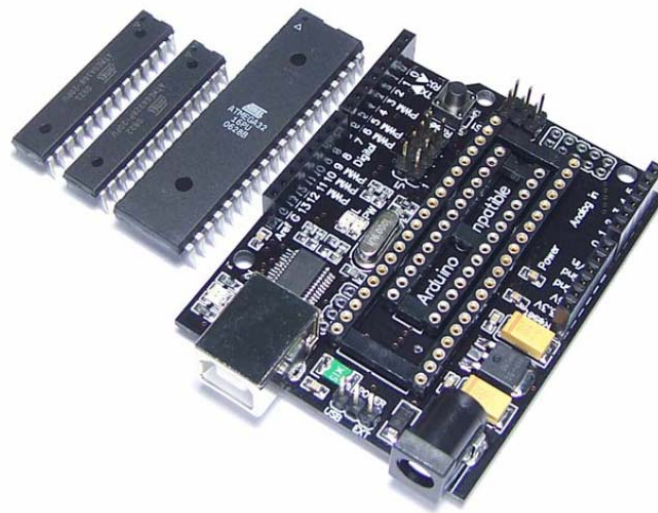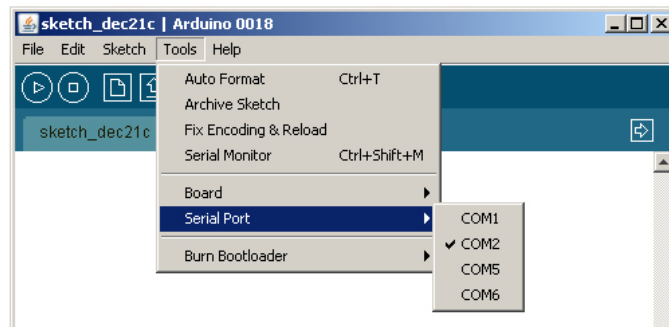# Ardunio Software User Guide
Version 018
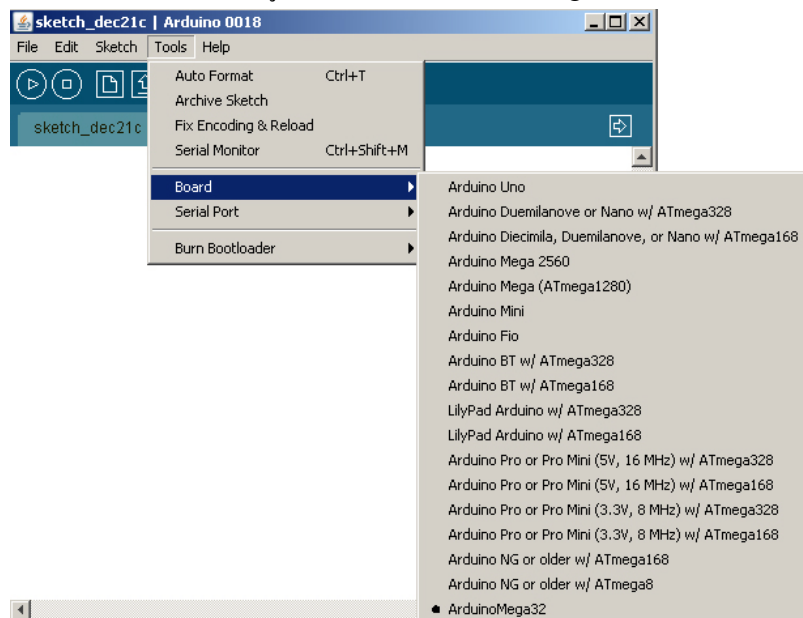
The Arduino Diecimila Compatible™ (DIP-28/40)

Software Setup (version 0018)

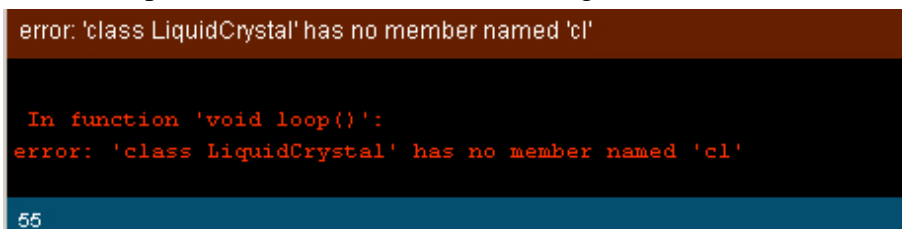1. ทำการกำหนด Port ในการสื่อสารกับ Board ได้จากเมนู Tools→Serial Ports

2. ทำการกำหนดชนิดของ Board จากเมนู Tools→Board→Atmega32

3. ขั้นตอนการ Compile โปรแกรมเพื่อทำการตรวจสอบเมื่อทำการเขียนโค๊ดเสร็จเรียบร้อย ให้ทำการกดปุ่ม

 ทำการ Compile โค๊ด สามารถสังเกต Error/Warning ได้จากพื้นที่สีดำดังภาพตัวอย่าง

4. สามารถเข้าดู Library reference ได้จากเมนู Help→References

การทดลองที่ 3HB03
Ardunio "ADC and LCD"

1. บทนำ

MCU ตระกูล ATMEGA ซึ่งเป็ตระกูลที่พัฒนาต่อมาจาก 89c51 ที่ได้รับความนิยมเป็นอย่างสูงจากในอดีต โดยได้เพิ่มเติมความสามารถให้กับ MCU จาก 89c51 ไปหลายส่วน เช่น ขนาดของ ROM RAM และ EEProm เพิ่มเติมความสามารถภายในการอ่านค่าจากสัญญญาณอนล๊อกจากภายนอก "Analog to Digital Coverter" และฟังก์ชั่นในการสร้าง Pulse width modulation และอื่น ๆ อีกหลายส่วน ซึ่งทำให้ MCU ตระกูล ATMEGA ถือได้ว่าเป็น MCU ที่ครบครันที่จะเลือกสรรในการใช้งาน

บอร์ด Ardunio กำลังได้รับความนิยมในการพัฒนาการใช้งานประยุกต์ของ Microcontroller เนื่องจาก สามารถเรียนรู้ได้ง่าย มีราคาไม่แพง โดย Board Ardunio นั้นได้ใช้ MCU ของ ATMEGA เป็น main controller ในการพัฒนาบอร์ดสำเร็จรูปสำหรับการทำงานพร้อมทั้งยังได้มีส่วนสนับสนุนทางด้านการ ติดต่อสื่อสารระหว่าง software และ Board ผ่าน Serial port (RS-232) และฟังก์ชั่นพื้นฐานที่สามารถเรียกใช้ งานได้อย่างสะดวกสบายและอาจจะเป็นเรียกได้ว่าเป็น 3G programming ซึ่งส่งผลให้การพัฒนาความสามารถของ MCU ใช้งานจริงมีความสะดวกรวดเร็วยิ่งขึ้น

2. วัตถุประสงค์
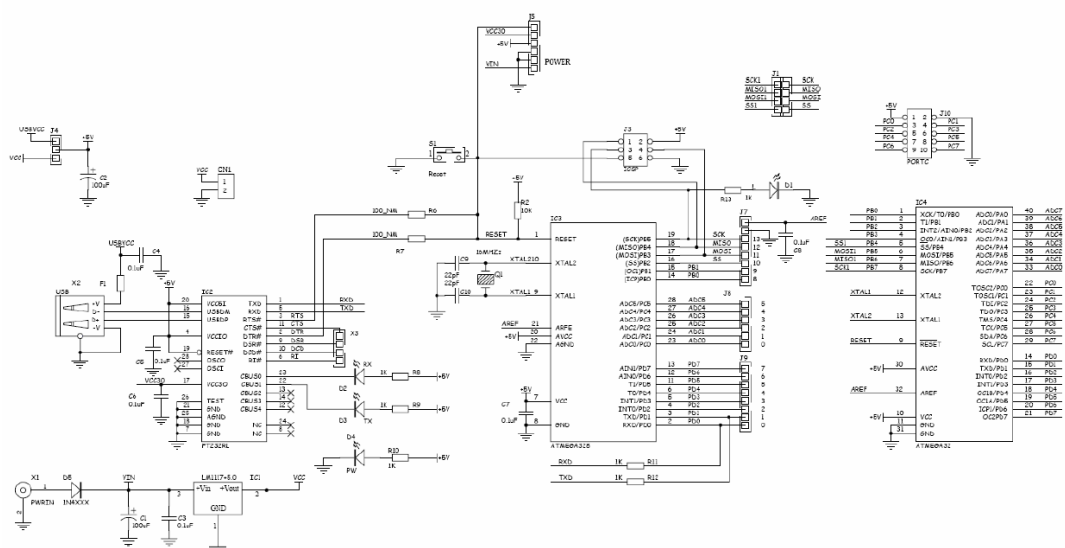
2.1. แนะนำให้รู้จักการใช้งาน Board Ardunio ในการออกแบบพัฒนาวงจรรวม

2.2. สามารถประยุกต์ใช้งาน Board Ardunio ในการแสดงผลสัญญาณต่าง ๆ ได้

3. อุปกรณ์

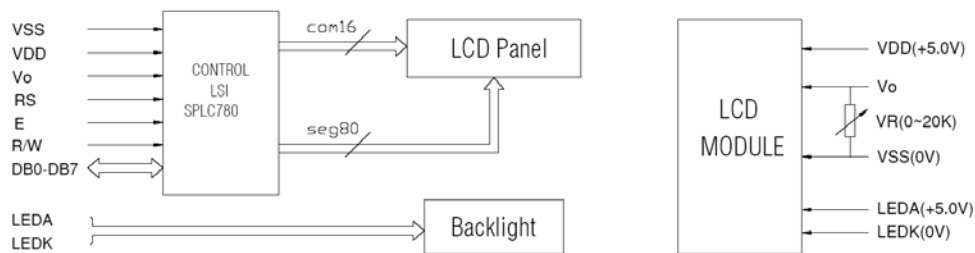3.1. LCD ขนาด 16x2 (16 charactors 2 lines)

3.2. Ardunio board รุ่น Atmega 32

3.3. Variable Resistor (VR) 20K

4. ทำการทดลอง

ภาพวงจรรวม Ardunio Atmga 32

ภาพวงจรรวมของ LCD

No.	Symbol	Function
2	VDD	Power supply for Logic(+5V)
1	VSS	GND(0V)
3	V0	Power supply for LCD drive
4	RS	Register selection (H: Data register, L: Instruction register)
5	R/W	Read/write selection (H: Read, L: Write)
6	E	Enable signal for LCM
7~14	DB0~DB7	Data Bus line
A	LEDA	Power supply for Backlight(+5V)
K	LEDK	Power supply for Backlight(0V)

4.1. ทำการเชื่อมโยงขาของ Board Ardunio เข้า กับ LCD ดังนี้

LCD	Ardunio
RS	digital pin 12
Enable	digital pin 11
D4	digital pin 5
D5	digital pin 4
D6	digital pin 3
D7	digital pin 2

4.2. เชื่อมโยงขา VDD และ VSS เข้ากับ Power Supply ขนาด 5 volt

4.3. เชื่อมโยง VR เข้ากับขา VO และ VSS

4.4. ตัวอย่างการกำหนดขาในโปรแกรม

- const int RS = 12;   //ขา RS ต่อกับขา 12
- const int Enable = 11;   //ขา Enable ต่อกับขา 11
- const int analogInput = 0;   //ขา analogInput ต่อกับขา 0

4.5. ตัวอย่างการกำหนดชนิดการทำงานของขา RS และ D4 ทำงานแบบ Output และ

- pinMode(RS,OUTPUT)
- pintMode(D4,OUTPUT)

4.6. โครงสร้างโปรแกรมใน Ardunio

```
const int RS =  12;                    // กำหนดชื่อขา I/O ของ Ardunio
int adcValue = 0;                      // กำหนดตัวแปรชนิด Interger ชื่อ adcValue
  .
  .
void setup()   {                       // กำหนดรูปแบบของขา I/O
  pinMode(RS, OUTPUT);
  .
  .
}
void loop()                            // Function การทำงานหลัก
{
 digitalWrite(RS, HIGH);       // set the RS=1
 delay(1000);                  // wait for a second
 digitalWrite(RS, LOW);        // set the RS=0
 delay(1000);                  // wait for a second
 adcValue = analogRead(analogInput);   // ทำการอ่านค่าขา ADC จากขา 0
  .
  .
  .
}
```

4.7. ทำการโปรแกรมกำหนดให้ LCD ทำงานแบบ 4 Bit communication chart (ห้ามใช้โค๊ดสำเร็จรูป จาก Ardunio ให้ทำการเขียนโปรแกรมเอง)
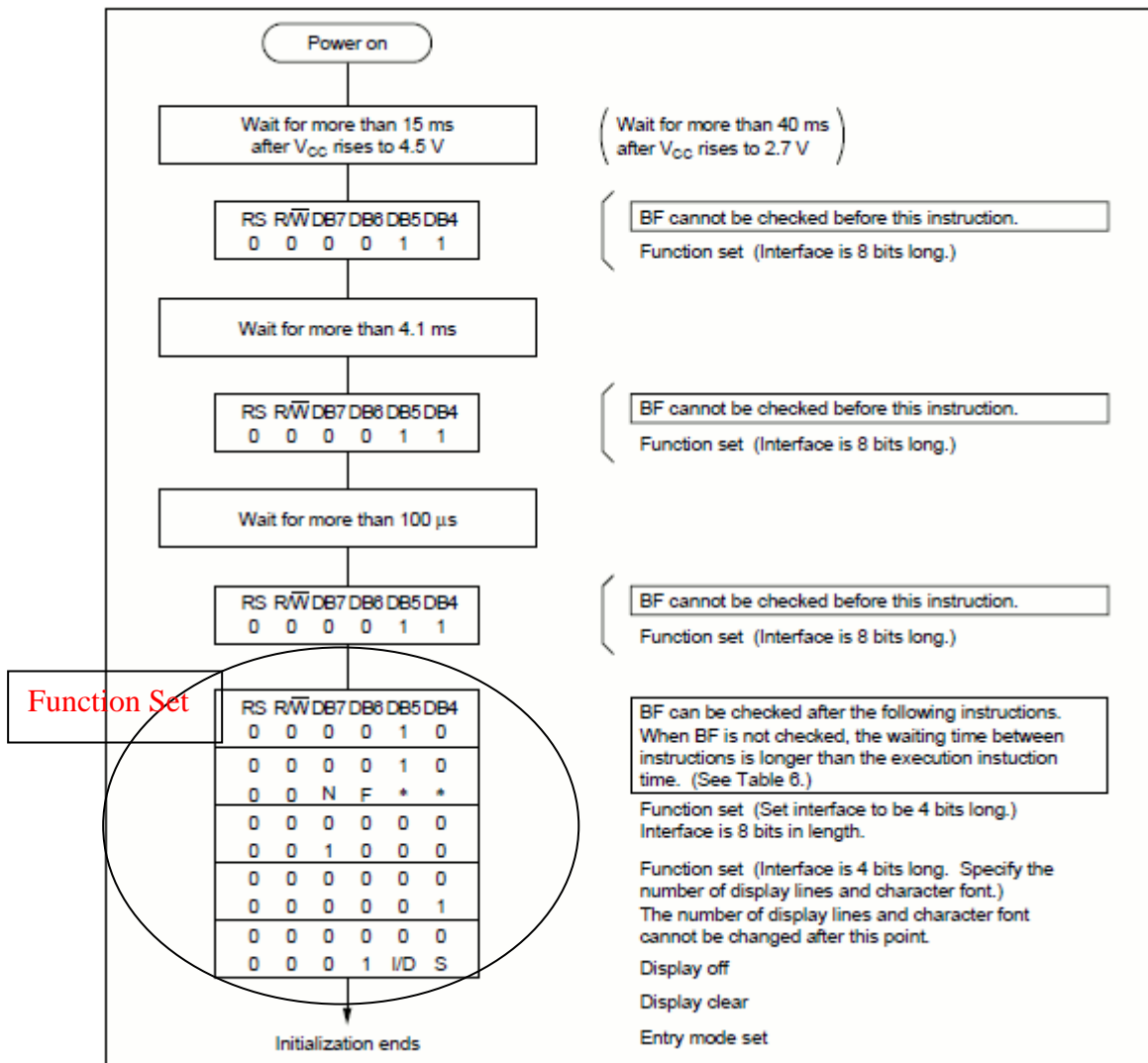
4.7.1. Send command 0x30   - Using 8-bit interface
4.7.2. Delay 20ms
4.7.3. Send command 0x30   - 8-bit interface
4.7.4. Delay 20ms
4.7.5. Send command 0x30   - 8-bit interface
4.7.6. Delay 20ms
4.7.7. **Send Function set**   - see Table 4 for more information

Check Point 1: ค่าในตาราง Function Set แต่ละบรรทัดเป็นการกำหนดอะไรบ้าง (TA สุ่มถาม 3 บรรทัด)

4.7.8. Display Clear command
4.7.9. Set entry mode command - explained below
4.8. ทำการเขียนโปรแกรมเพื่อแสดงรหัสนักศึกษาแสดงบน LCD ในบรรทัดที่ 1 และ ชื่อ ในบรรทัดที่ 2

Check Point 2: ดูผล Output บนจอ LCD

4.9. ทำการเขียนโปรแกรมติดต่อ ADC ขา 0 โดยแสดงบนผลหน้าจอLCD

```
Sensor: xxxx
Voltage: y.yy
```

xxxx = สัญญาณค่าระดับ interger ที่อ่านได้โดยตรงผ่าน ADC ความละเอียด 10 bits

y.yy = ระดับแรงดันสัญญาณ Input ที่มาจาก ADC โดยมีระดับแรงดันเต็มสเกลที่ 5 volts

Check Point 3: ดูผล Output บนจอ LCD

SPECIFICATION
FOR
LCM MODULE

MODULE NO.: ABC016002A07-GHY
DOC.REVISION: 00

Customer Approval:

	SIGNATURE	DATE
PREPARED BY (RD ENGINEER)		Apr-11-2006
PREPARED BY (QA ENGINEER)		
CHECKED BY		
APPROVED BY		

CONTENTS

1. FUNCTIONS & FEATURES

1.1. Format   : 16x2 characters
1.2. LCD mode   : STN / Positive Transflective Mode / Grey
1.3. Viewing direction   : 6 o'clock
1.4. Driving scheme   : 1/16 Duty , 1/5 Bias
1.5. Power supply voltage (V_{DD}) : 5.0V
1.6. LCD driving voltage(Vop) : 4.2V
1.7. Operation temp   : -20~70℃
1.8. Storage temp   : -30~80℃
1.9. Backlight color   : Y-G

2. MECHANICAL SPECIFICATIONS

2.1. Module size   : 80.0mm(L)*36.0mm(W)*14.5(H) max mm
2.2. Viewing area   : 62.2mm(L)*17.9mm(W)
2.3. Character pitch   : 3.55mm(L)*5.95mm(W)
2.4. Character size   : 2.95mm(L)*5.55mm(W)
2.5. Dot pitch   : 0.55mm(L)*0.65mm(W)
2.6. Dot size   : 0.60mm(L)*0.70mm(W)
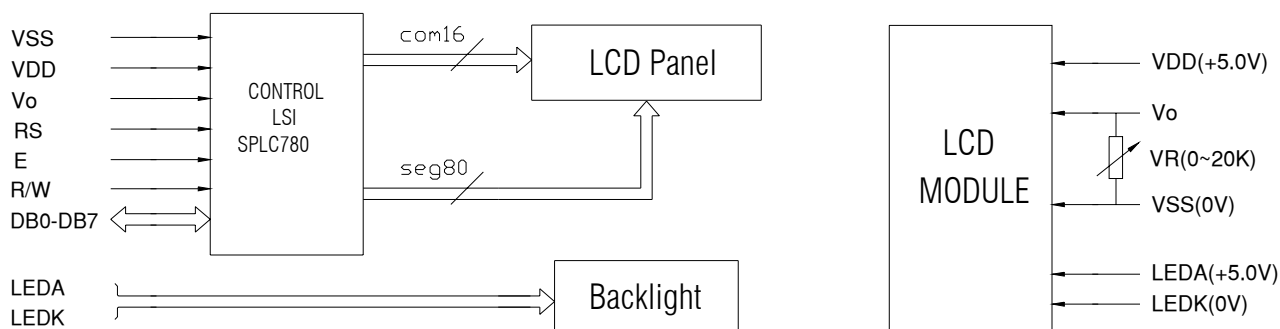2.7. Weight   : Approx.

3. BLOCK DIAGRAM
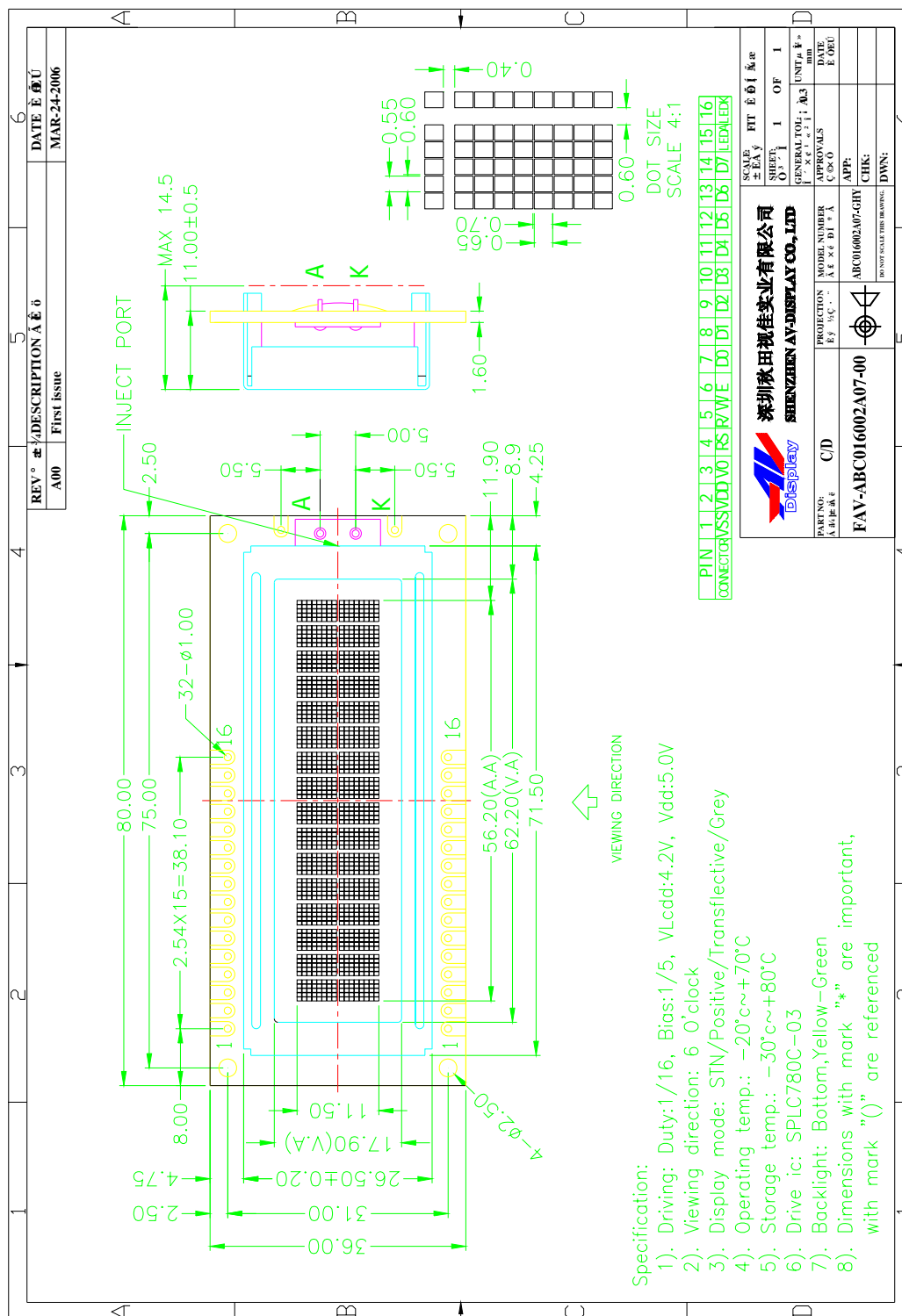

Figure1. Block diagram

4. DIMENSIONAL OUTLINE

Figure 2. Dimensional outline

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5. PIN DESCRIPTION

No.	Symbol	Function
1→2	VDD	Power supply for Logic(+5V)
2→1	VSS	GND(0V)
3	V0	Power supply for LCD drive
4	RS	Register selection (H: Data register, L: Instruction register)
5	R/W	Read/write selection (H: Read, L: Write)
6	E	Enable signal for LCM
7~14	DB0~DB7	Data Bus line
A	LEDA	Power supply for Backlight(+5V)
K	LEDK	Power supply for Backlight(0V)

6. MAXIMUM ABSOLUTE LIMIT

Maximum Absolute Power Ratings

Characteristic	Symbol	Unit	Value
Power Supply Voltage	V_{DD}	V	-0.3 to +7.0
Operating Voltage	V_{LCD}	V	V_{DD}-15.0 to V_{DD}+0.3
Input Voltage	V_{IN}	V	-0.3 to V_{DD}+ 0.3

NOTE: Voltage greater than above may damage the circuit.
VDD >V1 > V2 > V3 >V4 > V5

Temperature Characteristics

Characteristic	Symbol	Unit	Value
Operating Temperature	T_{OPR}	°C	-30 to +85
Storage Temperature	T_{STG}	°C	-55 to +125

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7. ELECTRICAL CHARACTERISTICS

7.1 DC CHARACTERISTICS
(VDD = 4.5V ~ 5.5V, Ta = -30℃ ~ +85℃)

Characteristic	Symbol	Condition	Min	Typ	Max	Unit
Operating Voltage	V_{DD}	–	4.5	–	5.5	V
Operating Current	I_{DD}	Internal oscillation or external clock (V_{DD} = 5.0V, fosc = 270kHz)	–	0.35	0.6	mA
Input Voltage (1)	V_{IH1}	–	2.2	–	V_{DD}	V
(except OSC1)	V_{IL1}	–	-0.3	–	0.6	
Input Voltage (2)	V_{IH2}	–	V_{DD}-1.0	–	V_{DD}	V
(OSC1)	V_{IL2}	–	-0.2	–	1.0	
Output Voltage (1)	V_{OH1}	I_{OH} = -0.205mA	2.4	–	–	V
(DB0 to DB7)	V_{OL1}	I_{OL} = 1.2mA	-	–	0.4	
Output Voltage (2)	V_{OH2}	I_O = -40μA	0.9V_{DD}	–	–	V
(except DB0 to DB7)	V_{OL2}	I_O = 40μA	–	–	0.1V_{DD}	
Voltage Drop	Vd_{COM}	I_O = ±0.1mA	–	–	1	V
	Vd_{SEG}		–	–	1	
Input Leakage Current	I_{LKG}	V_{IN} = 0V to V_{DD}	-1	–	1	μA
Input Low Current	I_{IL}	V_{IN} = 0V, V_{DD} = 5V (pull up)	-50	-125	-250	
Internal Clock (external Rf)	f_{OSC1}	Rf = 91kΩ ± 2% (V_{DD} = 5V)	190	270	350	kHz
External Clock	f_{OSC}	–	125	270	350	kHz
	duty		45	50	55	%
	t_R, t_F		–	–	0.2	μA
LCD Driving Voltage	V_{LCD}	V_{DD}-V5 (1/5, 1/4 bias)	3.0	–	13.0	V

4

7.2 AC Characteristics
(VDD = 4.5V ~ 5.5V, Ta = -30 ℃~ +85℃)

Mode	Characteristics	Symbol	Min	Typ	Max	Unit
Write Mode (refer to Figure-6)	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	-	-	
Read Mode (refer to Figure-7)	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	-	-	
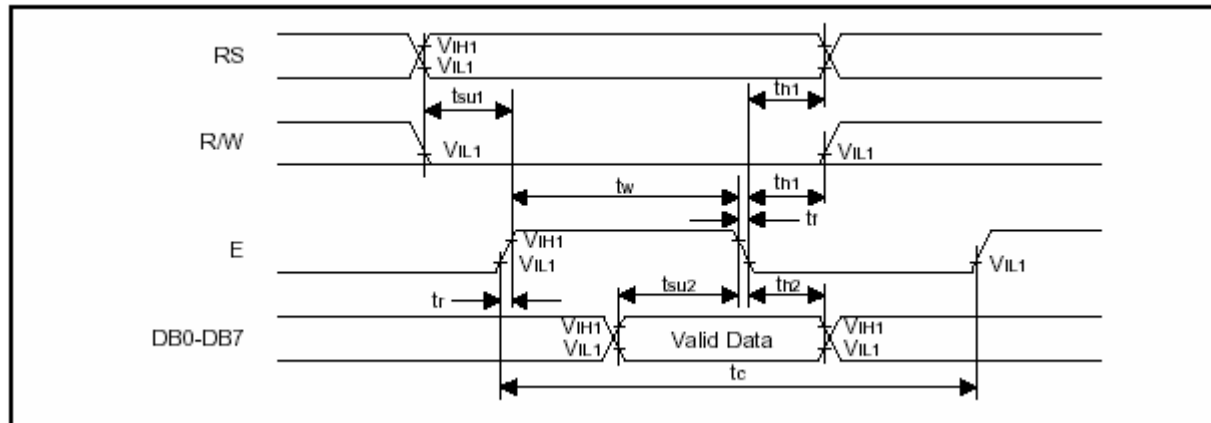
Figure 6. Write Mode Timing Diagram
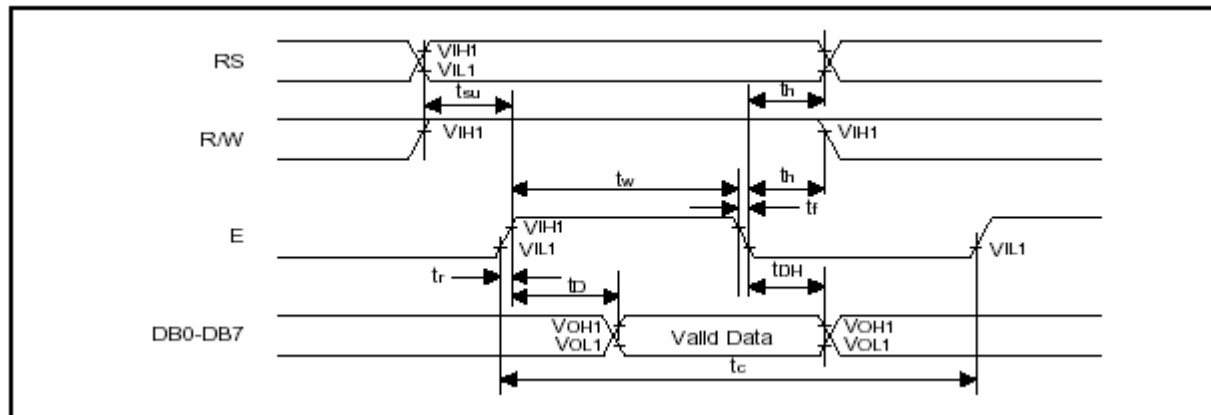
Figure 7. Read Mode Timing Diagram

5

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8. CONTROL AND DISPLAY INSTRUCTION

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".

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9. CHARACTER GENERATOR ROM

Upper 4 bit / Lower 4 bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL																
LLLH																
LLHL																
LLHH																
LHLL																
LHLH																
LHHL																
LHHH																
HLLL																
HLLH																
HLHL																
HLHH																
HHLL																
HHLH																
HHHL																
HHHH																

10. BACK LIGHT CHARACTERISTICS

LCD Module with bottom LED Backlight
ELECTRICAL   RATINGS

Ta = 25°C

Item	Symbol	Condition	Min	Typ	Max	Unit
Forward Voltage	VF	IF=110mA	4.0	4.2	4.5	V
Reverse Current	IR	VR=10V	---	---	0.11	mA
Wave length	λρ	IF=110mA	570	572	575	nm
Color		Yellow-green				

11. ELECTRO-OPTICAL CHARACTERISTICS

(V_{DD} = 5.0V, Ta = 25°C)

Item	Symbol	Condition	Min	Typ	Max	Unit
Operating Voltage Of LCD	Vop	Ta = -20°C	4.6	4.8	5.0	V
		Ta = 25°C	4.0	4.2	4.5	
		Ta = 70°C	3.7	3.8	4.0	
Response time	Tr	Ta = 25°C	---	185	---	ms
	Tf		---	200	---	ms
Contrast	Cr	Ta = 25°C	---	4	---	---
Viewing angle range	θ	Cr≥2	-40	---	+40	deg
	Φ		-40	---	+40	deg

$Cr = \dfrac{\text{Brightness of non-selected segment(B2)}}{\text{Brightness of selected segment(B1)}}$

8
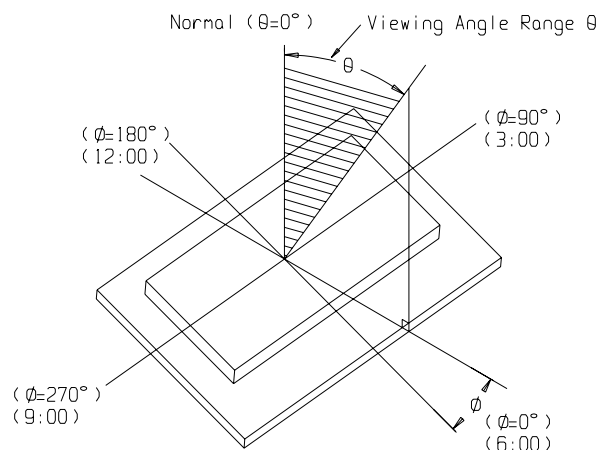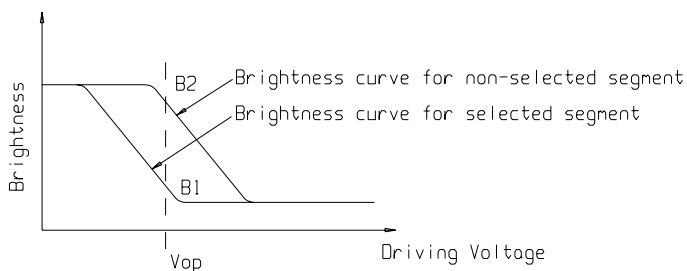
12.QUALITY SPECIFICATIONS

12.1 Standard of the product appearance test

Manner of appearance test: The inspection should be performed in using 20W x 2 fluorescent lamps. Distance between LCM and fluorescent lamps should be 100 cm or more. Distance between LCM and inspector eyes should be 30 cm or more.

Viewing direction for inspection is 45° from vertical against LCM.

Fluorescent
Lamps

30cm $_{min}$

100cm $_{min}$

45° 45°

LCM
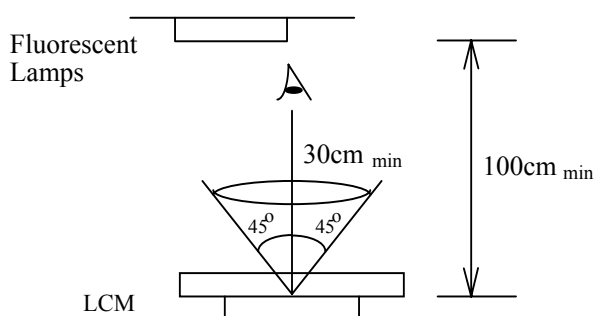
Definition of zone:
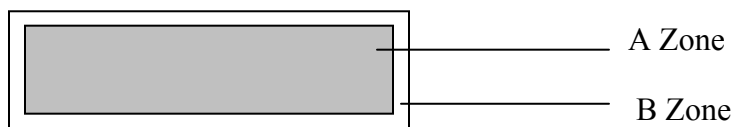
A Zone

B Zone

A Zone: Active display area (minimum viewing area).
B Zone: Non-active display area (outside viewing area).

12.2 Specification of quality assurance

AQL inspection standard
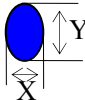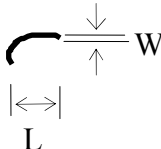
Sampling method: MIL-STD-105E, Level II, single sampling
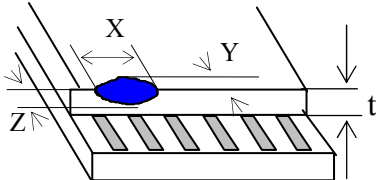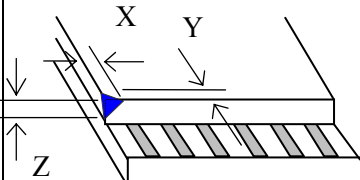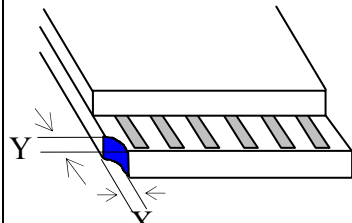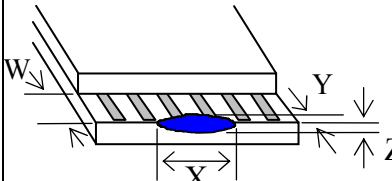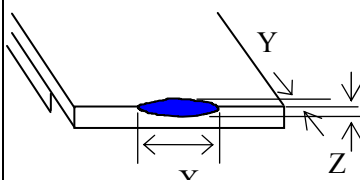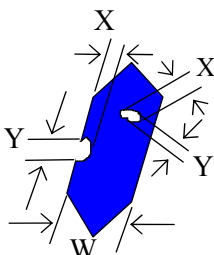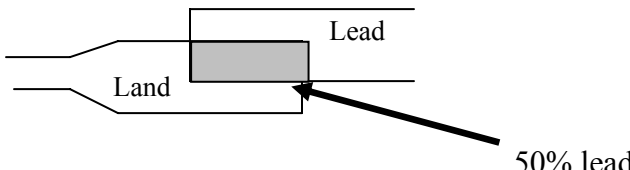
Defect classification **(Note: * is not including)**
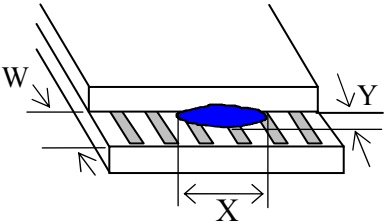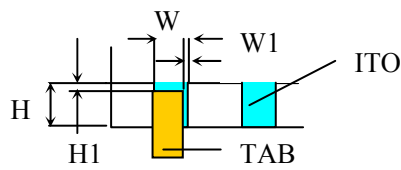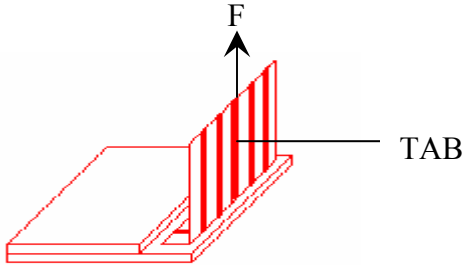
Classify		Item		Note	AQL
Major	Display state	Short or open circuit		1	0.65
		LC leakage			
		Flickering			
		No display			
		Wrong viewing direction			
		Contrast defect (dim, ghost)		2	
		Back-light		1,8	
	Non-display	Flat cable or pin reverse		10	
		Wrong or missing component		11	
Minor	Display state	Background color deviation		2	1.0
		Black spot and dust		3	
		Line defect, Scratch		4	
		Rainbow		5	
		Chip		6	
		Pin hole		7	
		Protruded		12	
	Polarizer	Bubble and foreign material		3	
	Soldering	Poor connection		9	
	Wire	Poor connection		10	
	TAB	Position, Bonding strength		13	

Note on defect classification

No.	Item	Criterion
1	Short or open circuit	Not allow
	LC leakage	
	Flickering	
	No display	
	Wrong viewing direction	
	Wrong Back-light	
2	Contrast defect	Refer to approval sample
	Background color deviation	
3	Point defect, Black spot, dust (including Polarizer) $\phi = (X+Y)/2$	See table below
4	Line defect, Scratch	See table below
5	Rainbow	Not more than two color changes across the viewing area.

Row 3 — Point defect table:

Point Size	Acceptable Qty.
$\phi \leq 0.10$	Disregard
$0.10 < \phi \leq 0.20$	3
$0.20 < \phi \leq 0.25$	2
$0.25 < \phi \leq 0.30$	1
$\phi > 0.30$	0

Unit：mm

Row 4 — Line defect table:

Line		Acceptable Qty.
L	W	
---	$0.015 \geq W$	Disregard
$3.0 \geq L$	$0.03 \geq W$	2
$2.0 \geq L$	$0.05 \geq W$	
$1.0 \geq L$	$0.1 > W$	1
---	$0.05 < W$	Applied as point defect

Unit: mm

No	Item	Criterion
6	Chip Remark: X: Length direction Y: Short direction Z: Thickness direction t: Glass thickness W: Terminal Width	*(diagrams with acceptable criterion tables)*

Acceptable criterion

X	Y	Z
≤2	0.5mm	≤t/2

Acceptable criterion

X	Y	Z
≤2	0.5mm	≤t

Acceptable criterion

X	Y	Z
≤3	≤2	≤t
shall not reach to ITO		

Acceptable criterion

X	Y	Z
Disregard	≤0.2	≤t

Acceptable criterion

X	Y	Z
≤5	≤2	≤t/3

No.	Item	Criterion
7	Segment pattern W = Segment width $\phi = (X+Y)/2$	(1) Pin hole $\phi < 0.10mm$ is acceptable. X X Y Y W | Point Size	Acceptable Qty
---	---
$\phi \leq 1/4W$	Disregard
$1/4W < \phi \leq 1/2W$	1
$\phi > 1/2W$	0	 Unit: mm
8	Back-light	(1) The color of backlight should correspond its specification. (2) Not allow flickering
9	Soldering	(1) Not allow heavy dirty and solder ball on PCB. (The size of dirty refer to point and dust defect) (2) Over 50% of lead should be soldered on Land. Lead Land 50% lead
10	Wire	(1) Copper wire should not be rusted (2) Not allow crack on copper wire connection. (3) Not allow reversing the position of the flat cable. (4) Not allow exposed copper wire inside the flat cable.
11*	PCB	(1) Not allow screw rust or damage. (2) Not allow missing or wrong putting of component.

No	Item	Criterion
12	Protruded W: Terminal Width	 Acceptable criteria: $Y \leq 0.4$
13	TAB	1. Position $W1 \leq 1/3W$ $H1 \leq 1/3H$ 2 TAB bonding strength test P (=F/TAB bonding width) $\geq$ 650gf/cm ,(speed rate: 1mm/min) 5pcs per SOA (shipment)
14	Total no. of acceptable Defect	A. Zone Maximum 2 minor non-conformities per one unit. Defect distance: each point to be separated over 10mm B. Zone It is acceptable when it is no trouble for quality and assembly in customer's end product.

12.3 Reliability of LCM

Reliability test condition:

Item	Condition	Time (hrs)	Assessment
High temp. Storage	80°C	48	
High temp. Operating	70°C	48	
Low temp. Storage	-30°C	48	No abnormalities
Low temp. Operating	-20°C	48	in functions
Humidity	40°C/ 90%RH	48	and appearance
Temp. Cycle	0°C ← 25°C →50°C (30 min ← 5 min → 30min)	10cycles	

Recovery time should be 24 hours minimum. Moreover, functions, performance and appearance shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions room temperature (20 ± 8°C), normal humidity (below 65% RH), and in the area not exposed to direct sun light.

12.4 Precaution for using LCD/LCM

LCD/LCM is assembled and adjusted with a high degree of precision. Do not attempt to make any alteration or modification. The followings should be noted.

General Precautions:

1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure onto the surface of display area.
2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isoproply alcohol, ethyl alcohol or trichlorotriflorothane, do not use water, ketone or aromatics and never scrub hard.
3. Do not tamper in any way with the tabs on the metal frame.
4. Do not make any modification on the PCB without consulting AV.
5. When mounting a LCM, make sure that the PCB is not under any stress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight dislocation of any of the elements.
6. Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels and also cause rainbow on the display.

7. Be careful not to touch or swallow liquid crystal that might leak from a damaged cell. Any liquid crystal adheres to skin or clothes, wash it off immediately with soap and water.

Static Electricity Precautions:

1. CMOS-LSI is used for the module circuit; therefore operators should be grounded whenever he/she comes into contact with the module.
2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.
4. The modules should be kept in anti-static bags or other containers resistant to static for storage.
5. Only properly grounded soldering irons should be used.
6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.
7. The normal static prevention measures should be observed for work clothes and working benches.
8. Since dry air is inductive to static, a relative humidity of 50-60% is recommended.

Soldering Precautions:

1. Soldering should be performed only on the I/O terminals.
2. Use soldering irons with proper grounding and no leakage.
3. Soldering temperature: 280°C$\pm$10°C
4. Soldering time: 3 to 4 second.
5. Use eutectic solder with resin flux filling.
6. If flux is used, the LCD surface should be protected to avoid spattering flux.
7. Flux residue should be removed.

Operation Precautions:

1. The viewing angle can be adjusted by varying the LCD driving voltage Vo.
2. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, the applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
3. Driving voltage should be kept within specified range; excess voltage will shorten display life.
4. Response time increases with decrease in temperature.
5. Display color may be affected at temperatures above its operational range.
6. Keep the temperature within the specified range usage and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel-off or generate bubbles.
7. For long-term storage over 40°C is required, the relative humidity should be kept below 60%, and avoid direct sunlight.

Limited Warranty

AV LCDs and modules are not consumer products, but may be incorporated by AV's customers into consumer products or components thereof, AV does not warrant that its LCDs and components are fit for any such particular purpose.

1. The liability of AV is limited to repair or replacement on the terms set forth below. AV will not be responsible for any subsequent or consequential events or injury or damage to any personnel or user including third party personnel and/or user. Unless otherwise agreed in writing between AV and the customer, AV will only replace or repair any of its LCD which is found defective electrically or visually when inspected in accordance with AV general LCD inspection standard . (Copies available on request)

2. No warranty can be granted if any of the precautions state in handling liquid crystal display above has been disregarded. Broken glass, scratches on polarizer mechanical damages as well as defects that are caused accelerated environment tests are excluded from warranty.

3. In returning the LCD/LCM, they must be properly packaged; there should be detailed description of the failures or defect.