	MAX	UNIT
Power Supply Rise Time	trcc	0.1	-	10	ms
Power Supply Off Time	tOFF	1.0	-	-	ms

$0.1ms \leq t_{rcc} \leq 10ms$ $t_{OFF} \geq 1ms$

Software Initialization

8 bit interface

POWER ON

Wait 20ms or more after VDD reaches 4.5V

Function set: 8 bit
Busy flag can not be checked

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

Wait 4.1ms or more

Function set: 8 bit
Busy flag can not be checked

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

Wait 100μs or more

Function set: 8 bit
Busy flag can not be checked

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

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

Function Set
Display Off
Display Clear
Entry Mode Set

End of Initialization

The busy flag cannot be checked until this point is reached. If the busy flag is not checked at all, the wait time should be longer than the total execution time of these instructions.

4 bit interface

POWER ON

Wait 15ms or more after VDD reaches 4.5V

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

Wait 4.1ms or more

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

Wait 100μs or more

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

Function set: 4 bit

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	0
0	0	0	0	1	0
0	0	N	F	*	*
0	0	0	0	0	0
0	0	1	0	0	0
0	0	0	0	0	0
0	0	0	0	0	1
0	0	0	0	0	0
0	0	0	1	I/D	S

End of Initialization

DISPLAY CHARACTER POSITION AND CHARACTER ADDRESS

1) 8 x 1: HDM08111H-1

DISPLAY POSITION	1	2	3	4	5	6	7	8
FIRST LINE (DD RAM ADDRESS)	00	01	02	03	04	05	06	07

2) 8 x 2: HDM08216H-1, HDM08216H-3, HDM08216L-3

DISPLAY POSITION	1	2	3	4	5	6	7	8
FIRST LINE	00	01	02	03	04	05	06	07
SECOND LINE	40	41	42	43	44	45	46	47

DD RAM ADDRESS

3) 12 x 2: HDM12216H, HDM12216L

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12
FIRST LINE	00	01	02	03	04	05	06	07	08	09	0A	0B
SECOND LINE	40	41	42	43	44	45	46	47	48	49	4A	4B

DD RAM ADDRESS

4) 16 x 1: HDM16116H-L, HDM16116L-L

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FIRST LINE (DD RAM ADDRESS)	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F

5) 16 x 1: HDM16116H-2, HDM16116L, HDM16116L-7

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FIRST LINE (DD RAM ADDRESS)	00	01	02	03	04	05	06	07	40	41	42	43	44	45	46	47

6) 16 x 2: HDM16216H-2, HDM16216H-4, HDM16216H-5, HDM16216H-B, HDM16216H-S
HDM16216L-2, HDM16216L-5, HDM16216L-6, HDM16216L-7, HDM16216L-B, HDM16216L-S

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

DD RAM ADDRESS

7) 16 x 4: HDM16416H, HDM16416L

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FIRST LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
SECOND LINE	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
THIRD LINE	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
FORTH LINE	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F

DD RAM ADDRESS

8) 20 x 2: HDM20216H-3, HDM20216H-L, HDM20216L, HDM20216L-L

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	DD RAM ADDRESS
FIRST LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	
SECOND LINE	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	

9) 20 x 4: HDM20416H, HDM20416L

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	DD RAM ADDRESS
FIRST LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	
SECOND LINE	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	
THIRD LINE	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27	
FORTH LINE	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	60	61	62	63	64	65	66	67	

10) 24 x 2: HDM24216H-2, HDM24216L-2

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DD RAM ADDRESS
FIRST LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	
SECOND LINE	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	54	55	56	57	

11) 24 x 4: HDM24416H, HDM24416L

DISPLAY POSITION	1	2	3	4	5	6	7		21	22	23	24	DD RAM ADDRESS
FIRST LINE	00	01	02	03	04	05	06	- - -	14	15	16	17	
SECOND LINE	20	21	22	23	24	25	26	- - -	34	35	36	37	
THIRD LINE	40	41	42	43	44	45	46	- - -	54	55	56	57	
FORTH LINE	60	61	62	63	64	65	66	- - -	74	75	76	77	

12) 40 x 1: HDM40108H-2

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		37	38	39	40	DD RAM ADDRESS
FIRST LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	— — —	24	25	26	27	

13) 40 x 2: HDM40216H-4, HDM40216L

DISPLAY POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		37	38	39	40	DD RAM ADDRESS
FIRST LINE	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	— — —	24	25	26	27	
SECOND LINE	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	— — —	64	65	66	67	

14) 40 x 4: HDM40416H-5, HDM40416L-4

DISPLAY POSITION	1	2	3	4	5	6	7		37	38	39	40	DD RAM ADDRESS
FIRST LINE	00	01	02	03	04	05	06	- - -	24	25	26	27	
SECOND LINE	40	41	42	43	44	45	46	- - -	64	65	66	67	
THIRD LINE	00	01	02	03	04	05	06	- - -	24	25	26	27	
FORTH LINE	40	41	42	43	44	45	46	- - -	64	65	66	67	

PROCESSOR INTERFACING

8051 CPU — **LCD MODULE**

$\overline{RD}$
$\overline{WR}$
E
A15
A14
A13
ADDRESS DECODER
ALE
AD0
AD7
ADDRESS LATCH
A0 — R/S
A1 — R/$\overline{W}$
D0
D7

6800 CPU — **LCD MODULE**

VmA
$\varnothing$2
E
A15
A14
A13
ADDRESS DECODER
R/$\overline{W}$ — R/$\overline{W}$
D0 — D0
D7 — D7
A0 — R/S
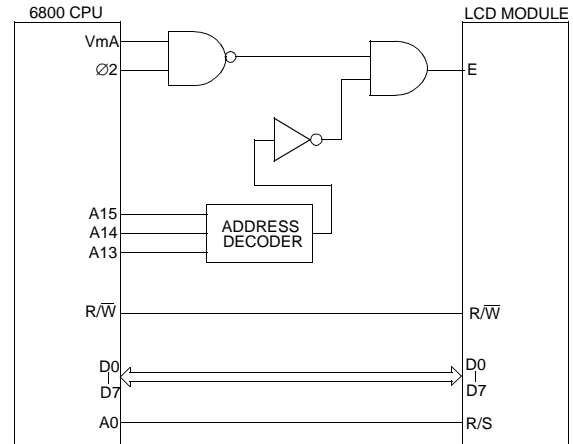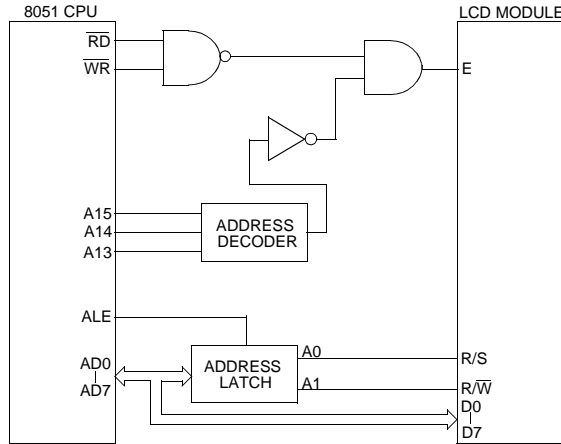
TIMING CHARACTERISTICS

ITEM	SYMBOL	MAX.	MIN.	UNIT
ENABLE CYCLE TIME	T_{CYC}		500	nS
ENABLE PULSE WIDTH	P_W		230	nS
ENABLE RISE/FALL TIME	T_{ER}, T_{EF}	20		nS
RS, R/W SET UP TIME	T_{AS}		40	nS
DATA DELAY TIME	T_{DDR}	360		nS
DATA SETUP TIME	T_{DSW}		60	nS
HOLD TIME	T_H		10	nS

POWER SUPPLY EXAMPLES

V_{DD} — +5V
V_L — 10-20K
LCD MODULE
V_{SS}
SINGLE POWER

V_{DD} — +5V
V_L — 10-20K
LCD MODULE
-5V
V_{SS}
DUAL POWER

DATA READ

RS — 2.2V 0.6V — 2.2V 0.6V
T_{AS} — T_H
R/W — 2.2V — 2.2V
T_H
P_W — T_{EF}
E — 0.6V 2.2V — 2.2V 0.6V
T_{ER}
T_{DDR} — T_H
D_0-D_7 — 2.2V 0.6V — VALID DATA — 2.2V 0.6V
T_{CYC}

DATA WRITE

RS — 2.2V 0.6V — 2.2V 0.6V
T_{AS} — T_H
R/W — 0.6V — 0.6V
T_H
P_W — T_{EF}
E — 0.6V 2.2V — 2.2V 0.6V
T_{ER}
T_{DDR} — T_{DSW} — T_H
D_0-D_7 — 2.2V 0.6V — VALID DATA — 2.2V 0.6V
T_{CYC}
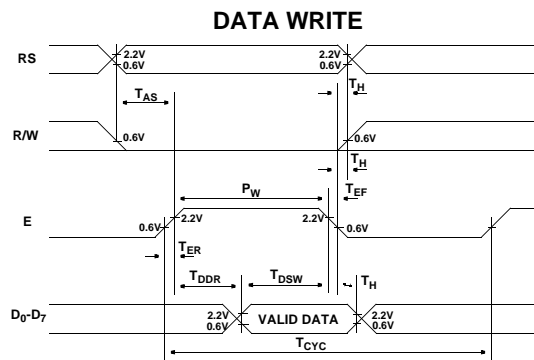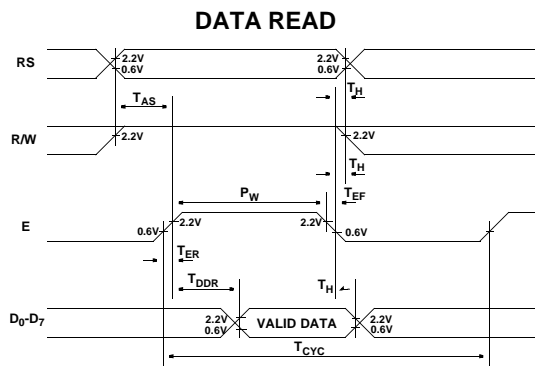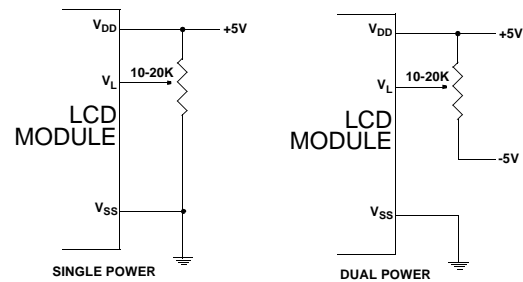
HANDLING LCD'S & LCD MODULES

CLEANING
● Wipe gently with cotton or soft material soaked in petroleum benzine.

● Do not use acetone, toluene, ethanol or isopropyl alcohol.

● Contact with water for a long period of time may damage the display.
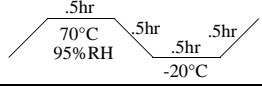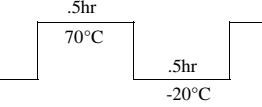
SAFETY
● The toxicity of liquid crystal fluid is very low, but wash it off immediately with soap and water if fluid touches the skin or clothing.

HANDLING
● Do not touch display area with bare hands.

● Do not touch exposed polarizer with hard objects.

● Do not expose the CMOS IC's to static electricity.

● Avoid exposing the module to excessive shock or pressure.

● Do not allow the storage temperature to exceed the specified range.

HANTRONIX Page 46

RELIABILITY DATA

SUMMARY: LIFETIME AND ENVIORNMENTAL TESTS

TEST ITEMS	TEST CONDITIONS	TEST TIME	NUMBR OF UNITS TESTED	FAILURE RATE (%)
TEMPERATURE LIFETIME	60°C, 5V, 32hZ 30°C, 5V, 32hZ	7,000hr 7,000hr	50 50	0 0
HIGH TEMPERATURE	70°C 95°C 60°C	1,000hr 100hr 5,000hr	300 300 300	0 0 0
LOW TEMPERATURE	-40°C -30°C	100hr 1,000hr	300 300	0 0
HIGH TEMPERATURE AND HUMIDITY	70°C, 95%RH 40°C, 95%RH	100hr 500hr	300 300	0 0
TEMPERATURE AND HUMIDITY CYCLE	.5hr / 70°C 95%RH / .5hr .5hr -20°C	25 CYCLES	50	0
POLARIZER AND REFLECTOR RELIABILITY	70°C, DRY 90°C, DRY	1,000hr 100hr	300 300	0 0
ULTRAVIOLET LIGHT	OUTDOOR EXPOSURE	5,000hr	50	0
HEAT SHOCK	.5hr 70°C .5hr -20°C	25 CYCLES	50	0
VIBRATION	10 - 50Hz, 1g, X,YX,Z DIRECTIONS 51 - 300Hz, 0.5g, X,Y,Z DIRECTIONS	1hr	50	0
MECHANICAL	50g 15ms ± X,Y,Z	3 TIMES EACH	50	0

SUMMARY: LIFE EXPECTANCY

| COMPONENT	TYPICAL LIFETIME
LCD DISPLAY (GLASS ASSEMBLY)	50,000hr (5.7yr)
LCD ELECTRONICS	100,000hr (12yr) min
EL BACK LIGHT	5,000hr (7mo) [1, 2]
CCFL BACK LIGHT	15,000hr (20mo) [2]
LED BACKLIGHT	100,000hr (12yr) min

NOTES:
1. It is recommended that the product be designed so that the EL back light is not left on continuously. This will greatly extend the lifo of the back light element.

2. Usable lifetime of the back light is reached when the light output reaches 50% of the original brightness.

POWER SUPPLY SEQUENCING (Graphics Modules Only)

The power supply voltages should be sequenced according to the following timing diagram. This will insure that the internal electronics have time to begin operation before the negative voltage is applied. The sequence of events should be as follows: Apply V_{DD} first. When V_{DD} is stable at 5v, apply the input signals and then apply V_L/V_{EE}. The shut down sequence is exactly the opposite. *Failure to follow this procedure may result in permanent damage to the LCD fluid or to the CMOS electronics on the module.*
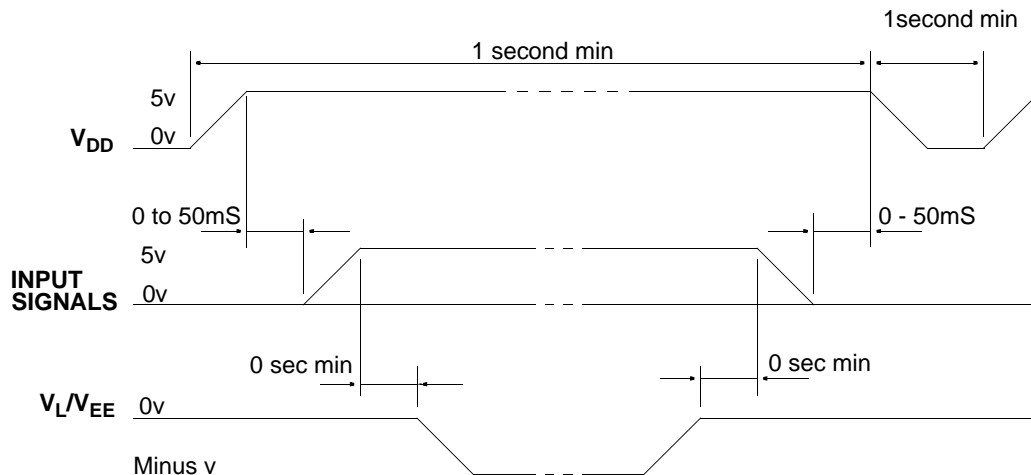
CHARACTER MODULE FONT TABLE (Standard font)

Character modules with built in controllers and Character Generator (CG) ROM & RAM will display 96 ASCII and special characters in a dot matrix format. Then first 16 locations are occupied by the character generator RAM. These locations can be loaded with the user designed symbols and then displayed along with the characters stored in the CG ROM.

CHARACTER FONT TABLE

LOWER 4 BITS / UPPER 4 BITS	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)		0	@	P	`	p		─	夕	ミ	α	p
0001	(2)	!	1	A	Q	a	q	。	ア	チ	ム	ä	q
0010	(3)	"	2	B	R	b	r	「	イ	ツ	メ	β	θ
0011	(4)	#	3	C	S	c	s	亅	ウ	テ	モ	ε	∞
0100	(5)	$	4	D	T	d	t	、	エ	ト	ヤ	μ	Ω
0101	(6)	%	5	E	U	e	u	・	オ	ナ	ユ	σ	Ü
0110	(7)	&	6	F	V	f	v	ヲ	カ	ニ	ヨ	ρ	Σ
0111	(8)	'	7	G	W	g	w	ア	キ	ヌ	ラ	g	π
1000	(1)	(	8	H	X	h	x	イ	ク	ネ	リ	ｊ	x̄
1001	(2)	)	9	I	Y	i	y	ウ	ケ	ノ	ル	ˉ¹	y
1010	(3)	*	:	J	Z	j	z	エ	コ	ハ	レ	j	千
1011	(4)	+	;	K	[	k	{	オ	サ	ヒ	ロ	˟	万
1100	(5)	,	<	L	¥	l	|	ャ	シ	フ	ワ	¢	円
1101	(6)	-	=	M	]	m	}	ュ	ス	ヘ	ン	￡	÷
1110	(7)	.	>	N	^	n	→	ョ	セ	ホ	゛	ñ	
1111	(8)	/	?	O	_	o	←	ッ	ソ	マ	゜	ö	█

HDM16216H-B

Dimensional Drawing

16 Character x 2 Lines, Connector on Bottom

Dimension tolerance: +/-0.3mm
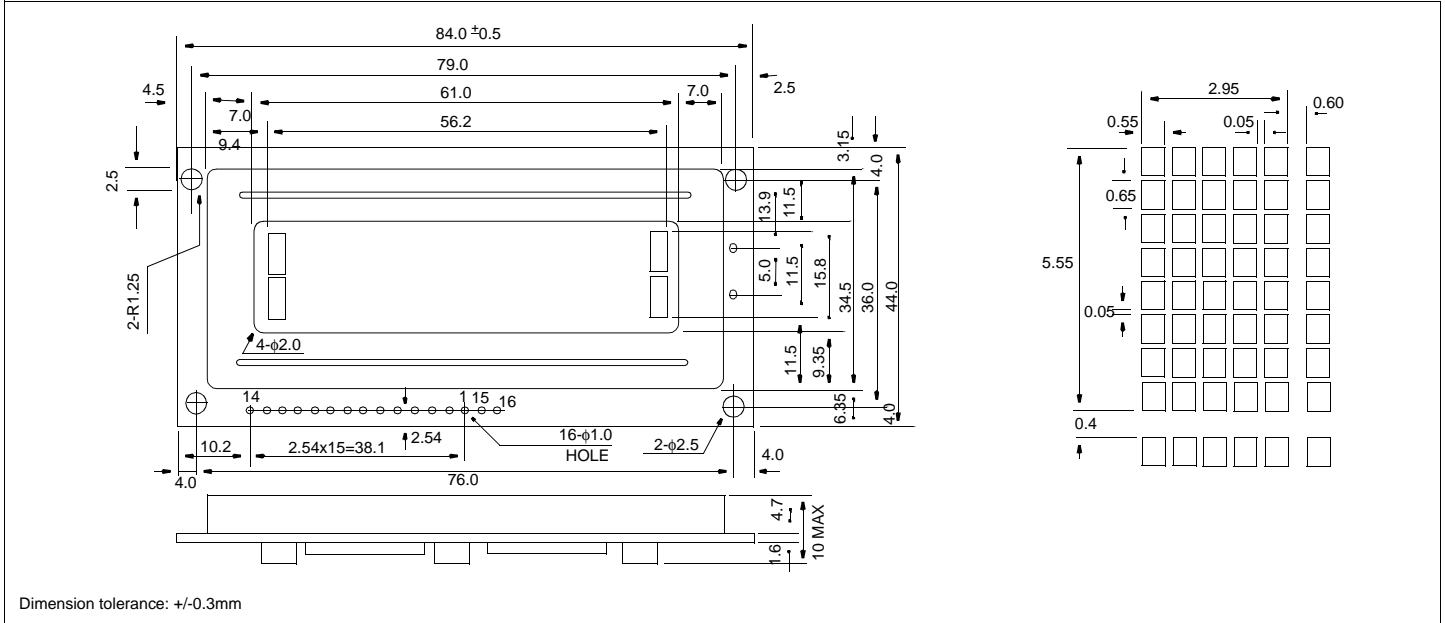
Features

Character Format ....5x7 Dots with Cursor
Backlight..EL Optional
Options....TN/Gray STN/Yellow STN, 12 o'Clock/6 o'Clock View
Normal/Extended Temperature
Normal/Negative Displays

Physical Data

Module Size.....................................84.0W x 44.0H x 10.0T mm
Viewing Area Size...61.0W x 15.8H mm
Weight..34g

Block Diagram
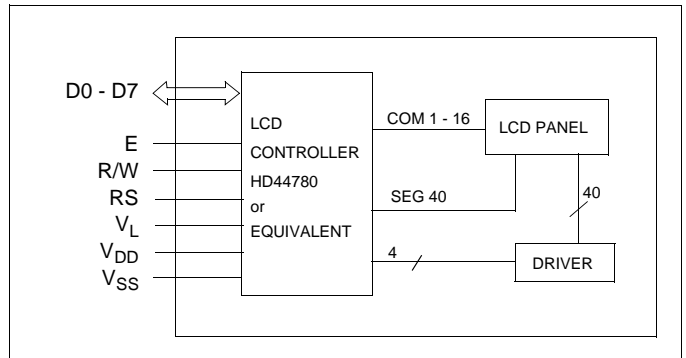
Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN	MAX	UNIT
SUPPLY VOLTAGE	V_{DD}-V_{SS}	0	7.0	V
SUPPLY VOLTAGE FOR LCD	V_{DD}-V_L	0	13.5	V
INPUT VOLTAGE	V_{IN}	V_{SS}	V_{DD}	V
OPERATING TEMPERATURE	T_{OP}	0	50	°C
STORAGE TEMPERATURE	T_{STG}	-20	70	°C

Electrical Characteristics (VDD=5.0±0.25V 25°C)

PARAMETER	SYM	CONDITION	MIN	TYP	MAX	UNIT
INPUT HIGH VOLTAGE	V_{IH}	-	2.2	-	-	V
INPUT LOW VOLTAGE	V_{IL}	-	-	-	.6	V
OUTPUT HIGH VOLTAGE	V_{OH}	I_{OH}=0.2mA	2.4	-	-	V
OUTPUT LOW VOLTAGE	V_{OL}	I_{OL}=1.2mA	-	-	0.4	V
POWER SUPPLY CURRENT	I_{DD}	V_{DD}=5.0V	-	1.0	2.2	mA
POWER SUPPLY FOR LCD	V_{DD}-V_L	TA=25°C	4.3	-	4.7	V
DRIVE METHOD	1/16 Duty					

Pin Connections

PIN NO.	SYMBOL	LEVEL	FUNCTION
1	V_{SS}	-	0V
2	V_{DD}	-	5V
3	V_L	-	-
			Power supply
4	RS	H/L	H: Data input L: Instruction data input
5	R/W	H/L	H: Data read L: Data write
6	E	H,H→L	Enable signal
7	D0	H/L	
8	D1	H/L	
9	D2	H/L	
10	D3	H/L	
11	D4	H/L	Data bus
12	D5	H/L	
13	D6	H/L	
14	D7	H/L	