



JEWEL HILL ELECTRONIC CO.,LTD.

**SPECIFICATIONS FOR
LCD MODULE**

Module No. GT2001

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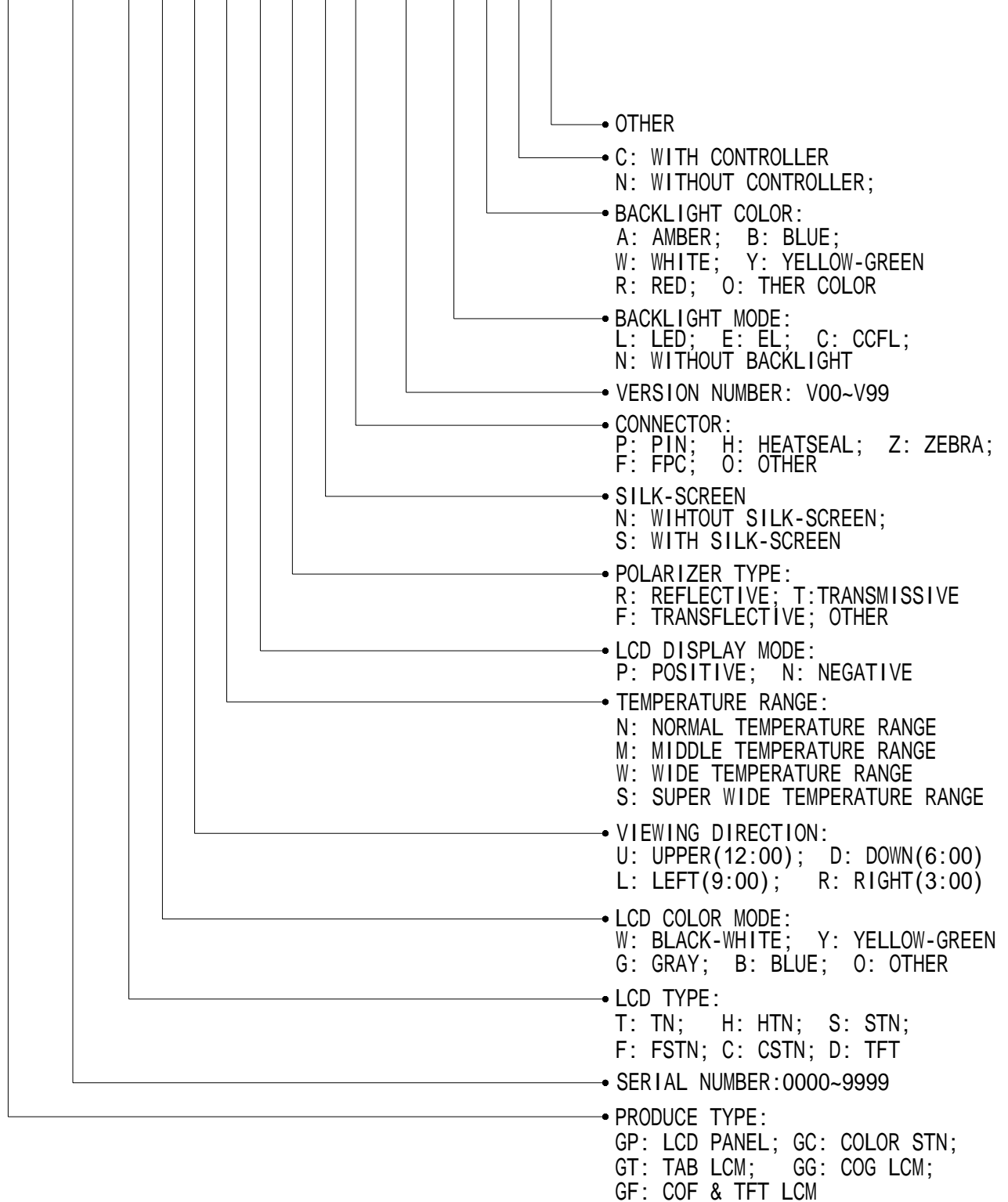
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LCM Number System

GT 2001 F W D S P F N F-V00-N O C X



1. GENERAL DESCRIPTION

The GT2001 is a 96 x 26 Dots+ICON Graphic LCD module. It has a FSTN panel composed of 96 segments and 26 commons. The LCM can be easily accessed by microcontroller via parallel or series interface.

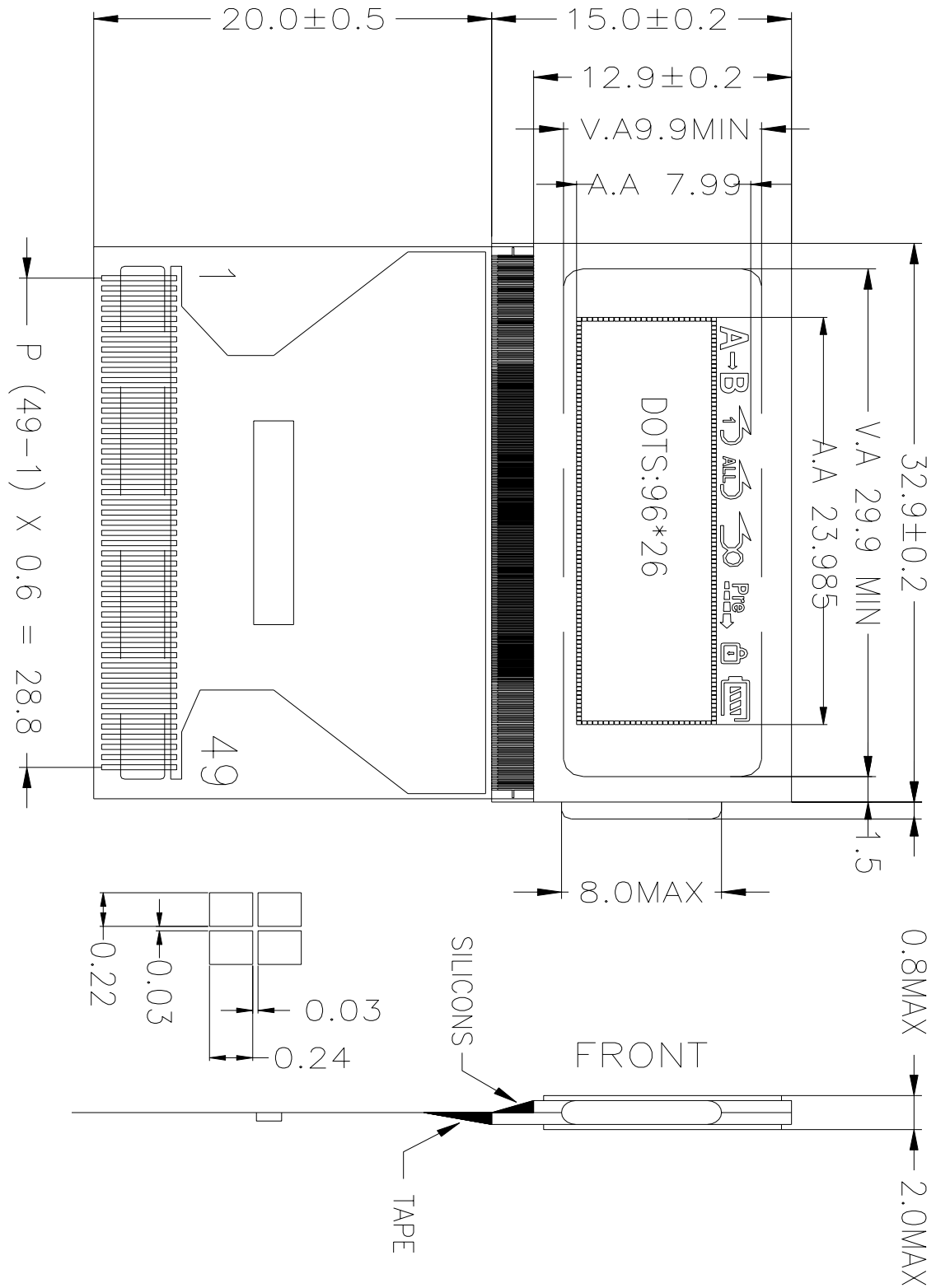
2. FEATURES

Display Mode	Transflective and positive
	FSTN module
Display Format	Graphic 96x26 dots+ICON
Input Data	8 bit parallel or series data input from MPU
Multiplexing Ratio	1/33 Duty
Bias	1/6 Bias
Viewing Direction	6 O'clock
Controller	NT7502
Backlight	NONE

3. MECHANICAL SPECIFICATION

Item	Specifications	Unit
Dimensional outline	32.5 x (15+20) x 2.0(max)	mm
Resolution	96segs x 26coms+Icon	dots
Active area	23.985(W) x 7.99(H)	mm
Dots pitch	0.25(W)×0.27(H)	mm
Dots size	0.22(W)×0.24(H)	mm

4. MECHANICAL DIMENSION



5. MAXIMUM RATINGS

Item	Symbol	Min	Max	Unit	Note
Supply voltage	$V_{DD} - V_{SS}$	-0.3	4.0	V	
	V_{LCD}	-0.3	18.0	V	
Input Voltage	V_{IN}	-0.3	$V_{DD}+0.3$	V	
Operating temperature	T_{OPR}	-20	+70	°C	
Storage temperature	T_{STR}	-30	+80	°C	
Humidity	---	---	90	%RH	

6. ELECTRICAL CHARACTERISTICS

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	Logic	V_{DD}	---	---	3.0	---	V
Input Voltage	H level	V_{IH}	---	$0.8V_{DD}$	---	V_{DD}	V
	L level	V_{IL}		V_{SS}	---	$0.2V_{DD}$	
Current Consumption (LCD DRIVER)		I_{DD}	$V_{DD}=3.0V;$ $V_{LCD}=5.0V, T_{amb}=25^{\circ}C;$	---	---	1.2	mA
LCD Driving Voltage		V_{LCD}	Bias=1/6 $V_{LCD}=V_0-V_{SS}$	---	5.0	---	V

7. MODULE FUNCTION DESCRIPTION

7.1. PIN DESCRIPTION

Pin No.	Symbol	Description
1-4	NC	No Connect
5	FR	LC Alternating Current I/O Terminal, No Connect
6	CL	Clock Signal I/O Terminal, No Connect
7	DOF	LCD Blanking Control Terminal, No Connect
8	NC	No Connect
9	/CS1	Chip Selection, the Chip is Active when CS1="L" and CS2="H"
10	CS2	
11	/RES	Reset Signal Input Terminal
12	A0	Command/Data Register Selection Terminal
13	/WR	Write Signal Input or Read/Write Selection Terminal
14	/RD	Read Signal Input or Read/Write Enable Control Terminal
15-22	D0-D7	8-bit Bi-directional Data Bus Input/Output
23	DUTY0	Duty Selection Terminal
24	DUTY1	
25	VDD	Power Supply for Positive
26	VDD2	Reference Voltage for DC/DC Circuit
27	VSS	Power Supply for Ground
28	VOUT	LCD Driving Voltage Output
29	NC	No Connect
30	CAP3+	Capacitance for DC/DC Voltage Converter Circuit
31	CAP1-	

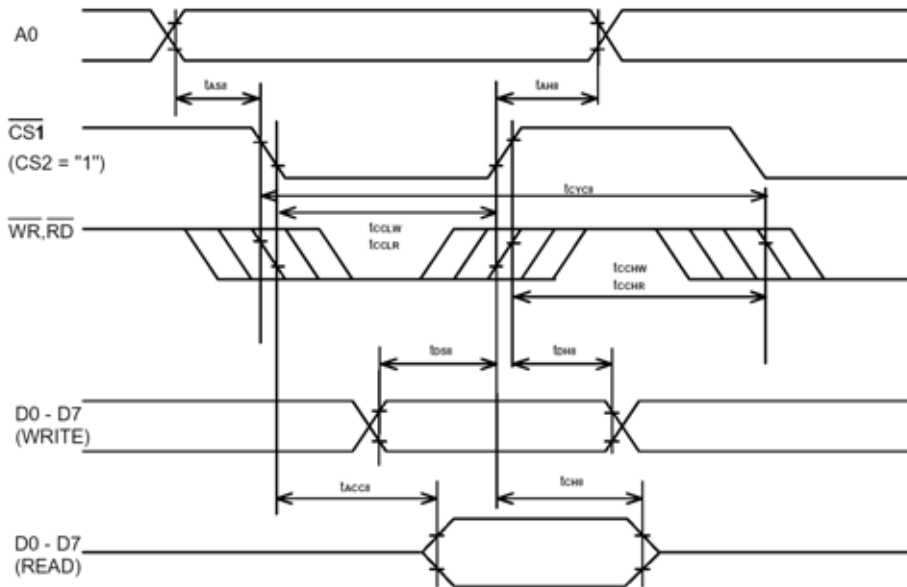


32	CAP1+	Capacitance for DC/DC Voltage Converter Circuit
33	CAP2+	
34	CAP2-	
35	VEXT	External Vref Input Terminal
36	VRS	Internal Vref Selection Terminal
37-40	V1-V4	LCD Bias Voltage
41	V0	
42	VR	External Voltage Regulation Terminal
43	M/S	Master/Slave mode Selection Terminal
44	CLS	Internal Oscillation Selection
45	C86	Timing Selection for 6800 or 8080
46	P/S	Interface Selection for Parallel or Serial
47	HPM	Power Control Terminal
48	IRS	Internal Voltage Regulator Selection
49	NC	No Connect

7.2 TIMING CHARACTERISTICS

1.SYSTEM BUS READ/WRITE CHARACTERISTIC

(1) System buses Read / Write characteristics 1 (For the 8080 Series MPU)



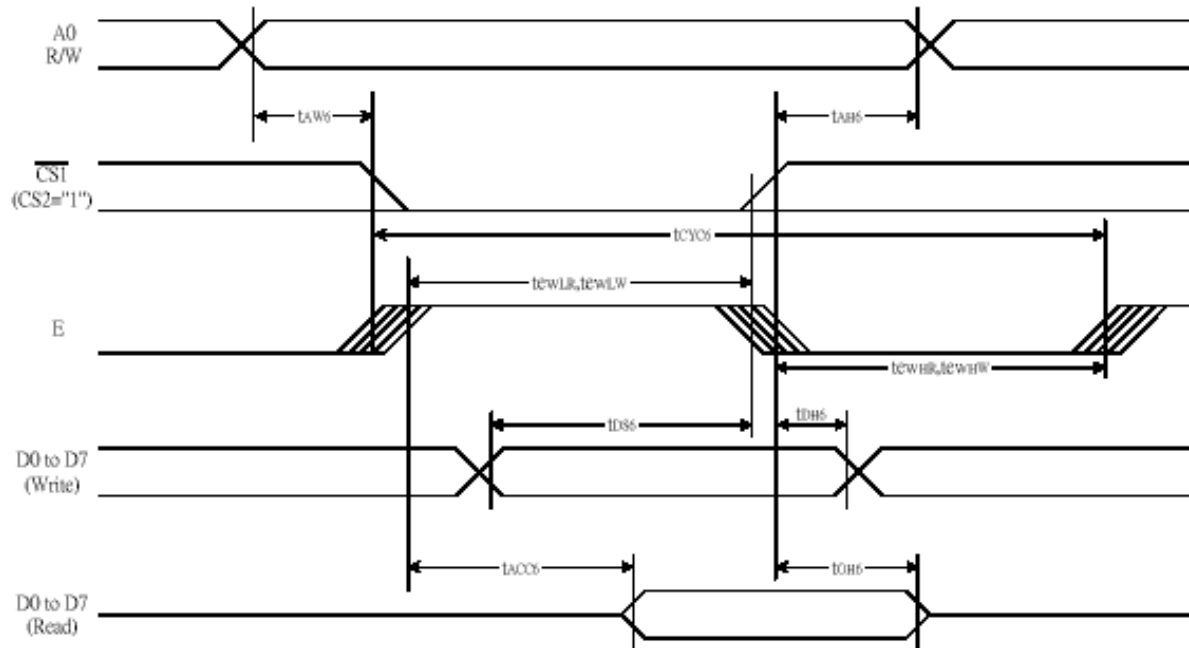
(VDD = 2.7 - 3.3V, TA = -40 - 85°C)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Condition
TAH8	Address hold time	0			ns	
TAS8	Address setup time	0			ns	
TCYC8	System cycle time	300			ns	
TCCLW	Control L pulse width (WR)	90			ns	
TCCLR	Control L pulse width (RD)	120			ns	
TCCHW	Control H pulse width (WR)	120			ns	
TCCHR	Control H pulse width (RD)	60			ns	
TDS8	Data setup time	40			ns	
TDH8	Data hold time	15			ns	
TACC8	\overline{RD} access time			140	ns	CL = 100pF
TCH8	Output disable time	10		100	ns	CL = 100pF

*1. The input signal rise time and fall time (t_r , t_f) is specified at 15ns or less. When the system cycle time is extremely fast, $(t_r+t_f) \leq (t_{CYC8}-t_{CCLW}-t_{CCHW})$ for $(t_r+t_f) \leq (t_{CYC8}-t_{CCLR}-t_{CCHR})$ are specified.

*2. All timing is specified using 20% and 80% of VDD as the reference.

*3. tCCLW and tCCLR are specified as the overlap between $\overline{CS1}$ being "L" (CS2 = "H") and \overline{WR} and \overline{RD} being at the "L" level.



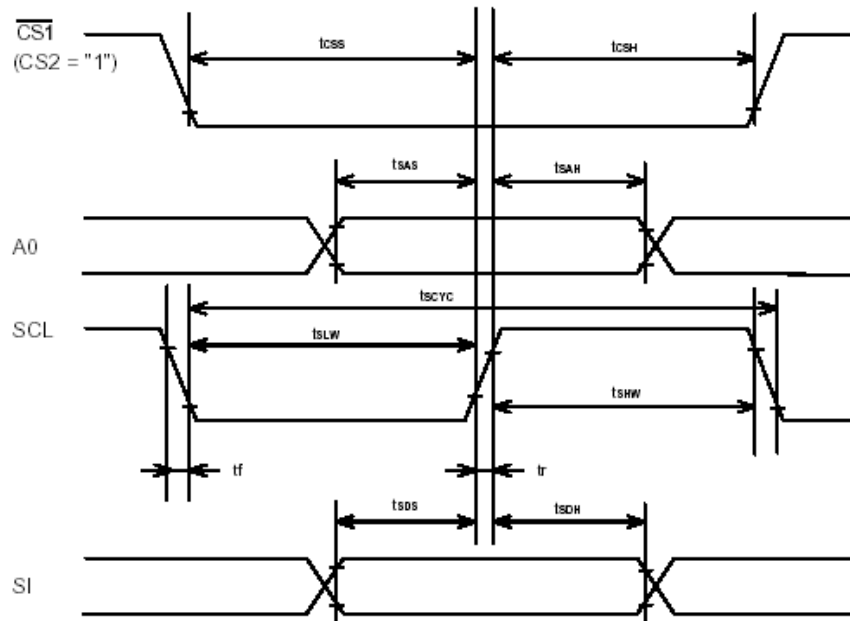
System Bus Read/Write Characteristics 2 (For the 6800 Series MPU)

Figure 38

Table 27

(VDD = 3.3 V , Ta = 25°C)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Address hold time	A0	tAH6		0	—	ns
Address setup time		tAW6		0	—	
System cycle time		tCYC6		240	—	
Enable L pulse width (WRITE)	WR	tEWLW		80	—	
Enable H pulse width (WRITE)		tEWHW		80	—	
Enable L pulse width (READ)	RD	tEWLR		80	—	
Enable H pulse width (READ)		tEWHR		140	—	
WRITE Data setup time	D0 to D7	tDS6		40	—	
WRITE Address hold time		tDH6		0	—	
READ access time		tACC6	CL = 100 pF	—	70	
READ Output disable time		tOH6	CL = 100 pF	5	50	

(2) Serial Interface


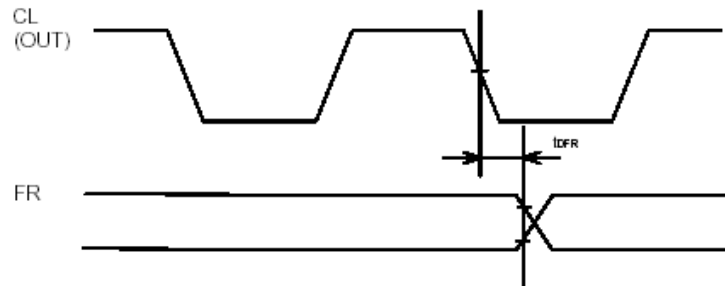
(VDD = 2.7 - 3.3V, TA = -40 - 85°C)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Condition
Tscyc	Serial clock cycle	250			nS	
Tshw	Serial clock H pulse width	100			nS	
Tslw	Serial clock L pulse width	100			nS	
TSAS	Address setup time	150			nS	
TSAH	Address hold time	150			nS	
TSDS	Data setup time	100			nS	
TSDH	Data hold time	100			nS	
Tcss	\overline{cs} serial clock time	150			nS	
Tcsh	\overline{cs} serial clock time	150			nS	

*1. The input signal rise time and fall time (t_r , t_f) are specified at 15ns or less

*2. All timings are specified using 20% and 80% of VDD as the standard.

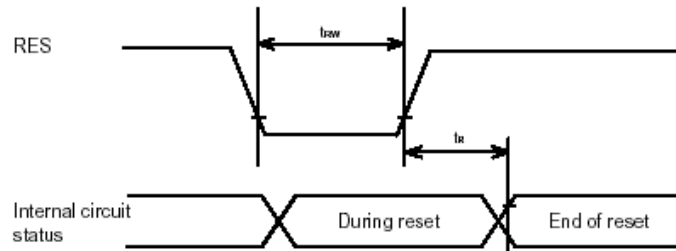
(3) Display Control Timing



(VDD = 2.7 - 3.3V, TA = -40 - 85°C)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Condition
TDFR	FR delay time		20	80	nS	CL = 50pF

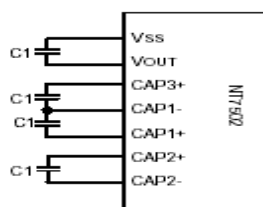
(4) Reset Timing



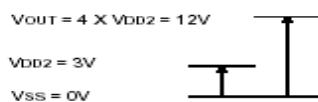
(VDD = 2.7 - 3.3V, TA = -40 - 85°C)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Condition
TR	Reset time			1.0	μS	
TRW	Reset low pulse width	1.0			μS	

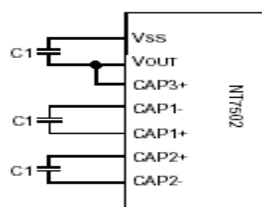
7.3 APPLICATION OF LCM



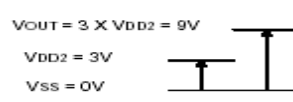
4x step-up voltage circuit



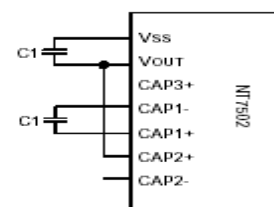
4x step-up voltage relationships



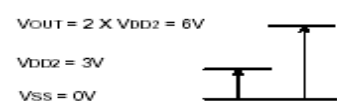
3x step-up voltage circuit



3x step-up voltage relationships



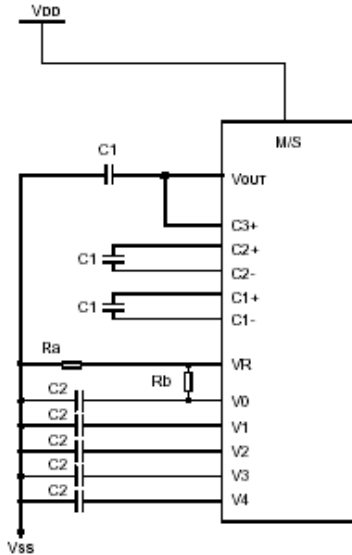
2x step-up voltage circuit



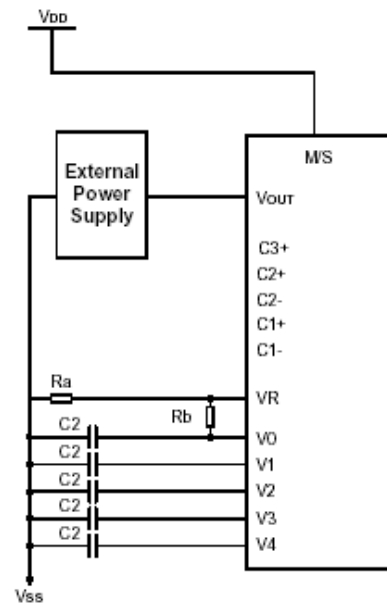
2x step-up voltage relationships

Reference Power Supply Circuit for Driving LCD Panel

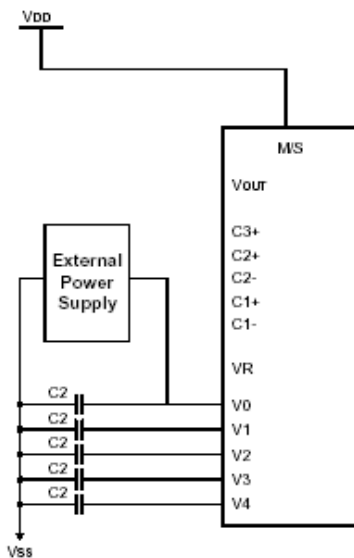
-When using all LCD power circuits
(Voltage converter regulator and follower)
(In case of 3X boosting circuit)



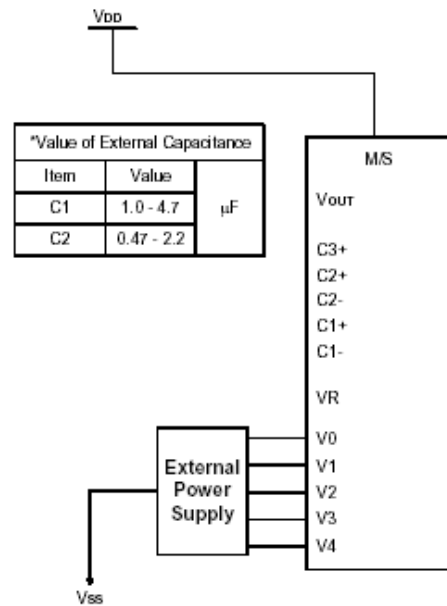
-When not using voltage booster circuits



When only using voltage follower



When not using internal LCD power supply circuits





7.4 TABLE OF COMMAND

Command	Code											Function
	A0	\overline{RD}	\overline{WR}	D7	D6	D5	D4	D3	D2	D1	D0	
(1) Display ON/OFF	0	1	0	1	0	1	0	1	1	1	D	Turns on LCD panel when goes high, and turns off when goes low
(2) Set Display Start Line	0	1	0	0	1	Display start address					Specifies RAM display line for COM0	
(3) Set Page Address	0	1	0	1	0	1	1	Page address				Sets the display RAM page in Page Address register
(4-1) Set Column Address 4 higher bits	0	1	0	0	0	0	1	Higher column address				Sets 4 higher bits of column address of display RAM in register
(4-2) Set column Address 4 lower bits	0	1	0	0	0	0	0	Lower column address				Sets 4 lower bits of column address of display RAM in register
(5) Read Status	0	0	1	Status				0	0	0	0	Reads the status information
(6) Write Display Data	1	1	0	Write data								Writes data in display RAM
(7) Read Display Data	1	0	1	Read data								Reads data from display RAM
(8) ADC select	0	1	0	1	0	1	0	0	0	0	D	Sets the display RAM address SEG output correspondence
(9) Normal/Reverse Display	0	1	0	1	0	1	0	0	1	1	D	Normal indication when low, but full indication when high
(10) Entire Display ON/OFF	0	1	0	1	0	1	0	0	1	0	0 1	Selects normal display (0) or Entire Display ON (1)
(11) Set LCD Bias	0	1	0	1	0	1	0	0	0	1	D	Sets LCD drive voltage bias ratio
(12) Read-Modify-Write	0	1	0	1	1	1	0	0	0	0	0	Increments Column Address counter during each write
(13) End	0	1	0	1	1	1	0	1	1	1	0	Releases the Read-Modify-Write
(14) Reset	0	1	0	1	1	1	0	0	0	1	0	Resets internal functions
(15) Common output mode select	0	1	0	1	1	0	0	D	*	*	*	Selects COM output scan direction. * Invalid data
(16) Set Power Control	0	1	0	0	0	1	0	1	Operation status			Selects the power circuit operation mode
(17) V0 voltage regulator internal resistor ratio set	0	1	0	0	0	1	0	0	Resistor ratio			Select internal resistor ratio (Rb / Ra) mode
(18) Electronic volume mode set Electronic Volume Register set	0	1	0	1	0	0	0	0	0	0	1	Sets the V0 output voltage electronic volume register
	0	1	0	*	*	Electronic control value						
(19) Set static indicator On/Off Set Static indicator register	0	1	0	1	0	1	0	1	1	0	D	Sets static indicator On/Off 0: OFF 1: ON
	0	1	0	*	*	*	*	*	*	Mode		Sets the flashing mode
(20) Power Save	-	-	-	-	-	-	-	-	-	-	-	Compound command of display OFF and entire display ON
(21) NOP	0	1	0	1	1	1	0	0	0	1	1	Command for non-operation
(22) Test Command	0	1	0	1	1	1	1	*	*	*	*	IC Test command. Do not use!
(23) Test Mode Reset	0	1	0	1	1	1	1	0	0	0	0	Command of test mode reset

Note: Do not use any other command, or system malfunction may result.

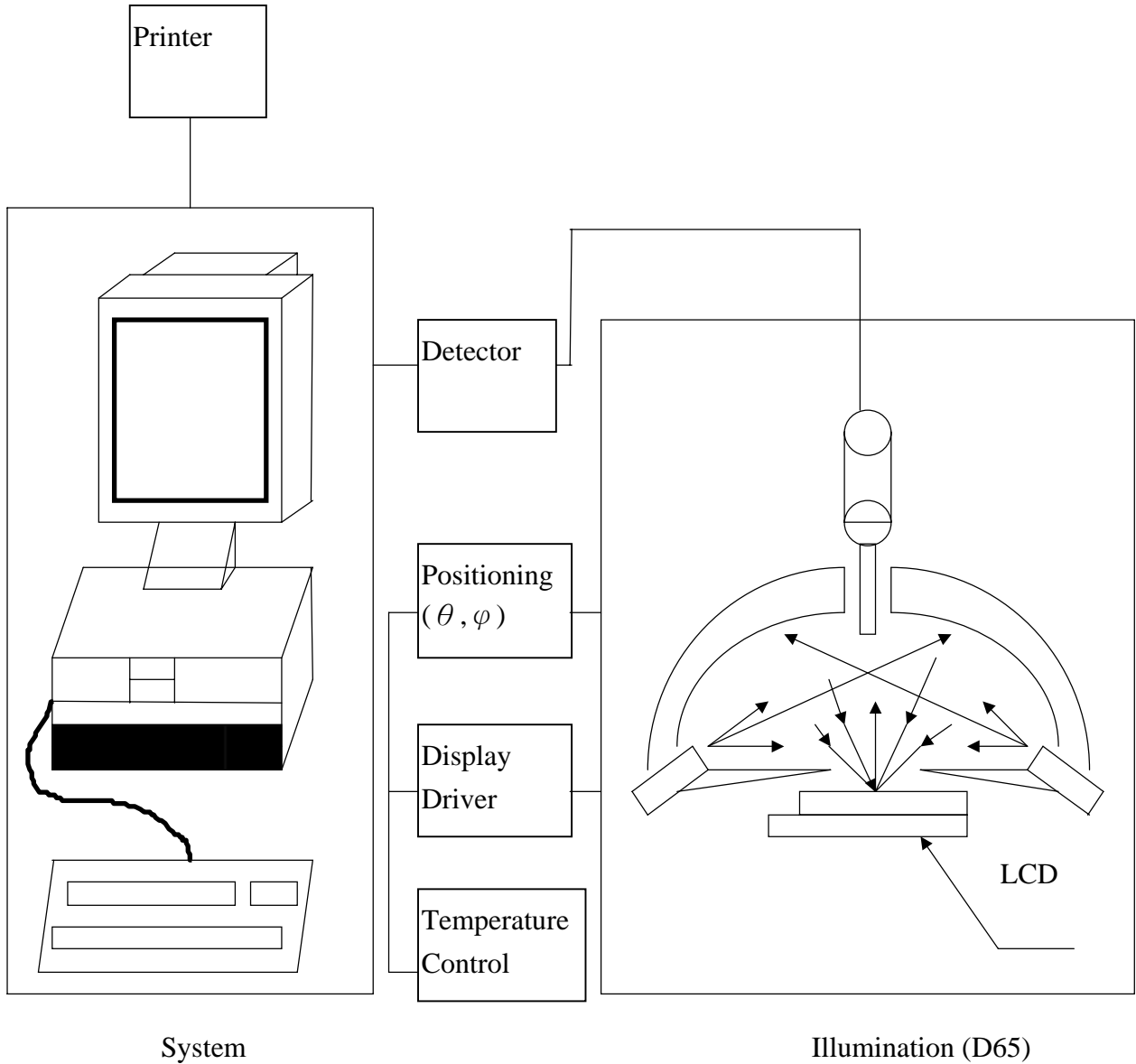
8. ELECTRO-OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Temp	Min	Typ.	Max	Units	Note
LCD driving voltage	V _{LCD}	$\theta = \phi = 0$	0°C	---	5.2	---	V	NOTE1
			25°C	4.7	5.0	5.3		
			50°C	---	4.8	---		
Response Time	Rise Time (Tr)	$\theta = \phi = 0$	0°C	---	---	--	msec	NOTE2
	Decay Time (Tf)			---	---	---		
	Rise Time (Tr)		25°C	---	225	340		
	Decay Time (Tf)			---	240	360		
	Rise Time (Tr)		50°C	---	---	--		
	Decay Time (Tf)			---	---	--		
Contrast Ratio	Cr	$\theta = \phi = 0$	25°C	5	10	---	---	NOTE4

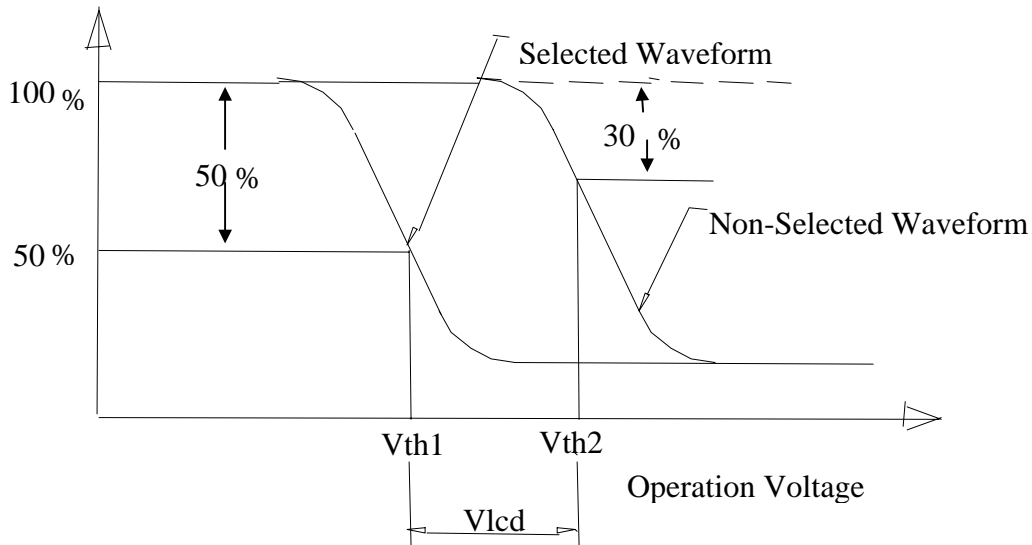
Viewing Angle Range	$\theta (\phi = 0^\circ)$ (6'')	$\phi = 90^\circ$ (3'')	$\phi = 180^\circ$ (12'')	$\phi = 270^\circ$ (9'')	備註
$\theta (25^\circ\text{C})$ CR≥2	45	35	25	30	Deg NOTE3

● For panel only

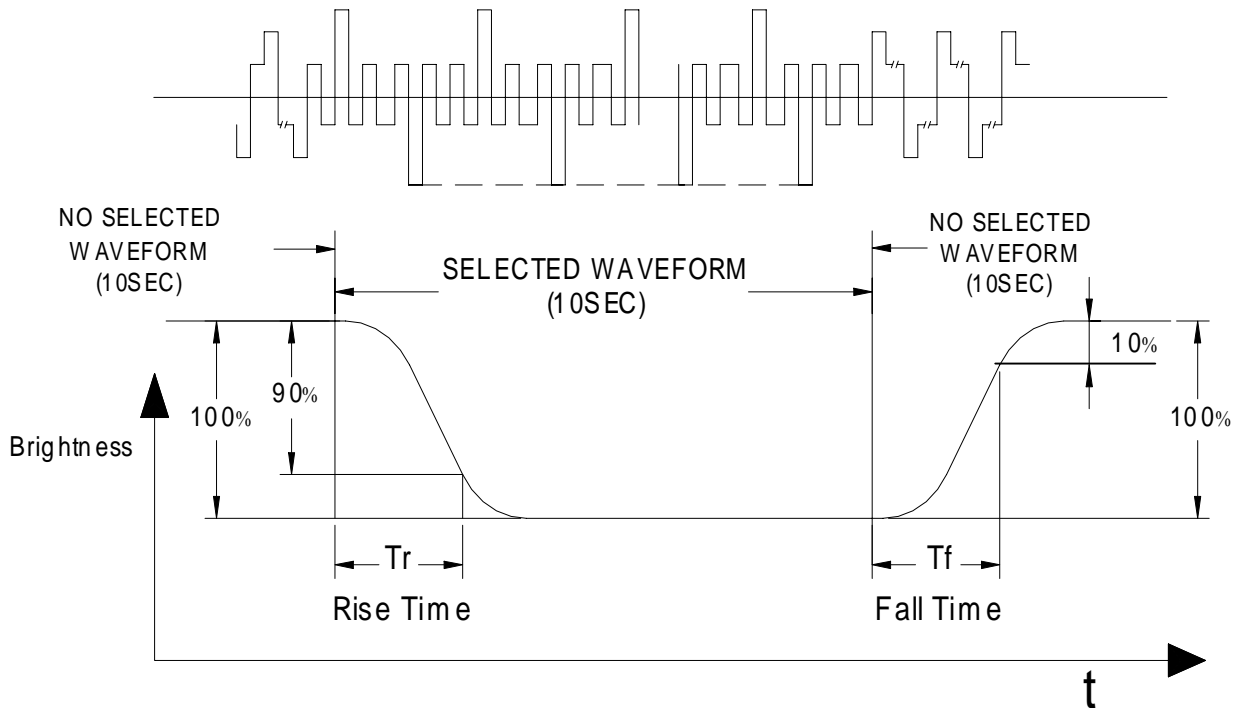
• **Electro-Optical Characteristics Measuring Equipment(DMS501)**



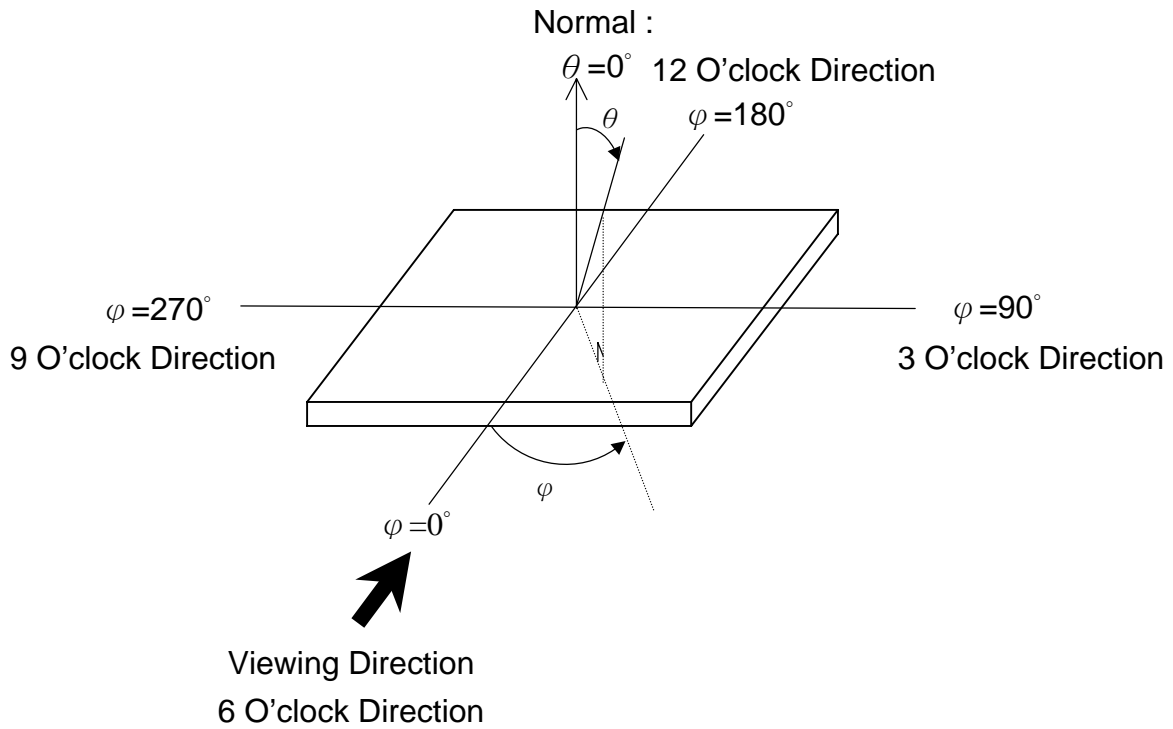
• **Note 1. Definition of Driving Voltage(V_{lcd}) :**



• Note 2. Definition of Optical Response Time :

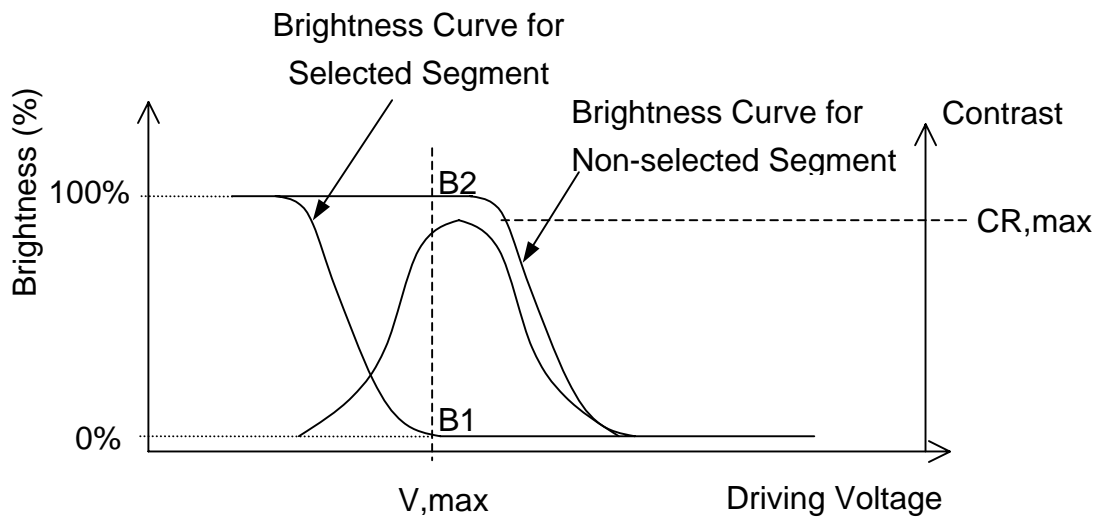


• Note 3. Definition of Viewing Angle θ and ϕ :



• **Note 4. Definition of Contrast ratio(CR) :**

$$CR = \frac{\text{Brightness of Non-selected Segment (B2)}}{\text{Brightness of Selected Segment (B1)}}$$



9. RELIABILITY

9.1. MTBF

The LCD module shall be designed to meet a minimum MTBF value of 50000 hours with normal. (25°C in the room without sunlight)

9.2. TESTS

NO.	ITEM	CONDITION	CRITERION
1	High Temperature Operating	70°C 120Hrs	<ul style="list-style-type: none"> ◦ No Defect Of Operational Function In Room Temperature Are Allowable. ◦ IDD of LCM in Pre-and post-test should follow specification
2	Low Temperature Operating	-20°C 120Hrs	
3	High Temperature/ Humidity Non-Operating	70°C ,90%RH ,120 Hrs	
4	High Temperature Non-Operating	80°C 120Hrs	
5	Low Temperature Non-Operating	-30°C 120Hrs	
6	Temperature Cycling Non-Operating	-20°C (30Min)↔ 70°C (30Min) 10 CYCLES	

Notes: Judgments should be made after exposure in room temperature for two hours.

10. PRECAUTIONS FOR USING LCD MODULES

10.1. HANDLING PRECAUTIONS

- (1) The display panel is made of glass. Do not subject it to a mechanical shock or impact by dropping it.
- (2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.
- (3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- (4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
- (5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten a cloth with one of the following solvents:
 - Isopropyl alcohol
 - Ethyl alcohol
- (6) Solvents other than those above mentioned may damage the polarizer.
Especially, do not use the following:
 - Water
 - Ketone
 - Aromatic solvents
- (7) Extra care to minimize corrosion of the electrode. Water droplets, moisture condensation or a current flow in a high-humidity environment accelerates corrosion of the electrode.
- (8) Install the LCD Module by using the mounting holes. When mounting the LCD Module, make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.
- (9) Do not attempt to disassemble or process the LCD Module.
- (10) NC terminal should be open. Do not connect anything.
- (11) If the logic circuit power is off, do not apply the input signals.
- (12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
 - Be sure to ground the body when handling the LCD Module.
 - Tools required for assembling, such as soldering irons, must be properly grounded.
 - To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.

-The LCD Module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

10.2. STORAGE CONDITIONS

When storing, avoid the LCD module to be exposed to direct sunlight of fluorescent lamps. For stability, to keep it away from high temperature and high humidity environment (The best condition is : $23\pm 5^{\circ}\text{C}$, $45\pm 20\%\text{RH}$). ESD protection is necessary for long-term storage also.

10.3. OTHERS

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD Module have been operating for a long time showing the same display patterns the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be recovered by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD Module resulting from destruction caused by static electricity etc. exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.
- Terminal electrode sections.

11. Using LCD modules

12.1 LIQUID CRYSTAL DISPLAY MODULES

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

- (1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.
- (2) Do not touch, push or rub the exposed polarizers with anything harder than a HB pencil lead (glass, tweezers, etc).
- (3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizers and reflectors made of organic substances, which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.
- (4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum ether. Do not scrub hard to avoid damaging the display surface.
- (5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.
- (6) Avoid contacting oil and fats.
- (7) Condensation on the surface and contact with terminals due to cold will damage, stain or polarizers. After products are tested at low temperature they must be warmed up in a container before coming in contact with room temperature air.
- (8) Do not put or attach anything on the display area to avoid leaving marks on.
- (9) Do not touch the display with bare hands. This will stain the display area and degrade insulation between terminals (some cosmetics are detrimental to the polarizers).
- (10) As glass is fragile, it tends to become chipped during handling especially on the edges. Please avoid dropping or jarring.

12.2 INSTALLING LCD MODULE

Attend to the following items when installing the LCM.

- (1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.
- (2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be ± 0.1 mm.

12.3 ELECTRO-STATIC DISCHARGE CONTROL

Since this module uses a CMOS LSI, the same careful attention should be paid for electrostatic discharge as for an ordinary CMOS IC.

- (1) Make certain that you are grounded when handling LCM.
- (2) Before removing LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.
- (3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not leak.
- (4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutator of the motor.
- (5) As far as possible, make the electric potential of your work clothes and that of the workbenches to the ground potential.
- (6) To reduce the generation of electro-static discharge, be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended.

12.4 PRECAUTIONS FOR OPERATION

- (1) Viewing angle varies with the change of liquid crystal driving voltage (V_o). Adjust V_o to show the best contrast.
- (2) Driving the LCD in the voltage above the limit will shorten its lifetime.
- (3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.
- (4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then on.
- (5) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, this product must be used and stored within the specified condition of $23\pm 5^{\circ}\text{C}$, $45\pm 20\% \text{RH}$.
- (6) When turning the power on, input each signal after the positive/negative voltage becomes stable.

12.5 SAFETY

- (1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.
- (2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

13. REVISION HISTORY

Version	Revise record	Date
1.0	Original version	05-11-21

SAMPLE APPROVED REPORT (样品确认单)

SAMPLE MODEL NO. (样品型号)	GT2001
SAMPLE SERIES NUMBER NO. (样品序号)	
SAMPLE QUANTITY (样品数量)	
COLOR/TYPE (底色/类型)	FSTN/POSITIVE
VIEWING DIRECTION (视角)	6:00
DRIVING METHOD (驱动参数)	1/33Duty, 1/6Bias
LOGIC VOLTAGE (IC 工作电压)	3.0V
LCD VOP (LCD 驱动电压)	5.0V
OPERATING TEMP. (操作温度)	-20~70
STORAGE TEMP. (储存温度)	-30~80
POLARIZER----FRONT (首偏光片)	TRANSMISSIVE
POLARIZER----BACK (后偏光片)	TRANSFLECTIVE
CONTROLLER/DRIVER IC(控制/驱动 IC)	NT7502
BACKLIGHT COLOR/TYPE (背光源类型/颜色)	NONE
DRAWING REV/NO./QUANTITY (图纸版本/数量)	
SPECIFICATION (规格书 份数)	
REMARKS : (备注)	
WRIT BY : _____ DATE : _____ APROV BY : _____ DATE : _____	
CUSTOMER'S APPROVAL (客户确认) :	
1) FUNCTION (功能) : <input type="checkbox"/> OK <input type="checkbox"/> N.G.	
2) DRIVER CONDITION (驱动条件) : <input type="checkbox"/> OK <input type="checkbox"/> N.G.	
3) DISPLAY MODE (显示模式) : <input type="checkbox"/> OK <input type="checkbox"/> N.G.	
4) VIEWING ANGLE (视角) : <input type="checkbox"/> OK <input type="checkbox"/> N.G.	
5) BACKLIGHT (背光源) : <input type="checkbox"/> OK <input type="checkbox"/> N.G.	
6) DISPLAYING PATTERN (显示效果) : <input type="checkbox"/> OK <input type="checkbox"/> N.G.	
CUSTOMER'S CONCLUSIONS (客户意见) : _____	

CUSTOMER'S SIGNATURE (客户签名) : _____ DATE (日期) : _____	