

Doc. Number:

- Tentative Specification
- Preliminary Specification
- Approval Specification

MODEL NO.: N156BGE
SUFFIX: P41

Customer:	
APPROVED BY	SIGNATURE
<u>Name / Title</u> Note	<hr/>
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CONTENTS

1. GENERAL DESCRIPTION	錯誤! 尚未定義書籤。
1.1 OVERVIEW	錯誤! 尚未定義書籤。
1.2 GENERAL SPECIFICATIONS	錯誤! 尚未定義書籤。
2. MECHANICAL SPECIFICATIONS	錯誤! 尚未定義書籤。
2.1 CONNECTOR TYPE	錯誤! 尚未定義書籤。
3. ABSOLUTE MAXIMUM RATINGS	錯誤! 尚未定義書籤。
3.1 ABSOLUTE RATINGS OF ENVIRONMENT (Based on CMI Module)	錯誤! 尚未定義書籤。
3.2 ABSOLUTE RATINGS OF ENVIRONMENT (OPEN CELL)	6
3.3 ELECTRICAL ABSOLUTE RATINGS (OPEN CELL)	7
3.3.1 TFT LCD MODULE	7
4. ELECTRICAL SPECIFICATIONS.....	錯誤! 尚未定義書籤。
4.1 TFT LCD OPEN CELL	錯誤! 尚未定義書籤。
4.2. INTERFACE CONNECTIONS	錯誤! 尚未定義書籤。
4.3 ELECTRICAL CHARACTERISTICS.....	錯誤! 尚未定義書籤。
4.3.1 TFT LCD OPEN CELL	錯誤! 尚未定義書籤。
4.3.2 LED CONVERTER SPECIFICATION.....	錯誤! 尚未定義書籤。
4.4 LVDS INPUT SIGNAL TIMING SPECIFICATIONS	錯誤! 尚未定義書籤。
4.4.1 LVDS DC SPECIFICATIONS	錯誤! 尚未定義書籤。
4.4.2 LVDS DATA FORMAT	錯誤! 尚未定義書籤。
4.4.3 COLOR DATA INPUT ASSIGNMENT	錯誤! 尚未定義書籤。
4.5 DISPLAY TIMING SPECIFICATIONS	錯誤! 尚未定義書籤。
4.6 POWER ON/OFF SEQUENCE	錯誤! 尚未定義書籤。
5. OPTICAL CHARACTERISTICS	錯誤! 尚未定義書籤。
5.1 TEST CONDITIONS.....	錯誤! 尚未定義書籤。
5.2 OPTICAL SPECIFICATIONS	錯誤! 尚未定義書籤。
6. PACKING.....	19
6.1 CMI OPEN CELL LABEL.....	23
6.2 Package Reliability	24
6.3 CARTON	24
6.4 PALLET.....	25
7. PRECAUTIONS.....	26
7.1 HANDLING PRECAUTIONS.....	26
7.2 STORAGE PRECAUTIONS	26
7.3 OPERATION PRECAUTIONS.....	26
Appendix. OUTLINE DRAWING	錯誤! 尚未定義書籤。

REVISION HISTORY

Version	Date	Page	Description
2.0	Mar, 23, 2012	All	Spec Ver.1.0 was first issued.

1. GENERAL DESCRIPTION

1.1 OVERVIEW

N156BGE-P41 is a 15.6 TFT Liquid Crystal Display with LED Driver ICs and a 40-pins-and-1ch-LVDS circuit board. This product supports 1366 x 768 HD mode and can display 262,144 colors. The backlight unit is not built in.

1.2 GENERAL SPECIFICATIONS

Item	Specification	Unit	Note
Screen Size	15.6" diagonal		
Driver Element	a-si TFT active matrix	-	-
Pixel Number	1366 x R.G.B. x 768	pixel	-
Pixel Pitch	0.252 (H) x 0.252 (V)	mm	-
Pixel Arrangement	RGB vertical stripe	-	-
Display Colors	262,144	color	-
Transmissive Mode	Normally white	-	-
Surface Treatment	Hard coating (3H), Glare	-	-

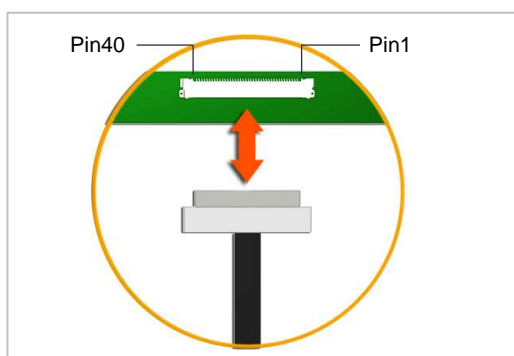
2. MECHANICAL SPECIFICATIONS

item		Min.	Typ.	Max.	Unit	Note
Size	Horizontal (H) with PCB	353.532	353.632	353.732	mm	(1) (2)
	Horizontal (H) w/o PCB	353.532	353.632	353.732	mm	
	Vertical (V) with PCB	216.436	216.536	216.636	mm	
	Vertical (V) w/o PCB	202.736	202.836	202.936	mm	
	Thickness (T) with PCB	-	1.565	-	mm	
	Thickness (T) w/o PCB	-	1.27	-	mm	
Weight		-	203.6		g	
I/F connector mounting position		The mounting inclination of the connector makes the screen center within ± 0.5 mm as the horizontal.				

Note (1) Please refer to the attached drawings for more information of front and back outline dimensions.

(2) Connector mounting position

2.1 CONNECTOR TYPE



Please refer Appendix Outline Drawing for detail design.

Connector Part No.: IPEX-20455-040E-12

User's connector Part No: IPEX-20453-040T-01 or equivalent

2.1.2 LED Light-Bar Connector

MSK24022P10A

3. ABSOLUTE MAXIMUM RATINGS

3.1 ABSOLUTE RATINGS OF ENVIRONMENT

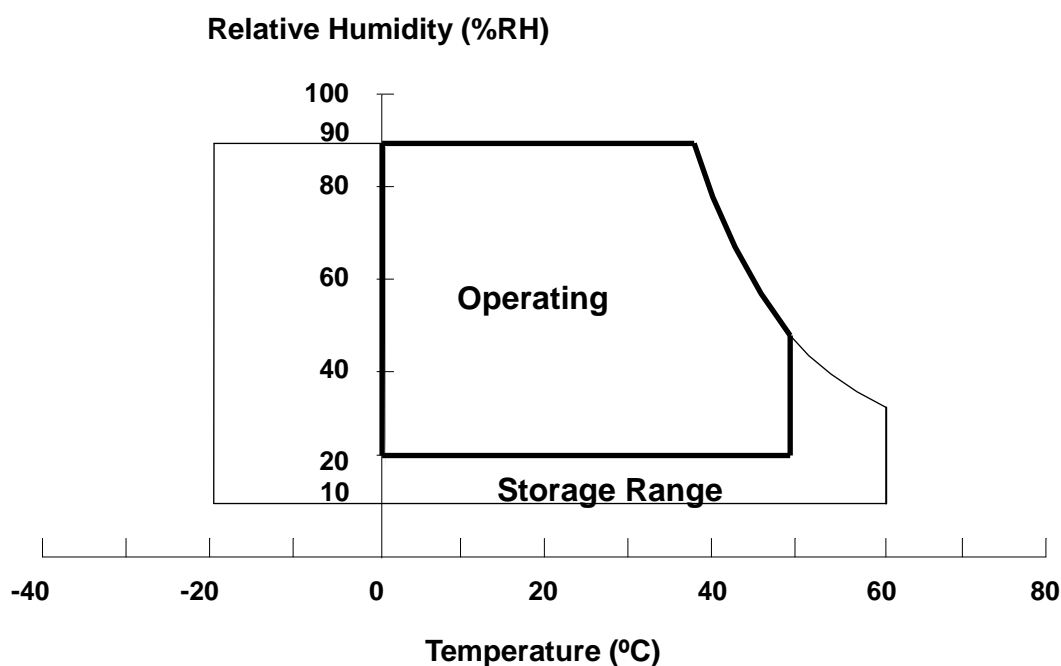
Item	Symbol	Value		Unit	Note
		Min.	Max.		
Storage Temperature	T _{ST}	-20	+60	°C	(1)
Operating Ambient Temperature	T _{OP}	0	+50	°C	(1), (2)

Note (1) (a) 90 %RH Max. (Ta ≤ 40 °C).

(b) Wet-bulb temperature should be 39 °C Max. (Ta > 40 °C).

(c) No condensation.

Note (2) The temperature of panel surface should be 0 °C min. and 60 °C max.



3.2 ABSOLUTE RATINGS OF ENVIRONMENT (OPEN CELL)

High temperature or humidity may reduce the performance of panel. Please store LCD panel within the specified storage conditions.

Storage Condition: With packing.

Storage temperature range: 25±5 °C.

Storage humidity range: 50±10%RH.

Shelf life: 30days

3.3 ELECTRICAL ABSOLUTE RATINGS (OPEN CELL)

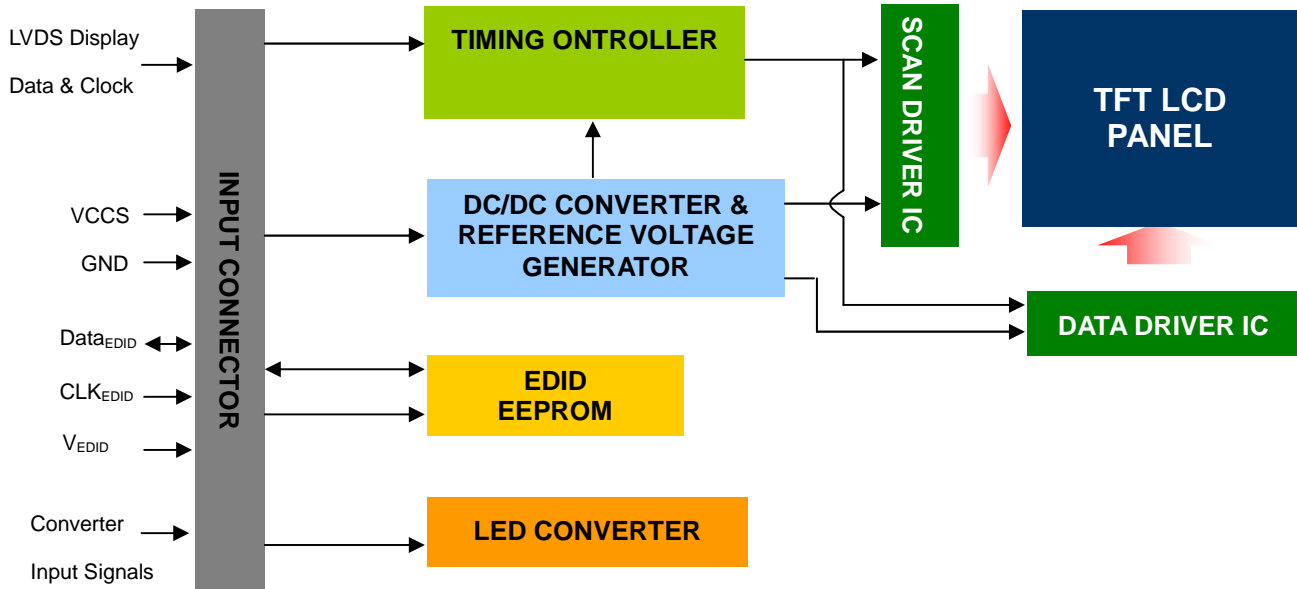
3.3.1 TFT LCD MODULE

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Power Supply Voltage	VCCS	-0.3	+4.0	V	(1)
Logic Input Voltage	V _{IN}	-0.3	VCCS+0.3	V	

Note (1) Stresses beyond those listed in above “ELECTRICAL ABSOLUTE RATINGS” may cause permanent damage to the device. Normal operation should be restricted to the conditions described in “ELECTRICAL CHARACTERISTICS”.

4. ELECTRICAL SPECIFICATIONS

4.1 FUNCTION BLOCK DIAGRAM



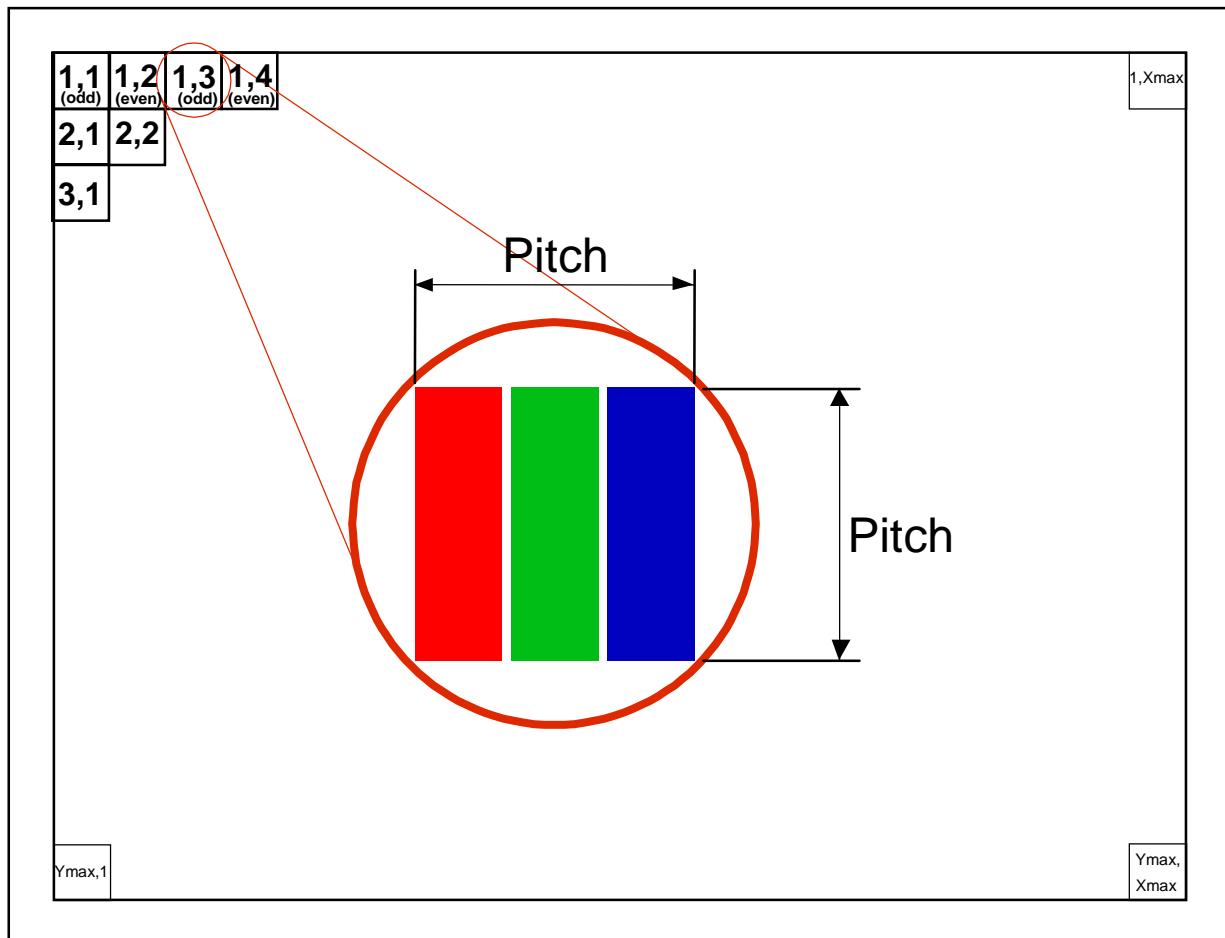
4.2. INTERFACE CONNECTIONS

PIN ASSIGNMENT

Pin	Symbol	Description	Remark
1	NC	No Connection (Reserve)	
2	VCCS	Power Supply (3.3V typ.)	
3	VCCS	Power Supply (3.3V typ.)	
4	VEDID	DDC 3.3V power	
5	NC	No Connection (Reserved for CMI test)	
6	CLKEDID	DDC clock	
7	DATAEDID	DDC data	
8	Rxin0-	LVDS differential data input	R0-R5, G0
9	Rxin0+	LVDS differential data input	
10	VSS	Ground	
11	Rxin1-	LVDS differential data input	G1-G5, B0, B1
12	Rxin1+	LVDS differential data input	
13	VSS	Ground	
14	Rxin2-	LVDS Differential Data Input	B2-B5,HS,VS, DE
15	Rxin2+	LVDS Differential Data Input	
16	VSS	Ground	
17	RxCLK-	LVDS differential clock input	LVDS CLK
18	RxCLK+	LVDS differential clock input	
19	VSS	Ground	
20	NC	No Connection (Reserve)	

21	NC	No Connection (Reserve)	
22	VSS	Ground	
23	NC	No Connection (Reserve)	
24	NC	No Connection (Reserve)	
25	VSS	Ground	
26	NC	No Connection (Reserve)	
27	NC	No Connection (Reserve)	
28	VSS	Ground	
29	NC	No Connection (Reserve)	
30	NC	No Connection (Reserve)	
31	LED_GND	LED Ground	
32	LED_GND	LED Ground	
33	LED_GND	LED Ground	
34	NC	No Connection (Reserve)	
35	LED_PWM	PWM Control Signal of LED Converter	
36	LED_EN	Enable Control Signal of LED Converter	
37	NC	No Connection (Reserve)	
38	LED_VCCS	LED Power Supply	
39	LED_VCCS	LED Power Supply	
40	LED_VCCS	LED Power Supply	

Note (1) The first pixel is odd as shown in the following figure.



4.2.2 LED CONVERTER OUTPUT PIN ASSIGNMENT

Pin	Symbol	Description	Remark
1	NC	No Connection (Reserve)	
2	NC	No Connection (Reserve)	
3	LED1-	LED Light Bar Feedback Channel	
4	LED2-	LED Light Bar Feedback Channel	
5	LED3-	LED Light Bar Feedback Channel	
6	LED4-	LED Light Bar Feedback Channel	
7	LED5-	LED Light Bar Feedback Channel	
8	NC	No Connection (Reserve)	
9	LED+	LED Light Bar Input Power Supply	
10	LED+	LED Light Bar Input Power Supply	

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD ELETRONICS SPECIFICATION

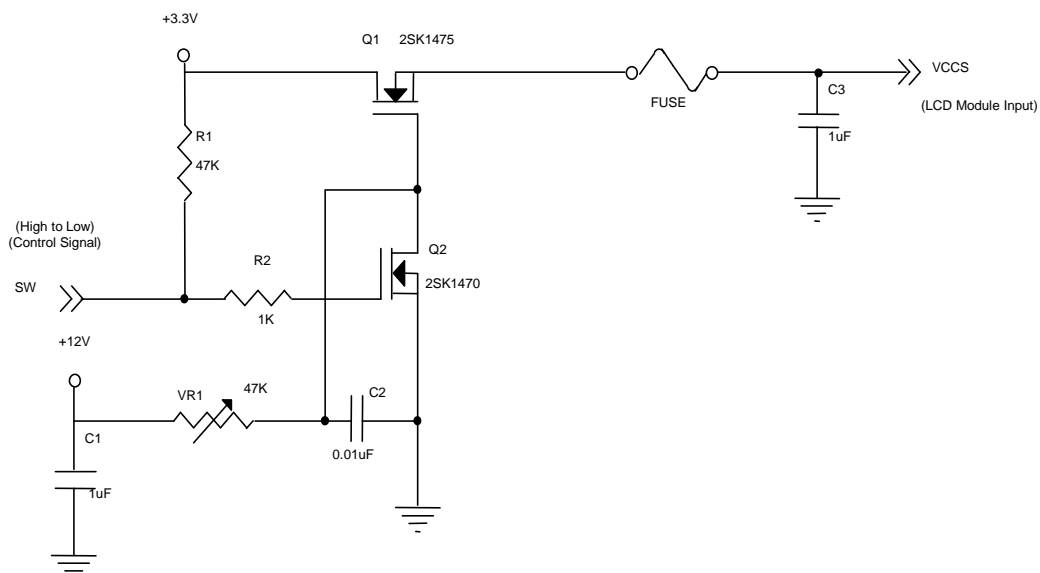
Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Power Supply Voltage	VCCS	3.0	3.3	3.6	V	(1)
Ripple Voltage	V _{RP}	-	50	-	mV	(1)
Inrush Current	I _{RUSH}	-	-	1.5	A	(1),(2)
Power Supply Current	Mosaic	-	270	320	mA	(3)a
	Black	-	340	380	mA	(3)b

Note (1) The ambient temperature is $T_a = 25 \pm 2$ °C.

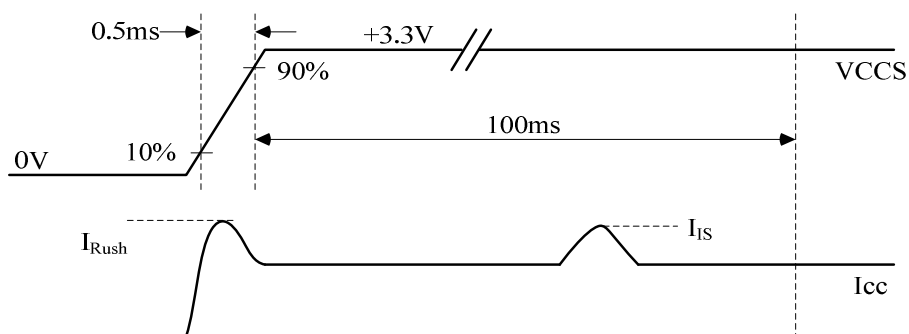
Note (2) I_{RUSH}: the maximum current when VCCS is rising

I_{IS}: the maximum current of the first 100ms after power-on

Measurement Conditions: Shown as the following figure. Test pattern: black.

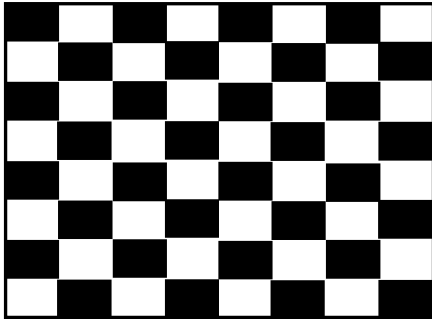


VCCS rising time is 0.5ms



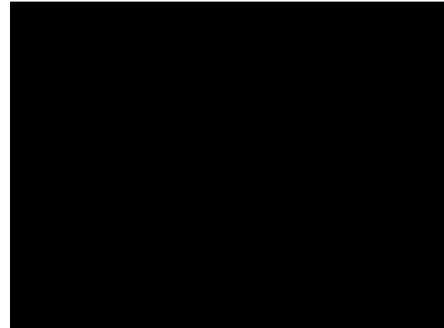
Note (3) The specified power supply current is under the conditions at $V_{CCS} = 3.3\text{ V}$, $T_a = 25 \pm 2\text{ }^\circ\text{C}$, DC Current and $f_v = 60\text{ Hz}$, whereas a power dissipation check pattern below is displayed.

a. Mosaic Pattern



Active Area

b. Black Pattern



Active Area

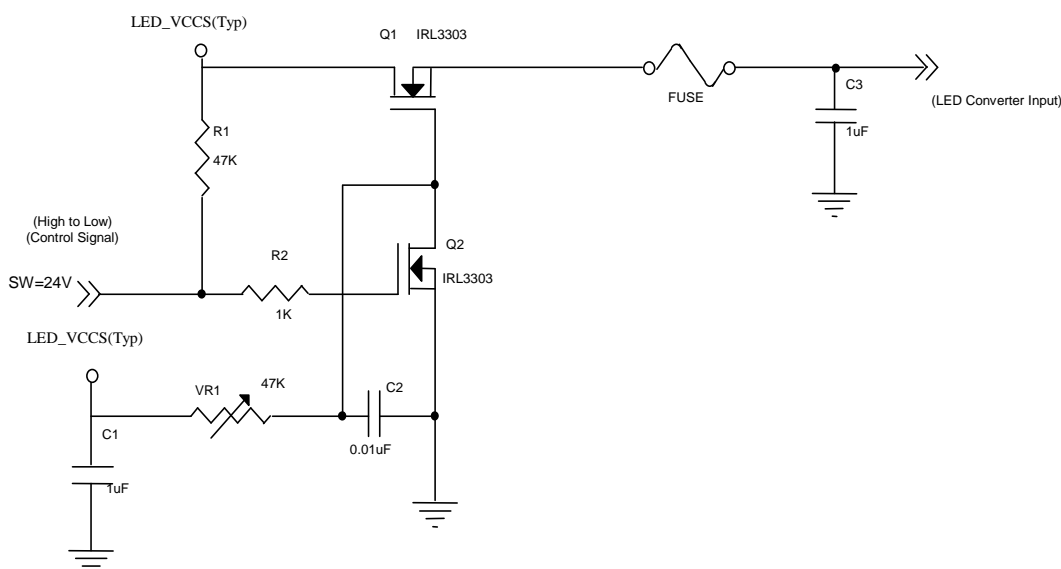
4.3.2 LED CONVERTER SPECIFICATION

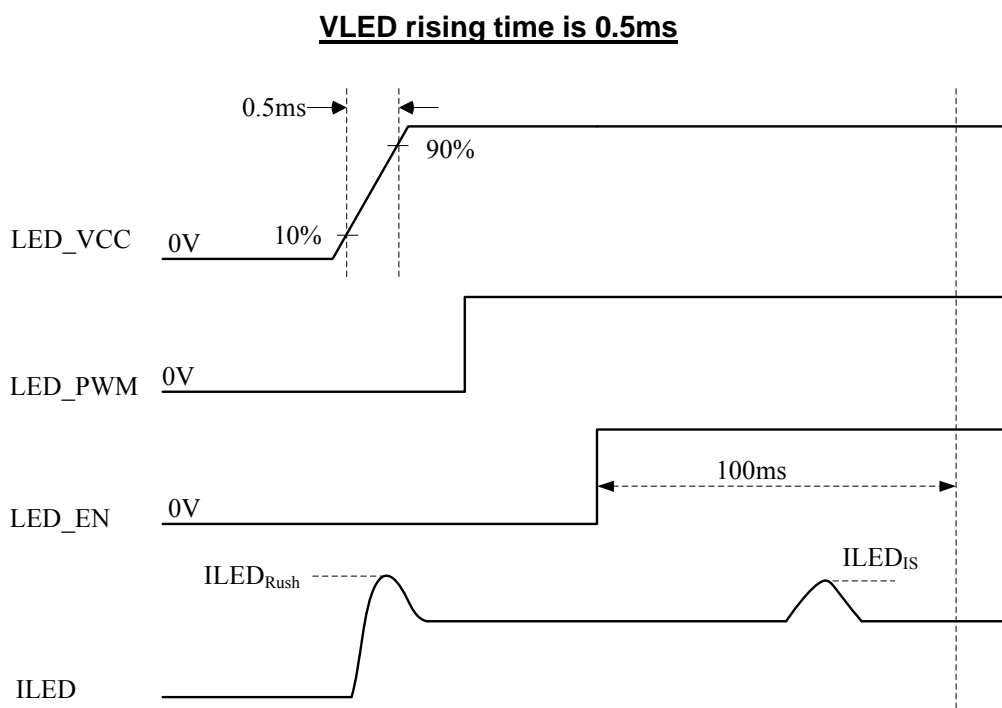
Parameter		Symbol	Value			Unit	Note
			Min.	Typ.	Max.		
Converter Input power supply voltage		LED_Vccs	6.0	12.0	21.0	V	
Converter Inrush Current		I _{LED_RUSH}	-	-	1.5	A	(1)
EN Control Level	Backlight On		3.0	-	3.6	V	
	Backlight Off		0	-	0.5	V	
PWM Control Level	PWM High Level		3.0	-	3.6	V	
	PWM Low Level		0	-	0.5	V	
PWM Control Duty Ratio			10	-	100	%	
			5	-	100	%	(2)
PWM Control Permissible Ripple Voltage		V _{PWM_pp}	-	-	100	mV	
PWM Control Frequency		f _{PWM}	190	-	2K	Hz	(3)
LED Power Current	LED_VCCS =Typ.	I _{LED}	171	197	214	mA	(4)

Note (1) I_{LED_RUSH}: the maximum current when LED_VCCS is rising,

I_{LED_{IS}}: the maximum current of the first 100ms after power-on,

Measurement Conditions: Shown as the following figure. LED_VCCS = Typ, Ta = 25 ± 2 °C, f_{PWM} = 200 Hz, Duty=100%.





Note (2) If the PWM control duty ratio is less than 10%, there is some possibility that acoustic noise or backlight flash can be found. And it is also difficult to control the brightness linearity.

Note (3) If PWM control frequency is applied in the range less than 1KHz, the “waterfall” phenomenon on the screen may be found. To avoid the issue, it’s a suggestion that PWM control frequency should follow the criterion as below.

PWM control frequency f_{PWM} should be in the range

$$(N + 0.33) * f \leq f_{PWM} \leq (N + 0.66) * f$$

N : Integer ($N \geq 3$)

f : Frame rate

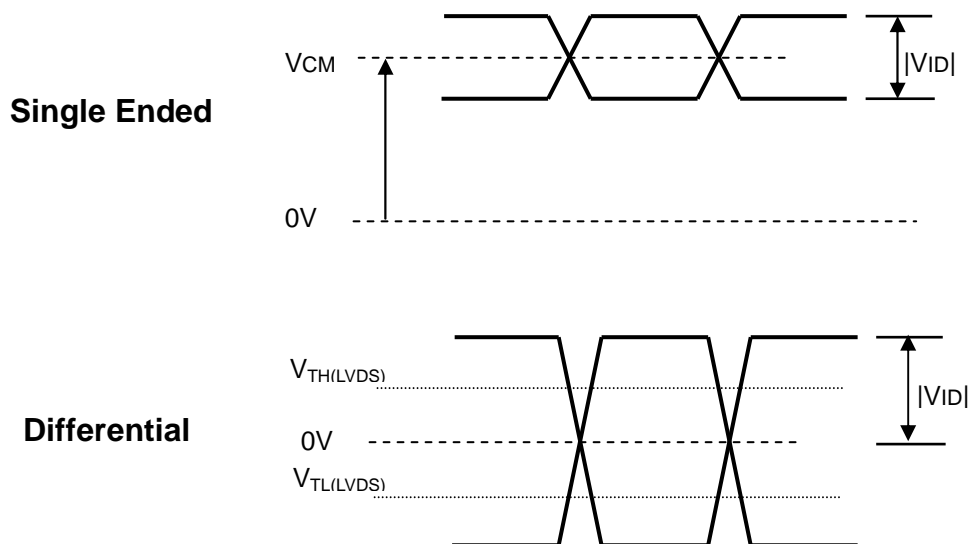
Note (4) The specified LED power supply current is under the conditions at “LED_VCCS = Typ.”, $T_a = 25 \pm 2$ °C, $f_{PWM} = 200$ Hz, Duty=100%.

4.4 LVDS INPUT SIGNAL TIMING SPECIFICATIONS

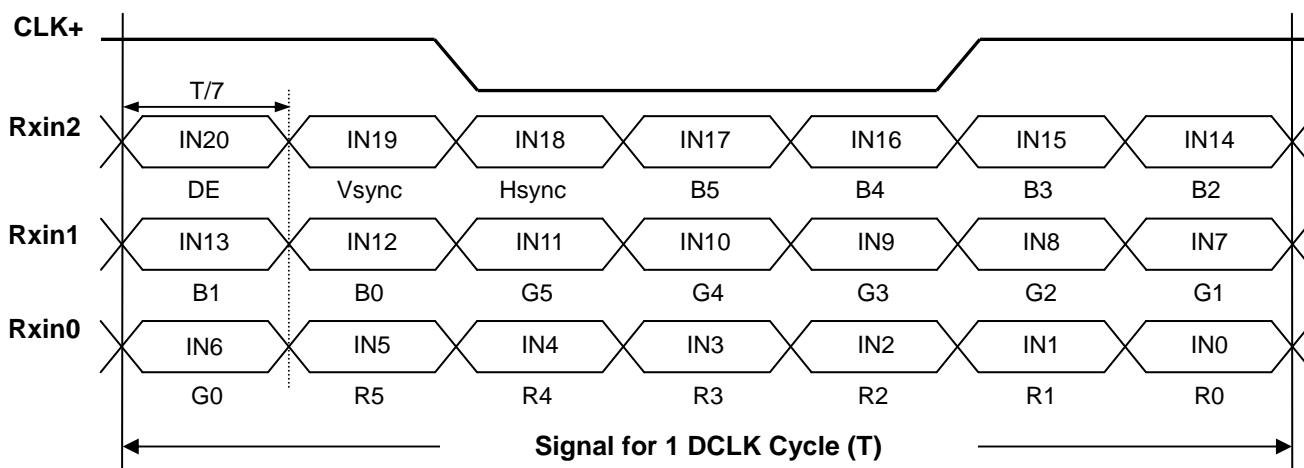
4.4.1 LVDS DC SPECIFICATIONS

Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
LVDS Differential Input High Threshold	$V_{TH(LVDS)}$	-	-	+100	mV	(1), $V_{CM}=1.2V$
LVDS Differential Input Low Threshold	$V_{TL(LVDS)}$	-100	-	-	mV	(1), $V_{CM}=1.2V$
LVDS Common Mode Voltage	V_{CM}	1.125	-	1.375	V	(1)
LVDS Differential Input Voltage	$ V_{ID} $	100	-	600	mV	(1)
LVDS Terminating Resistor	R_T		100		Ohm	-

Note (1) The parameters of LVDS signals are defined as the following figures.



4.4.2 LVDS DATA FORMAT



4.4.3 COLOR DATA INPUT ASSIGNMENT

The brightness of each primary color (red, green and blue) is based on the 6-bit gray scale data input for the color. The higher the binary input the brighter the color. The table below provides the assignment of color versus data input.

Color		Data Signal																	
		Red						Green						Blue					
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	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
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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
Gray Scale Of Red	Red(0)/Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Red(1)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
	Red(2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	Red(61)	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	
	Red(62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
	Red(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	
Gray Scale Of Green	Green(0)/Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
	Green(2)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
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	Green(61)	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	
	Green(62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	
	Green(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	
Gray Scale Of Blue	Blue(0)/Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Blue(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	Blue(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
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	Blue(61)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	
	Blue(62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	
	Blue(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	

Note (1) 0: Low Level Voltage, 1: High Level Voltage

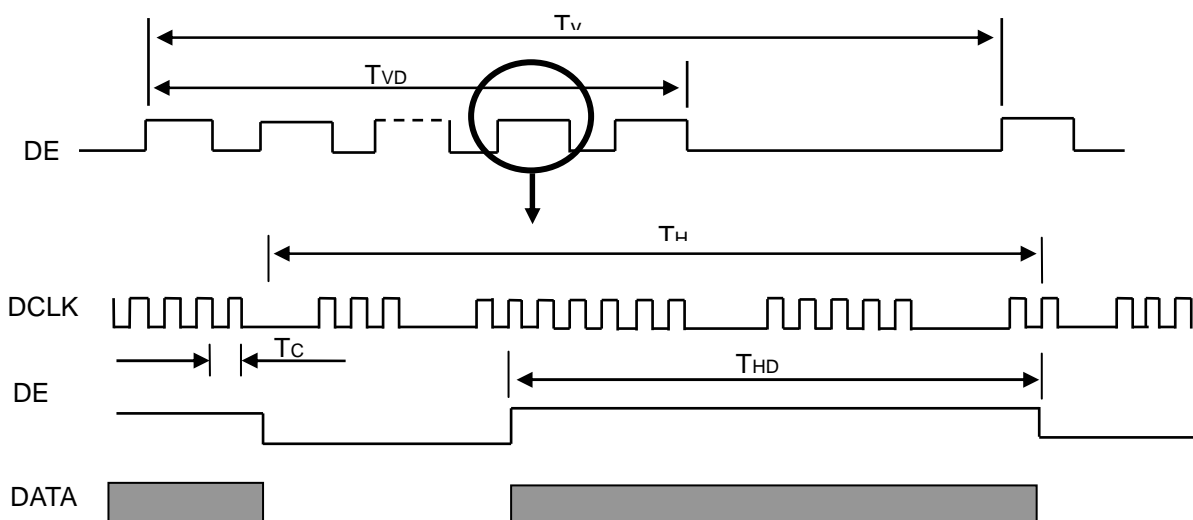
4.5 DISPLAY TIMING SPECIFICATIONS

The input signal timing specifications are shown as the following table and timing diagram.

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
DCLK	Frequency	1/Tc	67.86	75.4	79.17	MHz	-
DE	Vertical Total Time	TV	773	806	815	TH	-
	Vertical Active Display Period	TVD	768	768	768	TH	-
	Vertical Active Blanking Period	TVB	TV-TVD	38	TV-TVD	TH	-
	Horizontal Total Time	TH	1452	1560	1608	Tc	-
	Horizontal Active Display Period	THD	1366	1366	1366	Tc	-
	Horizontal Active Blanking Period	THB	TH-THD	194	TH-THD	Tc	-

Note (1) Because this module is operated by DE only mode, Hsync and Vsync are ignored.

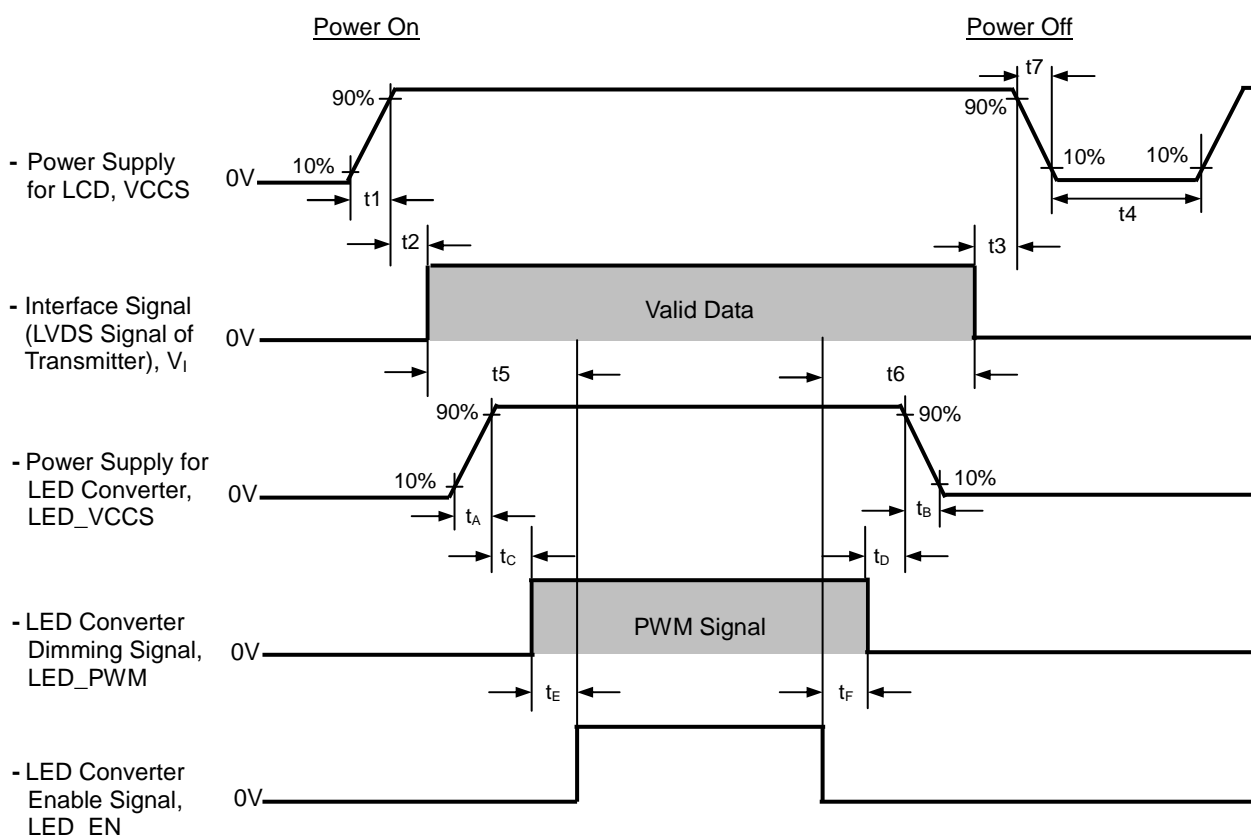
INPUT SIGNAL TIMING DIAGRAM



4.6 POWER ON/OFF SEQUENCE

The power sequence specifications are shown as the following table and diagram.

Symbol	Value			Unit	Note
	Min.	Typ.	Max.		
t1	0.5	-	10	ms	
t2	0	-	50	ms	
t3	0	-	50	ms	
t4	500	-	-	ms	
t5	200	-	-	ms	
t6	200	-	-	ms	
t7	0.5	-	10	ms	
t _A	0.5	-	10	ms	
t _B	0	-	10	ms	
t _C	10	-	-	ms	
t _D	10	-	-	ms	
t _E	10	-	-	ms	
t _F	10	-	-	ms	



Note (1) Please don't plug or unplug the interface cable when system is turned on.

Note (2) Please avoid floating state of the interface signal during signal invalid period.

Note (3) It is recommended that the backlight power must be turned on after the power supply for LCD and the interface signal is valid.

5. OPTICAL CHARACTERISTICS

5.1 TEST CONDITIONS

Item	Symbol	Value	Unit
Ambient Temperature	Ta	25±2	°C
Ambient Humidity	Ha	50±10	%RH
Supply Voltage	V _{CC}	3.3	V
LED Light Bar Input Current	I _L	63	mA

The measurement methods of optical characteristics are shown in Section 5.2. The following items should be measured under the test conditions described in Section 5.1 and stable environment shown in Note (5).

5.2 OPTICAL SPECIFICATIONS

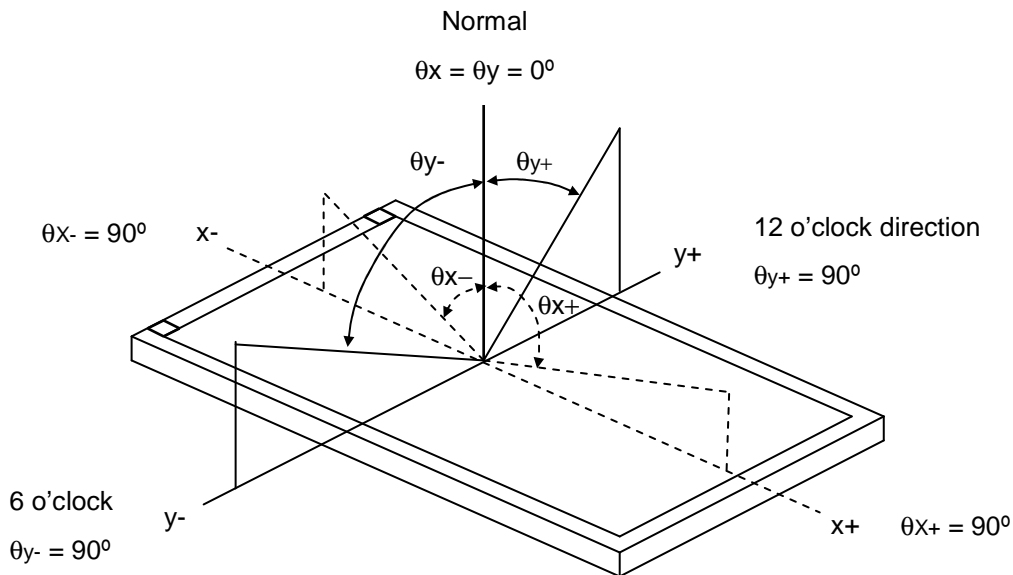
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note	
Center Transmittance	T%	$\theta_x=0^\circ, \theta_y=0^\circ$	7.47	7.86			(1), (5), (8)	
Contrast Ratio	CR	CS-1000T, CMO BLU	500	650			(1), (3), (5)	
Transmittance uniformity	δ T%	$\theta_x=0^\circ, \theta_y=0^\circ$ BM-5A			1.25		(1), (5), (7)	
Response Time	T _R	$\theta_x=0^\circ, \theta_y=0^\circ$	-	3	8	ms	(4)	
	T _F		-	7	13	ms		
Color Chromaticity	Red	Rcx	$\theta_x=0^\circ, \theta_y=0^\circ$ CS-1000T Standard light source "C"	Typ.- 0.03	Typ.+ 0.03	-	(0), (5)	
		Rcy				0.597		-
	Green	Gcx				0.342		-
		Gcy				0.301		-
	Blue	Bcx				0.557		-
		Bcy				0.140		-
	White	Wcx				0.173		-
		Wcy				0.313		-
Viewing Angle	Horizontal	θ_{x+}	40	45	-	Deg.	(1),(3),(5)	
		θ_{x-}	40	45	-			
	Vertical	θ_{y+}	15	20	-			
		θ_{y-}	40	45	-			

Note (0) Light source is the standard light source "C" which is defined by CIE and driving voltages are based on suitable gamma voltages. The calculating method is as following :

1. Measure Module's and BLU's spectrums. White is without signal input and R, G, B are with signal input. BLU is supplied by CMI.
2. Calculate cell's spectrum.
3. Calculate cell's chromaticity by using the spectrum of standard light source "C"

Note (1) Light source is the BLU which is supplied by CMO and driving voltages are based on suitable gamma voltages. White is without signal input and R, G, B are with signal input. SPEC is judged by CMO's golden sample.

Note (2) Definition of Viewing Angle (θ_x, θ_y):



Note (3) Definition of Contrast Ratio (CR):

The contrast ratio can be calculated by the following expression.

$$\text{Contrast Ratio (CR)} = L_{63} / L_0$$

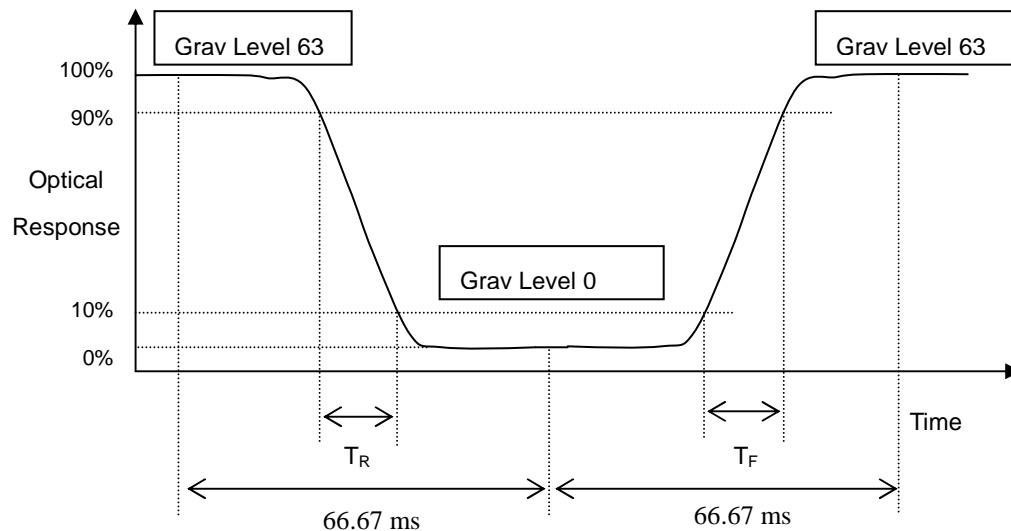
L63: Luminance of gray level 63

L 0: Luminance of gray level 0

$$CR = CR (1)$$

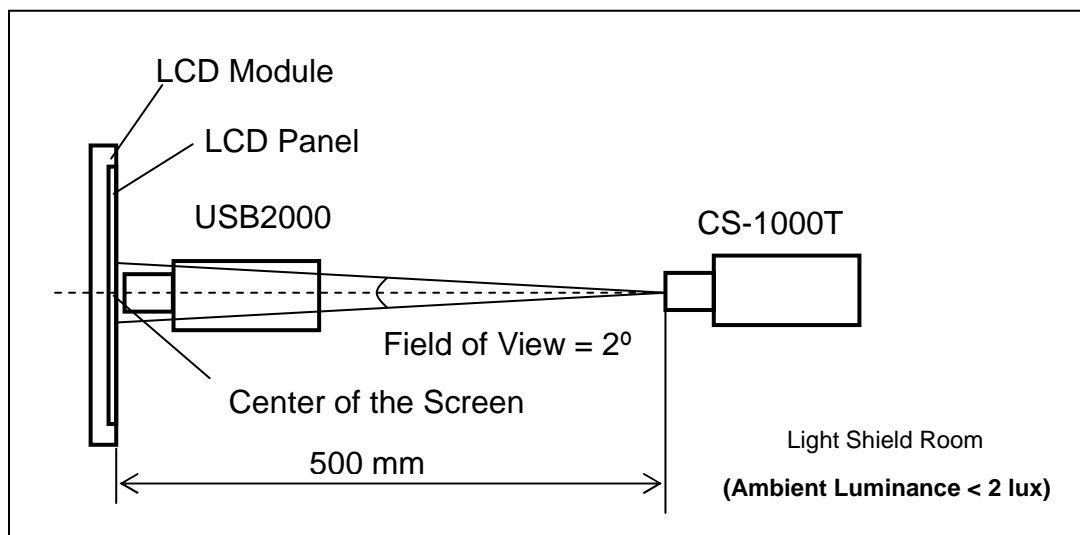
CR (X) is corresponding to the Contrast Ratio of the point X at Figure in Note (6).

Note (4) Definition of Response Time (T_R, T_F):



Note (5) Measurement Setup:

The LCD module should be stabilized at given temperature for 20 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 20 minutes in a windless room.



Note (6) Definition of Transmittance Variation ($\delta T\%$):

Measure the transmittance at 5 points

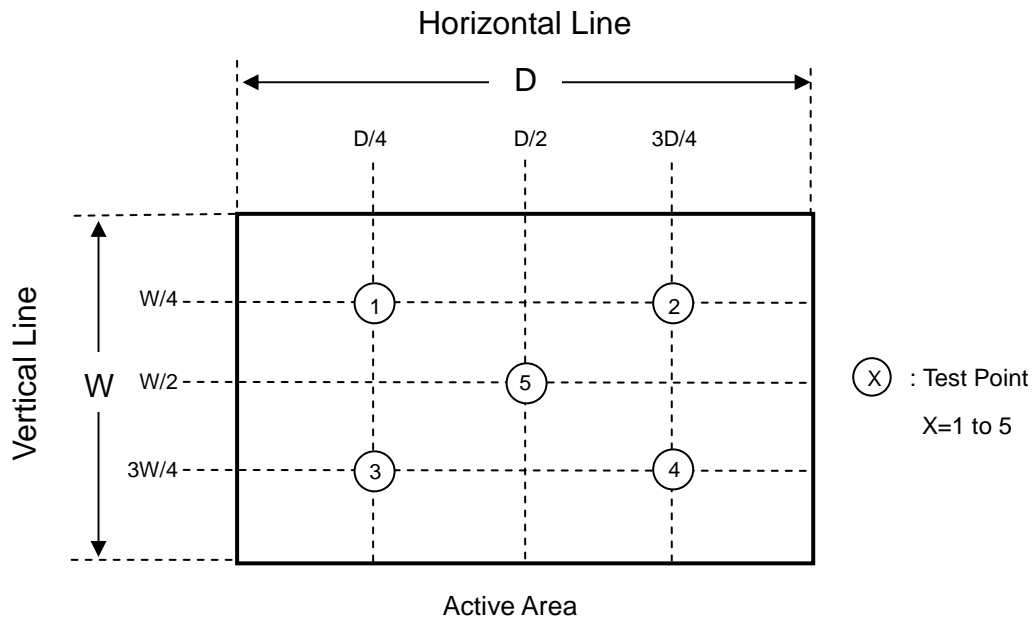
$$\delta T\% = \frac{\text{Maximum } [T\%(1), T\%(2), \dots T\%(5)]}{\text{Minimum } [T\%(1), T\%(2), \dots T\%(5)]}$$

Note (7) Definition of Transmittance (T%):

Module is without signal input.

BLU is supplied by CMO.

$$\text{Transmittance} = \frac{\text{Luminance of LCD module}}{\text{Luminance of backlight}} * 100\%$$



Note (8) The listed optical specifications refer to the initial value of manufacture, but the condition of the specifications after long-term operation will not be warranted.

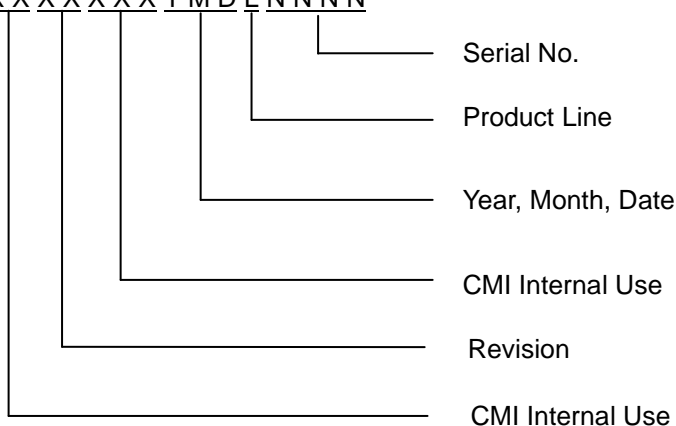
6. PACKING

6.1 CMI OPEN CELL LABEL

The barcode nameplate is pasted on each OPEN CELL as illustration for CMI internal control.



- (a) Model Name: N156BGE - P41
- (b) Revision: Rev. XX, for example: C1, C2 ...etc.
- (c) Serial ID: XXXXXXYMDLNNNN



Serial ID includes the information as below:

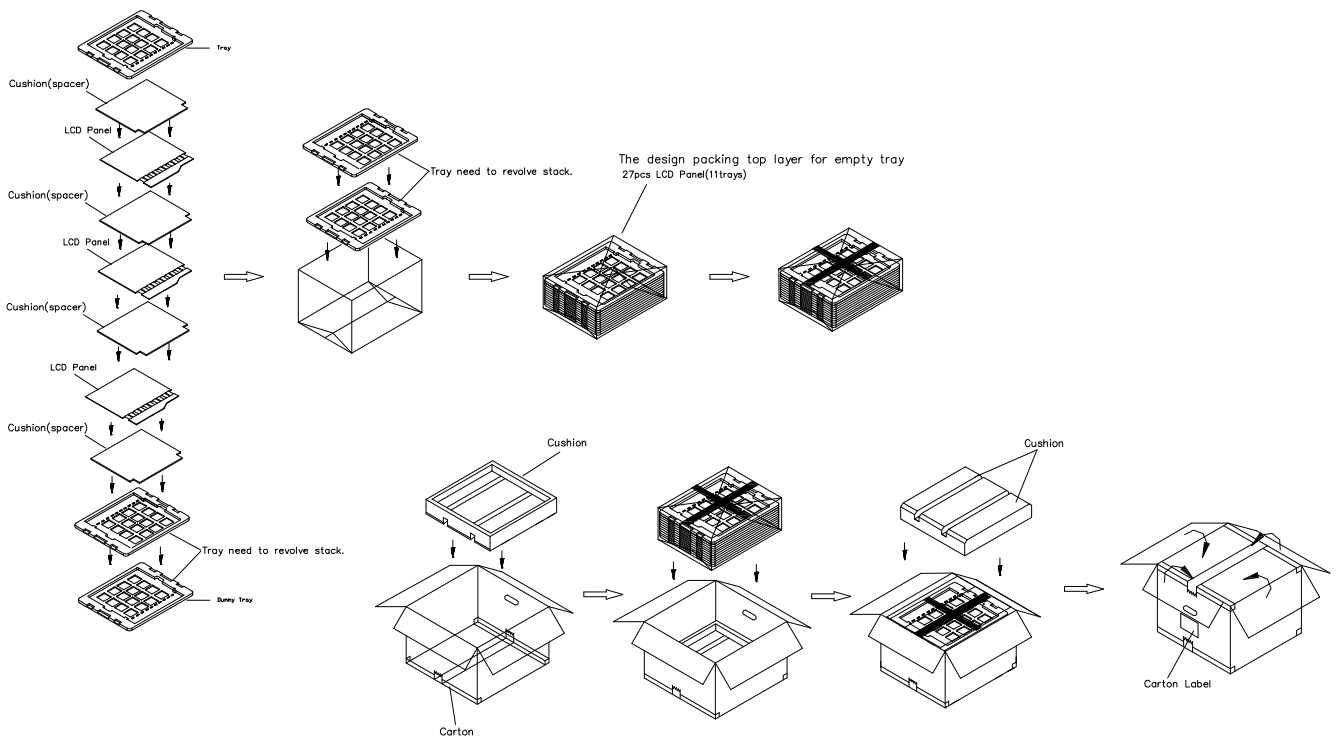
- (a) Manufactured Date: Year: 0~9, for 2010~2019
 Month: 1~9, A~C, for Jan. ~ Dec.
 Day: 1~9, A~Y, for 1st to 31st, exclude I, O and U
- (b) Revision Code: cover all the change
- (c) Serial No.: Manufacturing sequence of product
- (d) Product Line: 1 -> Line1, 2 -> Line 2, ...etc.

6.2 Package Reliability

(1) Carton Packing should have no failure in the following reliability test items

Test Item	Test Conditions	Note
Packing Vibration	ISTA STANDARD Random, Frequency Range: 1 – 200 Hz Top & Bottom: 30 minutes (+Z), 10 min (-Z), Right & Left: 10 minutes (X) Back & Forth 10 minutes (Y)	Non Operation

6.3 CARTON

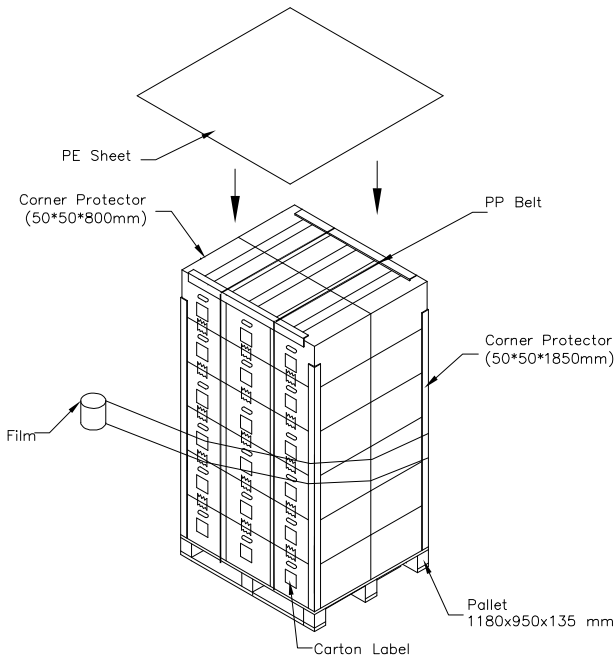


- (1) Carton Dimensions: 475(L)x390(W)x320(H)mm
- (2) 27 LCD Cells+PCB/Carton

Figure. 6-3 Packing method

6.4 PALLET

Sea and Land Transportation



Air Transportation

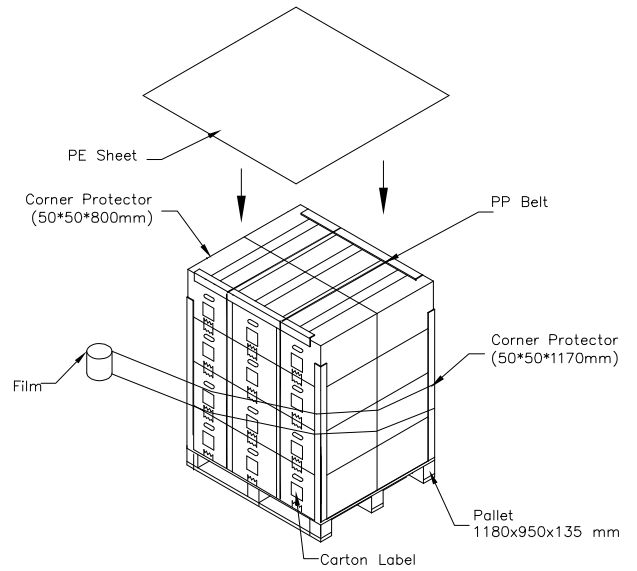


Figure. 6-4 Packing method

7. PRECAUTIONS

7.1 HANDLING PRECAUTIONS

- (1) The module should be assembled into the system firmly by using every mounting hole. Be careful not to twist or bend the module.
- (2) While assembling or installing modules, it can only be in the clean area. The dust and oil may cause electrical short or damage the polarizer.
- (3) Use fingerstalls or soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (4) Do not press or scratch the surface harder than a HB pencil lead on the panel because the polarizer is very soft and easily scratched.
- (5) If the surface of the polarizer is dirty, please clean it by some absorbent cotton or soft cloth. Do not use Ketone type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanently damage the polarizer due to chemical reaction.
- (6) Wipe off water droplets or oil immediately. Staining and discoloration may occur if they left on panel for a long time.
- (7) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contacting with hands, legs or clothes, it must be washed away thoroughly with soap.
- (8) Protect the module from static electricity, it may cause damage to the C-MOS Gate Array IC.
- (9) Do not disassemble the module.
- (10) Do not pull or fold the LED wire.
- (11) Pins of I/F connector should not be touched directly with bare hands.

7.2 STORAGE PRECAUTIONS

- (1) High temperature or humidity may reduce the performance of module. Please store LCD module within the specified storage conditions.
- (2) It is dangerous that moisture come into or contacted the LCD module, because the moisture may damage LCD module when it is operating.
- (3) It may reduce the display quality if the ambient temperature is lower than 10 °C. For example, the response time will become slowly, and the starting voltage of LED will be higher than the room temperature.

7.3 OPERATION PRECAUTIONS

- (1) Do not pull the I/F connector in or out while the module is operating.
- (2) Always follow the correct power on/off sequence when LCD module is connecting and operating. This can prevent the CMOS LSI chips from damage during latch-up.
- (3) The startup voltage of Backlight is approximately 1000 Volts. It may cause electrical shock while assembling with converter. Do not disassemble the module or insert anything into the Backlight unit.

