DATA DISPLAY AG

LM181E3-A2
18.1“ SXGA TFT LCD

PRELIMINARY SPECIFICATION

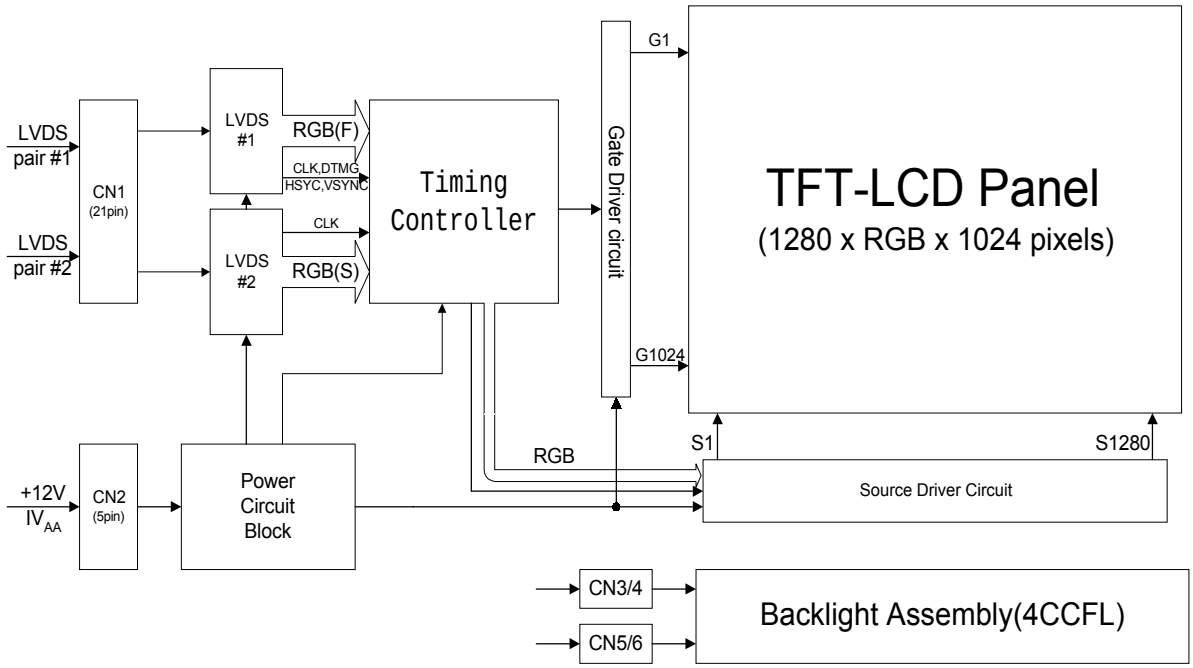
LG.Philips LCD: Rev. 0.0 May 4, 1999

1. GENERAL DESCRIPTION

The LG.Philips LCD model LM181E3-A2 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Tube (CCFT) back light system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. This TFT-LCD has a 18.1 inch diagonally measured active display area with SXGA resolution (1024 vertical by 1280 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,777,216 colors.

The LM181E3-A2 has been designed to apply the interface method that enables low power, high speed low EMI. FPD Link must be used as a LVDS (Low Voltage Differential Signaling) chip.

The LM181E3-A2 is intended to support applications where thin thickness, wide viewing angle, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LM181E3-A2 characteristics provide an excellent flat panel display for office automation products such as monitors.



General Features

The following are general features of the model LM181E3-A2 LCD:

Active screen size	18.1 inches (45.97cm) diagonal
Outline dimensions	412.5 (H) × 333.0 (V) × 22.5 (D) mm (typ)
Pixel pitch	0.2805 mm × 0.2805 mm
Pixel format	1280 horiz. By 1024 vert. pixels RGB stripe arrangement
Color depth	8-bit, 16,777,216 colors
Luminance,White	220 cd/m^2 (typ)
Power Consumption	Total 29.16 Watt, typ (6.6 Watt @ IV_{AA}, 22.56 Watt @ 200 cd/m^2, Lamp)
Weight	2835 (typ)
Display operating mode	transmissive mode, normally black
Surface treatments	hard coating (3H), anti-glare treatment of the front polarizer

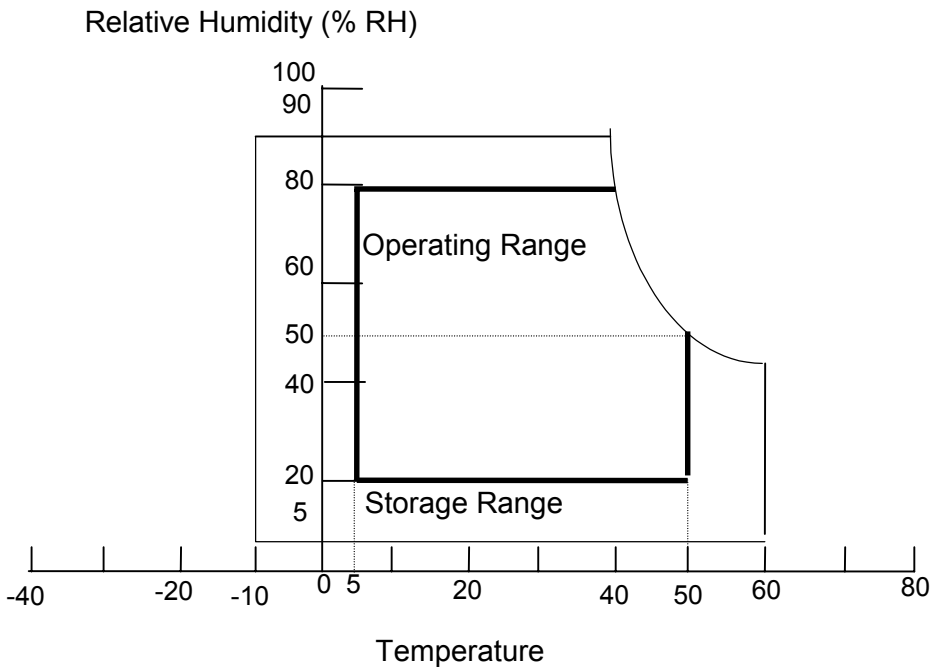
2. MAXIMUM RATINGS

The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1: ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min.	Max.		
Power Input Voltage	IV_{AA}	-0.3	+13.2	Vdc	at 25°
Operating Temperature	T_{OP}	5	+50	°	1
Storage Temperature	T_{ST}	-10	+60	°	1

Note 1: Temperature and relative humidity range are shown in the figure below.


Relative Humidity (% RH)
100
90
80
60
50
40
20
5
Operating Range
Storage Range
-40
-20
-10
0
5
20
40
50
60
80
Temperature

3. ELECTRICAL SPECIFICATIONS

3.1 Electrical Characteristics

The LM181E3-A2 requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The other input which powers the CCFL, is typically generated by an inverter. The inverter is an external unit to the LCD.

Table 2: ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Units	Notes
		Min.	Typ.	Max.		
MODULE:						
Power Supply Input Voltage	IV_{AA}	11.2	12.0	12.6	Vdc	
Power Supply Input Current	I_{CC}	-	0.55	0.9	A	1
Power Consumption	P_c	-	6.6	10.8	Watts	1
LAMP						
Operating Voltage	V_{BL}	634	705	776	V_{RMS}	2
Operating Current	I_{BL}	-	8.0	8.5	mA	
Established Starting Voltage						
at 25°		1250		-	V_{RMS}	3
at 0°		1550	-	-	V_{RMS}	
Operating Frequency	f_{BL}	30	-	60	kHz	
Power Consumption	P_{BL}	-	22.56	-	Watts	4
Half Life Time		20,000	30,000		Hrs	5

Note 1: The current draw and power consumption specified is for 12.0 Vdc at 25°and fv at 60Hz (at 8-gray pattern displayed)

Note 2: The variance of the voltage is ± 10%.

Note 3: The output voltage at the transformer in the inverter must be high considering to the loss of the ballast capacitor in the inverter.

Note 4: The lamp power consumption shown above does not include loss of external inverter.

Note 5: The life time is determined as the time at which brightness of lamp is 50 % compare to that of initial value at the typical lamp current

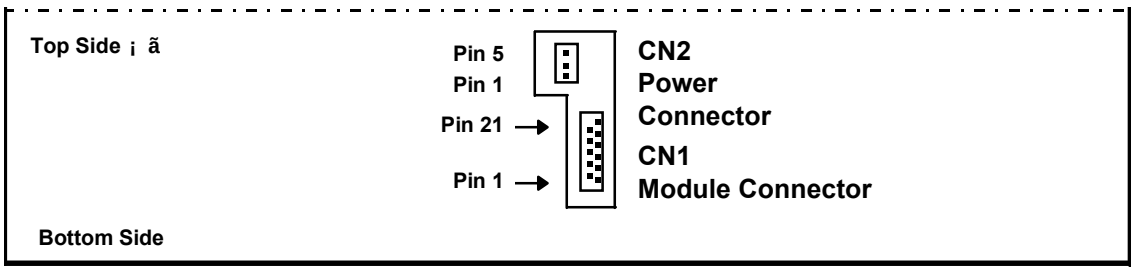
3.2 Interface Connections

Interface chip must be used LVDS, part No. DS90CF383MTD (Transmitter), DS90CF384MTD (Receiver) made by National Semiconductor or compatible interface chip (TI: SN75LVDS83, Thine).
This LCD employs six interface connections. A 21-pin connector is used for the module electronics interface. A 5-pin connector is used for the module power (+12V). Four 2-pin connectors are used for the integral backlight system.

The electronics interface connector is model FI-TWE21P-VF manufactured by JAE. The pin configuration for the connector is shown in table 3.

Table 3: MODULE CONNECTOR PIN CONFIGURATION (LVDS)

Pin	Symbol	Description	Notes
1	FR3P	Plus Signal of Odd Channel 3 (LVDS)	
2	FR3M	Minus Signal of Odd Channel 3 (LVDS)	
3	FCLKINP	Plus Signal of Odd Clock Channel (LVDS)	
4	FCLKINM	Minus Signal of Odd Clock Channel (LVDS)	
5	FR2P	Plus Signal of Odd Channel 2 (LVDS)	
6	FR2M	Minus Signal of Odd Channel 2 (LVDS)	First Data
7	FR1P	Plus Signal of Odd Channel 1 (LVDS)	
8	FR1M	Minus Signal of Odd Channel 1 (LVDS)	
9	FR0P	Plus Signal of Odd Channel 0 (LVDS)	
10	FR0M	Minus Signal of Odd Channel 0 (LVDS)	
11	SR3P	Plus Signal of Even Channel 3 (LVDS)	
12	SR3M	Minus Signal of Even Channel 3 (LVDS)	
13	SCLKINP	Plus Signal of Even Clock Channel (LVDS)	
14	SCLKINM	Minus Signal of Even Clock Channel (LVDS)	
15	SR2P	Plus Signal of Even Channel 2 (LVDS)	
16	SR2M	Minus Signal of Even Channel 2 (LVDS)	Second Data
17	SR1P	Plus Signal of Even Channel 1 (LVDS)	
18	SR1M	Minus Signal of Even Channel 1 (LVDS)	
19	SR0P	Plus Signal of Even Channel 0 (LVDS)	
20	SR0M	Minus Signal of Even Channel 0 (LVDS)	
21	NC	Not Connect	



Back side of LCD Module

The module power connector is model B5B-ZR-SM3-TF manufactured by JST. The pin configuration for the connector is shown in the table 4.

Table 4: POWER CONNECTOR PIN CONFIGURATION

Pin	Symbol	Description	Notes
1	GND	Ground	1
2	GND	Ground	
3	GND	Ground	
4	IV_{AA}	Supply voltage for LCD module	2
5	IV_{AA}	Supply voltage for LCD module	

Note 1: All GND (ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
Note 2: All IV_{AA} (power input) pins should be connected together.

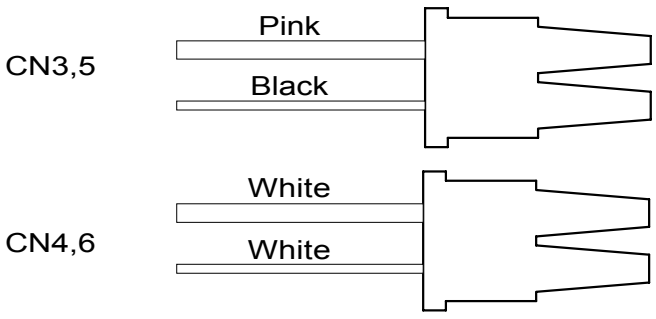
The backlight interface connector is model BHSR-02VS-1, manufactured by JST. The mating connector part number is SM02B-BHSS-1 or equivalent. The pin configuration for the connector is shown in the table 5.

Table 5: BACKLIGHT CONNECTOR PIN CONFIGURATION

Pin	Symbol	Description	Notes
1	HV	Lamp power input	1
2	LV	Ground	2

Note1: The input power terminal is colored pink or white. Ground pin color is white or black.

The lamp ground should be common with GND.



3.3 Signal Timing Specification

This is the signal timing required at the input of the LVDS Transmitter. All the interface signal timing should be satisfied with the following specifications for it's proper operation.

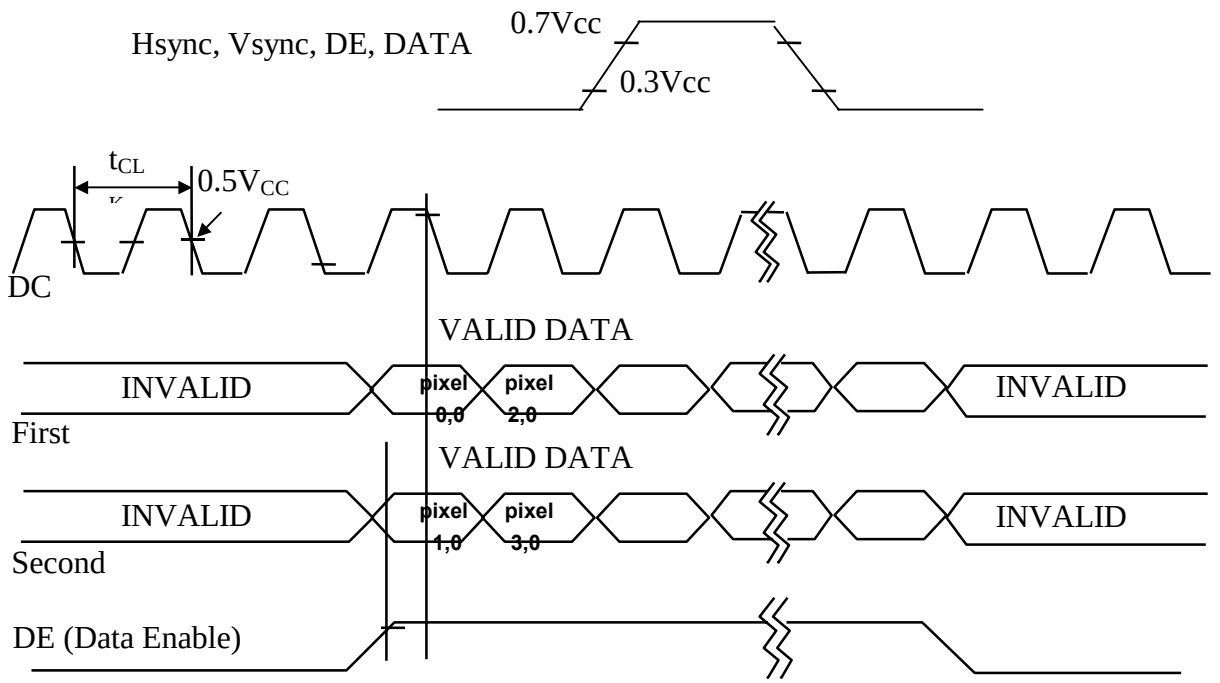
Table 6: Timing Table

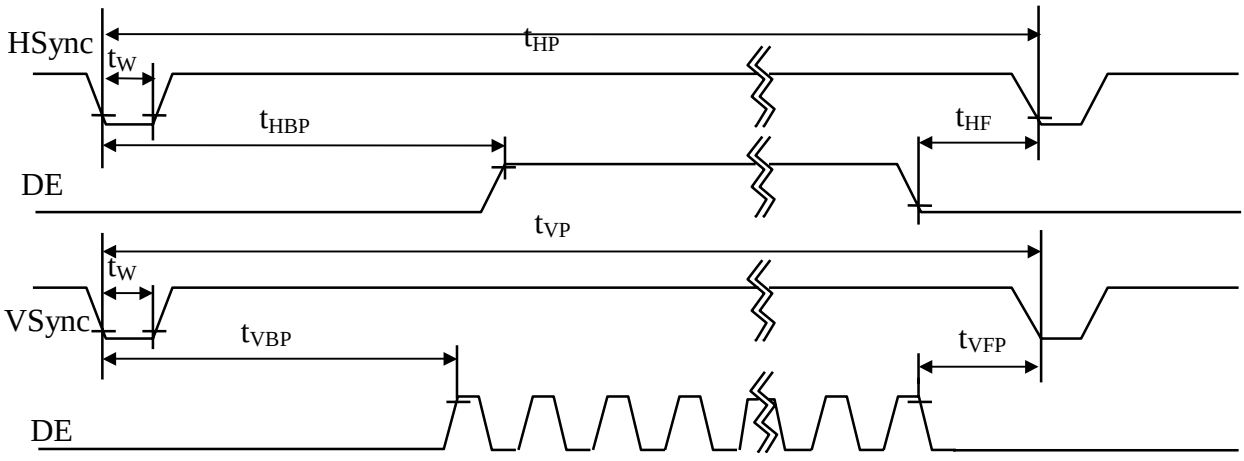
Item		Symbol	Min.	Typ.	Max.	Unit	Note
Dclk	Period	t_{CLK}	18.5	-	18.5	ns	1
Hsync	Period	t_{HP}	760	844	928	t_{CLK}	
	Width-Active	t_{WH}	8	56	240		
Vsync	Period	t_{VP}	1032	1066	1097	t_{HP}	
	Width-Active	t_{WV}	2	3	24		
DE (Data Enable)	Horizontal Back Porch	t_{HBP}	12	124	-	t_{CLK}	
	Horizontal Active	-	-	640	-		
	Horizontal Front Porch	t_{HFP}	8	24	-		
	Vertical Back Porch	t_{VBP}	1	38	-	t_{HP}	
	Vertical Active	-	-	1024	-		
	Vertical Front Porch	t_{VFP}	1	-	-		

Note 1: Two pixel data are sampled at the same time.

pixel 0,0	**pixel 1,0**	**pixel 2,0**	**pixel 3,0**			**pixel 1278,0**	**pixel 1279,0**
Pixel 0,1	**pixel 1,1**	**pixel 2,1**	**pixel 3,1**			**pixel 1278,1**	**pixel 1279,1**
pixel 0,1023	**pixel 1,1023**	**pixel 2,1023**	**pixel 3,1023**			**pixel 1278,1023**	**pixel 1279,1023**

3.4 Signal Timing Wave Form





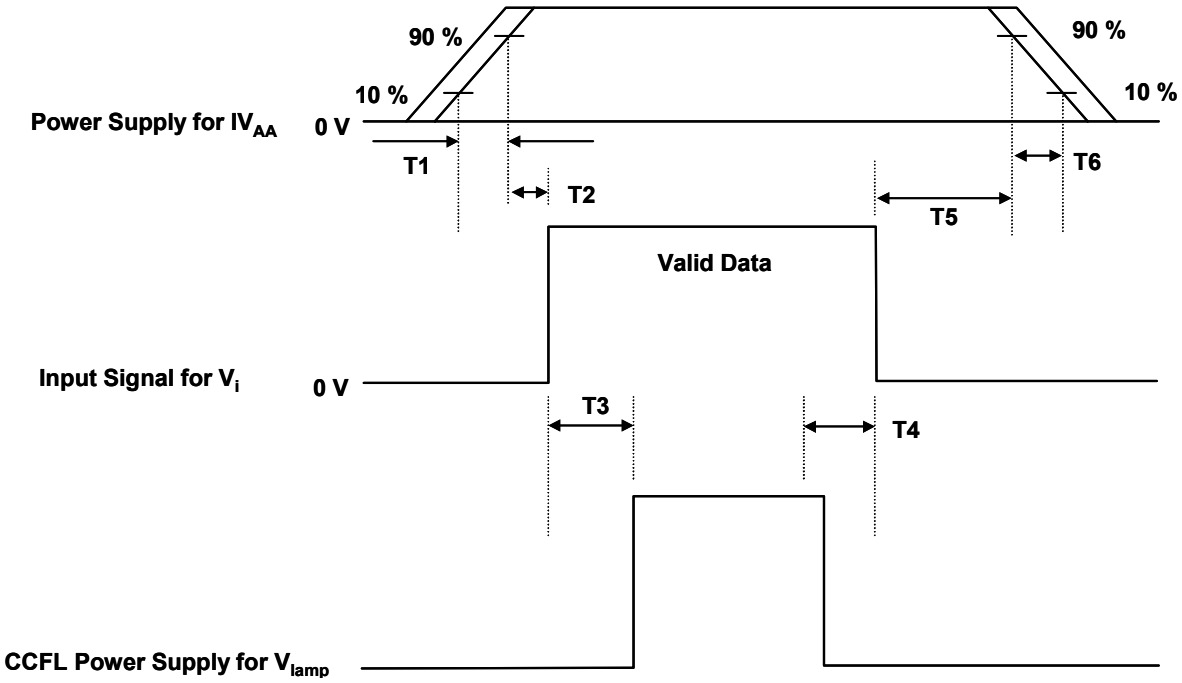
3.5 Color Input Data Reference

The brightness of each primary color (red, green and blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 7: COLOR DATA REFERENCE

Color		Input Color Data																							
		Red								Green								Blue							
		MSB						LSB		MSB						LSB		MSB						LSB	
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green(255)	0	0 0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red	Red(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(002)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red(253)	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(255) Bright	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green	Green(000)Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green(001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Green(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green(255)Bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Blue	Blue(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue(001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue(255) Bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

3.6 Power Sequences



Parameter	Values			Units
	Min.	Typ.	Max.	
T_1	10	-	20	ms
T_2	10	-	20	ms
T_3	100	-	200	ms
T_4	100	-	200	ms
T_5	10	-	20	ms
T_6	10	-	20	ms

Note 1: Please avoid floating state of interface signal at invalid period.

Note 2: When the interface signal is invalid, be sure to pull down the power supply for LCD V_{CC} to 0V. Invalid input with IV_{AA} for a long time, cause permanent damage to LCD panel.

Note 3: Lamp power must be turn on after power supply for LCD and interface signal are valid.

4. OPTICAL SPECIFICATIONS

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25°. The values specified are at an approximate distance 50 cm from the LCD surface at a viewing angle of Φ and θ equal to 0°. Appendix 11.1 presents additional information concerning the measurement equipment and method.

Table 8: OPTICAL CHARACTERISTICS

Parameter	Symbol	Values			Units	Notes
		Min.	Typ.	Max.		
Contrast Ratio	CR	200	250	-		1
Surface Luminance, white	L_{WH}	200	220	-	cd/m^2	2
Luminance Variation	δWHITE	-	1.25	1.45		3
Response Time	Tr				msec	4
Rise Time	Tr_R	-	17	30		
Delay Time	Tr_D	-	13	20		
CIE Color Coordinates						
Red	x_R	TBD	TBD	TBD		
	y_R	TBD	TBD	TBD		
Green	x_G	TBD	TBD	TBD		
	y_G	TBD	TBD	TBD		
Blue	x_B	TBD	TBD	TBD		
	y_B	TBD	TBD	TBD		
White	x_W	TBD	TBD	TBD		
	y_W	TBD	TBD	TBD		
Viewing Angle						
x axis, right (Φ=0°)	θx	+80	-	-	degree	5
x axis, left(Φ=180°)	θx	-80	-	-		
y axis, up(Φ=90°)	θy	+80	-	-		
y axis, down (Φ=270°)	θy	-80	-	-		
Gamma Value (reference value)			2.3			6

Notes 1: Contrast Ratio (CR) is defined mathematically as :

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

Note 2: Surface luminance is the center point across the LCD surface, 50 cm from surface with all pixels displaying white. For more information see Appendix 11.2.

Note 3: The variation in surface Luminance, δ_{WHITE} is determined by measuring L_{ON} at each test position 1 through 5, and then dividing the maximum L_{ON} of 5 points luminance by minimum L_{ON} of 5 points luminance. For more information see Appendix 11.2.

δ_{WHITE} Maximum (L_{ON1}, L_{ON2}, ...L_{ON5}) ÷ Minimum (L_{ON1}, L_{ON2}, ...L_{ON5})

Note 4: Response time is the time required for the display to transition from white to black (Rise Time, Tr_R) and from black to white (Delay Time, Tr_D). For additional information see Appendix 11.4.

Note 5: Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see Appendix 11.4.

5. GRAY SCALE SPECIFICATION IS AS FOLLOWING.

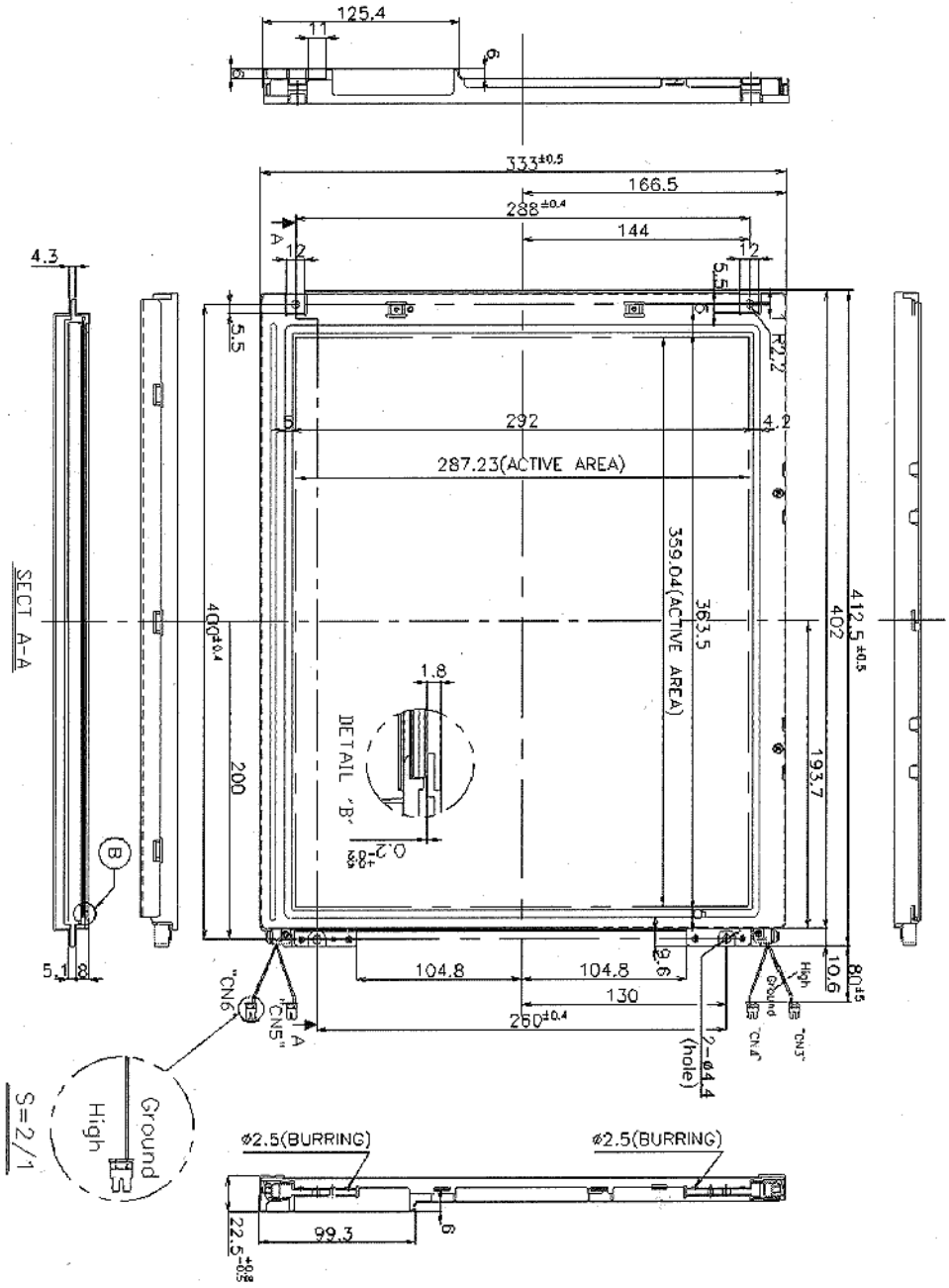
Gray Level	Luminance (%) (typ)
L0	TBD
L31	TBD
L63	TBD
L95	TBD
L127	TBD
L159	TBD
L191	TBD
L223	TBD
L255	TBD

6. MECHANICAL CHARACTERISTICS

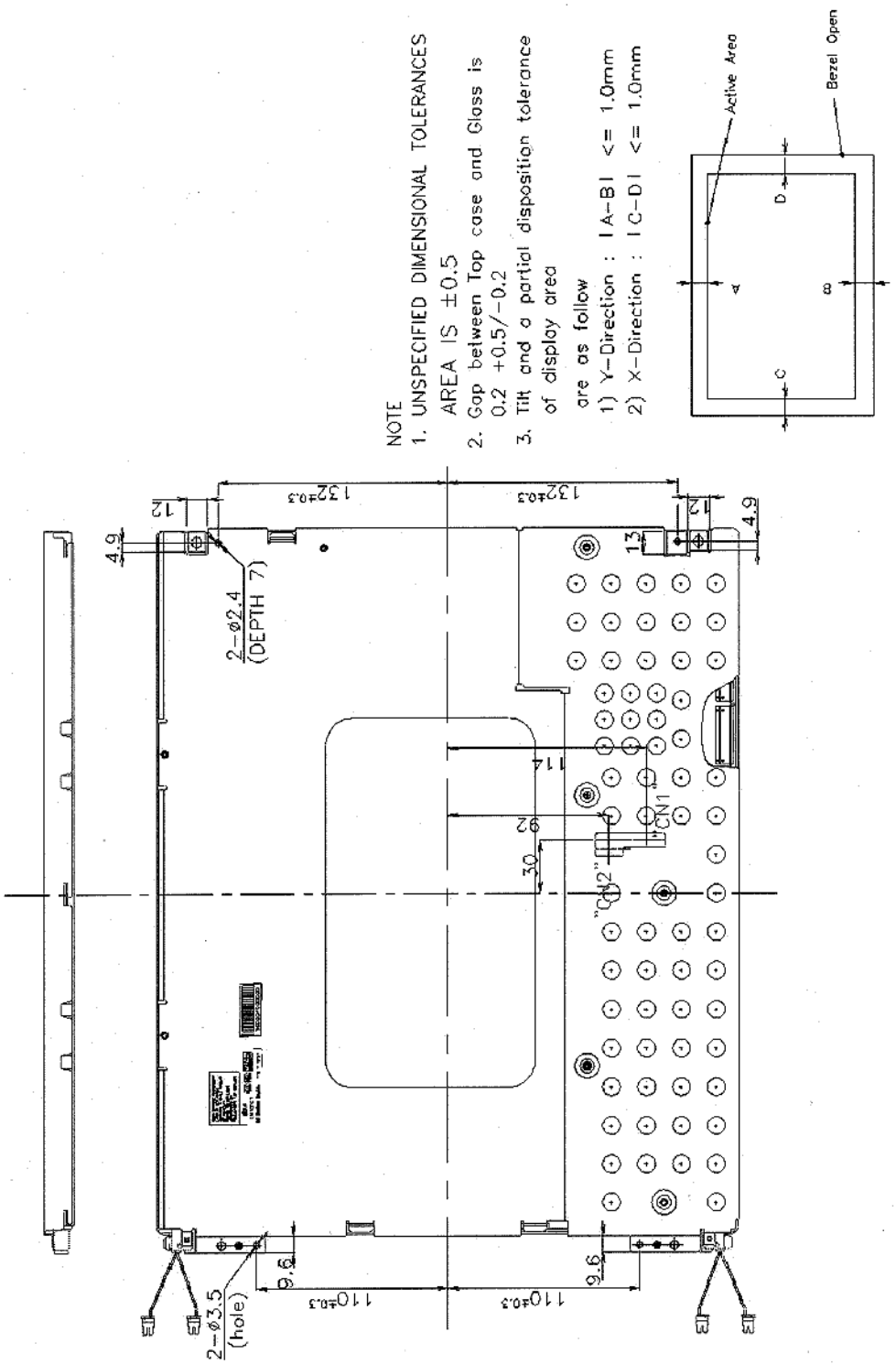
The chart below provides the general mechanical characteristics for model LM181E3-A2 LCD. In addition, the figure below is a detailed mechanical drawing of the LCD. Please note that dimensions are given for reference purposes only.

Parameters	Value	Unit	Notes
Outside dimensions Horizontal Vertical Depth	 412.5 333.0 22.5	mm	-
Bezel area Horizontal Vertical	 363.5 292.0	mm	-
Active Display area Horizontal Vertical	 359.040 287.232	mm	-
Weight	2835	gram	-
Surface Treatment	Hard coating 3H. Anti-glare treatment of front polarizer	-	-

FRONT VIEW


125.4
11
333±0.5
166.5
288±0.4
144
12
12
4.3
5.5
5.5
R2.2
292
4.2
287.23(ACTIVE AREA)
359.04(ACTIVE AREA)
363.5
412.5±0.5
402
400±0.4
200
193.7
SECT A-A
1.8
DETAIL 'B'
2.0
5.1
8
104.8
104.8
130
260±0.4
2.6
10.6
80±5
"CN6"
"CN5"
A
B
High
Ground
"CN4"
"CN3"
2-ø4.4
(hole)
S=2/1
ø2.5(BURRING)
ø2.5(BURRING)
99.3
22.5±0.8
6

REAR VIEW


NOTE
1. UNSPECIFIED DIMENSIONAL TOLERANCES
AREA IS ±0.5
2. Gap between Top case and Glass is
0.2 +0.5/−0.2
3. Tilt and a partial disposition tolerance
of display area
are as follow
1) Y-Direction : |A−B| <= 1.0mm
2) X-Direction : |C−D| <= 1.0mm
Active Area
Bezel Open
A
B
C
D
132±0.3
132±0.3
12
12
4.9
4.9
13
2−ø2.4
(DEPTH 7)
114
92
30
CN1
"CN2"
9.6
9.6
110±0.3
110±0.3
2−ø3.5
(hole)

7. RELIABILITY

Environment test condition

No.	Test Item	Conditions
1	High temperature storage test	Ta = 60° 240 h
2	Low temperature storage test	Ta = -10° 240 h
3	High temperature operation test	Ta = 50° 50 % RH 240 h
4	Low temperature operation test	Ta = 5° 240 h
5	Vibration test (non-operating)	TBD
6	Shock test (non-operating)	TBD
7	Altitude operating storage/shipment	 0 - 10,000 feet (3048 m) 0 - 40,000 feet (12192 m)
8	Drop test (Packing)	TBD

{Result Evaluation Criteria}
There should be no change which might affect the practical display function when the display quality test is conducted under normal operating condition.

8. INTERNATIONAL STANDARDS

8.1 Safety

UL 1950 Third Edition, Underwriters Laboratories, Inc. Jan. 28, 1995.
Standard for Safety of Information Technology Equipment Including Electrical Business Equipment.
CAN/CSA C22.2 No. 950-95 Third Edition, Canadian Standards Association, Jan. 28, 1995.
Standard for Safety of Information Technology Equipment Including Electrical Business Equipment.
EN 60950 : 1992 + A1 : 1993 + A2 : 1993 + A3 : 1995 + A4 : 1997 + A11 : 1997
IEC 950 : 1991 + A1 : 1992 + A2 : 1993 + A3 : 1995 + A4 : 1996
European Committee for Electrotechnical Standardization (CENELEC)
EUROPEAN STANDARD for Safety of Information Technology Equipment Including Electrical Business Equipment.

8.2 EMC

ANSI C63.4 „Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz.“ American National Standards Institute (ANSI), 1992.
C.I.S.P.R „Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment.“ International Special Committee on Radio Interference
EN 55022 „Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment.“ European Committee for Electrotechnical Standardization (CENELEC),1988

9. PACKAGING

9.1 Designation of Lot Mark

Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L

A, B, C : MODEL CODE
D : YEAR
E : MONTH
F, G : DIVISION CODE
H : MODULE LINE
I, J, K, L, M : SERIAL NO.

Note 1: YEAR

YEAR	89	90	91	92	93	94	95	96	97	98	99
Mark	9	0	1	2	3	4	5	6	7	8	9

Note 2: MONTH

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jun	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

Location of Lot Mark

Serial NO. is printed on the label. The label is attached to the backside of the LCD module. This is subject to change without prior notice.

9.2 Packing Form

Package quantity in one box: 5 pcs
Box Size : 524 mm×301 mm×444 mm

10. PRECAUTIONS

Please pay attention to the followings when you use this TFT/LCD module.

10.1 Mounting Precautions

- You must mount a module user holes arranged in four corners.
- You should consider the mounting structure so that uneven force (ex. twisted stress) is not applied to the module. The case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- Please attach the surface with a transparent protective plate in order to protect the polarizer LC cell. Transparent protective plate should have sufficient strength in order to resist external force.
- You should adopt radiation structure to satisfy the temperature specification.
- Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.

- Do not touch, push or rub the exposed polarizer with glass, tweezers or anything harder than HB pencil head, please do not rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth. (Some cosmetics are detrimental to the polarizer.)

- When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaked with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizer. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.

- Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.

- Do not open the case because inside circuits do not have sufficient strength.

10.2 Operating Precautions

- The spike noise causes the malfunction of circuits. It should be lower than following voltage: V = ± 200mV (Over and under shoot voltage).

- Response time depends on the temperature (in lower temperature, it becomes longer).

- Brightness depends on the temperature (in lower temperature, it becomes lower). In lower temperature response time (required time that brightness is stable after turned on) becomes longer.

- Be careful for condensation at sudden temperature change. Condensation causes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.

- When fixed patterns are displayed for a long time, remnant image is likely to occur.

- A module has high frequency circuit. If you need to shield the electromagnetic noise, please do in yours.

- When a Back-light unit is operating, it sounds. If you need to shield the noise, please do in yours.

10.3 Electrostatic Discharge Control

If a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. Do not touch I/F pin directly.

10.4 Precaution for strong light exposure

Strong light exposure causes degradation of polarizer and color filter.

10.5 Storage

When storing modules as spares for a long time, the following precautions are necessary.

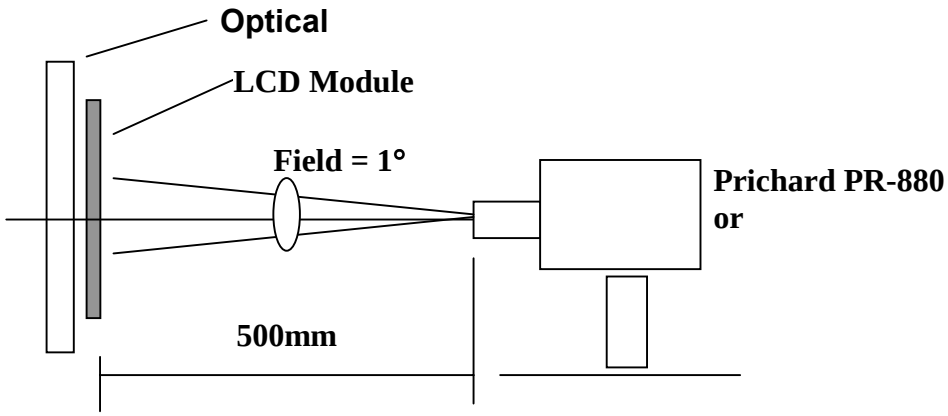
- Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5° and 35° at normal humidity.
- The polarizer surface should not come in contact with any other object. It is recommended that they be stored in the container in which they were shipped.

10.6 Handling precaution for protection film

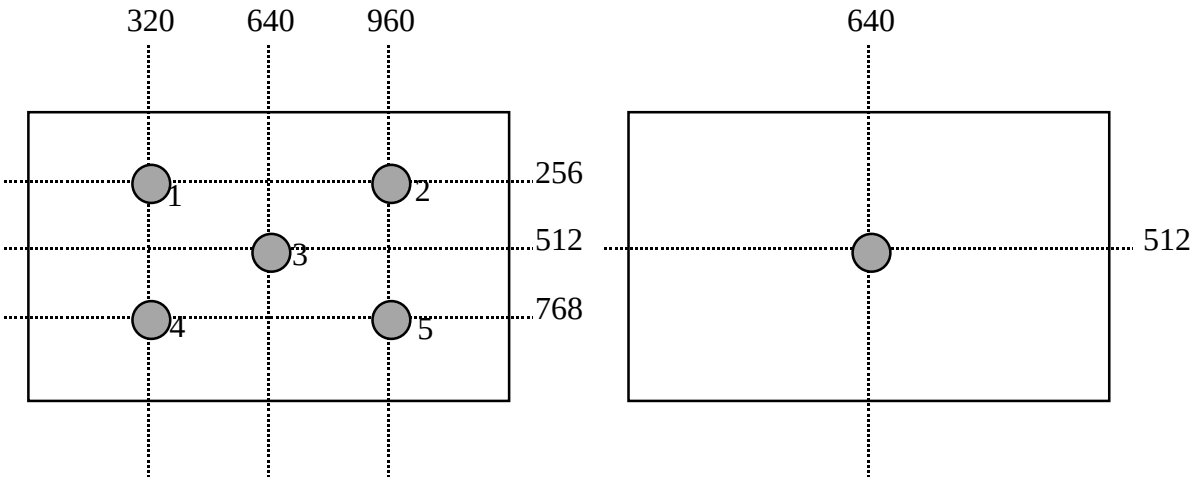
- When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion- blown equipment or in such a condition, etc.
- The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt to remain on the polarizer. Please carefully peel off the protection film without rubbing it against the polarizer.
- When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the polarizer after the protection film is peeled off.
- You can remove the glue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal- hexane.

11. APPENDIX

11.1 Optical Characteristic Measurement Equipment and Method



11.2 Luminance Measurement

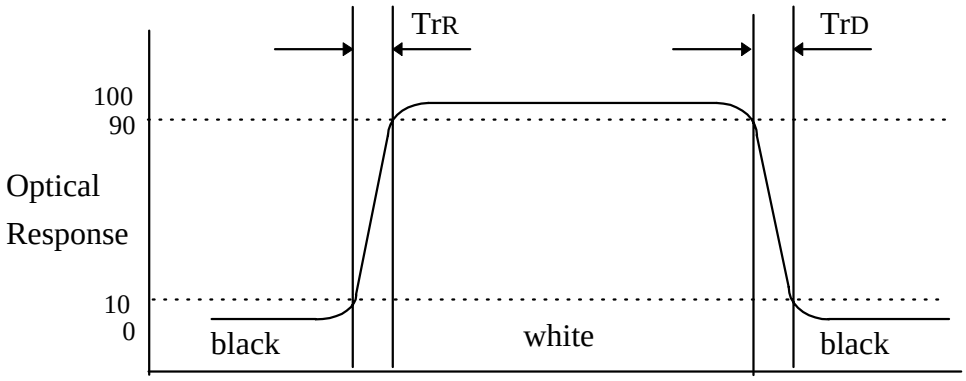


<measuring point for luminance variation>

<measuring point for surface luminance >

11.3 Response Time

The response time is defined as the following figure and shall be measured by switching the input signal for „black“ and „white“.



11.4 Viewing angle

Definition of viewing angle range