PRELIMINARY

NLT Technologies

TFT COLOR LCD MODULE

NL192108AC18-01D

40cm (15.6 Type)
FHD
eDP interface

PRELIMINARY DATA SHEET

DOD-PP-2202 (4th edition)

This PRELIMINARY DATA SHEET is updated document from DOD-PP-2187(3).

All information is subject to change without notice. Please confirm the sales representative before starting to design your system.

INTRODUCTION

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The products are classified into three grades: **"Standard"**, **"Special"**, and **"Specific"**.
Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

The **Standard:** Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.
Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

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Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

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Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the **"Standard"** unless otherwise specified in this document.

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL192108AC18-01D is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATION

- Color monitor system

1.3 FEATURES

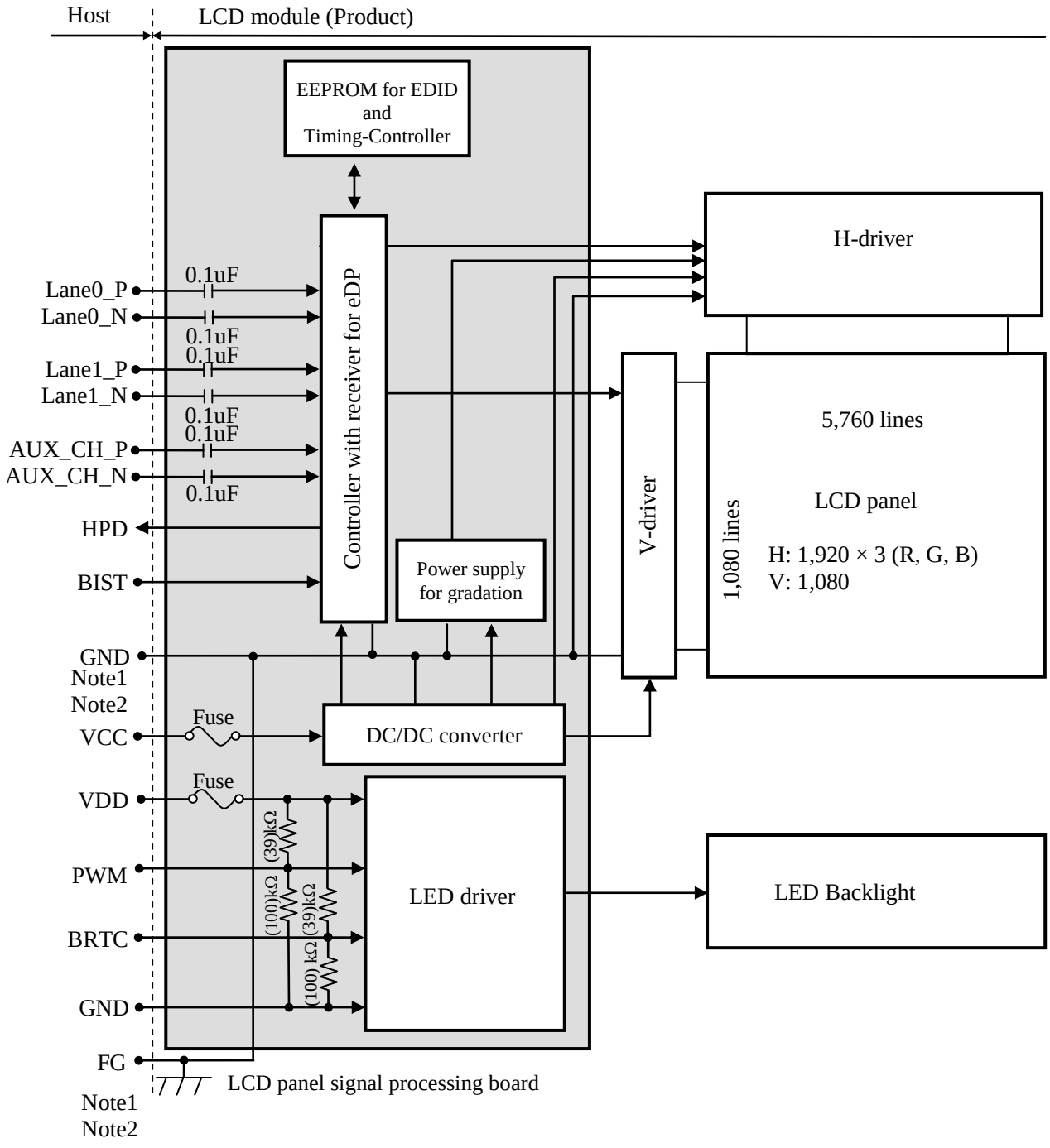
- Ultra Wide viewing angle
- High contrast
- Wide color gamut
- Wide temperature range
- eDP interface
- 8-bit digital signals for data of RGB
- Narrow frame
- LED backlight built in LED driver
- This product will comply with the European RoHS directive (2011/65/EU) when starting mass production.

2. GENERAL SPECIFICATIONS

Display area	344.16 (H) × 193.59 (V) mm
Diagonal size of display	40cm (15.6 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors
Pixel	1,920 (H) × 1,080 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.05975 (H) × 0.17925 (V) mm
Pixel pitch	0.17925 (H) × 0.17925 (V) mm
Module size	363.8 (W) × 215.9 (H) × (6.3) (D) mm (typ.)
Weight	TBD g (typ.)
Contrast ratio	750:1 (typ.)
Viewing angle	*At the contrast ratio ≥10:1* • Horizontal: Right side 88° (typ.), Left side 88° (typ.) • Vertical: Up side 88° (typ.), Down side 88° (typ.)
Designed viewing direction	• Viewing angle with optimum grayscale ($\gamma \fallingdotseq$ 2.2): Normal axis (perpendicular)
Polarizer surface	Antiglare
Polarizer pencil-hardness	3H (min.) [by JIS K5600]
Color gamut	*At LCD panel center* 72% (typ.) [against NTSC color space]
Response time	*Ton+Toff (10%←→ 90%)* TBD ms (typ.)
Luminance	*At the maximum luminance control* 400cd/m^2 (typ.)
Signal system	eDP 2lanes [8-bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE)]
Power supply voltage	LCD panel signal processing board: 3.3V LED backlight: 12.0V
Backlight	LED backlight built in LED driver
Power consumption	*At the maximum luminance control, Checkered flag pattern* (13.9) W (typ.)

3. BLOCK DIAGRAM

4



Note1: Relation between GND (Signal ground) and FG (Frame ground) in the LCD module is as follows.

GND- FG	Connected

Note2: GND and FG must be connected to customer equipment's ground, and it is recommended that these grounds to be connected together in customer equipment.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	363.8 ± 0.5 (W) × 215.9 ± 0.5 (H) × (6.3) (D)	Note1	mm
Display area	344.16 (H) × 193.59 (V)	Note1	mm
Weight	TBD (typ.), TBD (max.)		

Note1: See "**8. OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal processing board	VCC	(-0.3to +5.5)	V	-
	LED driver	VDD	(0.3to +15)		
Input voltage for signals	Display signals	VD	TBD	V	
	Function signal for LED driver	PWM	(-0.3to +5.5)	V	
		BRTC	(-0.3to +5.5)	V	
Storage temperature		Tst	-20 to +70	°C	-
Operating temperature	Front surface	TopF	-20 to +70	°C	Note1
	Rear surface	TopR	-20 to +70	°C	Note2
Relative humidity Note3		RH	≤ 95	%	Ta ≤ 40°C
			≤ 85	%	40°C < Ta ≤ 50°C
			≤ 55	%	50°C < Ta ≤ 60°C
			≤ 36	%	60°C < Ta ≤ 70°C
Absolute humidity Note3		AH	≤ 70 Note4	g/m^3	Ta = 70°C

Note1: Measured at LCD panel surface (including self-heat)
Note2: Measured at LCD module's rear shield surface (including self-heat)
Note3: No condensation
Note4: Water amount at Ta= 70°C and RH= 36%

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage	VCC	3.0	3.3	3.6	V	-
Power supply current	ICC	-	(580) Note1	TBD Note2	mA	at VCC= 3.3V
Permissible ripple voltage	VRPC	-	-	100	mVp-p	for VCC

Note1: Checkered flag pattern [by EIAJ ED-2522]
Note2: Pattern for maximum current

4

4.3.2 LED driver

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	13.2	V	Note1
Power supply current Note3		IDD	-	(1,000)	TBD Note2	mA	at VDD= 12.0V Note6
Permissible ripple voltage		VRPD	-	-	100	mVp-p	for VDD
Input voltage for PWM signal	High	VDFH1	(2.0)	-	(5.0)	V	-
	Low	VDFL1	0	-	(0.8)	V	
Input voltage for BRTC signal	High	VDFH2	(2.0)	-	(5.0)	V	-
	Low	VDFL2	0	-	(0.8)	V	
PWM frequency		f_{PWM}	(200)	-	(1k)	Hz	Note4, Note5
PWM duty ratio		DR_{PWM}	(1)	-	100	%	Note7, Note8
PWM pulse width		tPWH	(20)	-	-	μs	

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.
Note2: This value excludes peak current such as overshoot current.
Note3: The power supply lines (VDD and GND) may have ripple voltage during luminance control of LED. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor between the power supply lines (VDD and GND) to reduce the noise if necessary.
Note4: A recommended f_{PWM} value is as follows.

$$f_{PWM} = \frac{2n-1}{4} \times fv$$

$$(n = \text{integer},\ fv = \text{frame frequency of LCD module})$$

Note5: Depending on the frequency used, so noise may appear on the screen, please conduct a thorough evaluation.
Note6: At the maximum luminance control.
Note7: While the BRTC signal is high, do not set the tPWH (PWM pulse width) is less than (20)μs. It may cause abnormal working of the backlight. In this case, turn the backlight off and then on again by BRTC signal.
Note8: Regardless of the PWM frequency, both PWM duty ratio and PWM pulse width must be always more than the minimum values.

4.3.3 Power supply voltage ripple

This product works, even if the ripple voltage levels are over the permissible values as the following table, but there might be noise on the display image.

Power supply voltage		Ripple voltage Note1 (Measure at input terminal of power supply)	Unit
VCC	3.3V	≤ 100	mVp-p
VDD	12.0V	≤ 100	mVp-p

Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	(FCC152AB)	KAMAYA ELECTRIC CO.,LTD	(1.5A) (36V)	TBD	Note1
VDD	(FCC202AB)	KAMAYA ELECTRIC CO.,LTD	(2A) (36V)	TBD	

4

Note1: The power supply's rated current must be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel

TBD

4.4.2 LED driver

TBD

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS 4

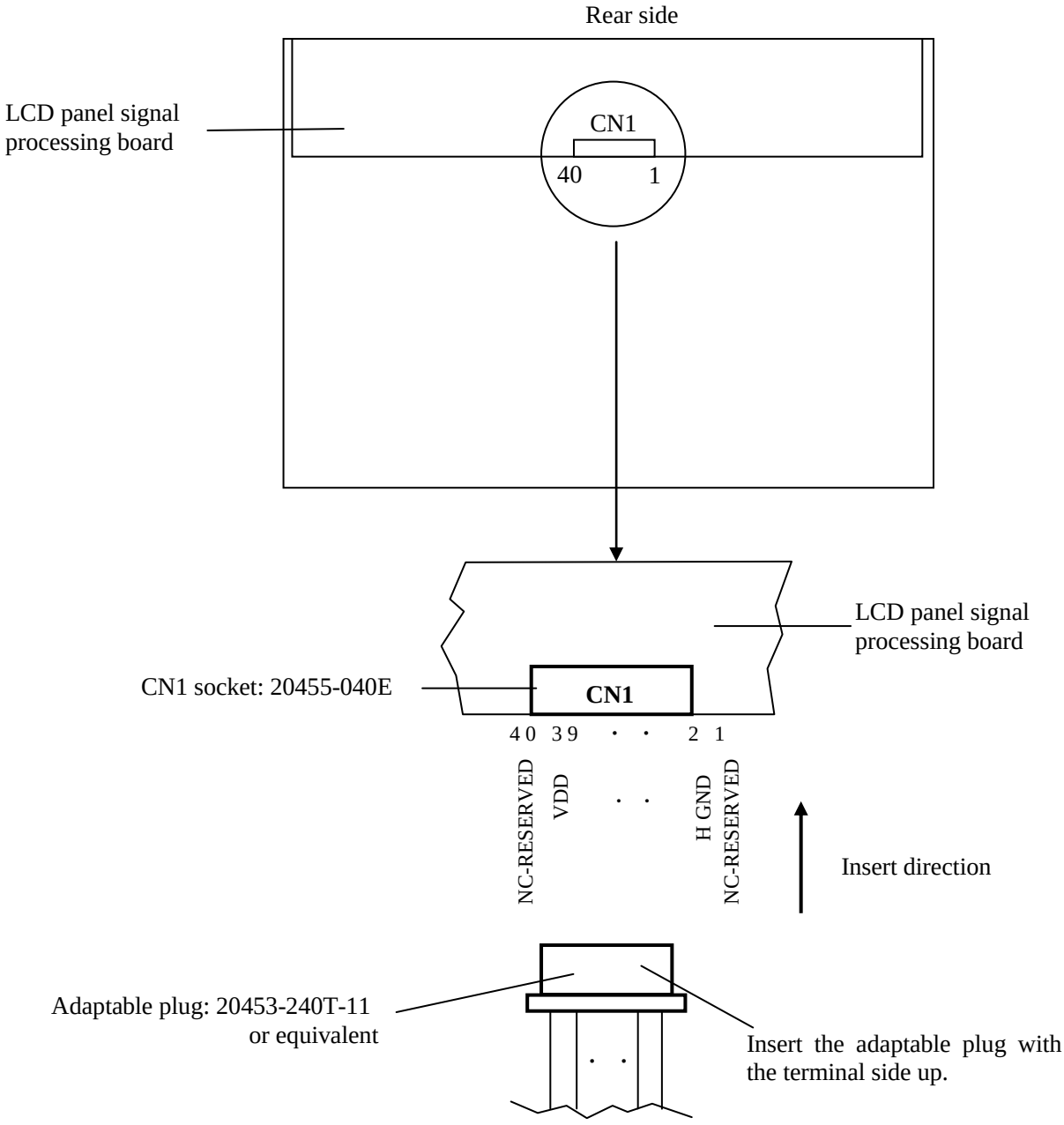
4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): 20455-040E (IPEX) 4
Adaptable plug: 20453-240T-11 (IPEX, Plug Set) 4
20454-240T (IPEX, HOUSING) or equivalent

Pin	Signal Name	Description
1	NC-RESERVED	RESERVED for LCD manufacturer's use
2	NC-RESERVED	RESERVED for LCD manufacturer's use
3	NC-RESERVED	RESERVED for LCD manufacturer's use
4	NC-RESERVED	RESERVED for LCD manufacturer's use
5	NC-RESERVED	RESERVED for LCD manufacturer's use
6	NC-RESERVED	RESERVED for LCD manufacturer's use
7	NC-RESERVED	RESERVED for LCD manufacturer's use
8	H_GND	High Speed Ground
9	Lane1_N	Complement Signal Link Lane1
10	Lane1_P	True Signal Link Lane1
11	H_GND	High Speed Ground
12	Lane0_N	Complement Signal Link Lane0
13	Lane0_P	True Signal Link Lane0
14	H_GND	High Speed Ground
15	AUX_CH_P	True Signal Auxiliary Channel
16	AUX_CH_N	Complement Signal Auxiliary Channel
17	H_GND	High Speed Ground
18	VCC	LCD Logic and Driver Power
19	VCC	LCD Logic and Driver Power
20	VCC	LCD Logic and Driver Power
21	VCC	LCD Logic and Driver Power
22	LCD_Self_Test or NC	LCD Panel Self Test Enable (Optional)
23	LCD_GND	LCD Logic and Driver Ground
24	LCD_GND	LCD Logic and Driver Ground
25	LCD_GND	LCD Logic and Driver Ground
26	LCD_GND	LCD Logic and Driver Ground
27	HPD	HPD Signal Pin
28	BL_GND	Backlight Ground
29	BL_GND	Backlight Ground
30	BL_GND	Backlight Ground
31	BL_GND	Backlight Ground
32	BRTC	Backlight On/Off
33	PWM	System PWM signal input for dimming
34	NC-RESERVED	RESERVED for LCD manufacturer's use
35	NC-RESERVED	RESERVED for LCD manufacturer's use
36	VDD	Backlight Power
37	VDD	Backlight Power
38	VDD	Backlight Power
39	VDD	Backlight Power
40	NC-RESERVED	RESERVED for LCD manufacturer's use

4.5.2 Positions of socket

4



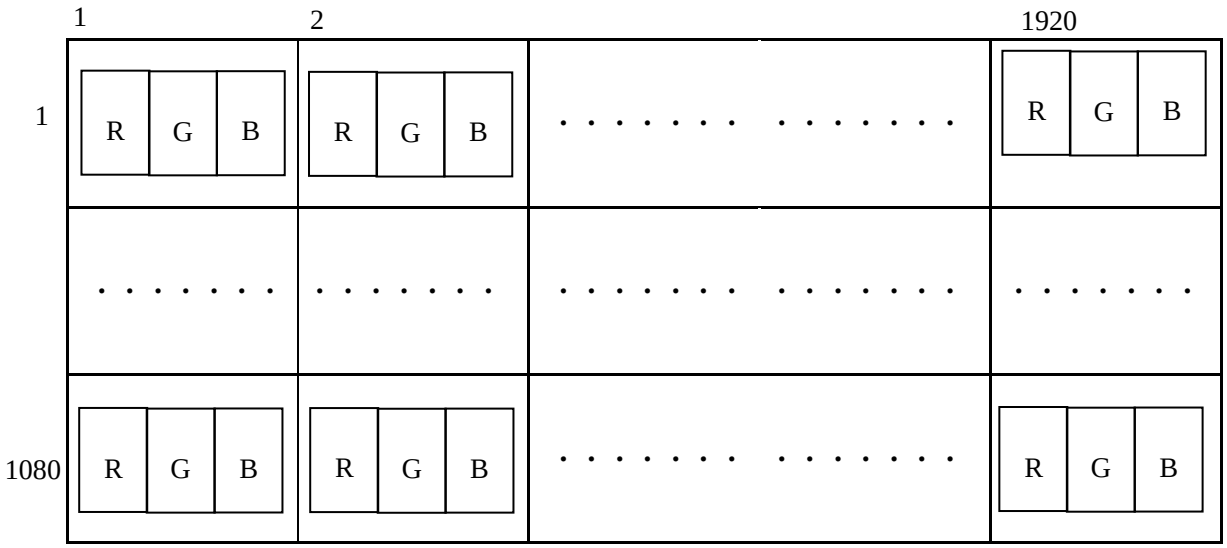
4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

4.6.1 16,777,216 colors

This product can display equivalent of 16,777,216 colors with 256 gray scales.
Also the relation between display colors and input data signals is as follows.

Display colors		Input color data																							
		Red								Green								Blue							
		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
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	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	1
Red gray scale	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
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑				:	:							:	:							:	:			
	↓				:	:							:	:							:	:			
	bright	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		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	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 gray scale	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
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑				:	:							:	:							:	:			
	↓				:	:							:	:							:	:			
	bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
		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	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 gray scale	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
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑				:	:							:	:							:	:			
	↓				:	:							:	:							:	:			
	bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
		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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

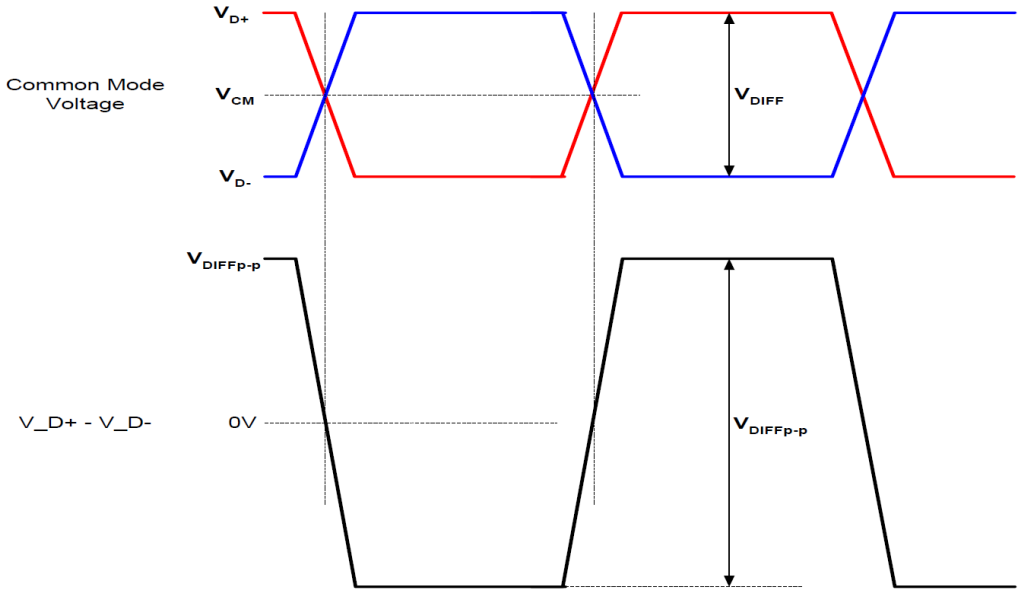
4.7 PIXEL ARRANGEMENT



4.8 eDP SIGNAL TIMING SPECIFICATIONS

4.8.1 Display Port main link signal

Display Port main link signal is compliant to VESA Embedded Display Port Standard 1.2.



Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Differential peak-to-peak Input voltage	VDIFFp-p	(100)	-	TBD	mV	-
Rx input DC common Mode Voltage	VCM	-	0	-	V	-

4.8.2 Display Port VHPD signal

Display Port VHPD signal is compliant to VESA Embedded Display Port Standard 1.2.

Description	Symbol	min.	typ.	max.	Unit	Remarks
Hot Plug detect	VHPD	(2.25)	-	(3.6)	V	I/O type: LVTTL

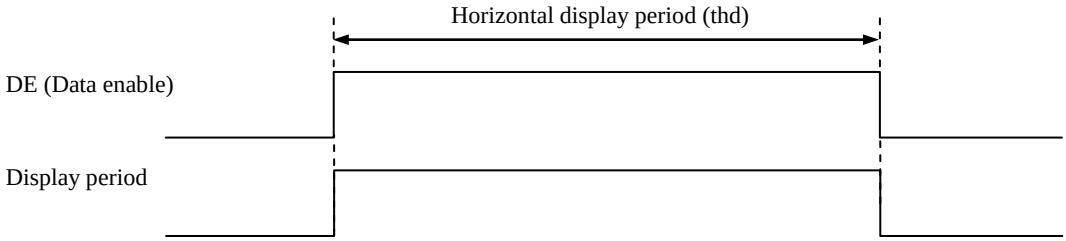
4

4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

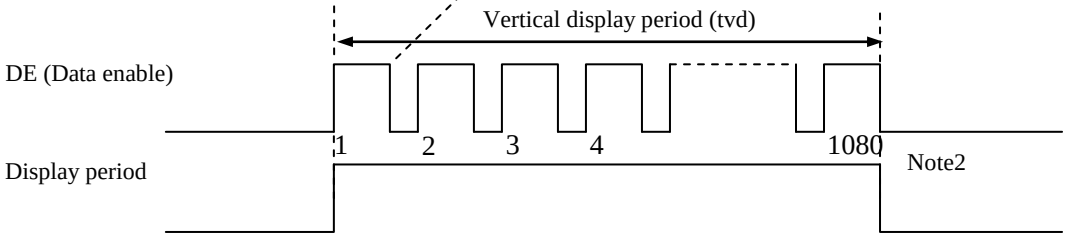
- Horizontal signal

Note1



- Vertical signal

Note1



Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.9.3 Input signal timing chart**" for the pulse number.

4.9.2 Timing characteristics

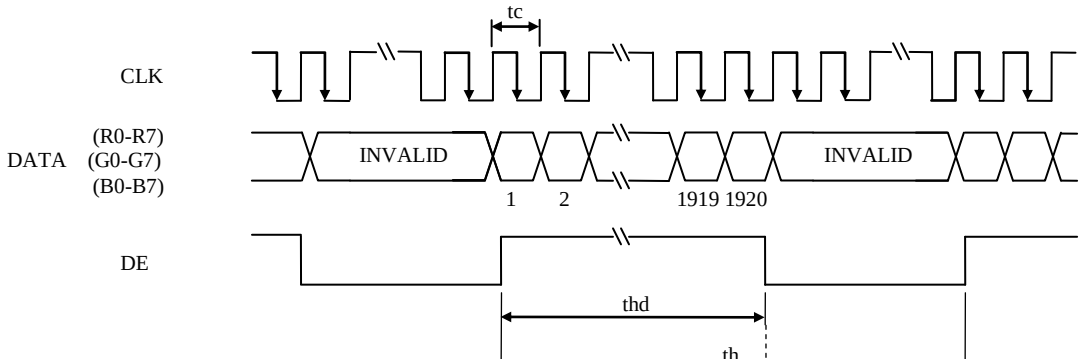
(Note1)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	TBD	138.5	TBD	MHz	-
	Duty ratio		-	-			-	-
	Rise time, Fall time		-				ns	
DE	Horizontal	Cycle	th	TBD	15.02	TBD	μs	66.59 kHz (typ.)
				-	2,080	-	CLK	
		Display period	thd	1,920			CLK	-
	Vertical (One frame)	Cycle	tv	-	16.69	-	ms	59.88Hz (typ.)
				-	1,112	-	H	
		Display period	tvd	1,080			H	-

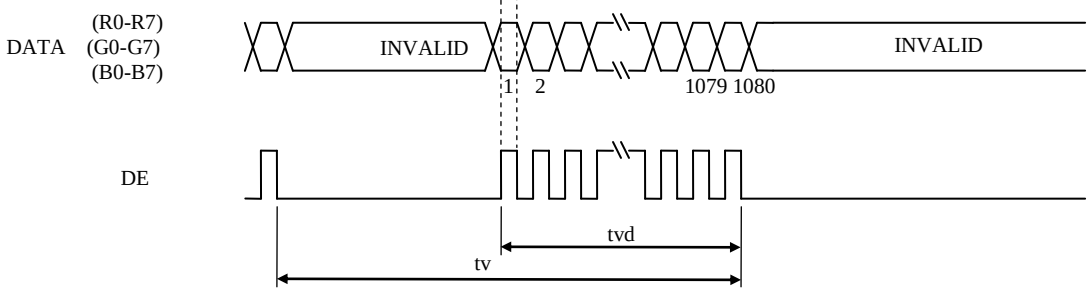
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

4.9.3 Input signal timing chart

Horizontal timing



Vertical timing



4.10 OPTICS

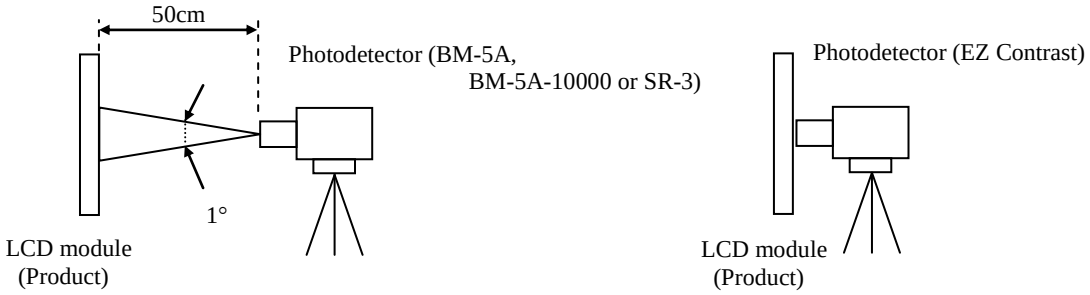
4.10.1 Optical characteristics

(Note1, Note2)

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	(320)	400	-	cd/m^2	BM-5A	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	(400)	750	-	-	BM-5A	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	-	1.25	1.4	-	BM-5A	Note4
Chromaticity	White	**x** coordinate	Wx	0.263	0.313	0.363	-	SR-3	Note5
		y coordinate	Wy	0.279	0.329	0.379	-		
	Red	**x** coordinate	Rx	-	TBD	-	-		
		y coordinate	Ry	-	TBD	-	-		
	Green	**x** coordinate	Gx	-	TBD	-	-		
		y coordinate	Gy	-	TBD	-	-		
	Blue	**x** coordinate	Bx	-	TBD	-	-		
		y coordinate	By	-	TBD	-	-		
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space	C	65	72	-	%		
Response time		Black to White	Ton	-	TBD	TBD	ms	BM-5A -10000	Note6 Note7
		White to Black	Toff	-	TBD	TBD	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	70	88	-	°	EZ Contrast	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	70	88	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	70	88	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	70	88	-	°		

Note1: These are initial characteristics.
Note2: Measurement conditions are as follows.
Ta= 25°C, VCC= 3.3V, VDD=12.0V, PWM duty ratio: 100%,
Display mode: FHD, Horizontal cycle= 1/66.59kHz, Vertical cycle= 1/59.88Hz,

Optical characteristics are measured at luminance saturation 20minutes after the product works, in the dark room. Also measurement methods are as follows.



Note3: See "**4.10.2 Definition of contrast ratio**".
Note4: See "**4.10.3 Definition of luminance uniformity**".
Note5: These coordinates are found on CIE 1931 chromaticity diagram.
Note6: Product surface temperature: TopF= TBD°C
Note7: See "**4.10.4 Definition of response times**".
Note8: See "**4.10.5 Definition of viewing angles**".

4.10.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

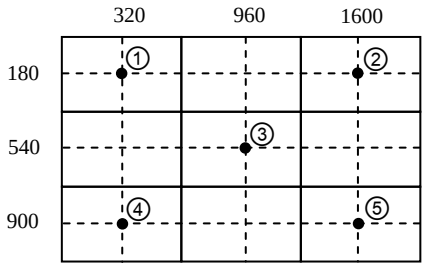
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

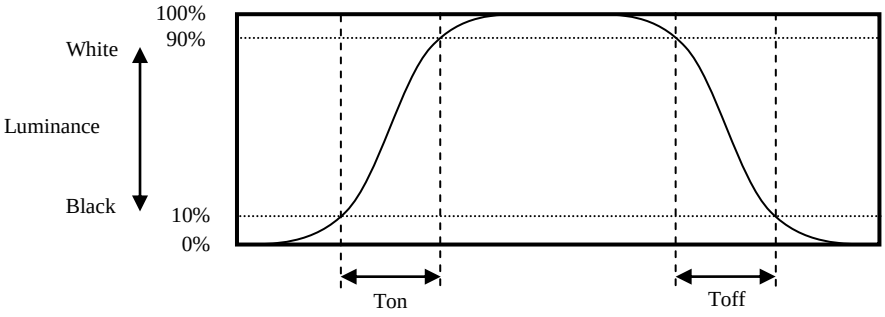
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

The luminance is measured at near the 5 points shown below.

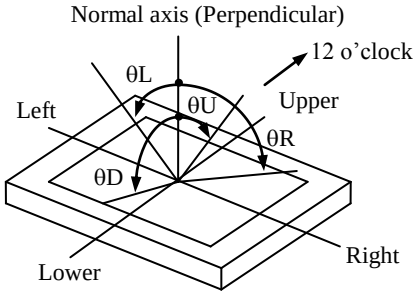


4.10.4 Definition of response times

Response time is measured at the time when the luminance changes from "black" to "white ", or "white" to "black " on the same screen point, by photo-detector. Ton is the time when the luminance changes from 10% up to 90%. Also Toff is the time when the luminance changes from 90% down to 10% (See the following diagram.).



4.10.5 Definition of viewing angles



5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

This lifetime is the estimated value, and is not guarantee value.

Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of the product) Continuous operation, PWM duty ratio:100%	50,000	h

Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

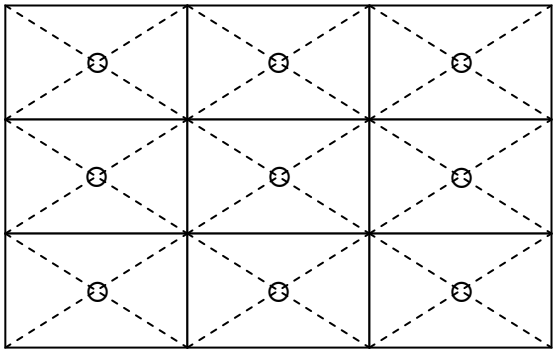
6. RELIABILITY TESTS

4

Test item	Condition	Judgment Note1
High temperature and humidity (Operation)	① (+50) ± 2°C, RH= (80%), 300hours ② Display data is white.	No display malfunctions
High temperature (Operation)	① +70 ± 3°C, 300hours ② Display data is white.	
Low temperature (Operation)	① -20 ± 3°C, 240hours ② Display data is white.	
Thermal shock (Non operation)	① -20 ± 3°C…30minutes +(70) ± 3°C…30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.	
ESD (Operation)	① 150pF, 150Ω, ±10kV ② 9 places on a panel surface Note2 ③ 10 times each points at 1 sec interval	
Dust (Operation)	① Sample dust: No. 15 (by JIS-Z8901) ② 15 seconds stir ③ 8 times repeat at 1 hour interval	
Vibration (Non operation)	① 5 to 100Hz, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 50 times each directions	No display malfunctions No physical damages
Mechanical shock (Non operation)	① 294m/ s^2, 11ms ② ±X, ±Y, ±Z directions ③ 3 times each directions	

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.

Note2: See the following figure for discharge points.



7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!**

This sign has the meaning that a customer will be injured or the product will sustain damage if the customer practices wrong operations.

This sign has the meaning that a customer will be injured if the customer practices wrong operations.

7.2 CAUTIONS

- **Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than TBD m/s^2 and equal to or no greater than TBD ms, Pressure: Equal to or no greater than 19.6 N (ϕ16mm jig))**

7.3 ATTENTIONS

7.3.1 Handling of the product

① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
② When the product is put on the table temporarily, display surface must be placed downward.
③ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
④ The torque for product mounting screws must never exceed 0.23N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ (2.5mm). 4
⑤ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.
⑥ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.
⑦ Do not push or pull the interface connectors while the product is working. When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.
⑧ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.

7.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
③ Do not operate in high magnetic field. If not, circuit boards may be broken.
④ This product is not designed as radiation hardened.

7.3.3 Characteristics

The following items are neither defects nor failures.

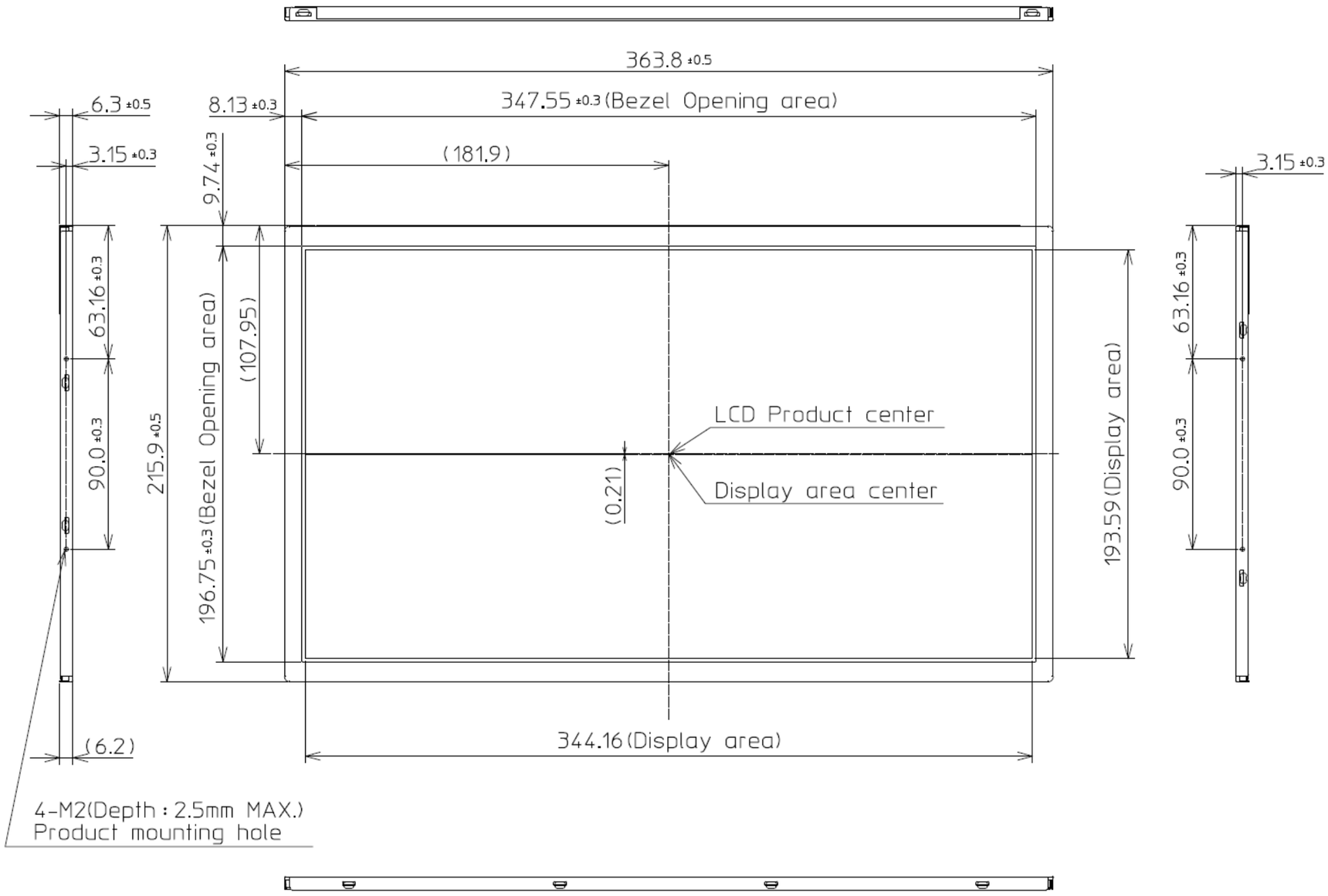
① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough time being left under condition of operating temperature.
② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
⑤ Optical characteristics may be changed depending on input signal timings.

7.3.4 Others

① All GND, VCC and VDD terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT.

8. OUTLINE DRAWINGS

8.1 FRONT VIEW

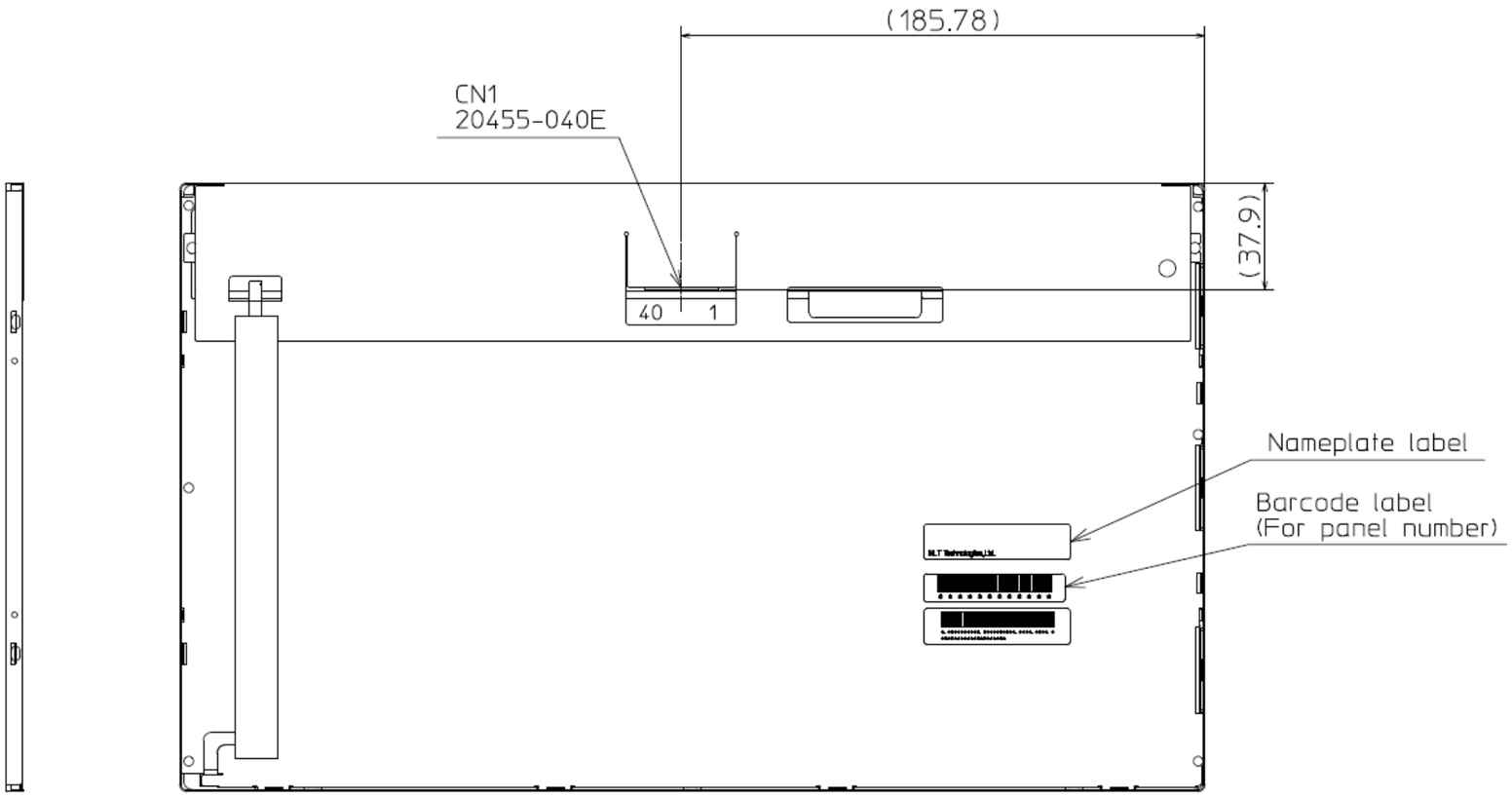


Note1: The values in parentheses are for reference.

Note2: The torque for product mounting screws must never exceed 0.23N·m. And the length of product mounting screws must be ≤ (2.5mm).

Unit: mm

8.2 REAR VIEW



Note1: The values in parentheses are for reference.

Unit: mm

Appendix: Extended Display Identification Data (EDID™)

4

	Adress (Dec)	Adress (Hex)	Description		Value (BIN)	Value (Hex)
Header	0	00	Header	00	00000000	00
	1	01		FF	11111111	FF
	2	02		FF	11111111	FF
	3	03		FF	11111111	FF
	4	04		FF	11111111	FF
	5	05		FF	11111111	FF
	6	06		FF	11111111	FF
	7	07		00	00000000	00
Vendor/ Product Identification	8	08	ID Manufacturer Name	NLT	00111001	39
	9	09			10010100	94
	10	0A	ID Product code	TBD	00000000	00
	11	0B		TBD	00000000	00
	12	0C	ID Serial number	TBD	00000000	00
	13	0D		TBD	00000000	00
	14	0E		TBD	00000000	00
	15	0F		TBD	00000000	00
	16	10	Week of Manufacture	00	00000000	00
	17	11	Year of Manufacture	2015	00011001	19
Ver/ Rev	18	12	EDID Version Number	1	00000001	01
	19	13	EDID Revison Number	4	00000100	04
Parameters/ Features	20	14	Video Input Definition	Digital Video Input : DisplayPort Color .bit Depth : 8 Bits per Primary Color	10100101	A5
	21	15	Horizontal Screen Size or Aspect Ratio	Undefined	00000000	00
	22	16	Vertical Screen Size or Aspect Ratio	Undefined	00000000	00
	23	17	Display Transfer Characteristic(Gamma)	2.2	01111000	78
	24	18	Feature Support	・Standby Mode is not supported. ・Suspend Mode is not supported. ・Active Off = Very Low Power is not supported. ・Supported Color Encoding Format RGB 4:4:4 ・sRGB Standard is not the default color space. ・Preferred Timing Mode does not include the native pixel format and preferred refresh rate of the display device. ・Display is non-continuous frequency (multi-mode).	00000000	00
Color Characteristics	25	19	Red/Green Low Bits	TBD	00000000	00
	26	1A	Blue/White Low Bits	TBD	00000000	00
	27	1B	Red-x	TBD	00000000	00
	28	1C	Red-y	TBD	00000000	00
	29	1D	Green-x	TBD	00000000	00
	30	1E	Green-y	TBD	00000000	00
	31	1F	Blue-x	TBD	00000000	00
	32	20	Blue-y	TBD	00000000	00
	33	21	White-x	TBD	00000000	00
	34	22	White-y	TBD	00000000	00
Established Timings	35	23	Established Timing Ⅰ	TBD	00000000	00
	36	24	Established Timing Ⅱ	TBD	00000000	00
	37	25	Manufacturer's Timings	TBD	00000000	00
Standard Timing Identification	38	26	Standard Timing Identification#1	Not used	00000001	01
	39	27			00000001	01
	40	28	Standard Timing Identification#2	Not used	00000001	01
	41	29			00000001	01
	42	2A	Standard Timing Identification#3	Not used	00000001	01
	43	2B			00000001	01
	44	2C	Standard Timing Identification#4	Not used	00000001	01
	45	2D			00000001	01
	46	2E	Standard Timing Identification#5	Not used	00000001	01
	47	2F			00000001	01
	48	30	Standard Timing Identification#6	Not used	00000001	01
	49	31			00000001	01
	50	32	Standard Timing Identification#7	Not used	00000001	01
	51	33			00000001	01
	52	34	Standard Timing Identification#8	Not used	00000001	01
	53	35			00000001	01
Detailed Timing Description#1	54	36	Pixel clock [MHz]	138.5	00011010	1A
	55	37			00110110	36
	56	38	Horizontal Active (HA), (Lower8bits)	1920	10000000	80
	57	39	Horizontal Blanking(HB),(Lower8bits)	160	10100000	A0
	58	3A	↑ HA/HB Upper4bits	--	01110000	70
	59	3B	Vertical Active (VA),(Lower8bits)	1080	00111000	38
	60	3C	Vertical Blanking (VB),(Lower8bits)	32	00100000	20
	61	3D	↑ VA/VB Upper4bits	--	01000000	40
	62	3E	Horizontal Front Porch	64	01000000	40
	63	3F	Horizontal Sync Pulse Width	48	00110000	30
	64	40	Vertical Front Porch(Lower4bits)/ Vertical Sync Pulse Width(Lower4bits)	3/6	00110110	36
	65	41	Horizontal Front Porch(upper2 bits)/ Horizontal Sync Pulse Width(upper2 bits)/ Vertical Front Porch(upper2 bits)/ Vertical Sync Pulse Width(upper 2 bits)	0/0/0/0	00000000	00
	66	42	Horizontal Image size [mm](Lower 8bits)	344	01011000	58
	67	43	Vertical Image size [mm](Lower 8bits)	194	11000010	C2
	68	44	Horizontal Image size /Vertical Image size(Upper4bits)	--	00010000	10
	69	45	No Horizontal Border	0	00000000	00
	70	46	No Vertical Border	0	00000000	00
	71	47	Signal Intrerface Type、 Sync Signal Definitions	Non-interlaced Nomal display - no stereo Digital Separate Sync Vsync : Negative Hsync : Negative (outside of V-sync)	00011000	18

Continue to next page

4

	Adress (Dec)	Adress (Hex)	Description		Value (BIN)	Value (Hex)
Detailed Timing Descriptions#2/ Display Descriptor	72	48	TBD	TBD	00000000	00
	73	49	TBD	TBD	00000000	00
	74	4A	TBD	TBD	00000000	00
	75	4B	TBD	TBD	00001111	0F
	76	4C	TBD	TBD	00000000	00
	77	4D	TBD	TBD	00100000	20
	78	4E	TBD	TBD	00100000	20
	79	4F	TBD	TBD	00100000	20
	80	50	TBD	TBD	00100000	20
	81	51	TBD	TBD	00100000	20
	82	52	TBD	TBD	00100000	20
	83	53	TBD	TBD	00100000	20
	84	54	TBD	TBD	00100000	20
	85	55	TBD	TBD	00100000	20
	86	56	TBD	TBD	00100000	20
	87	57	TBD	TBD	00100000	20
	88	58	TBD	TBD	00100000	20
	89	59	TBD	TBD	00100000	20
Detailed Timing Descriptions#3/ Display Descriptor	90	5A	TBD	TBD	00000000	00
	91	5B	TBD	TBD	00000000	00
	92	5C	TBD	TBD	00000000	00
	93	5D	TBD	TBD	00001111	0F
	94	5E	TBD	TBD	00000000	00
	95	5F	TBD	TBD	00100000	20
	96	60	TBD	TBD	00100000	20
	97	61	TBD	TBD	00100000	20
	98	62	TBD	TBD	00100000	20
	99	63	TBD	TBD	00100000	20
	100	64	TBD	TBD	00100000	20
	101	65	TBD	TBD	00100000	20
	102	66	TBD	TBD	00100000	20
	103	67	TBD	TBD	00100000	20
	104	68	TBD	TBD	00100000	20
	105	69	TBD	TBD	00100000	20
	106	6A	TBD	TBD	00100000	20
	107	6B	TBD	TBD	00100000	20
Detailed Timing Descriptions#4/ Display Descriptor	108	6C	TBD	TBD	00000000	00
	109	6D	TBD	TBD	00000000	00
	110	6E	TBD	TBD	00000000	00
	111	6F	TBD	TBD	00001111	0F
	112	70	TBD	TBD	00000000	00
	113	71	TBD	TBD	00100000	20
	114	72	TBD	TBD	00100000	20
	115	73	TBD	TBD	00100000	20
	116	74	TBD	TBD	00100000	20
	117	75	TBD	TBD	00100000	20
	118	76	TBD	TBD	00100000	20
	119	77	TBD	TBD	00100000	20
	120	78	TBD	TBD	00100000	20
	121	79	TBD	TBD	00100000	20
	122	7A	TBD	TBD	00100000	20
	123	7B	TBD	TBD	00100000	20
	124	7C	TBD	TBD	00100000	20
	125	7D	TBD	TBD	00100000	20
Extension Flag	126	7E	Extension Flag	00	00000000	00
	127	7F	Checksum	--	10000001	81

REVISION HISTORY

The inside of latest specifications is revised to the clerical error and the major improvement of previous edition. Only a changed part such as functions, characteristic value and so on that may affect a design of customers, are described especially below.

Edition	Document number	Prepared date	Revision contents and signature
1st edition	DOD-PP-2104	May 25, 2015	**Revision contents** New issue. **Writer** *Approved by* R. KAWASHIMA *Checked by* ——— *Prepared by* E. YOSHIMURA
2nd edition	DOD-PP-2149	July 15, 2015	**Revision contents** 4.6.1 Display colors and input data signals - Command sequence (elimination) P13-14 Display colors and input data signals (Updated) 4.7 Display positions (elimination) 4.8 Display directions (elimination) P15 Pixel arrangement (addition) P16 eDP signal timing specifications - Display Port main link signal (addition) P16 eDP signal timing specifications - Display Port main VHPD signal (addition) **Writer** *Approved by* R. KAWASHIMA *Checked by* ——— *Prepared by* E. YOSHIMURA
3rd edition	DOD-PP-2187	Sep. 30, 2015	**Revision contents** P4 Outline - features • Selectable 8-bit or 6-bit digital signals for data of RGB (elimination) • 8-bit digital signals for data of RGB (addition) P5 General specifications • Display color: 16,777,216 colors (At 8-bit) → 16,777,216 colors : 262,144 colors (At 6-bit) (elimination) • Signal system: 6-bit (elimination) P8 Electrical characteristics - LCD panel signal processing board • Note3 (addition) P8 Electrical characteristics - LED driver • Input voltage for PWM signal: VDD (max.) V → (5.0) (max.) V • Input voltage for BRTC signal: VDD (max.) V → (5.0) (max.) V P14 4.6.2 262,144 colors (elimination) P17 Input signal timing chart • DATA: (R0-R5), (G0-G-5), (B0-B5) (2 point) (elimination) P22 Cautions • 539 m/s^2, 11 ms → TBD m/s^2, TBD ms **Writer** *Approved by* R. KAWASHIMA *Checked by* ——— *Prepared by* E. YOSHIMURA
4th edition	DOD-PP-2202	Nov. 25, 2015	**Revision contents** P6 Block diagram (Specified) P7 Absolute maximum ratings • VCC, VDD, PWM, BRTC (Specified) P8 Electrical characteristics - LCD panel signal processing board • Note3 (elimination) P9 Fuse (Revised)

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
4th edition	DOD-PP-2202	Nov. 25, 2015	**Revision contents** P11 Connections and functions for interface pins - LCD panel signal processing board (Revised) • CN1 socket: 20455-030E → 20455-040E • Adaptable plug: 20453-030T → 20453-240T-11, 20454-240T or equivalent P12 Positions of plug and socket (Revised) P15 eDP signal timing specifications - Display Port VHPD signal • Description: VHPD → Hot Plug detect • Remarks (addition) P21 Reliability tests (Specified) P22 Attentions - Handling of the product • ④: ≤ (2.0) mm → ≤ 2.5 mm P24 Outline drawings - Front view (Revised) • Top view (Barrier figure change) • (6.3) mm → 6.3±0.5 mm • 3.15±0.3 mm (2Point) (addition) • (63.16) mm → 63.16±0.3 mm (2Point) • (90) mm → 90.0±0.3 mm (2Point) • 9.59±0.3 mm → 9.74±0.3 mm • (107.95) mm (addition) • (181.9) mm (addition) • Note2: ≤ (2.0) mm → ≤ 2.5 mm P25 Outline drawings - Rear view (Revised) • Barrier figure change • (37.66) mm → (37.9) mm • CN1 (change) • Labels (position change) P26, 27 Appendix (addition) **Signature of writer** *Approved by* R. KAWASHIMA *Checked by* *Prepared by* E. YOSHIMURA