

LCD Module

Product Specification

: APPROVAL FOR SPECIFICATION

For Customer : _____ : APPROVAL FOR SAMPLE

Module No. : TSM160128B-18

For Customer's Acceptance :

Approved by	Comment

Team Source Display :

Presented by	Reviewed by	Organized by

This module uses ROHS material

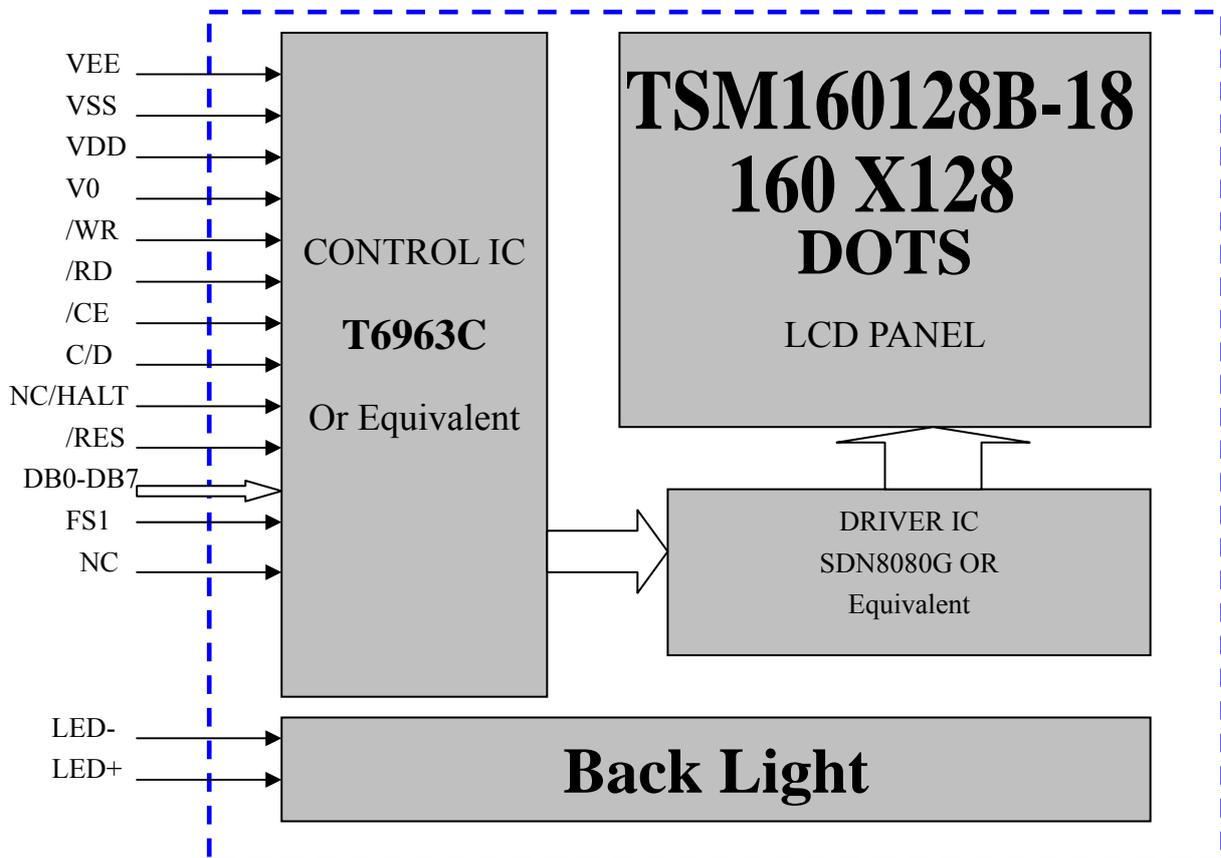
CONTENTS

FUNCTIONS & FEATURES	3
BLOCK DIAGRAM	3
MODULE OUTLINE DRAWING	4
INTERFACE PIN FUNCTIONS	5
ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)	5
DC ELECTRICAL CHARACTERISTICS	5
LED BACKLIGHT CHARACTERISTICS	6
CONNECTION WITH MCU	6
Typical V0 connections for display contrast	6
AC CHARACTERISTICS	7
OPTICAL CHARACTERISTICS	10
DISPLAY FUNCTIONS	12
CHARACTER CODE MAP	14
RELIABILITY TEST CONDITION	15
PRECAUTION FOR USING LCM MODULE	16
OTHERS	16
APPENDIX A: DATE CODE RULES	17
APPENDIX B: CHANGE NOTES	17

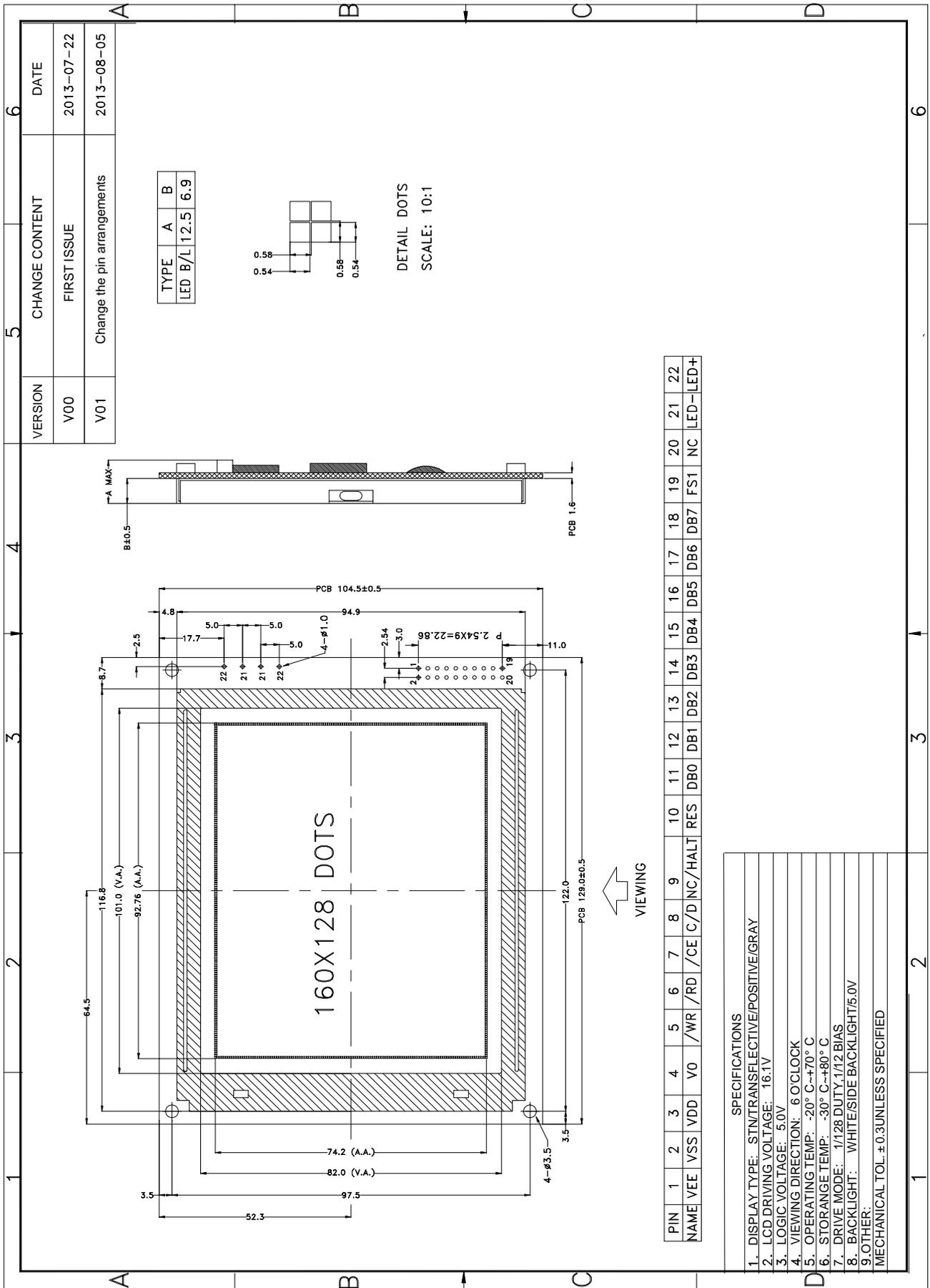
FUNCTIONS & FEATURES

● Construction	: COB
● Display Format	: 160x128 dots
● Display Type	: STN, Transflective, Positive, gray
● Controller	: T6963C or equivalent controller
● Interface	: 8-bit parallel interface
● Backlight	: white/ side light
● Viewing Direction	: 6 O'clock
● Driving Scheme	: 1/128 Duty Cycle, 1/12 Bias
● Power Supply Voltage	: 5.0 V
● V _{LCD} Adjustable For Best Contrast	: 16.1 V (V _{OP.})
● Operation temperature	: -20°C to +70°C
● Storage temperature	: -30°C to +80°C

BLOCK DIAGRAM



MODULE OUTLINE DRAWING



INTERFACE PIN FUNCTIONS

Pin No.	Symbol	Level	Description
1	VEE	--	Voltage output.
2	VSS	0V	Ground output for pad option.
3	VDD	+5.0V	Supply voltage for logic operating.
4	V0	--	Adjusting LCD driver supplies voltages.
5	/WR	H/L	Data write. Write data into T6963C when WR=L.
6	/RD	H/L	Data read. Read data from T6963C when RD=L.
7	/CE	H/L	Chip Enable for T6963C. CE must be L when CPU communicates with T6963C.
8	C/D	H/L	WR=L.....C/D=H: Command Write C/D=L: Data Write RD=L.....C/D=H: Status Read C/D=L: Data Read
9	NC/HALT	H/L	NC/H.....Normal, L.....Stop the oscillation of the clock (Non-connection.)
10	/RES	H/L	H.....Normal (T6963C has internal pull-up resister) L.....Initialize T6963C. Text and Graphic have addresses and text and graphic area settings are retained.
11	DB0	H/L	Data I/O pins between CPU and T6963C (DB7 is MSB)
12	DB1	H/L	
13	DB2	H/L	
14	DB3	H/L	
15	DB4	H/L	
16	DB5	H/L	
17	DB6	H/L	
18	DB7	H/L	
19	FS1	H/L	Pins for selection of font 8X8. The pin FS0 has been connected to the LOW in the PCB.(J13 is shorted)
20	NC	--	Non-connection.
21	LED-	0V	The backlight ground.
22	LED+	+5.0V	Power supply for backlight.

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

Parameter	Symbol	Min	Max	Unit
Supply voltage for logic	V _{DD}	-0.3	+6.5	V
Supply voltage for LCD	V _o	-0.3	+18.2	V
Input voltage	V _i	-0.3	V _{DD} +0.3	V
Normal Operating temperature	T _{OP}	-20	+70	°C
Normal Storage temperature	T _{ST}	-30	+80	°C

Note: Stresses beyond those given in the Absolute Maximum Rating table may cause operational errors or damage to the device. For normal operational conditions see AC/DC Electrical Characteristics.

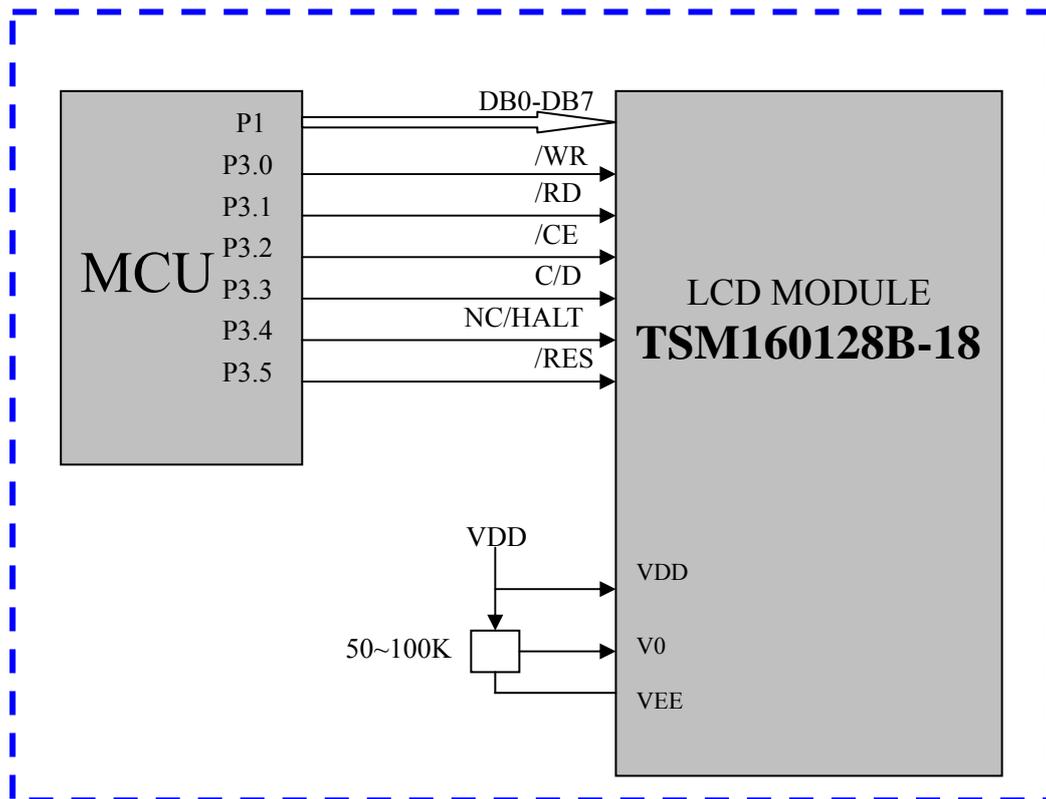
DC ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Min	T _{YP}	Max	Unit
Supply voltage for logic	VDD	--	4.8	5.0	5.2	V
Supply current for logic	IDD	--	--	75	100	mA
Operating voltage for LCD	VLCD	-20°C				
		+25°C	15.8	16.1	16.3	V
		+70°C				
Input voltage "H" level	VIH	--	0.8 VDD	--	VDD	V
Input voltage "L" level	VIL	--	0	--	0.2VDD	V

LED BACKLIGHT CHARACTERISTICS

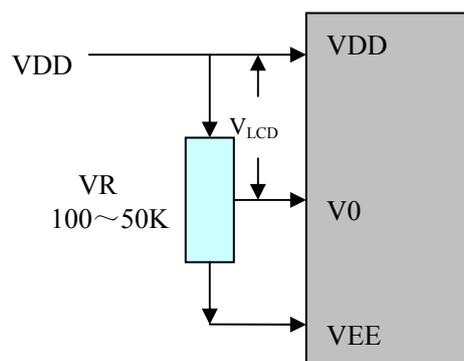
COLOR	Wavelength λ p(nm)	Operating Voltage($\pm 0.15V$)	Spectral line half width $\Delta \lambda$ (nm)	Forward Current (mA)
white	--	3.0	--	120.0

CONNECTION WITH MCU



Typical V0 connections for display contrast

Adjust V0 to VDD (VLCD=-16.1V) as an initial setting. When the module is operational, readjust V0 for optimal display appearance.



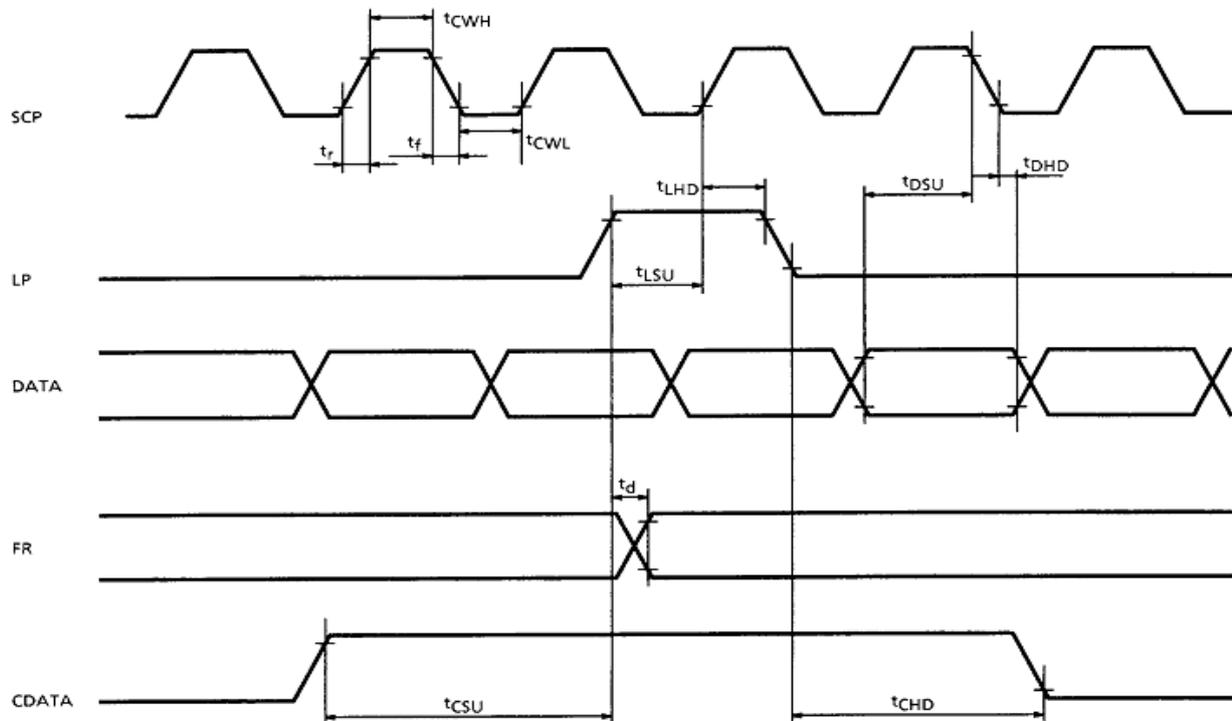
We recommend allowing field adjustment of V_0 for all designs. The optimal value for V_0 will change with temperature, variations in V_{DD} , and viewing angle. V_0 will also vary module-to-module and batch-to-batch due to normal manufacturing variations.

Ideally, adjustment to V_0 should be available to the end user so each user can adjust the display to the optimal contrast for their required viewing conditions. As a minimum, your design should allow V_0 to be adjusted as part of your product's final test.

Although a potentiometer is shown as a typical connection, V_0 can be driven by your microcontroller, either by using a DAC or a filtered PWM. Displays that require V_0 to be negative may need a level-shifting circuit. Please do not hesitate to contact Tinspring application support for design assistance on your application.

AC CHARACTERISTICS

Switching Characteristics (1)

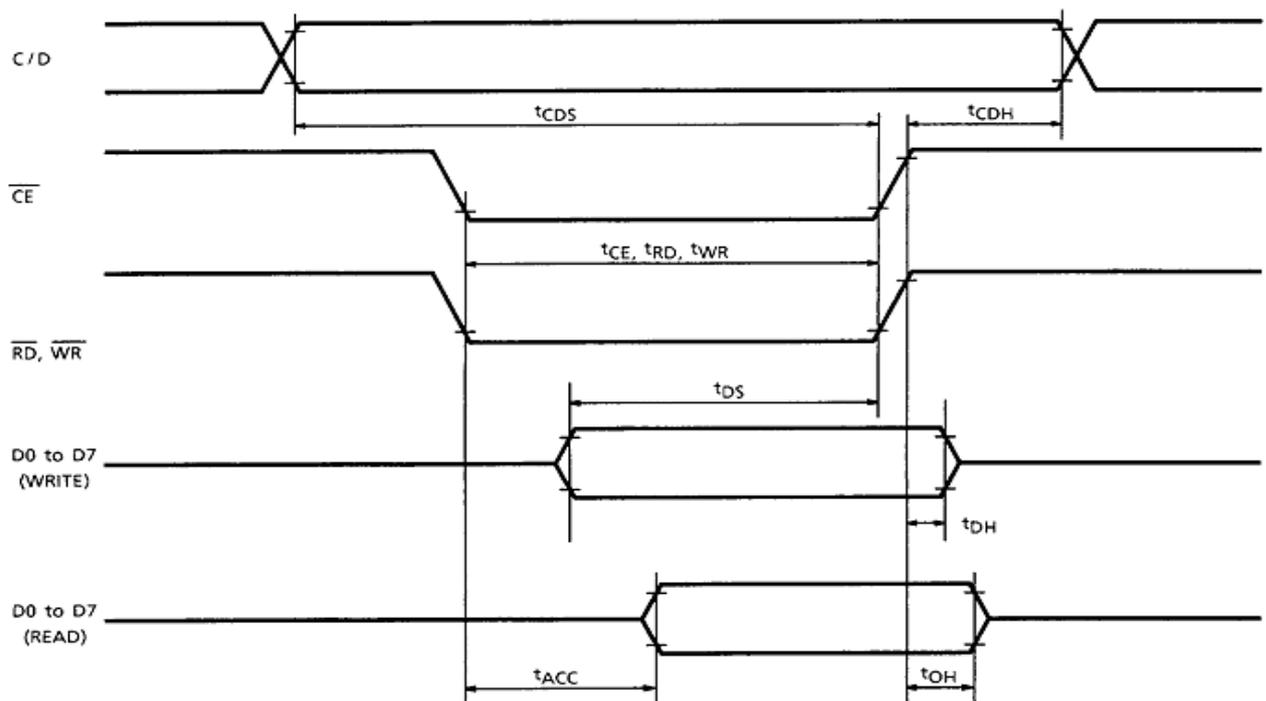


TEST CONDITIONS (Unless otherwise noted, $V_{DD} = 5.0V \pm 10\%$, $V_{SS} = 0V$, $T_a = -20$ to $70^\circ C$)

ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Operating Frequency	f_{scp}	$T_a = -10 \sim 70^\circ C$	—	2.75	MHz
SCP Pulse Width	t_{CWH}, t_{CWL}	—	150	—	ns
SCP Rise / Fall Time	t_r, t_f	—	—	30	ns
LP Set-up Time	t_{LSU}	—	150	290	ns
LP Hold Time	t_{LHD}	—	5	40	ns
Data Set-up Time	t_{DSU}	—	170	—	ns
Data Hold Time	t_{DHD}	—	80	—	ns
FR Delay Time	t_d	—	0	90	ns
CDATA Set-up Time	t_{CSU}	—	450	850	ns
CDATA Hold Time	t_{CHD}	—	450	950	ns

Switching Characteristics (2)

Bus Timing

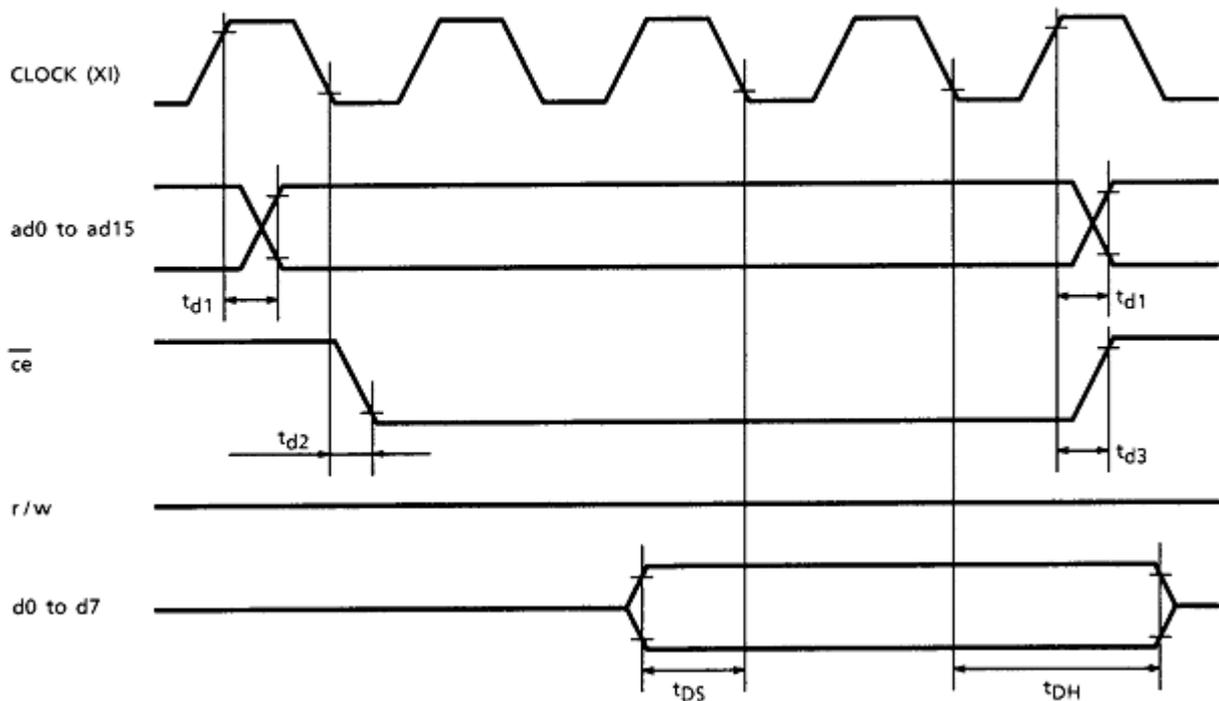


TEST CONDITIONS (Unless otherwise noted, $V_{DD} = 5.0V \pm 10\%$, $V_{SS} = 0V$, $T_a = -20$ to $75^\circ C$)

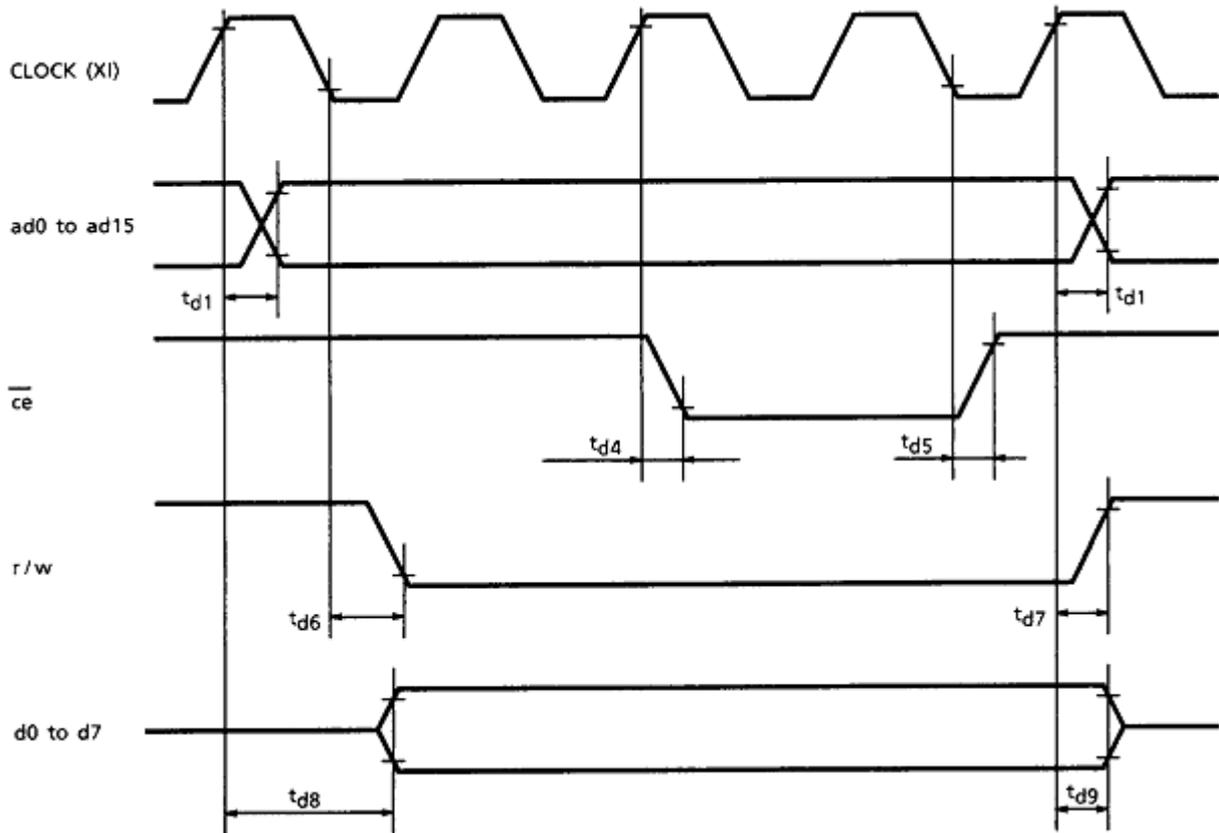
ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
C/D Set-up Time	t_{CDS}	—	100	—	ns
C/D Hold Time	t_{CDH}	—	10	—	ns
\overline{CE} , RD, WR Pulse Width	t_{CE} , t_{RD} , t_{WR}	—	80	—	ns
Data Set-up Time	t_{DS}	—	80	—	ns
Data Hold Time	t_{DH}	—	40	—	ns
Access Time	t_{ACC}	—	—	150	ns
Output Hold Time	t_{OH}	—	10	50	ns

Switching Characteristics (3)

(1) External RAM Read mode



(2) External RAM Write mode



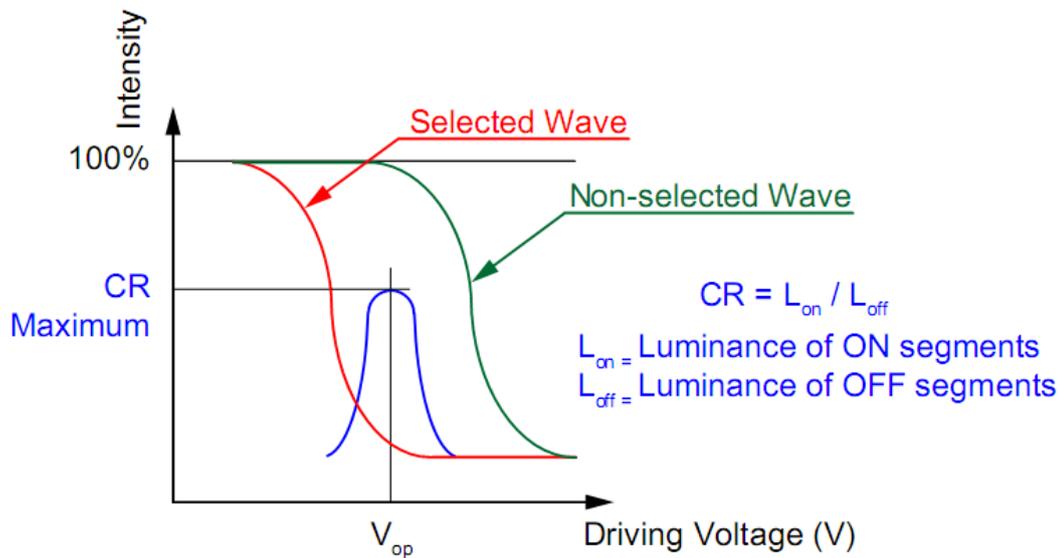
TEST CONDITIONS (Unless otherwise noted, $V_{DD} = 5.0V \pm 10\%$, $V_{SS} = 0V$, $T_a = -20$ to $70^\circ C$)

ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Address Delay Time	t_{d1}	—	—	250	ns
\overline{ce} Fall Delay Time (Read)	t_{d2}	—	—	180	ns
\overline{ce} Rise Delay Time (Read)	t_{d3}	—	—	180	ns
Data Set-up Time	t_{DS}	—	0	—	ns
Data Hold Time	t_{DH}	—	30	—	ns
\overline{ce} Fall Delay Time (Write)	t_{d4}	—	—	200	ns
\overline{ce} Rise Delay Time (Write)	t_{d5}	—	—	200	ns
r/w Fall Delay Time	t_{d6}	—	—	180	ns
r/w Rise Delay Time	t_{d7}	—	—	180	ns
Data Stable Time	t_{d8}	—	—	450	ns
Data Hold Time	t_{d9}	—	—	200	ns

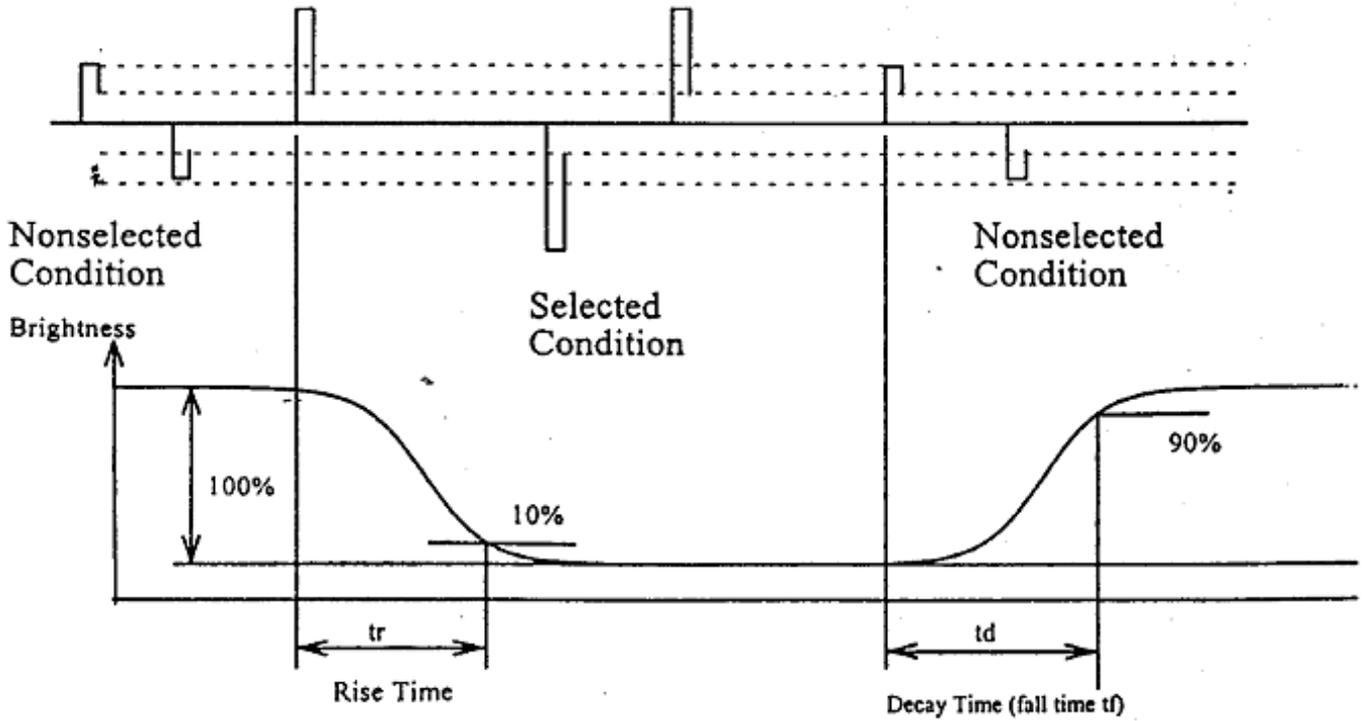
OPTICAL CHARACTERISTICS

ITEM	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT	NOTE
Contrast ratio	CR	$\theta=0, \Phi=0$	-	3	-		
Response time(rise)	Tr	25°C		-	250	ms	
Response time(fall)	Td			-	350		
Viewing angle	θ_f	25°C				deg.	
	θ_b						
	θ_l			-			
	θ_r			-			

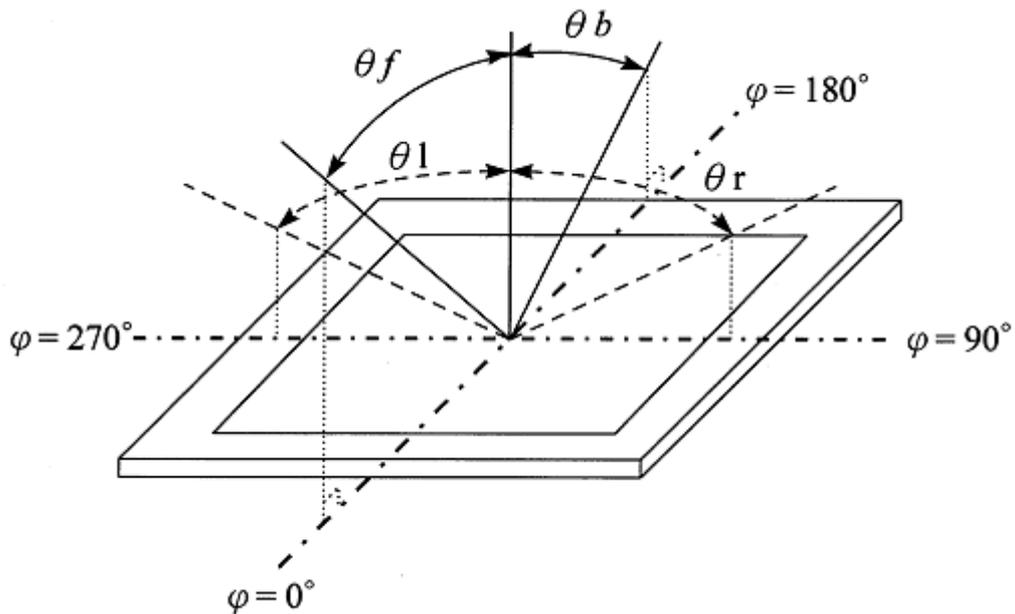
Note1: Definition Operation Voltage. (V_{OP})



Note2: Response time



Note3: Viewing angle



DISPLAY FUNCTIONS

FUNCTIONAL DEFINITION:

- After power on, it is necessary to reset. $\overline{\text{RESET}}$ is kept L between 5 clocks up (oscillation clock).
- When $\overline{\text{HALT}} = \text{L}$, the oscillation stops. The power supply for the LCD must now be turned off, to protect the LCD from DC bias.
- The HALT function includes the RESET function.
- The column/line counter and display register are cleared by RESET. (Other registers are not cleared.) Disable the display using the clear-display register.
- The status must be checked before data or commands are sent. The MSB = 0 status check must be done in particular. There is a possibility of erroneous operation due to a hard interrupt.
- STA0 and STA1 must be checked at the same time. When a command is executed, data transmission errors may occur.
- The T6963C can only handle one byte per machine cycle (16 clocks). It is impossible to send more than two data in a machine cycle.
- When using a command with operand data, it important to send the data first, and then execute the command.
- The character codes used by the T6963C are different from ASCII codes.

COMMAND DEFINITIONS:

COMMAND	CODE	D1	D2	FUNCTION
REGISTERS SETTING	00100001	X address	Y address	Set Cursor Pointer
	00100010	Data	00H	Set Offset Register
	00100100	Low address	High address	Set Address Pointer
SET CONTROL WORD	01000000	Low address	High address	Set Text Home Address
	01000001	Columns	00H	Set Text Area
	01000010	Low address	High address	Set Graphic Home Address
	01000011	Columns	00H	Set Graphic Area
MODE SET	1000X000	—	—	OR mode
	1000X001	—	—	EXOR mode
	1000X011	—	—	AND mode
	1000X100	—	—	Text Attribute mode
	10000XXX	—	—	Internal CG ROM mode
	10001XXX	—	—	External CG RAM mode
DISPLAY MODE	10010000	—	—	Display off
	1001XX10	—	—	Cursor on, blink off
	1001XX11	—	—	Cursor on, blink on
	100101XX	—	—	Text on, graphic off
	100110XX	—	—	Text off, graphic on
	100111XX	—	—	Text on, graphic on

CURSOR PATTERN SELECT	10100000	—	—	1-line cursor
	10100001	—	—	2-line cursor
	10100010	—	—	3-line cursor
	10100011	—	—	4-line cursor
	10100100	—	—	5-line cursor
	10100101	—	—	6-line cursor
	10100110	—	—	7-line cursor
	10100111	—	—	8-line cursor
DATA AUTO READ/ WRITE	10110000	—	—	Set Data Auto Write
	10110001	—	—	Set Data Auto Read
	10110010	—	—	Auto Reset
DATA READ/WRITE	11000000	Data	—	Data Write and Increment ADP
	11000001	—	—	Data Read and Increment ADP
	11000010	Data	—	Data Write and Decrement ADP
	11000011	—	—	Data Read and Decrement ADP
	11000100	Data	—	Data Write and Nonvariable ADP
	11000101	—	—	Data Read and Nonvariable ADP
SCREEN PEEK	11100000	—	—	Screen Peek
SCREEN COPY	11101000			Screen Copy
BIT SET/RESET	11110XXX	—	—	Bit Reset
	11111XXX	—	—	Bit Set
	1111X000	—	—	Bit 0 (LSB)
	1111X001	—	—	Bit 1
	1111X010	—	—	Bit 2
	1111X011	—	—	Bit 3
	1111X100	—	—	Bit 4
	1111X101	—	—	Bit 5
	1111X110	—	—	Bit 6
	1111X111	—	—	Bit 7 (MSB)

X : invalid

CHARACTER CODE MAP

ROM code 0101

MSB \ LSB	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		!	"	#	\$	%	&	'	()	*	+	,	-	.	/
1	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
2	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
3	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	_
4	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
5	P	q	r	s	t	u	v	w	x	y	z	{		}	~	
6	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
7	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6

CG ROM TYPE 0201

MSB \ LSB	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		!	"	#	\$	%	&	'	()	*	+	,	-	.	/
1	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
2	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
3	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	_
4	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2
5	-	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1
6	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
7	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8

RELIABILITY TEST CONDITION

No.	TEST Item	Content of Test	Test Condition	Applicable Standard
1	High temperature storage	Endurance test applying the high storage Temperature for a long time.	80° C 96hrs	-----
2	Low temperature storage	Endurance test applying the low storage Temperature for a long time	-30° C 96hrs	-----
3	High temperature operation	Endurance test applying the electric stress (Voltage & current)and the thermal stress to the element for a long time	70° C 96hrs	-----
4	Low temperature operation	Endurance test applying the electric stress Under low temperature for a long time	-20° C 96hrs	-----
5	High temperature/ Humidity storage	Endurance test applying the electric stress(Voltage & current) and Temperature/ Humidity stress to the element for a long time	40° C 90%RH 96hrs	
6	High temperature/ Humidity operation	Endurance test applying the electric stress (voltage & current)and temperature/ humidity stress to the element for a long time	40° C 90%RH 96hrs	
7	Temperature cycle	Endurance test applying the low and high temperature cycle. -20° C →25° C→70° C 30min←5min←30min.(1 cycle)	-20° C/70° C 10 cycle	-----

Supply voltage for logic system = 5V. Supply voltage for LCD system = Operating voltage at 25° C.

Mechanical Test

Vibration test	Endurance test applying the vibration during transportation and using	10~22Hz→1.5mmp-p 22~500Hz→1.5G Total 0.5hour	
Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G half sign wave 11 msede 3 times of each direction	
Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air	115mbar 40hrs	
Static electricity test	Endurance test applying the electric stress to the terminal	VS=800V,RS-1.5K Ω CS=100pF, 1 time	

Environmental condition

The inspection should be performed at the 1metre height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25°C and normal humidity 60±15%RH).

PRECAUTION FOR USING LCM MODULE

- Please remove the protection foil of polarizer before using.
- The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
- If the display panel is damaged and the liquid crystal substance inside it leaks out, do not get any in your mouth. If the substance come into contact with your skin or clothes promptly wash it off using soap and water.
- Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarize carefully.
- 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 assembly, such as soldering irons, must be properly grounded.
 - To reduce the amount of static electricity generated, do not conduct assembly 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.
- Storage precautions

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.
Keep the modules in bags designed to prevent static electricity charging under low temperature / normal humidity conditions (avoid high temperature / high humidity and low temperatures below 0°C).Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

OTHERS

- Liquid crystals solidify at low temperature (below the storage temperature range) leading to defective orientation of liquid crystal or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subjected to a strong shock at a low temperature.
- If the LCD modules have been operating for a long time showing the same display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. Abnormal operating status can be resumed to be normal condition by suspending use for some time. It should be noted that this phenomena does not adversely affect performance reliability.
- To minimize the performance degradation of the LCD modules resulting from 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