NEC

TFT COLOR LCD MODULE

NL6448AC63-01

51.0cm (20.1 Type)
VGA

SPECIFICATIONS

(5th Edition)

PRELIMINARY

All information is subject to change without notice.

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CONTENTS

INTRODUCTION **2**

1. OUTLINE **5**
1.1 STRUCTURE AND PRINCIPLE 5
1.2 APPLICATIONS 5
1.3 FEATURES 5
2. GENERAL SPECIFICATIONS **6**
3. BLOCK DIAGRAM **7**
4. DETAILED SPECIFICATIONS **8**
4.1 MECHANICAL SPECIFICATIONS 8
4.2 ABSOLUTE MAXIMUM RATINGS 8
4.3 ELECTRICAL CHARACTERISTICS 9
4.3.1 Driving for LCD panel signal processing board 9
4.3.2 Driving for backlight inverter 9
4.3.3 Supply voltage ripple 10
4.3.4 Fuses 10
4.4 SUPPLY VOLTAGE SEQUENCE 11
4.4.1 Sequence for LCD panel signal processing board 11
4.4.2 Sequence for backlight inverter 11
4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS 12
4.5.1 LCD panel signal processing board 12
4.5.2 Backlight inverter 13
4.5.3 Positions of sockets 13
4.6 LUMINANCE CONTROLS 14
4.6.1 Luminance control methods 14
4.6.2 Detail of PWM timing 15
4.7 DISPLAY COLORS AND INPUT DATA SIGNALS 16
4.8 DISPLAY POSITIONS 17
4.9 SCANNING DIRECTIONS 17
4.10 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD 18
4.10.1 Outline of input signal timings 18
4.10.2 Detailed input signal timing chart for DE mode 19
4.10.3 Detailed input signal timing chart for fixed mode 20
4.10.4 Timing characteristics 21
4.11 OPTICS 22
4.11.1 Optical characteristics 22
4.11.2 Definition of contrast ratio 23
4.11.3 Definition of luminance uniformity 23
4.11.4 Definition of response times 23
4.11.5 Definition of viewing angles 23
4.12 DEFECT CRITERIA 24
4.12.1 Display specifications 24
4.12.2 Defects of adjacent 24
4.12.3 Distance among 3 defect dots 25
4.12.4 Appearance specifications 25

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CONTENTS

5. RELIABILITY TESTS 26
6. PRECAUTIONS 27
6.1 MEANING OF CAUTION SIGNS 27
6.2 CAUTIONS 27
6.3 ATTENTIONS 27
7. OUTLINE DRAWINGS 29
7.1 FRONT VIEW 29
7.2 REAR VIEW 30

REVISION HISTORY 31
1st edition 31
2nd edition 31
3rd edition 39
4th edition 43
5th edition 47

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

NL6448AC63-01 module 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 unit.

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. PC, 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 APPLICATIONS

- Multimedia monitor
- TV monitor
- Display terminal for control system

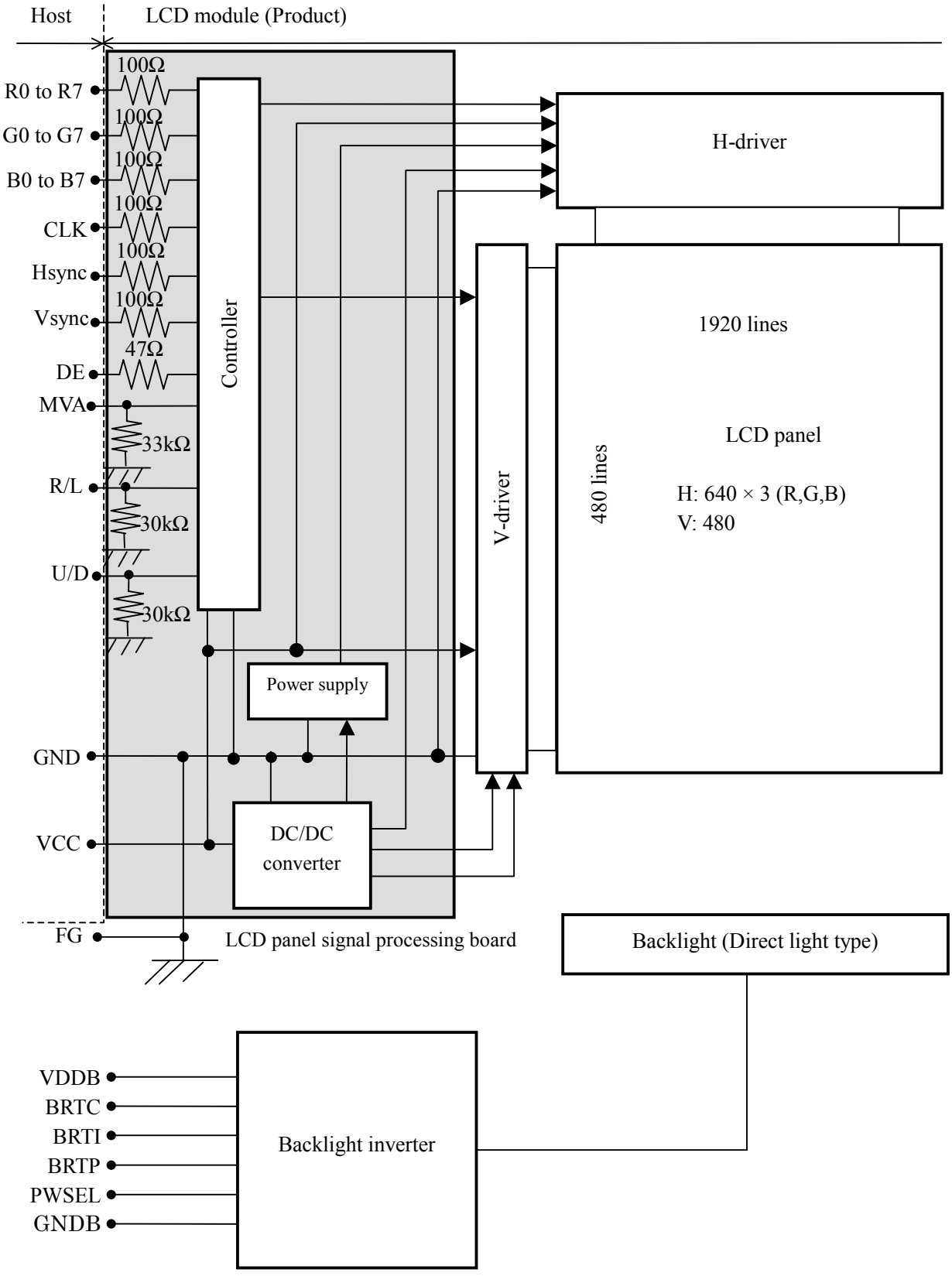
1.3 FEATURES

- High luminance
- Wide viewing angle
- High contrast
- Low reflection
- 8-bit digital RGB signals
- Select function of best viewing angle
- Reversible-scan direction
- Direct light type
- Replaceable backlight unit and inverter

2. GENERAL SPECIFICATIONS

Display area	408.0 (H) × 306.0 (V) mm (typ.)
Diagonal size of display	51.0 cm (20.1 inches)
Drive system	a-Si TFT active matrix
Display color	16,194,277 colors
Pixel	640 (H) × 480 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.2125 (H) × 0.6375 (V) mm
Pixel pitch	0.6375 (H) × 0.6375 (V) mm
Module size	448.0 (H) × 348.0 (V) × 33.2 (D) mm (typ.)
Weight	1,900 g (typ.)
Contrast ratio	400:1 (typ.)
Viewing angle	*At the contrast ratio 10:1* • Horizontal: Left side 65° (typ.), Right side 65° (typ.) • Vertical: Up side 55° (typ.), Down side 50° (typ.)
Designed viewing direction	*At normal scan* • Viewing direction without image reversal: up side (12 o'clock) • Viewing direction with contrast peak: down side 5° to 10° (6 o'clock) *At MVA signal: Low or Open* • Viewing angle with optimum grayscale (γ=2.2): normal axis
Polarizer surface	Antiglare treatment
Polarizer pencil-hardness	3H (min.) [by JIS K5400]
Color gamut	*At LCD panel center* 57 % (typ.) [against NTSC color space]
Response time	4 ms (typ.)
Luminance	500 cd/m^2 (typ.)
Signal system	8-bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE), Horizontal synchronous signal (Hsync), Vertical synchronous signal (Vsync)
Supply voltages	LCD panel signal processing board: 3.3V Backlight inverter: 12V
Backlight	Direct light type: 12 cold cathode fluorescent lamps (Replaceable parts • Backlight unit: type No. 201LHS04 • Inverter: type No. 201PW051)
Power consumption	*At maximum luminance and checkered flag pattern* 47 W (typ.)

3. BLOCK DIAGRAM



Note 1: GND is connected to FG (Frame ground). GNDB is not connected to FG.
GND and GNDB should be connected together in customer equipment.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	448.0 ± 1.0 (H) × 348.0 ± 1.0 (V) × 33.2 ± 1.0 (D)	Note1	mm
Display area	408.0 ± 0.5 (H) × 306.0 ± 0.5 (V)	Note1	mm
Weight	1,900 (typ.), 2,060 (max.)		g

Note1: See "**11.OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

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Parameter			Symbol	Rating	Unit	Remarks
Supply voltage	LCD panel signal board and driver		VCC	-0.3 to +6.5	V	Ta = 25°C
	Backlight inverter		VDDB	-0.3 to +14	V	
Input voltage	LCD panel signal board	Display signals Note1	Vi	-0.3 to VCC+0.3	V	Ta = 25°C
	Backlight inverter	BRTI signal	ViBI	-0.3 to +1.5	V	Ta = 25°C VDDB = 12.0V
		BRTP signal	ViBP	-0.3 to +5.5	V	
		BRTC signal	ViBC	-0.3 to +5.5	V	
		PWSEL signal	ViBS	-0.3 to +5.5	V	
Storage temperature			Tst	-20 to +60	°C	-
Operating temperature Note2			Top	0 to +55	°C	
Relative humidity Note3			RH	≤ 95	%	Ta ≤ 40°C
				≤ 85	%	40 < Ta ≤ 50°C
				≤ 70	%	50 < Ta ≤ 55°C
Absolute humidity Note3			-	≤ 78 Note4	g/m^3	Ta > 55°C

Note1: Display signals are CLK, Hsync, Vsync, DE, MVA, DATA (R0 to R7, G0 to G7, B0 to B7), R/L and U/D.

Note2: Measured at the LCD panel surface

Note3: No condensation

Note4: Ta = 55°C, RH = 70%

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 Driving for LCD panel signal processing board

(Ta = 25°C)

Parameter		Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage		VCC	3.0	3.3	3.6	V	-
Supply current		ICC	-	395 Note1	660	mA	VCC = 3.3V
Logic input voltage for display signals	Low	ViL	0	-	0.3Vcc	V	CMOS level
	High	ViH	0.7Vcc	-	Vcc	V	

Note1: Checkered flag pattern [by EIAJ ED-2522]

4.3.2 Driving for backlight inverter

(Ta = 25°C) 5

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage			VDDB	10.8	12.0	13.2	V	-
Supply current			IDDB	-	3,800	-	mA	at maximum luminance, VDDB = 12.0V Note1
Input voltage for control system	BRTI signal		ViBI	0	-	1.2	V	-
	BRTP signal	Low	ViBPL	0	-	0.8	V	
		High	ViBPH	2.0	-	5.0	V	
	BRTC signal	Low	ViBCL	0	-	0.8	V	
		High	ViBCH	2.0	-	5.0	V	
	PWSEL signal	Low	ViBSL	0	-	0.8	V	
		High	ViBSH	2.0	-	5.0	V	
Input current for control system	BRTI signal		IiBI	-130	-	-	μA	
	BRTP signal	Low	IiBPL	-1,580	-	-	μA	
		High	IiBPH	-	-	3,500	μA	
	BRTC signal	Low	IiBCL	-610	-	-	μA	
		High	IiBCH	-	-	440	μA	
	PWSEL signal	Low	IiBSL	-610	-	-	μA	
		High	IiBSH	-	-	440	μA	

Note1: The power supply lines (VDDB and GNDB) occurs large ripple voltage while dimming. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor (5,000 to 6,000μF) between the power source lines (VDDB and GNDB) to reduce the noise, if the noise occurred in the circuit.

4.3.3 Supply voltage ripple

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

Supply voltage	Ripple voltage Note1 (Measure at input terminal of power supply)	Unit
VCC (for LCD panel signal processing board; 3.3V)	≤ 100	mVp-p
VDDB (for backlight inverter; 12V)	≤ 200	mVp-p

Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuses

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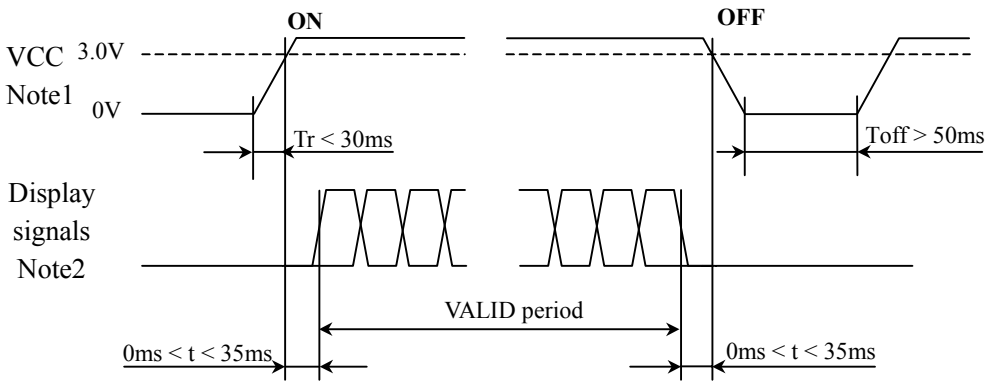
Fuse		Rating Note1	Unit	Remarks
Type	Supplier			
TF16N2.50TE	KOA Corp.	2.5	A	VCC (for LCD panel signal processing board)
		32	V	
R451007	Littel Fuse Inc.	7.0	A	VDDB (for backlight inverter)
		125	V	

Note1: The power capacity should be more than twice of fuse current ratings. If the power capacity is less than the criteria value, the fuse may not blow, and then nasty smell, smoking and so on may occur.

4.4 SUPPLY VOLTAGE SEQUENCE

4.4.1 Sequence for LCD panel signal processing board

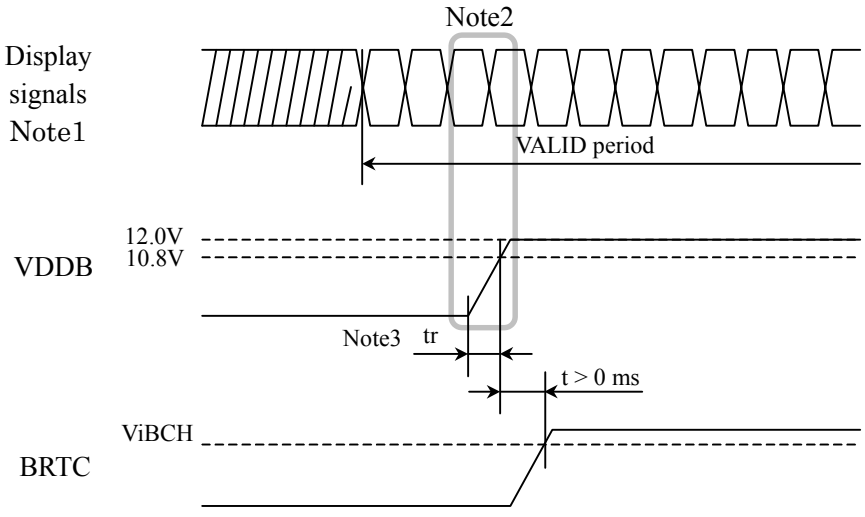


Note1: In terms of voltage variation (voltage drop) while VCC rising edge is below 3.0V, a protection circuit may work, and then this product may not work.

Note2: Display signals (CLK, Hsync, Vsync, DE, MVA, R0 to R7, G0 to G7, B0 to B7, R/L and U/D) must be Low or High-impedance, exclude the VALID period (See above sequence diagram), in order to avoid that internal circuits is damaged.

If some of display signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If customer stop display signals, they should be cut VCC.

4.4.2 Sequence for backlight inverter



Note1: These are the display signals for LCD panel signal processing board.

Note2: The backlight power voltage (VDDB) should be inputted within the valid period of display signals, in order to avoid unstable data display.

Note3: The tr should be less than 800ms when BRTC terminal [Socket: CN202, Pin No.: 4] (See '4.5.2 Backlight inverter'.) is Open.

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): FH12S-50S-0.5SH (Hirose Electric Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	GND	Ground	-
2	GND	Ground	
3	R7	Red data (MSB)	Most significant bit
4	R6	Red data	-
5	R5	Red data	
6	R4	Red data	
7	GND	Ground	
8	R3	Red data	
9	R2	Red data	
10	R1	Red data	
11	R0	Red data (LSB)	Least significant bit
12	GND	Ground	-
13	G7	Green data (MSB)	Most significant bit
14	G6	Green data	-
15	G5	Green data	
16	G4	Green data	
17	GND	Ground	
18	G3	Green data	
19	G2	Green data	
20	G1	Green data	
21	G0	Green data (LSB)	Least significant bit
22	GND	Ground	-
23	B7	Blue data (MSB)	Most significant bit
24	B6	Blue data	-
25	B5	Blue data	
26	B4	Blue data	
27	GND	Ground	
28	B3	Blue data	
29	B2	Blue data	
30	B1	Blue data	
31	B0	Blue data (LSB)	Least significant bit
32	GND	Ground	-
33	DE	Data enable	DE mode: Data enable signal, Fixed mode: High
34	Hsync	Horizontal sync.	-
35	GND	Ground	
36	Vsync	Vertical sync.	
37	GND	Ground	
38	CLK	Dot clock	
39	GND	Ground	
40	MVA	Select of best viewing angle	Normal axis (0°): Low or Open, Down side (-10°): High
41	R/L	Select of scan direction (Horizontal)	Normal scan: Low or Open, Reverse scan: High
42	U/D	Select of scan direction (Vertical)	Note1
43	VCC	Power supply	-
44	VCC	Power supply	
45	VCC	Power supply	
46	VCC	Power supply	
47	VCC	Power supply	
48	GND	Ground	
49	GND	Ground	
50	GND	Ground	

Note1: See "4.9 SCANNING DIRECTIONS".

CN1: Figure of socket

1 2 ..... 49 50

4.5.2 Backlight inverter

CN201 socket: DF3-8P-2H (Hirose Electric Co., Ltd.)
Adaptable plug: DF3-8S-2S (Hirose Electric Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	GNDB	Backlight ground	-
2	GNDB	Backlight ground	
3	GNDB	Backlight ground	
4	GNDB	Backlight ground	
5	VDDB	Power supply	
6	VDDB	Power supply	
7	VDDB	Power supply	
8	VDDB	Power supply	

CN201: Figure of socket

1 2 ..... 7 8

CN202 socket: IL-Z-9PL1-SMTY (Japan Aviation Electronics Industry Limited)
Adaptable plug: IL-Z-9S-S125C3 (Japan Aviation Electronics Industry Limited)

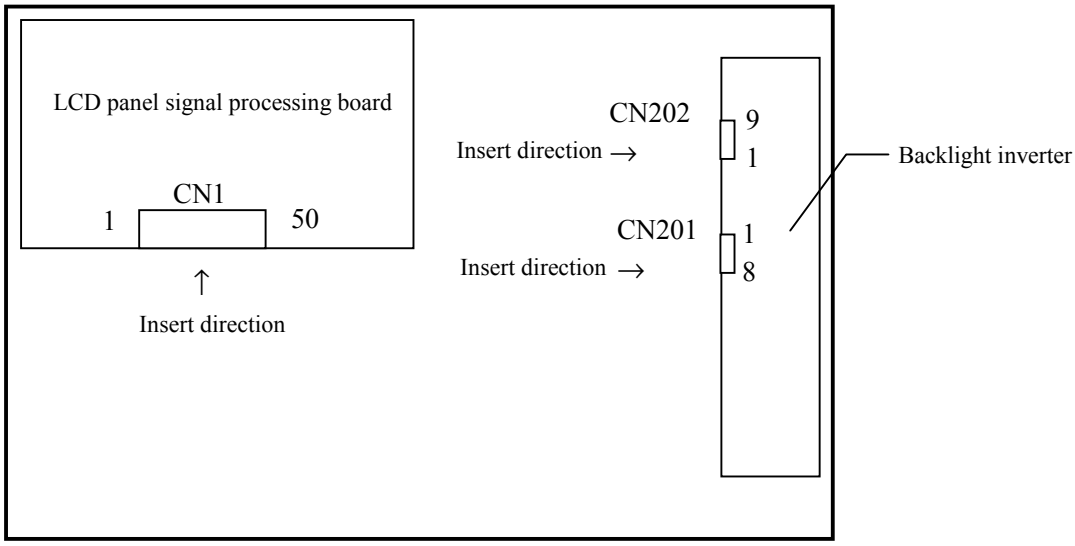
Pin No.	Symbol	Signal	Remarks
1	GNDB	Backlight ground	-
2	GNDB	Backlight ground	
3	N.C.	Non-connection	
4	BRTC	Backlight ON/OFF signal	ON: High or Open, OFF: Low
5	GNDB	Backlight ground	-
6	BRTI	Luminance control by resistor method or voltage method	Note1
7	BRTP	PWM signal	
8	GNDB	Backlight ground	-
9	PWSEL	Select signal of luminance control method	Note1

Note1: See "4.6.1 Luminance control method".

CN202: Figure of socket

9 8 ..... 2 1

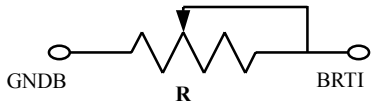
4.5.3 Positions of sockets



4.6 LUMINANCE CONTROLS

4.6.1 Luminance control methods

<table>
<tr><th>Method</th><th>Adjustment and luminance ratio</th><th>PWSEL signal</th><th>BRTP signal</th></tr>
<tr><td>Resistor control

Note1</td><td>• Adjustment
The variable resistor (R) for luminance control should be 10kΩ ±5%, B curve, 1/10W. Minimum point of the resistor is the minimum luminance. Also maximum point of the resistor is the maximum luminance.
 

• Luminance ratio Note3
<table><tr><th>Resistance</th><th>Luminance ratio</th></tr><tr><td>0 kΩ</td><td>30% (Minimum)</td></tr><tr><td>10 kΩ</td><td>100% (Maximum)</td></tr></table></td><td rowspan="2">High or Open</td><td rowspan="2">Open</td></tr>
<tr><td>Voltage control

Note1</td><td>• Adjustment
This control method can carry out continuation adjustment of luminance, if it is adjusted within the rated voltage for BRTI signal (ViBI).
• Luminance ratio Note3
<table><tr><th>BRTI Voltage (ViBI)</th><th>Luminance ratio</th></tr><tr><td>0V</td><td>30% (Minimum)</td></tr><tr><td>1.0V</td><td>100% (Maximum)</td></tr></table></td></tr>
<tr><td>Pulse width modulation
Note1
Note2</td><td>• Adjustment
Pulse width modulation (PWM) method works, when PWSEL signal is Low and PWM signal (BRTP signal) is inputted into BRTP terminal. The luminance is controlled by duty ratio of BRTP signal.
• Luminance ratio Note3
<table><tr><th>Duty ratio Note4</th><th>Luminance ratio</th></tr><tr><td>0.3</td><td>30% (Minimum)</td></tr><tr><td>1.0</td><td>100% (Maximum)</td></tr></table></td><td>Low</td><td>PWM signal</td></tr>
</table>

△5

Note1: In case of the resistor control method and the voltage control method, noises may appear on the display image depending on the input signals timing for LCD panel signal processing board.

Use PWM method, if interference noises appear on the display image!

Note2: In case BRTC signal is High or Open, the inverter will stop work when BRTP signal is fixed to Low. In this case, backlight will not turn on, even if BRTP signal is inputted again. This is not out of order. Backlight inverter will start to work when power is supplied again.

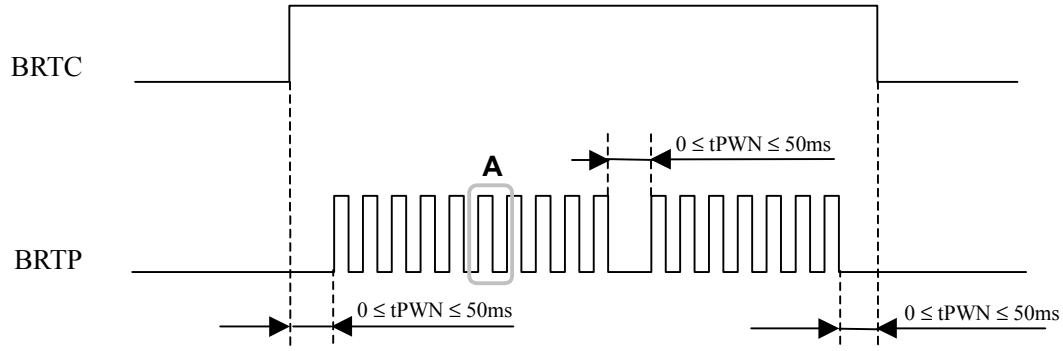
Note3: These data are the target values.

Note4: See '4.6.2 Detail of PWM timing'.

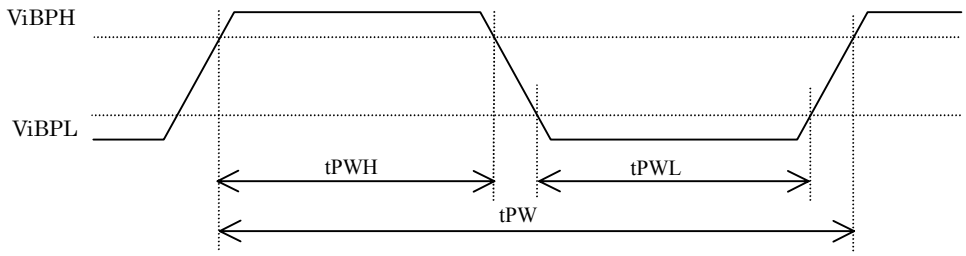
4.6.2 Detail of PWM timing

(1) Timing diagrams

- Outline chart



- Detail of **A** part



(2) Each parameter

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Luminance control frequency	1/tPW	202	280	290	Hz	Note1
Duty ratio	tPWH/tPW	0.3	-	1.0	-	Note2
Non signal period	tPWN	0	-	50	ms	Note3

Note1: See the following formula for luminance control frequency.
Luminance control frequency = tv × (n+0.25) [or (n + 0.75)]
n = 1, 2, 3 · · · · · ·
tv: See '4.10.4 Timing characteristics'.

The interference noise of luminance control frequency and input signal frequency for LCD panel signal processing board may appear on a display. Set up luminance control frequency so that the interference noise does not appear!

Note2: See '4.6.1 Luminance control methods'.
Note3: If tPWN is more than 50ms, the backlight will be turned off by a protection circuit for inverter.

4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

Display colors Note1		Data signal (0: Low level, 1: High level)																									
		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 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 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 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

Note 1: The combination of 8-bit signals (256-scale level) is 16,194,277 colors.

4.8 DISPLAY POSITIONS

The following table is the coordinates per pixel (See figure of "4.9 SCANNING DIRECTIONS").

C(0, 0)	C(1, 0)	•••	C(X, 0)	•••	C(638, 0)	C(639, 0)
C(0, 1)	C(1, 1)	•••	C(X, 1)	•••	C(638, 1)	C(639, 1)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, Y)	C(1, Y)	•••	C(X, Y)	•••	C(638, Y)	C(639, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, 478)	C(0,478)	•••	C(X,478)	•••	C(638,478)	C(639,478)
C(0,479)	C(1,479)	•••	C(X,479)	•••	C(638,479)	C(639,479)

4.9 SCANNING DIRECTIONS

The following figures are seen from a front view. Also the arrow shows the direction of scan.

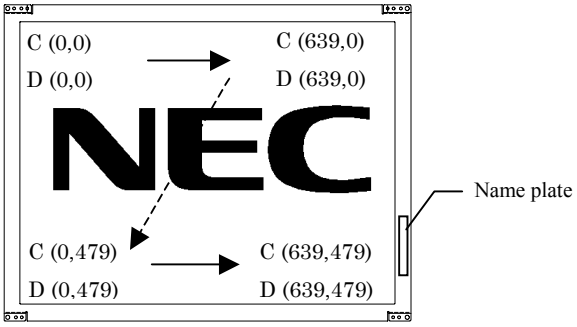


Figure 1. R/L: Low or Open, U/D: Low or Open

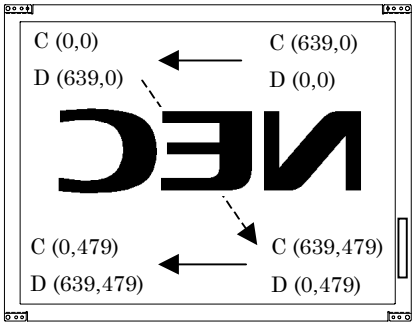


Figure 2. R/L: High, U/D: Low or Open

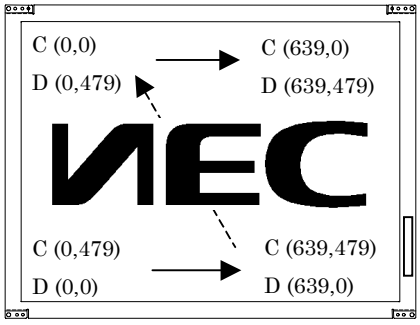


Figure 3. R/L: Low or Open, U/D: High

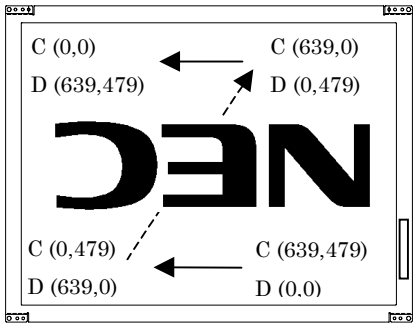


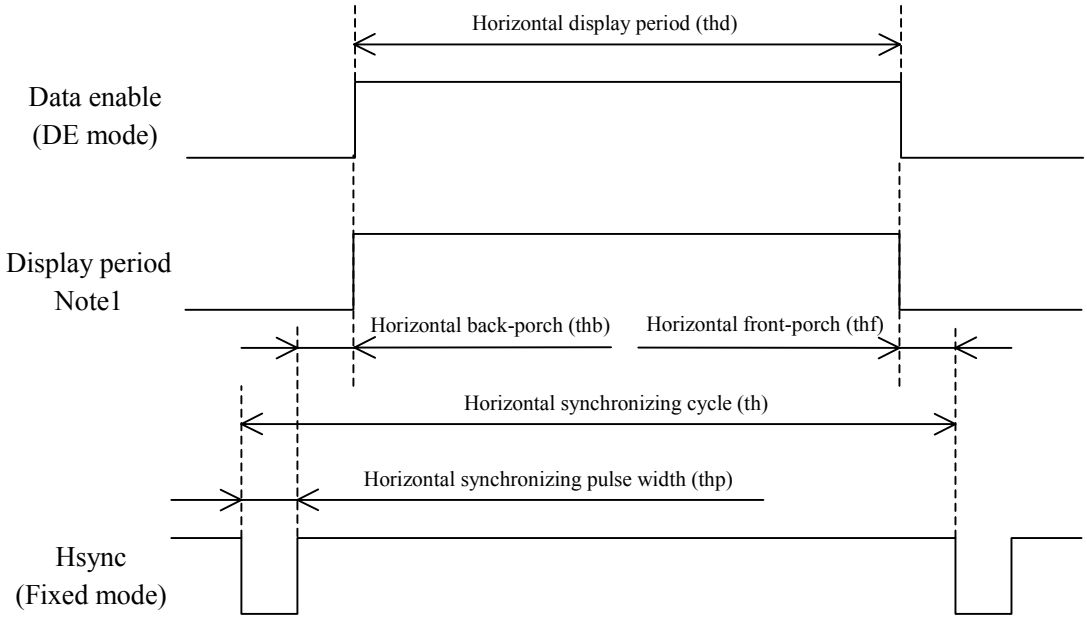
Figure 4. R/L: High, U/D: High

Note1: Meaning of C (X, Y) and D (X, Y)
C (X, Y): The coordinates of the display position (See "4.8 DISPLAY POSITIONS".)
D (X, Y): The data number of input signal for LCD panel signal processing board

4.10 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD

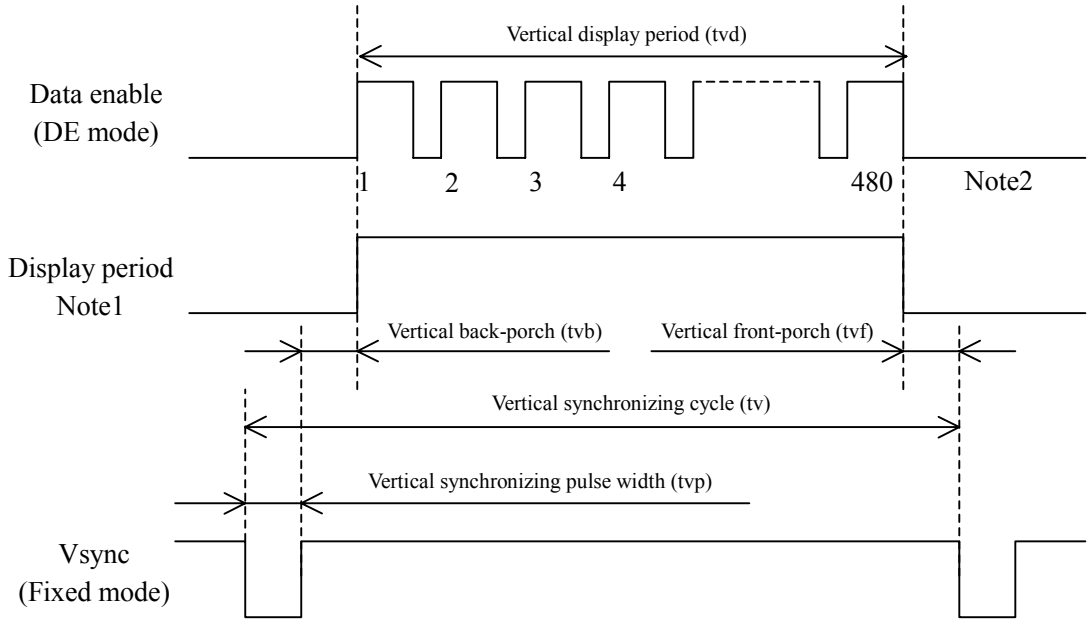
4.10.1 Outline of input signal timings

- Horizontal signal



Note1: This diagram indicates virtual signal for set up to timing.

- Vertical signal

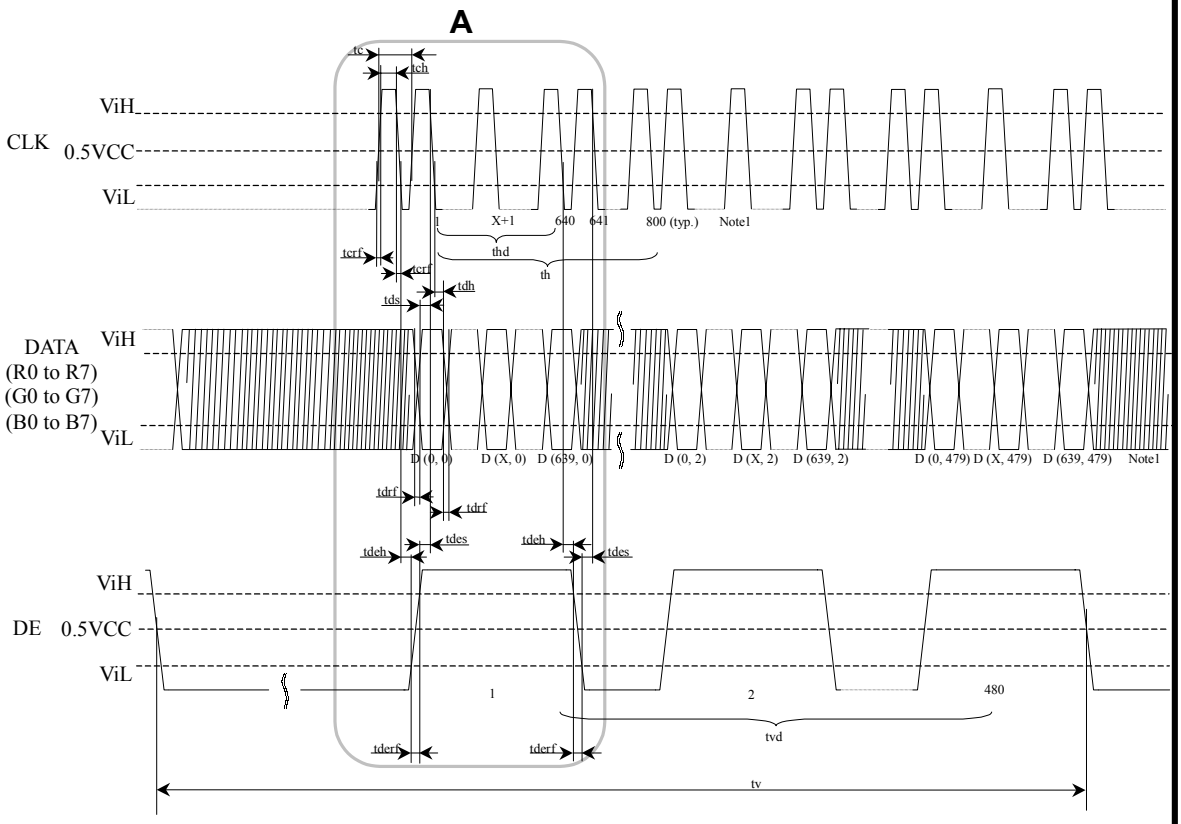


Note1: This diagram indicates virtual signal for set up to timing.

Note2: See "4.10.2 Detailed input signal timing chart for DE mode" and "4.10.3 Detailed input signal timing chart for fixed mode" for numeration of pulse.

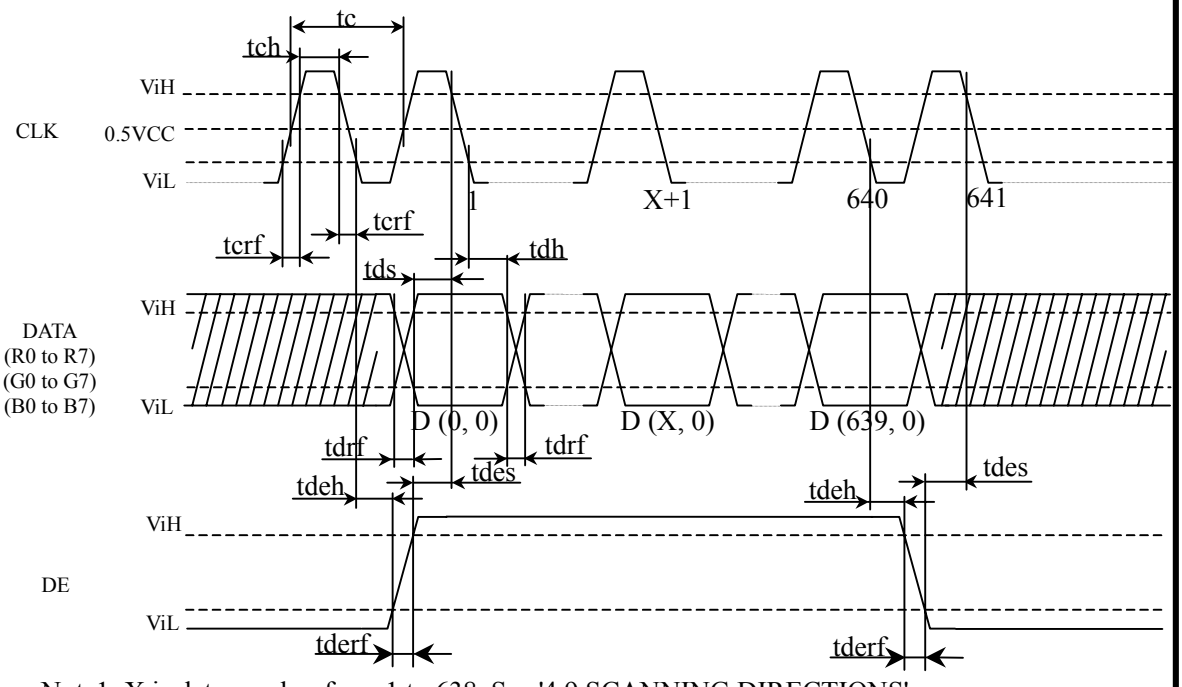
4.10.2 Detailed input signal timing chart for DE mode

- Outline chart



Note1: X is data number from 1 to 638. See '4.9 SCANNING DIRECTIONS'.

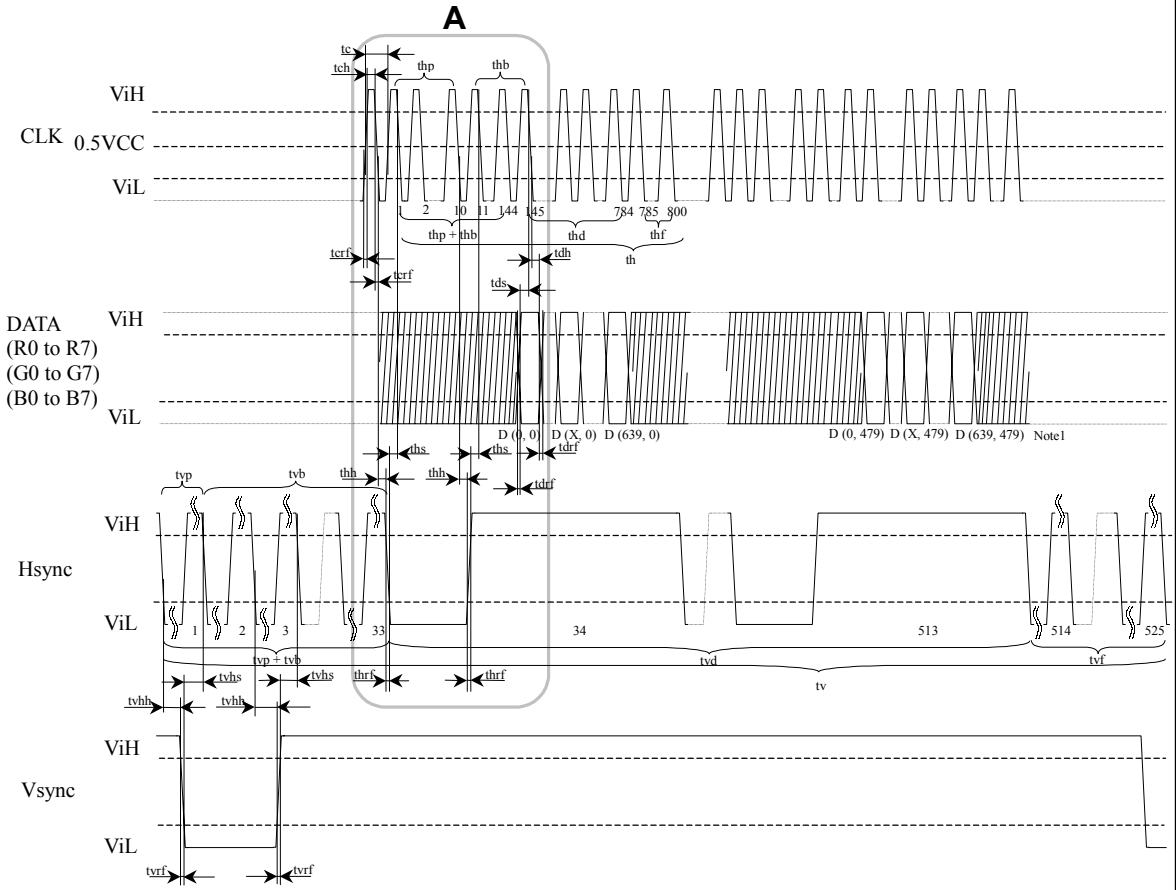
- Detail of **A** part



Note1: X is data number from 1 to 638. See '4.9 SCANNING DIRECTIONS'.

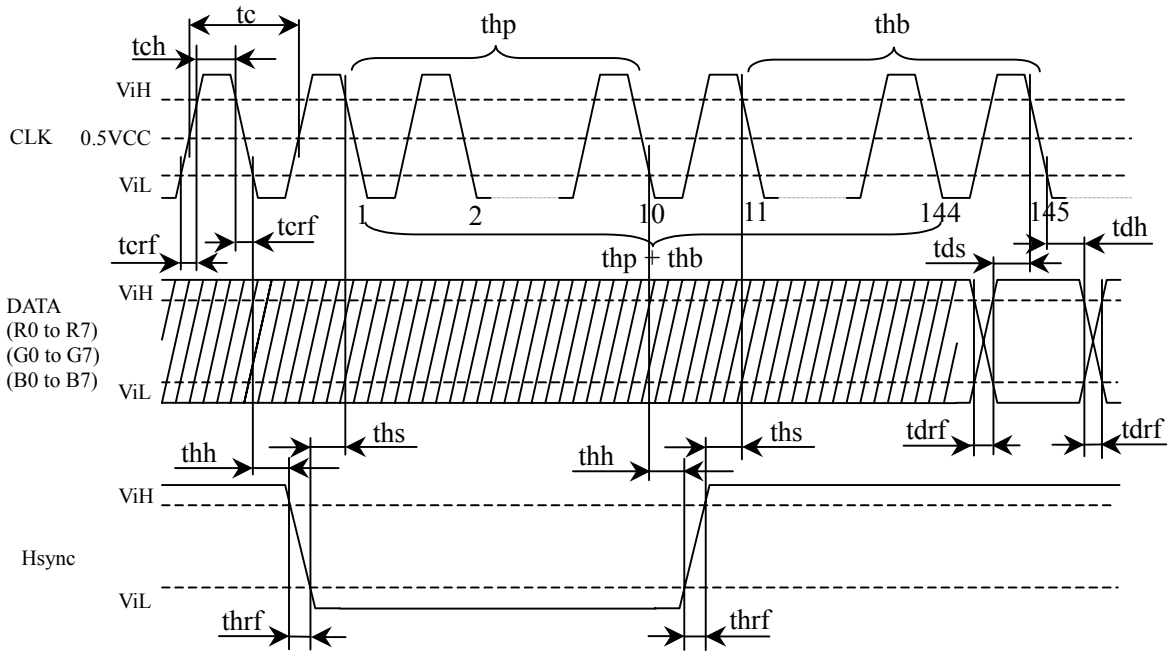
4.10.3 Detailed input signal timing chart for fixed mode

- Outline chart



Note1: X is data number from 1 to 638. See '4.9 SCANNING DIRECTIONS'.

- Detail of **A** part



4.10.4 Timing characteristics

5

• Common to DE mode and fixed mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency		1/tc	21.0	25.2	29.0	MHz	39.7 ns (typ.)
	Duty		tch/tc	0.5	-	0.6	-	-
	Rise time, Fall time		tcrf	-	-	10	ns	
DATA	CLK-DATA	Setup time	tds	8	-	-	ns	
		Hold time	tdh	12	-	-	ns	
	Rise time, Fall time		tdrf	-	-	10	ns	

• DE mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
DE	Horizontal	Cycle	th	-	800	-	CLK	Note1
		Display period	thd	640			CLK	
	Vertical (One frame)	Cycle	tv	-	525	-	H	
		Display period	tvd	480			H	
	CLK-DE	Setup time	tdes	8	-	-	ns	-
		Hold time	tdeh	12	-	-	ns	
	Rise time, Fall time		tderf	-	-	10	ns	

Note1: Definition of units is as follows.
tc = 1CLK, tehc = 1H

• Fixed mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
Hsync	Cycle		th	30.0	31.8	33.6	μs	31.4 kHz (typ.)
				800			CLK	Note1
	Display period		thd	640			CLK	
	Front-porch		thf	16			CLK	
	Pulse width		thp	10	96	-	CLK	
	Back-porch		thb	-	48	134	CLK	
	Total of pulse width and back-porch		thp + thb	144			CLK	Note1, Note2
	CLK- Hsync	Setup time	ths	8	-	-	ns	-
		Hold time	thh	12	-	-	ns	
	Rise time, Fall time		thrf	-	-	10	ns	
Vsync	Cycle		tv	16.1	16.7	17.2	ms	59.9 Hz (typ.)
				525			H	Note1
	Display period		tvd	480			H	
	Front-porch		tvf	12			H	
	Pulse width		tvp	1	-	2	H	
	Back-porch		tvb	31	-	32	H	
	Total of pulse width and back-porch		tvp + tvb	33			H	Note1, Note2
	Vsync-Hsync	Setup time	tvhs	1	-	-	CLK	Note1
		Hold time	tvhh	30	-	-	ns	-
	Rise time, Fall time		tvrf	-	-	10	ns	

Note1: Definition of units is as follows.
tc = 1CLK, thsc = 1H

Note2: Keep tvp + tvb and thp + thb within the table. If it is out of specification, display position will be shifted to right/left side or up/down.

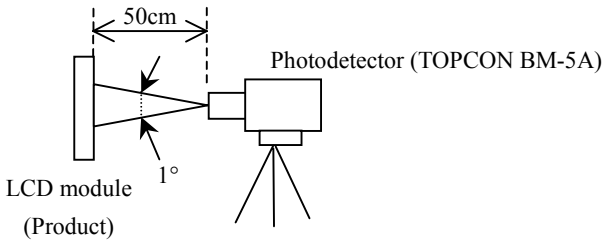
4.11 OPTICS

4.11.1 Optical characteristics

Parameter Note1			Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio			CR	White/Black at center, θx± = 0°, θy± = 0°	300	400	-	-	Note2
Luminance			L	White at center, θx± = 0°, θy± = 0°	400	500	-	cd/m^2	-
Luminance uniformity			LU	-	-	1.25	1.40	-	Note3
Chromaticity			W	White (x, y)	-	0.275, 0.280	-	-	-
			R	Red (x, y)	-	0.628, 0.336	-	-	
			G	Green (x, y)	-	0.307, 0.547	-	-	
			B	Blue (x, y)	-	0.142, 0.073	-	-	
Color gamut			C	θx± = 0°, θy± = 0° at center, to NTSC space	-	57	-	%	
Response time Note4			Ton	White to Black	-	4	10	ms	Note5
			Toff	Black to White	-	28	40	ms	
Viewing angle	CR = 10	Right	θx+	θy± = 0°	55	65	-	°	Note6
		Left	θx-	θy± = 0°	55	65	-	°	
		Up	θy+	θx± = 0°	45	55	-	°	
		Down	θy-	θx± = 0°	40	50	-	°	
	CR = 5	Right	θx+	θy± = 0°	-	80	-	°	
		Left	θx-	θy± = 0°	-	80	-	°	
		Up	θy+	θx± = 0°	-	70	-	°	
		Down	θy-	θx± = 0°	-	60	-	°	

Note1: Measurement conditions are as follows.
Ta = 25°C, VCC = 3.3V, VDDB = 12.0V, R/L = Low, U/L = Low, MVA = Low

Optical characteristics are measured at luminance saturation after 20minutes from working the product, in the dark room. Also measurement method for luminance is as follows.



Note2: See '4.11.2 Definition of contrast ratio'.
Note3: See '4.11.3 Definition of luminance uniformity'.
Note4: Product surface temperature: 25°C
Note5: See '4.11.4 Definition of response times'.
Note6: See '4.11.5 Definition of viewing angles'.

4.11.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

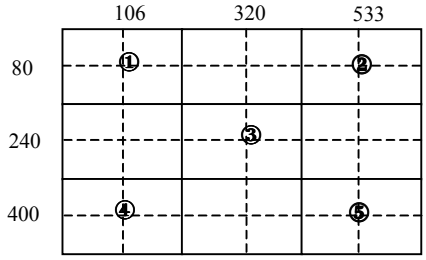
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.11.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

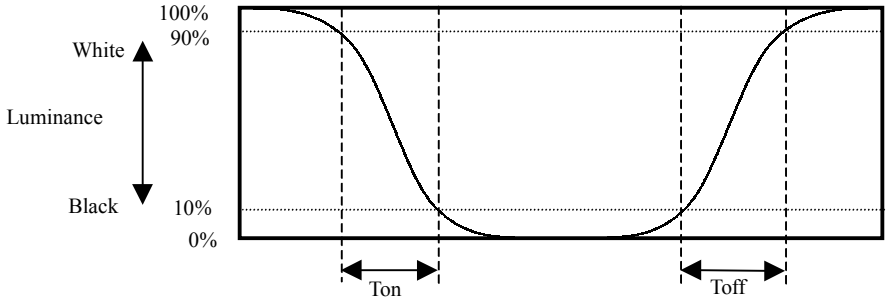
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

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

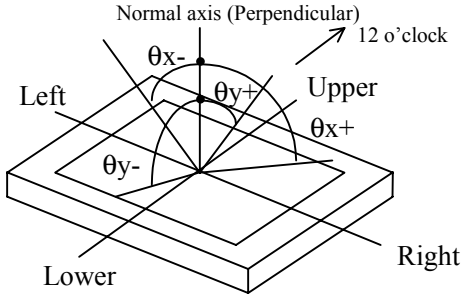


4.11.4 Definition of response times

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



4.11.5 Definition of viewing angles



4.12 DEFECT CRITERIA

4.12.1 Display specifications

Defect pattern	Condition		Criteria Note1
Bright dots Note2, Note3	Red dots + Green dots + Blue dots		≤ 2 dots
	Distance between 2 defect dots (**D**)	**D** = 0 mm (Adjacent) Note5	0 set
		0 mm < **D** ≤ 6.5 mm	0 set
		D > 6.5 mm	Allowed
Dark dots Note2, Note4	Red dots + Green dots + Blue dots		≤ 3 dots
	Distance between 2 defect dots (**D**)	**D** = 0 mm (Adjacent) Note5	0 set
		D > 0 mm	Allowed
	Number of the pair of which '**D**' is less than 6.5 mm (**N**)	**N** ≤ 1 pair Note6	Allowed
		N ≥ 2 pair Note6	0 set
Combination of bright and dark defect dots	Distance between 2 defect dots (**D**)	**D** = 0 mm (Adjacent) Note5	0 set
		D > 0 mm	Allowed
Line defect	Display of black , white, red, green, blue		0 line

Note1: Inspection conditions are as follows.

Temperature	25 ± 5 °C
Inspection viewing distance	20 cm (The distance between the inspector's eye and screen.)
Inspection direction	-20° ≤ θx ≤ +20°, 0° ≤ θy ≤ +20°
Inspection illumination	60 lx (at a display surface)

Note2: Regardless of bright or intermittent bright, 1/3 or more defects of a dot area is counted as the defect dot.

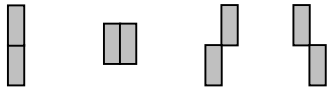
Note3: Bright dots are counted while the display is black.

Note4: Dark dots are counted while the display is illuminated with Red, Green or Blue.

Note5: See "4.12.2 Defects of adjacent".

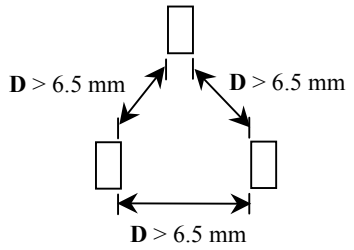
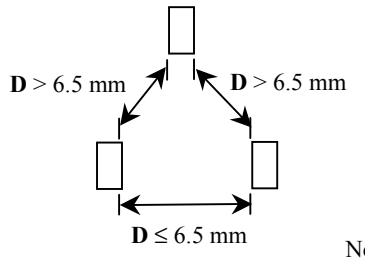
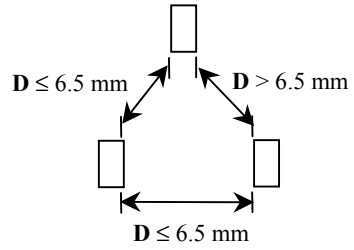
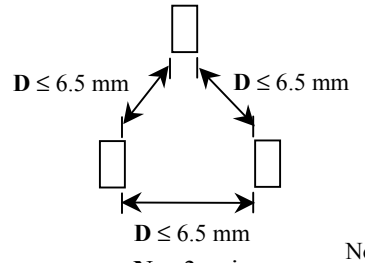
Note6: See "4.12.3 Distance among 3 defect dots".

4.12.2 Defects of adjacent

Defect pattern	Criteria
 Note1	0 set

Note1: ▯ is bright dots or dark dots.

4.12.3 Distance among 3 defect dots

Defect pattern	Criteria
 **N** = 0 pair  **N** = 1 pair Note1	Allowed
 **N** = 2 pair  **N** = 3 pair Note1	0 set

Note1: **D** is distance between 2 defect dots. Also **N** is number of the pair of which '**D′**' is less than 6.5 mm.

4.12.4 Appearance specifications

Defect pattern		Condition Note1		Criteria Note2
Impure ingredient Stains Dust	Dot shape	d < 0.2 mm		Allowed
		0.2 mm ≤ d < 0.3 mm		≤ 10 points
		0.3 mm ≤ d ≤ 0.5 mm		≤ 3 points
		d > 0.5 mm		0 point
	Line shape	W < 0.05 mm		Allowed
		0.05 mm ≤ W ≤ 0.1 mm	L < 0.7 mm	
			0.7 mm ≤ L ≤ 1.0 mm	≤ 4 points
			L > 1.0 mm	0 point
		W > 0.1 mm		
Bubbles, Wrinkles, Dent		d ≤ 0.2 mm		Allowed
		0.2 mm < d ≤ 0.5 mm		≤ 2 points
		d > 0.5 mm		0 point
Scratch (Surface of polarizer)		S ≤ 0.2 mm^2		Allowed
		S > 0.2 mm^2		0 point

5

Note1: Definition of symbols is as follows.
d: Average diameter, W: Width, L: Length, S: Area

Note2: Inspection conditions are as follows.

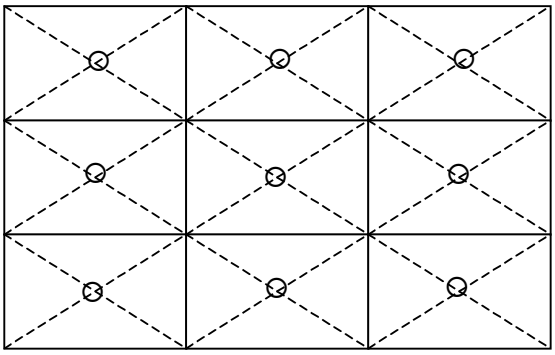
Temperature	25 ± 5 °C
Inspection viewing distance	20cm (The distance between the inspector's eye and screen.)
Inspection direction	45° ≤ θx ≤ +45°, -45° ≤ θy ≤ +45°
Illumination	700lx (at an inspection desk surface)

5. RELIABILITY TESTS

Test item	Condition	Judgement
High temperature and humidity (Operation)	① 60 ± 2°C, RH = 60%, 240hours ② Display data is black.	No display malfunctions Note1
Heat cycle (Operation)	① 0 ± 3°C…1hour 55 ± 3°C…1hour ② 50cycles, 4hours/cycle ③ Display data is black.	No display malfunctions Note1
Thermal shock (Non operation)	① -20 ± 3°C…30minutes 60 ± 3°C…30minutes ② 100cycles, 30minutes/cycle ③ Temperature transition time is within 5 minutes.	No display malfunctions Note1
Vibration (Non operation)	① 5 to 100Hz, 11.76m/s^2 (1.2G) ② 1 minute/cycle ③ X, Y, Z direction ④ 10 times each directions	No display malfunctions Note1 No physical damages
Mechanical shock (Non operation)	① 294m/ s^2 (30G), 11ms ② X, Y, Z direction ③ 3 times each directions	No display malfunctions Note1 No physical damages
ESD (Operation)	① 150pF, 150Ω, ±10kV ② 9 places on a panel surface Note2 ③ 10 times each places at 1 sec interval	No display malfunctions Note1
Dust (Operation)	① 15 kinds of dust (by JIS-Z8901) ② 15 seconds stir ③ 8 times repeat at 1 hour interval	No display malfunctions Note1

Note1: Display functions are checked under the same conditions as product inspection.

Note2: See the following figure for discharge points.



6. PRECAUTIONS

6.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read '6.2 CAUTIONS', after understanding this contents!**

⚠CAUTION	This sign has the meaning that customer will be injured by himself, or the product will sustain a damage, if customer has wrong operations.
	This sign has the meaning that customer will get an electrical shock, if customer has wrong operations.
	This sign has the meaning that customer will be injured by himself, if customer has wrong operations.

6.2 CAUTIONS

Do not touch HIGH VOLTAGE PART of the inverter while turned on! Danger of an electrical shock.

∗ Pay attention to burn injury for the working backlight! It may be over 35°C from ambient temperature.

∗ Do not shock and press the LCD panel and the backlight! Danger of breaking, because they are made of glass. (Shock: To be not greater 294m/s^2 (30G) and to be not greater 11ms, Pressure: To be not greater 19.6N (2kgf))

6.3 ATTENTIONS

(1) Handling of the product

① Take hold of both ends without touch the circuit board when customer pulls out products (LCD modules) from inner packing box. If customer touches it, products may be broken down or out of adjustment, because of stress to mounting parts.

② Do not hook cables nor pull connection cables such as flexible cable and so on, for fear of damage.

③ If customer puts down the product temporarily, the product puts on flat subsoil as a display side turns down.

④ Take the measures of electrostatic discharge such as earth band, ionic shower and so on, when customer deals with the product, because products may be damaged by electrostatic.

⑤ The torque for mounting screws must never exceed 0.39N·m (4kgf·cm). Higher torque values might result in distortion of the bezel.

⑥ Do not press or rub on the sensitive display surface. If customer clean on the panel surface, NEC Corporation recommends using the cloth with ethanolic liquid.

⑦ Do not push-pull the interface connectors while the product is working, because wrong power sequence may break down the product.

(2) Environment

① Dewdrop atmosphere must be avoided.

② Do not operate or store in high temperature or high humidity atmosphere. Keep the product in antistatic pouch in room temperature, because of avoidance for dusts and sunlight, if customer stores the product.

③ Do not operate in high magnetic field. Circuit boards may be broken down by it.

④ Use an original protection sheet on the product surface (polarizer). Adhesive type protection sheet should be avoided, because it may change color or properties of the polarizer.

(3) Characteristics

① 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.

② The display color may be changed by viewing angle because of the use of condenser sheet in the backlight unit.

③ The luminance may be changed by voltage variation (voltage drop), even if power source applies recommended voltage to backlight inverter.

④ Optical characteristics may be changed by input signal timings.

(4) Other

① All GND, GNDB, VCC and VDDB terminals should be used without a non-connected line.

② Do not disassemble a product or adjust volume without permission of NEC Corporation.

③ See 'REPLACEMENT MANUAL FOR BACKLIGHT', if customer would like to replace backlight lamps.

④ Pay attention not to insert waste materials inside of products, if customer uses screwnails.

⑤ Pack the product with original shipping package, because of avoidance of some damages during transportation, when customer returns it to NEC Corporation for repair and so on.

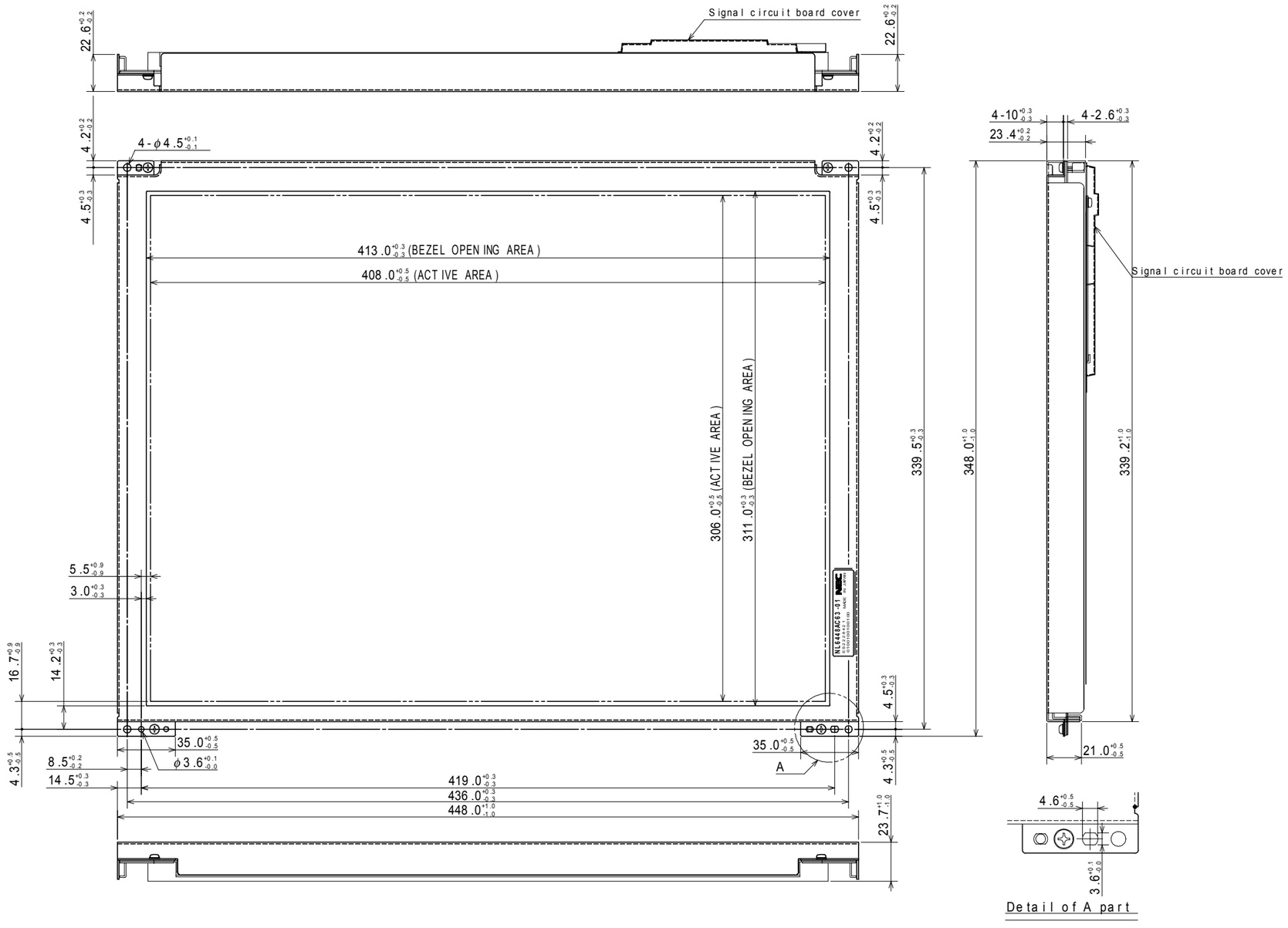
General characteristics for the LCD

The following items are neither defects nor failures.

- **Response time, luminance and color may be changed by ambient temperature.**
- **The LCD may be seemed luminance non-uniformity, flicker, vertical seam or small spot by display patterns.**
- **Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating time, and especially low temperature, because the LCD has cold cathode fluorescent lamps.**

7. OUTLINE DRAWINGS

7.1 FRONT VIEW



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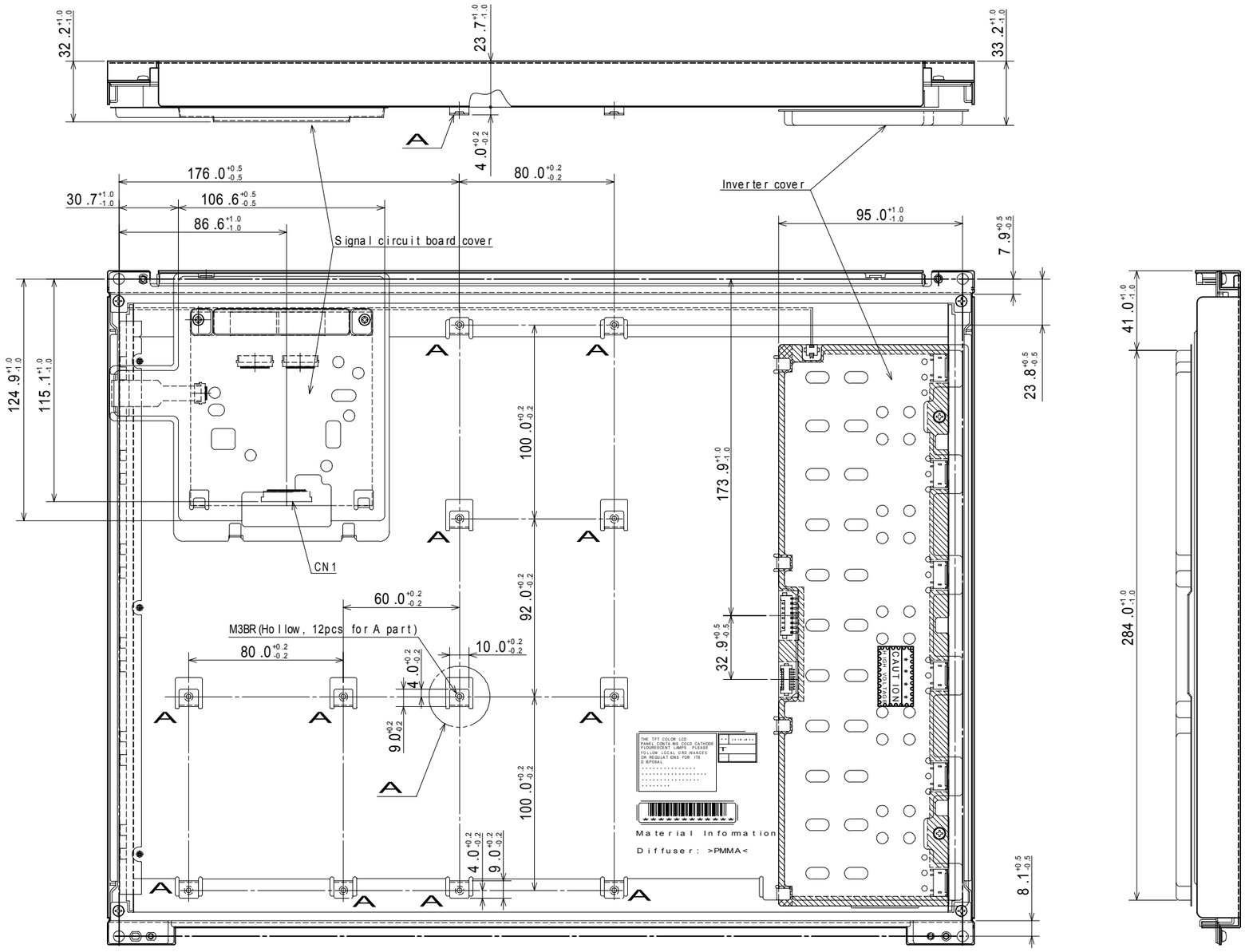
7.2 REAR VIEW



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REVISION HISTORY

The inside of latest specifications is revised to the clerical error, undecided mater (TBD, etc.) 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 writer
1st edition	DOD - H - 8143	Feb. 23, 2001	**Revision contents** New issue **Writer** *Approved by* A. OKAMOTO *Checked by* T. KUSANAGI *Prepared by* N. KANO
2nd edition	DOD - M - 0196	Feb. 28, 2001	**Revision contents** • Change part (Before-1st edition → After-2nd edition) **(1)** ***page*** **4/30** ***lines*** **1, 4, 9, 10~13, 20~21,27~31** 5. OUTLINE OF CHARACTERISTICS (at room temperature) Display colors 16,190,000 colors Weight 1970g (Typ.) Contrast ratio 300:1 (Typ.) Viewing angle (more than contrast ratio of 10:1) •Horizontal: 60° (Typ., left side, right side) •Vertical: 40° (Typ., up side), 50° (Typ., down side) Color gamut 60% (Typ., At center, To NTSC) Response time TBD (Typ.), "white" to "black" Backlight Direct light type: twelve cold fluorescent lamps (cold cathode type) [Replaceable parts] • Backlight unit: type No. TBD • Inverter: type No. TBD Power consumption 47.5W (typ.) → ***page*** **5/39** ***lines*** **1, 4, 9, 10~13, 20~21,27~31** **5. CHARACTERISTICS (at room temperature)** ***Display colors*** 16,194,277 colors ***Weight*** 1900g (Typ.) ***Contrast ratio*** 400:1 (Typ.) ***Viewing angle*** (To be out of 10:1 for the contrast ratio) •Horizontal: 65° (Typ., left side, right side) •Vertical: 55° (Typ., up side), 50° (Typ., down side) ***Color gamut*** 57% (Typ., At center, To NTSC) ***(This part continues to the next page.)***

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
2nd edition	DOD - M - 0196	Feb. 28, 2001	***(This part continues from the front page.)*** ***Response time*** 32ms (Typ.), Ton+Toff ***Backlight*** Direct light type: 12 cold fluorescent lamps (cold cathode type) [Replaceable parts] • Backlight unit: type No. 201LHS04 • Inverter: type No. 201PW051 ***Power consumption*** 47W (Typ.) (Checkered flag pattern, at max. luminance) **(2) *page* 5/30** 6. BLOCK DIAGRAM Backlight (Edge light type) → ***page* 6/39** **6. BLOCK DIAGRAM** Backlight (Direct light type) **(3) *page* 6/30 *lines* 4~6, 10~11** 7.1 GENERAL SPECIFICATIONS Module size 448±1.0(H)×348.0±1.0(V)×33.2±1.0(D) Display area 408.0(H)×306.0(V) Number of pixels 640×3(H)×480(V) Display colors 16,190,000 Weight 2060(Max.) → ***page* 7/39 *lines* 4~7, 11~13** 7.1 GENERAL SPECIFICATIONS Module size 448±1.0(H)×348.0±1.0(V)×23.7±1.0(D) Note1 Display area 408.0(H)×306.0(V) Diagonal display area: 51cm (Type 20.1) Number of pixels 640(H)×480(V) Display colors 16,194,277 Weight 1,900(Typ.), 2,060(Max.) Note1: Exclude the signal processing board, inverter and projection of rear side.

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
2nd edition	DOD - M - 0196	Feb. 28, 2001	**(4)** ***page*** **6/30** ***lines*** **22~24** 7.2 ABSOLUTE MAXIMUM RATINGS Relative humidity Note2 ≤95 ≤85 Absolute humidity Note2 Absolute humidity shall not exceed Ta=50°C, RH=85% Ta>50°C → ***page*** **7/39** ***lines*** **24~27** 7.2 ABSOLUTE MAXIMUM RATINGS Relative humidity Note2 ≤95 ≤85 ≤70 50<Ta≤55°C Absolute humidity Note2 Absolute humidity shall not exceed Ta=55°C, RH=70% Ta>55°C **(5)** ***page*** **7/30** ***lines*** **7~10, 13~16, 20** (2) Backlight Logic input "H" voltage ViH2 ~ Logic input "L" voltage ViL3 ~ Logic input "H" voltage ViH3 ~ Logic input "L" current IiL1 ~ Logic input "H" current IiH2 ~ Logic input "L" current IiL3 ~ Logic input "H" current IiH3 ~ Supply current Note1 IDDB ~ VDDB=12.0V (at max. luminance) Luminance control frequency: 262 to 290Hz 276Hz(typ.) → ***page*** **8/39** ***lines*** **17~18, 21~22, 26** (2) Backlight Logic input "H" voltage ViH2 ~ Logic input "L" current IiL1 ~ Logic input "H" current IiH2 ~ Supply current Note1 IDDB ~ VDDB=12.0V (at max. luminance) Note2 Luminance control frequency: 262 to 290Hz 280Hz(typ.) Note3

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
2nd edition	DOD - M - 0196	Feb. 28, 2001	**(6) *page* 8/30 *lines* 8~10**

Supply voltage	Part No.	Supplier	Ratings	Remarks
VDD	TBD	TBD	TBD	-
VDDB	TBD	TBD	TBD	-

→

***page* 9/39 *lines* 15~17**

Supply voltage	Type	Supplier	Rating
VCC	TF16N2.50TE	KOA	2.5A Note1
VDDB	R451007	Littel Fuse Inc.	4.5A Note1

(7) *page* 12/30 *lines* 14~20

Parameters	Symbols	Min.	Typ.	Max.	Unit	Remarks
Frequency""	1/tPW	202	-	290	Hz	Note 1
"L" period	tLPW	-	-	50	ms	Note 2
Pulse-width	tHPW/tPW	30	-	100	%	at Max. luminance (100%)
Luminance	Lu	30	-	100	%	-
Input voltage	ViBL1, ViBL2, ViBL3	0	-	0.8	V	-
	ViBH1, ViBH2, ViBH3	2.0	-	5.0	V	-

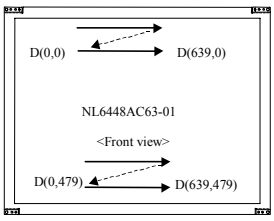
→

***page* 14/39 *lines* 1~7**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Frequency	1/tPW	202	-	290	Hz	Note1
"L" period	tLPW	-	-	50	ms	Note2
Duty ratio	tHPW/tPW	30	-	100	%	Note3
Luminance ratio	-	-	30~100	-	%	-
Input voltage	ViBL1, ViBL2, ViBL3	0	-	0.8	V	-
	ViBL1, ViBL2, ViBL3	2.0	-	5.0	V	-

(8) *page* 19/30 *line* 9

Remark: Below drawings shows scan direction.

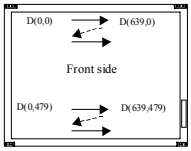


→

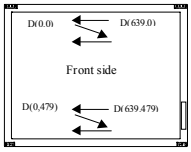
***page* 21/39 *line* 10**

Scanning directions see under diagrams.

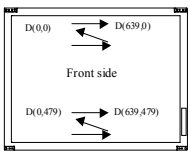
RL: L or OPEN
UD: L or OPEN



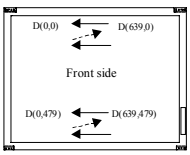
RL: H
UD: L or OPEN



RL: L or OPEN
UD: H



RL: H
UD: H



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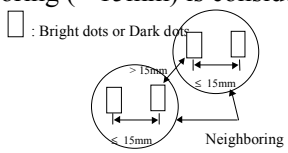
REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
2nd edition	DOD - M - 0196	Feb. 28, 2001	**(9) *page* 20/30 *lines* 3, 11~37** Distance: The distance between the inspector's eye and the LCD panel is TBD cm.

Items	Specifications		
Line defect	Not allowed		
Dot defect (Bright dots) *1	Luminous dots are measured while the screen is black.		
	R+G+B		TBD
	G		TBD
	Neighboring *2	Same color ≤ 6.5mm	TBD
		Different color ≤ 6.5mm	TBD
		Between neighboring ≤ 10mm	TBD
	Linkage	Linked two dots (same color)	TBD
		Linked two dots (different color)	TBD
		Linked three or more dots (same color)	TBD
		Linked three or more dots (different color)	TBD
Dot defect (Dark dots)	Dark dots are measured while the screen is illuminated with Red, Green, or Blue.		
	R, G, B		≤ 7
	R+G+B		≤ 12
	Neighboring *2	Same color ≤ 6.5mm	≤ 0
		Different color ≤ 6.5mm	All allowed
		Between neighboring ≤ 10mm	All allowed
	Linkage	Linked two dots (same screen)	Linked two dots are counted as one dot
		Linked two dots (different screen)	All allowed
		Linked three or more dots (same screen)	R,G,B ≤ 0
		Linked three or more dots (different screen)	R,G,B ≤ 0
Dot defect total	Bright dots + Dark dots = TBD		

*1 Defect > 1/3 of one dot
Dot defects include intermittent luminous and dark dot.
*2 Dark dots are measured while the screen is illuminated with Red, Green and Blue.
*3 Neighboring (< 15mm) is considered as follows.



* Distance between these 2 pairs must be more than 15 mm.
* 1 pair is counted as two dots.

→

***page* 22/39 *lines* 4, 11~34**

Viewing distance: 20cm (The distance between the inspector's eye and screen.)

Item	Specification		
Line defect	Not allowed		
Dot defect (Bright dots) Note1, Note2	Bright dots are measured while the display is black.		
	R+G+B		≤ 2 dots
	Neighboring	Same color ≤ 6.5 mm	0 dot
		Different color ≤ 6.5 mm	0 dot
		Between neighboring ≤ 10 mm	0 dot
	Linkage	Linked two dots (same colors)	0 dot
		Linked two dots (different colors)	0 dot
		Linked three or more dots (same colors)	0 dot
		Linked three or more dots (different colors)	0 dot
Dot defect (Dark dots) Note1, Note2	Dark dots are measured while the display is illuminated with Red, Green or Blue.		
	R, G, B		≤ 3 dots each
	R+G+B		≤ 3 dots
	Neighboring	Same color ≤ 6.5 mm	≤ 1 dot
		Different color ≤ 6.5 mm	≤ 1 dot
		Between neighboring ≤ 10 mm	0 dot
	Linkage	Linked two dots (same colors)	0 dot
		Linked two dots (different colors)	0 dot
		Linked three or more dots (same colors)	0 dot
		Linked three or more dots (different colors)	0 dot
Dot defect total	Bright dots + Dark dots ≤ 5 dots		

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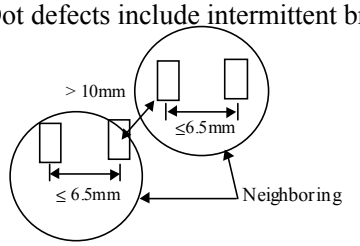
REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
2nd edition	DOD - M - 0196	Feb. 28, 2001	

(This part continues from the front page.)

Note1: Defect area is out of 1/3 dot size.

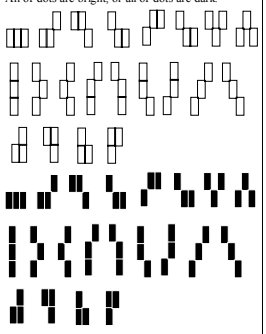
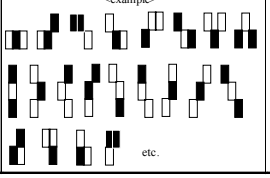
Note2: Dot defects include intermittent bright dots and dark dots.



* Defect distance between 2pairs must be more than 10 mm.
* 1 pair is counted as two dots.

(10) *page* 21/30 *lines* 1~7

<Examples>

Items	: Bright dot : Dark dot : Bright or Dark dot	Specifications	Dot defect
Linked 2 dots		≤ 2 pair/each color total 6pair	Count as 2 dots
		OK	Count as 1 dot
		OK	Count as 2 dots
Linked 3 dots	All of dots are bright, or all of dots are dark. 	NG	NG
	Combination of bright and dark dots <example>  etc.	OK	Count as 3 dots

(This part continues to the next page.)

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
2nd edition	DOD - M - 0196	Feb. 28, 2001	

(This part continues from the front page.)

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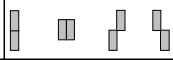
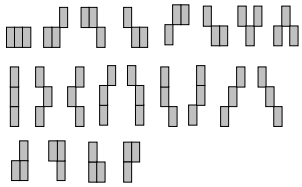
***page* 23/39 *lines* 1~4**

(3) Example for defect dots

Items	Bright or Dark dots	Specification	Dot defect
Linked 2 dots		NG	NG
Linked 3 dots		NG	NG

(11) *page* 22/30

c) Appearance specifications

Items		Specifications		
		Measurement criteria		Quantity
Foreign Materials Stains Dust	Dot shape	Average diameter(ϕ) mm		Allowed value
		$\phi \leq 0.2$		all allowed
		$0.2 < \phi < 0.3$		≤ 10 points
		$0.3 \leq \phi \leq 0.5$		≤ 3 points
		$0.5 < \phi$		0 point
		Linked other objects		
Foreign Materials Stains Dust	Line shape	Width(W) mm	Length(L) mm	
		W < 0.05	-	all allowed
		0.05 ≤ W ≤ 0.1	L < 0.7	
			0.7 ≤ L ≤ 1.0	≤ 4 points
			1.0 < L	0 point
		0.1 < W	-	
Polarizer Bubbles Wrinkles Dent		Average diameter(ϕ) mm		
		$\phi \leq 0.5$		≤ 2 points
Polarizer Scratch		More than 0.2mm^2 (Remarkable scratches)		0 point

→

***page* 23/39 *lines* 5~25**

(4) Example for defect dots

Item	Specifications		
	Criteria		Quantity
Other objects Stains Dust (Dot shape)	Average diameter (ϕ) mm		
	$\phi \leq 0.2$		All allowed
	$0.2 < \phi < 0.3$		≤ 10 points
	$0.3 \leq \phi \leq 0.5$		≤ 3 points
	$0.5 < \phi$		0 point
	Linked other objects		
Other objects Stains Dust (Line shape)	Width (W) mm	Length (L) mm	
	W < 0.05	-	All allowed
	0.05 ≤ W ≤ 0.1	L < 0.7	
		0.7 ≤ L ≤ 1.0	≤ 4 points
		1.0 < L	0 point
	0.1 < W	-	
Polarizer (Bubbles, Wrinkles, Dent)	Average diameter (ϕ) mm		
	$\phi \leq 0.5$		≤ 2 points
Panel dent	Average diameter (ϕ) mm		
	$\phi \leq 0.5$		≤ 2 points
Polarizer scratch	Area (S) mm^2		
	0.2 < S		0 point

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
2nd edition	DOD - M - 0196	Feb. 28, 2001	**(12)** ***page*** **23/30** ***lines*** **1~27** 9. OPTICAL CHARACTERISTICS

(Ta = 25°C, Note1)

Items	Symbols	Condition	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio	CR	Note 3	-	300	-	-	Note 4
Luminance	Lu	Note 3	-	500	-	cd/m^2	Note 6
Luminance uniformity	-	Max. / Min.	-	1.25	1.40	-	Note 7

Reference data

(Ta = 25°C, Note1)

Parameters		Symbols	Condition	Min.	Typ.	Max.	Unit	Remarks
Color gamut		C	at center, to NTSC	-	60	-	%	-
Chromaticity Coordinates		W	White (x,y)	-	TBD	-	-	-
		R	Red (x,y)	-	TBD	-	-	-
		G	Green (x,y)	-	TBD	-	-	-
		B	Blue (x,y)	-	TBD	-	-	-
Viewing angle range	Horizontal	θx+	CR > 10, θy = ±0°	-	60	-	deg.	Note 2
		θx-	CR > 10, θy = ±0°	-	60	-	deg.	
	Vertical	θy+	CR > 10, θx = ±0°	-	40	-	deg.	
		θy-	CR > 10, θx = ±0°	-	50	-	deg.	
Viewing angle range	Horizontal	θx+	CR > 5, θy = ±0°	-	TBD	-	deg.	
		θx-	CR > 5, θy = ±0°	-	TBD	-	deg.	
	Vertical	θy+	CR > 5, θx = ±0°	-	TBD	-	deg.	
		θy-	CR > 5, θx = ±0°	-	TBD	-	deg.	
Luminance control range		-	Maximum luminance: 100%	-	30 to 100	-	%	-
Response time (Module surface temp.=29°C)		Ton	White to Black (100%→10%)	-	TBD	-	ms	Note 6
			(90%→10%)	-	TBD	-		
		Toff	Black to White (0%→90%)	-	TBD	-		
			(10%→90%)	-	TBD	-		

→

page **23/39** ***lines*** **1~4**

9. OPTICAL CHARACTERISTICS

(Ta=25°C, VCC=3.3V, VDDB=12.0V, MVA=L) Note1

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio	CR	White/Black at center, θx±=0°, θy±=0°	300	400	-	-	Note2
Luminance	Lumax	White at center, θx±=0°, θy±=0°	400	500	-	cd/m^2	-
Luminance uniformity	-	Max./Min. of luminance for ①-⑤	-	1.25	1.40	-	Note3

Reference data

(Ta=25°C, VCC=3.3V, VDDB=12.0V, MVA=L) Note1

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Chromaticity		W	White (x, y)	-	0.275, 0.280	-	-	-
		R	Red (x, y)	-	0.628, 0.336	-	-	-
		G	Green (x, y)	-	0.307, 0.547	-	-	-
		B	Blue (x, y)	-	0.142, 0.073	-	-	-
Color gamut		C	θx±=0°, θy±=0° at center, to NTSC	-	57	-	%	-
Viewing angle	CR>10	θx+	θy±=0°	55	65	-	°	Note5
		θx-	θy±=0°	55	65	-	°	
		θy+	θx±=0°	45	55	-	°	
		θy-	θx±=0°	40	50	-	°	
	CR>5	θx+	θy±=0°	-	80	-	°	
		θx-	θy±=0°	-	80	-	°	
		θy+	θx±=0°	-	70	-	°	
		θy-	θx±=0°	-	60	-	°	
Response time Note4		Ton	White to Black	-	4	10	Ms	Note6
		Toff	Black to White	-	28	40		
Luminance control range		-	Control range for white (Max. luminance: 100%)	-	30~100	-	%	-

(13) ***page*** **25/30** ***lines*** **1, 3**

9. RELIABILITY TEST

1. High ~ 50±2°C, RH=85%, 240hours ~

→

page 27/39 *lines* 1, 3

10. RELIABILITY TEST

High ~ 60±2°C, RH=60%, 240hours ~

Writer

Approved by	*Checked by*	*Prepared by*
A. OKAMOTO		A. SAWADA

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
3rd edition	DOD - M - 0210	Mar. 12, 2001	**Revision contents**

• Change part (Before-2nd edition → After-3rd edition)

(1) ***page*** **7/39** ***lines*** **2~13**

7.1 GENERAL SPECIFICATIONS

Item	Specification	Unit
Module size	448.0±1.0 (H) ×348.0±1.0 (V) ×23.7±1.0 (D) Note1	mm
Display area	408.0 (H) ×306.0 (V)	mm
	Diagonal display area: 51cm (Type 20.1)	cm
Number of pixels	640 (H)×480 (V)	pixel
Dot pitch	0.2125 (H) ×0.6375 (V)	mm
Pixel pitch	0.6375 (H) ×0.6375 (V)	mm
Pixel arrangement	RGB (Red, Green, Blue) Vertical stripe	-
Display colors	16,194,277	color
Weight	1,900 (Typ.), 2,060 (Max.)	g

Note1: Exclude the signal processing board, inverter and projection of rear side.

→

page **7/43** ***lines*** **2~12**

7.1 GENERAL SPECIFICATIONS

Item	Specification	Unit
Module size	448.0 ± 1.0 (H) × 348.0 ± 1.0 (V) × 33.2 ± 1.0 (D)	mm
Display area	408.0 (H) × 306.0 (V)	mm
Diagonal size of display	51 (20.1 inches)	cm
Number of pixels	640 (H) × 480 (V)	pixel
Dot pitch	0.2125 (H) × 0.6375 (V)	mm
Pixel pitch	0.6375 (H) × 0.6375 (V)	mm
Pixel arrangement	RGB (Red, Green, Blue) Vertical stripe	-
Display colors	16,194,277	color
Weight	1,900 (Typ.), 2,060 (Max.)	g

(2) ***page*** **7/39** ***line*** **18**

Input voltage (LCD)~ Ta = 25°C VDD = 12.0V

→

page **7/43** ***lines*** **17**

Input voltage (LCD)~ Ta = 25°C

(3) ***page*** **14/39** ***line*** **7**

Input voltage ViBL1, ViBL2, ViBL3 2.0 - 5.0 V -

→

page **14/43** ***lines*** **7**

Input voltage ViBH1, ViBH2, ViBH3 2.0 - 5.0 V -

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REVISION HISTORY

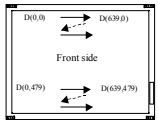
Edition	Document number	Prepared date	Revision contents and writer
3rd edition	DOD - M - 0210	Mar. 12, 2001	**(4) *page* 21/39** 7.8 DISPLAY POSITIONS

RL: L or OPEN, UD: L or OPEN

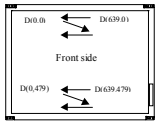
D(0, 0)	D(1, 0)	•••	D(X, 0)	•••	D(638, 0)	D(639, 0)
D(0, 1)	D(1, 1)	•••	D(X, 1)	•••	D(638, 1)	D(639, 1)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D(0, Y)	D(1, Y)	•••	D(X, Y)	•••	D(638, Y)	D(639, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D(0, 478)	D(0,478)	•••	D(X,478)	•••	D(638,478)	D(639,478)
D(0,479)	D(1,479)	•••	D(X,479)	•••	D(638,479)	D(639,479)

Scanning directions see under diagrams.

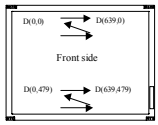
RL: L or OPEN
UD: L or OPEN



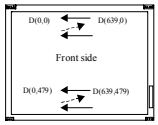
RL: H
UD: L or OPEN



RL: L or OPEN
UD: H



RL: H
UD: H



→

***page* 16/43**

7.7 DISPLAY POSITIONS

The following table is the coordinates which divided the display domain per pixel, in case functions are **'RL: Low or Open'** and **'UD: Low or Open'** (See 'Figure 1 of 7.8 SCANNING DIRECTIONS').

D(0, 0)	D(1, 0)	···	D(X, 0)	···	D(638, 0)	D(639, 0)
D(0, 1)	D(1, 1)	···	D(X, 1)	···	D(638, 1)	D(639, 1)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D(0, Y)	D(1, Y)	···	D(X, Y)	···	D(638, Y)	D(639, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
D(0, 478)	D(0,478)	···	D(X,478)	···	D(638,478)	D(639,478)
D(0,479)	D(1,479)	···	D(X,479)	···	D(638,479)	D(639,479)

7.8 SCANNING DIRECTIONS

The following figures are seen from a front view. Also, the arrow shows the direction of scan.

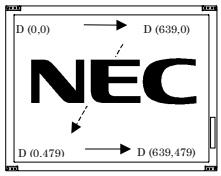


Figure 1. RL: Low or Open, UD: Low or Open

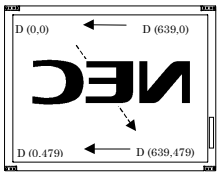


Figure 2. RL: High, UD: Low or Open

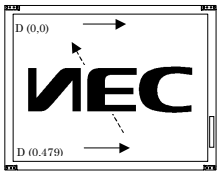


Figure 3. RL: Low or Open, UD: High

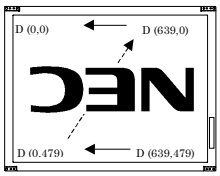


Figure 4. RL: High, UD: High

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
3rd edition	DOD - M - 0210	Mar. 12, 2001	**(5) *page* 22/39 *lines* 10~34** (2) Display specifications

Item	Specification		
Line defect	Not allowed		
Dot defect (Bright dots) Note1, Note2	Bright dots are measured while the display is black.		
	R+G+B		≤ 2 dots
	Neighboring	Same color ≤ 6.5 mm	0 dot
		Different color ≤ 6.5 mm	0 dot
		Between neighboring ≤ 10 mm	0 dot
	Linkage	Linked two dots (same colors)	0 dot
		Linked two dots (different colors)	0 dot
		Linked three or more dots (same colors)	0 dot
		Linked three or more dots (different colors)	0 dot
Dot defect (Dark dots) Note1, Note2	Dark dots are measured while the display is illuminated with Red, Green or Blue.		
	R, G, B		≤ 3 dots each
	R+G+B		≤ 3 dots
	Neighboring	Same color ≤ 6.5 mm	≤ 1 dot
		Different color ≤ 6.5 mm	≤ 1 dot
		Between neighboring ≤ 10 mm	0 dot
	Linkage	Linked two dots (same colors)	0 dot
		Linked two dots (different colors)	0 dot
		Linked three or more dots (same colors)	0 dot
		Linked three or more dots (different colors)	0 dot
Dot defect total	Bright dots + Dark dots ≤ 5 dots		

Note1: Defect area is out of 1/3 dot size.

Note2: Dot defects include intermittent bright dots and dark dots.

→

***page* 22/43 *lines* 10~24**

(2) Display specifications

Item		Specification	
Dot defect (Bright dots) Note1, Note2, Note3	Indirect link types	Between defect dots of same color ≤ 6.5 mm	0 set
		Between defect dots of different color ≤ 6.5 mm	0 set
	Combination type	Red + Green + Blue	≤ 2 dots
Dot defect (Dark dots) Note1, Note2, Note4	Indirect link types	Between defect dots of same color ≤ 6.5 mm	≤ 1 set
		Between defect dots of different color ≤ 6.5 mm	≤ 1 set
	Direct link type	Adjacent two or more defect dots	0 set
	Combination types	Red + Green + Blue	≤ 3 dots
		Between indirect link types and one defect dot of dark ≤ 6.5 mm	0 set
Line defect		Not allowed	

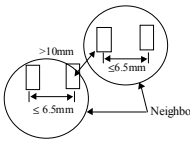
Note1: Defect area is out of 1/3 dot size.

Note2: Dot defects include intermittent bright dots and dark dots.

Note3: Bright dots are measured while the display is black.

Note4: Dark dots are measured while the display is illuminated with Red, Green or Blue.

(6) *page* 23/39 *lines* 35~36



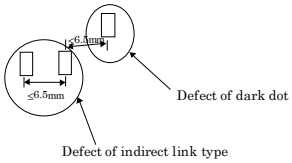
* Defect distance between 2pairs must be more than 10 mm.
* 1 pair is counted as two dots.

→

***page* 23/43 *lines* 1~2**

(4) Example for defect of combination type

Distance between defect of indirect link type and defect of dark dot must not be greater than 6.5 mm.



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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
3rd edition	DOD - M - 0210	Mar. 12, 2001	**(7) *page* 23/39 *lines* 5~25**

(4) Appearance specifications

Item	Specifications		
	Criteria		Quantity
Other objects Stains Dust (Dot shape)	Average diameter (ϕ) mm		
	ϕ ≤ 0.2		All allowed
	0.2 < ϕ < 0.3		≤ 10 points
	0.3 ≤ ϕ ≤ 0.5		≤ 3 points
	0.5 < ϕ		0 point
	Linked other objects		
Other objects Stains Dust (Line shape)	Width (W) mm	Length (L) mm	
	W < 0.05	-	All allowed
	0.05 ≤ W ≤ 0.1	L < 0.7	
		0.7 ≤ L ≤ 1.0	≤ 4 points
		1.0 < L	0 point
	0.1 < W	-	
Polarizer (Bubbles, Wrinkles, Dent)	Average diameter (ϕ) mm		
	ϕ ≤ 0.5		≤ 2 points
Panel dent	Average diameter (ϕ) mm		
	ϕ ≤ 0.5		≤ 2 points
Polarizer scratch	Area (S) mm^2		
	0.2 < S		0 point

→

***page* 23/43 *lines* 3~23**

(5) Appearance specifications

Item	Specifications		
	Criteria Note1		Quantity
Other objects Stains Dust (Dot shape)	ϕ ≤ 0.2		All allowed
	0.2 < ϕ < 0.3		≤ 10 points
	0.3 ≤ ϕ ≤ 0.5		≤ 3 points
	0.5 < ϕ		0 point
	Linked other objects		
Other objects Stains Dust (Line shape)	W < 0.05		All allowed
	0.05 ≤ W ≤ 0.1	L < 0.7	
		0.7 ≤ L ≤ 1.0	≤ 4 points
		1.0 < L	0 point
	0.1 < W		
Polarizer (Bubbles, Wrinkles, Dent)	0.5 ≤ ϕ		≤ 2 points
Panel dent	0.5 ≤ ϕ		≤ 2 points
Polarizer scratch	0.2 < S		0 point

Note1: Definition to symbol

ϕ: Average diameter (mm)

W: Width (mm)

L: Length (mm)

S: Area (mm^2)

Writer

Approved by	*Checked by*	*Prepared by*
A. OKAMOTO		A. SAWADA

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
4th edition	DOD - M - 0277	Mar. 30, 2001	**Revision contents**

• Change part (Before-3rd edition → After-4th edition)

(1) ***page*** **5/43** ***line*** **22**
Response time 32 ms (Typ.), Ton+Toff
→
page **6/46** ***line*** **24**
Response time 4 ms (Typ.)

(2) ***page*** **7/43** ***line*** **26**
Absolute humidity - Absolute humidity shall not exceed Ta=55°C, RH=70% ~
→
page **8/46** ***lines*** **21, 25**
Absolute humidity - ≤78 Note4 ~
Note4: Ta=55°C, RH=70%

(3) ***page*** **16/43**
7.7 DISPLAY POSITIONS

The following table is the coordinates which divided the display domain per pixel, in case functions are **'RL: Low or Open'** and **'UD: Low or Open'** (See 'Figure 1 of 7.8 SCANNING DIRECTIONS').

D(0, 0)	D(1, 0)	···	D(X, 0)	···	D(638, 0)	D(639, 0)
D(0, 1)	D(1, 1)	···	D(X, 1)	···	D(638, 1)	D(639, 1)
⋮	⋮	⋱	⋮	⋱	⋮	⋮
D(0, Y)	D(1, Y)	···	D(X, Y)	···	D(638, Y)	D(639, Y)
⋮	⋮	⋱	⋮	⋱	⋮	⋮
D(0, 478)	D(0,478)	···	D(X,478)	···	D(638,478)	D(639,478)
D(0,479)	D(1,479)	···	D(X,479)	···	D(638,479)	D(639,479)

7.8 SCANNING DIRECTIONS

The following figures are seen from a front view. Also, the arrow shows the direction of scan.

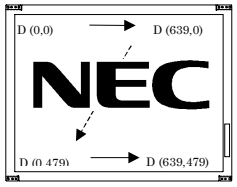

Figure 1. RL: Low or Open, UD: Low or Open

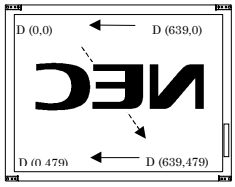

Figure 2. RL: High, UD: Low or Open

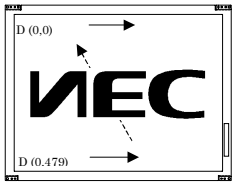

Figure 3. RL: Low or Open, UD: High

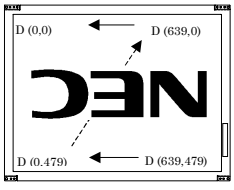

Figure 4. RL: High, UD: High

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
4th edition	DOD - M - 0277	Mar. 30, 2001	

(This part continues from the front page.)
→
page **17/46**

4.8 DISPLAY POSITIONS

The following table is the coordinates that divided the display domain per pixel (See figure of "4.9 SCANNING DIRECTIONS").

C(0, 0)	C(1, 0)	•••	C(X, 0)	•••	C(638, 0)	C(639, 0)
C(0, 1)	C(1, 1)	•••	C(X, 1)	•••	C(638, 1)	C(639, 1)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, Y)	C(1, Y)	•••	C(X, Y)	•••	C(638, Y)	C(639, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, 478)	C(0,478)	•••	C(X,478)	•••	C(638,478)	C(639,478)
C(0,479)	C(1,479)	•••	C(X,479)	•••	C(638,479)	C(639,479)

4.9 SCANNING DIRECTIONS

The following figures are seen from a front view. Also, the arrow shows the direction of scan.

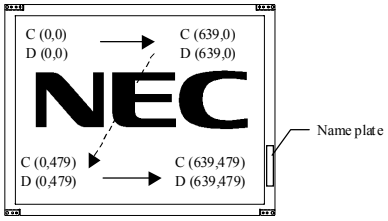

Figure 1. R/L: Low or Open, U/D: Low or Open

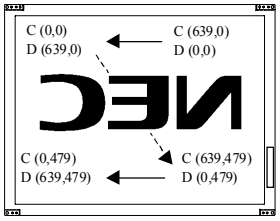

Figure 2. R/L: High, U/D: Low or Open

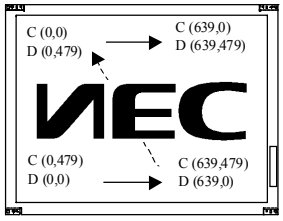

Figure 3. R/L: Low or Open, U/D: High

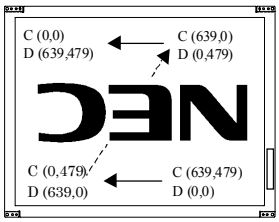

Figure 4. R/L: High, U/D: High

Note1: Meaning of C (X, Y) and D (X, Y)

C (X, Y): The coordinates on the display domain (See "4.8 DISPLAY POSITIONS".)

D (X, Y): The data number for input signal

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
4th edition	DOD - M - 0277	Mar. 30, 2001	**(4) *page* 22/43 *lines* 10~24**

(2) Display specifications

Item		Specification	
Dot defect (Bright dots) Note1, Note2, Note3	Indirect link types	Between defect dots of same color ≤ 6.5 mm	0 set
		Between defect dots of different color ≤ 6.5 mm	0 set
	Combination type	Red + Green + Blue	≤ 2 dots
Dot defect (Dark dots) Note1, Note2, Note4	Indirect link types	Between defect dots of same color ≤ 6.5 mm	≤ 1 set
		Between defect dots of different color ≤ 6.5 mm	≤ 1 set
	Direct link type	Adjacent two or more defect dots	0 set
	Combination types	Red + Green + Blue	≤ 3 dots
		Between indirect link types and one defect dot of dark ≤ 6.5 mm	0 set
Line defect		Not allowed	

Note1: Defect area is out of 1/3 dot size.

Note2: Dot defects include intermittent bright dots and dark dots.

Note3: Bright dots are measured while the display is black.

Note4: Dark dots are measured while the display is illuminated with Red, Green or Blue.

→

***page* 25/46 *lines* 10~24**

4.12.2 Display specifications

Defect	Specification			
Bright dot defects Note1, Note2	Red + Green + Blue			≤ 2 dots
	Distance between 2 defect dots (**D**)	**D** = 0 mm (Adjacent)	Note4	0 set
		0 mm < **D** ≤ 6.5mm		0 set
		D > 6.5mm		Allowed
Dark dot defects Note1, Note3	Red + Green + Blue			≤ 3 dots
	Distance between 2 defect dots (**D**)	**D** = 0 mm (Adjacent)	Note4	0 set
		D > 0 mm		Allowed
	Number of the pair of which '**D**' is less than 6.5mm (**N**)	**N** ≤ 1 pair	Note5	Allowed
		N ≥ 2 pair	Note5	0 set
Combination of bright and dark dot defects	Distance between 2 defect dots (**D**)	**D** = 0 mm (Adjacent)	Note4	0 set
		D > 0 mm		Allowed
Line defect	Not allowed			

Note1: Defect area is out of 1/3 dot size. Also dot defects include intermittent bright dots and dark dots.

Note2: Bright dots are measured while the display is black.

Note3: Dark dots are measured while the display is illuminated with Red, Green or Blue.

Note4: See "4.12.3 Defects of adjacent".

Note5: See "4.12.4 Distance among 3 defect dots".

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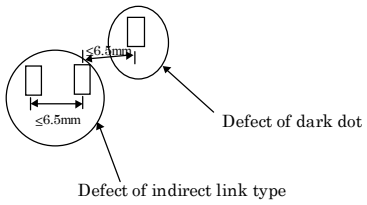
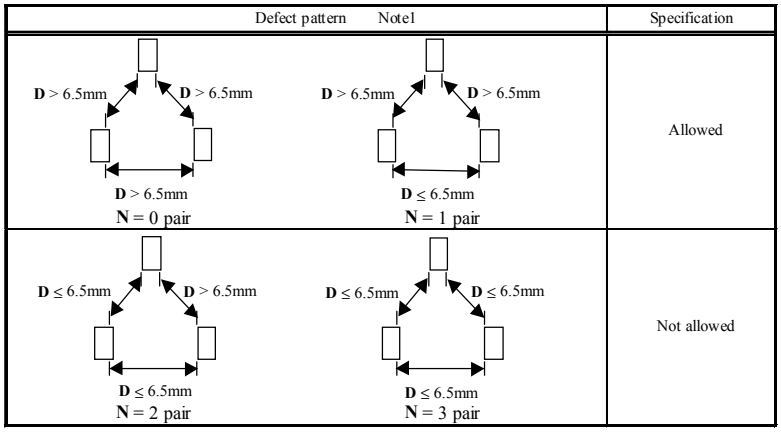
REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
4th edition	DOD - M - 0277	Mar. 30, 2001	**(5) *page* 23/43 *lines* 1~2** (4) Example for defect of combination type Distance between defect of indirect link type and defect of dark dot must not be greater than 6.5 mm.  → ***page* 26/46 *lines* 1~6** 4.12.4 Distance among 3 defects dots  Note1: **D** is distance between 2 defect dots. Also **N** is number of the pair of which '**D**' is less than 6.5mm. **(6) *page* 23/39 *lines* 3~23** (5) Appearance specifications

Item	Specifications		
	Criteria Note1		Quantity
Other objects Stains Dust (Dot shape)	$\phi \leq 0.2$		All allowed
	$0.2 < \phi < 0.3$		≤ 10 points
	$0.3 \leq \phi \leq 0.5$		≤ 3 points
	$0.5 < \phi$		0 point
	Linked other objects		
Other objects Stains Dust (Line shape)	$W < 0.05$		All allowed
	$0.05 \leq W \leq 0.1$	$L < 0.7$	
		$0.7 \leq L \leq 1.0$	≤ 4 points
		$1.0 < L$	0 point
	$0.1 < W$		
Polarizer (Bubbles, Wrinkles, Dent)	$0.5 \leq \phi$		≤ 2 points
Panel dent	$0.5 \leq \phi$		≤ 2 points
Polarizer scratch	$0.2 < S$		0 point

Note1: Definition to symbol

ϕ: Average diameter (mm)

W: Width (mm)

L: Length (mm)

S: Area (mm^2)

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
4th edition	DOD - M - 0277	Mar. 30, 2001	*(This part continues from the front page.)* → ***page* 26/46 *lines* 7~27** 4.12.5 Appearance specifications

Item		Criteria	Note1	
Impure ingredient Stains Dust	Dot shape	$\phi \leq 0.2$		Allowed
		$0.2 < \phi < 0.3$		≤ 10 points
		$0.3 \leq \phi \leq 0.5$		≤ 3 points
		$\phi > 0.5$		0 point
		Linked other objects		
	Line shape	W < 0.05		Allowed
		$0.05 \leq W \leq 0.1$	L < 0.7	
			$0.7 \leq L \leq 1.0$	≤ 4 points
			L > 1.0	0 point
		W > 0.1		
Bubbles, Wrinkles, Dent		$\phi < 0.5$		Allowed
		$\phi \geq 0.5$		≤ 2 points
Scratch		$S \leq 0.2$		Allowed
		S > 0.2		0 point

Note1: Definitions of symbols

ϕ: Average diameter (mm)

W: Width (mm)

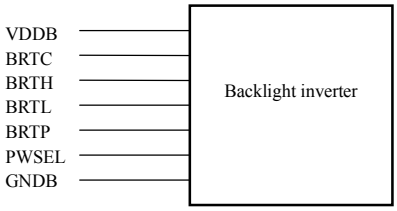
L: Length (mm)

S: Area (mm^2)

Writer

Approved by	*Checked by*	*Prepared by*
A. OKAMOTO		A. SAWADA

5th edition	DOD - M - 0412	Jun. 26, 2001	**Revision contents** • Change part (Before-4th edition → After-5th edition) **(1) *page* 7/46** **3. BLOCK DIAGRAM**



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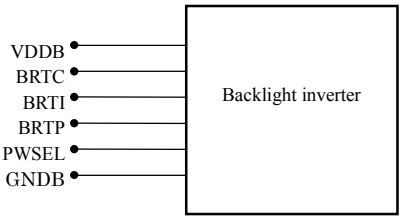
***page* 7/53**
3. BLOCK DIAGRAM



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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
5th edition	DOD - M - 0412	Jun. 26, 2001	**(2)** ***page*** **8/46** 4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Supply voltage	LCD panel signal board and driver	VCC	-0.3 to +6.5	V	Ta = 25°C
	Inverter	VDDB	-0.3 to +14	V	
Input voltage	Display signals Note2	Vi	-0.3 to VCC+0.3	V	Ta = 25°C
	BRTP	ViB1	-0.3 to +5.5	V	Ta = 25°C VDDB = 12.0V
	BRTC and PWSEL	ViB2	-0.3 to +5.5	V	
	BRTL	ViB2	-0.3 to +1.5	V	

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page **8/53**

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter			Symbol	Rating	Unit	Remarks
Supply voltage	LCD panel signal board		VCC	-0.3 to +6.5	V	Ta = 25°C
	Backlight inverter		VDDB	-0.3 to +14	V	
Input voltage	LCD panel signal board	Display signals Note1	Vi	-0.3 to VCC+0.3	V	Ta = 25°C
	Backlight inverter	BRTI signal	ViBI	-0.3 to +1.5	V	Ta = 25°C VDDB = 12.0V
		BRTP signal	ViBP	-0.3 to +5.5	V	
		BRTC signal	ViBC	-0.3 to +5.5	V	
		PWSEL signal	ViBS	-0.3 to +5.5	V	

(3) ***page*** **9/46**

4.3.2 Driving for backlight inverter

(Ta = 25°C)

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
Logic input voltage	BRTP	Low	ViB1L	0	-	0.8	V	-
		High	ViB1H	2.0	-	5.0	V	
	BRTC and PWSEL	Low	ViB2L	0	-	0.8	V	
		High	ViB2H	2.0	-	5.0	V	
Logic input current	BRTP	Low	IiB1L	-1,580	-	-	μA	-
		High	IiB1H	-	-	3,500	μA	
	BRTC and PWSEL	Low	IiB2L	-610	-	-	μA	
		High	IiB2H	-	-	440	μA	
Supply voltage			VDDB	10.8	12.0	13.2	V	-
Supply current Note1			IDDB	-	3,800	-	mA	VDDB = 12.0V Note2 (Maximum luminance)

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
5th edition	DOD - M - 0412	Jun. 26, 2001	

(This part continues from the front page.)

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***page* 9/53**

4.3.2 Driving for backlight inverter

(Ta = 25°C)

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage			VDDB	10.8	12.0	13.2	V	-
Supply current			IDDB	-	3,800	-	mA	at maximum luminance, VDDB = 12.0V Note1
Input voltage for control system	BRTI signal		ViBI	0	-	1.2	V	-
	BRTP signal	Low	ViBPL	0	-	0.8	V	
		High	ViBPH	2.0	-	5.0	V	
	BRTC signal	Low	ViBCL	0	-	0.8	V	
		High	ViBCH	2.0	-	5.0	V	
	PWSEL signal	Low	ViBSL	0	-	0.8	V	
		High	ViBSH	2.0	-	5.0	V	
Input current for control system	BRTI signal		IiBI	-130	-	-	μA	
	BRTP signal	Low	IiBPL	-1,580	-	-	μA	
		High	IiBPH	-	-	3,500	μA	
	BRTC signal	Low	IiBCL	-610	-	-	μA	
		High	IiBCH	-	-	440	μA	
	PWSEL signal	Low	IiBSL	-610	-	-	μA	
		High	IiBSH	-	-	440	μA	

(4) *page* 10/46

4.3.4 Fuses

Fuse		Rating Note1	Unit	Remarks
Type	Supplier			
TF16N2.50TE	KOA	2.5	A	VCC (for LCD panel signal processing board)
R451007	Littel Fuse Inc.	4.5	A	VDDB (for backlight inverter)

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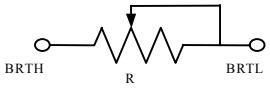
***page* 10/53**

4.3.4 Fuses

Fuse		Rating Note1	Unit	Remarks
Type	Supplier			
TF16N2.50TE	KOA Corp.	2.5	A	VCC (for LCD panel signal processing board)
		32	V	
R451007	Littel Fuse Inc.	7.0	A	VDDB (for backlight inverter)
		125	V	

(5) *page* 14/46

4.6.1 Luminance control method

Control method	Function and adjustment	PWSEL	BRTP
PWM	Luminance controlled by BRTP signal. See "4.6.2 Luminance control with external luminance".	Low	Input
Variable resistor Note1	The variable resistor for luminance control should be 10kΩ type, and zero point of the resistor corresponds to the minimum of luminance.  Max. luminance (100%): R=10kΩ Min. luminance (30%): R=0Ω Mating variable resistor: 10kΩ ±5%, B curve, 1/10W	High or Open	Open
Voltage Note1	BRTH should be fixed to 0V, and input to BRTL as follows. Max. Luminance (100%): 1V(Typ.) Min. Luminance (30%): 0V		

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
5th edition	DOD - M - 0412	Jun. 26, 2001	

(This part continues from the front page.)

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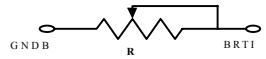
***page* 14/53**

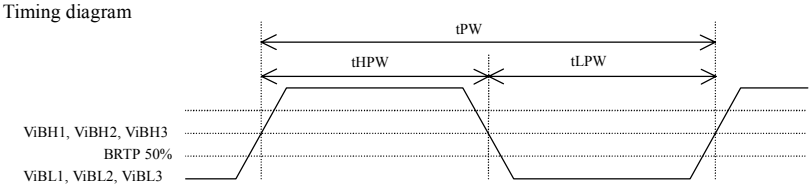
4.6.1 Luminance control method

Method	Adjustment and luminance ratio	PWSEL signal	BRTP signal
Resistor control Note1	• Adjustment The variable resistor (**R**) for luminance control should be 10kΩ ±5%, B curve, 1/10W. Minimum point of the resistor is the minimum luminance. Also maximum point of the resistor is the maximum luminance.  • Luminance ratio Note3 Resistance: 0 kΩ → Luminance ratio: 30% (Minimum) Resistance: 10 kΩ → Luminance ratio: 100% (Maximum)	High or Open	Open
Voltage control Note1	• Adjustment This control method can carry out continuation adjustment of luminance, if it is adjusted within the rated voltage for BRTI signal (ViBI). • Luminance ratio Note3 BRTI Voltage (ViBI): 0V → Luminance ratio: 30% (Minimum) BRTI Voltage (ViBI): 1.0V → Luminance ratio: 100% (Maximum)		
Pulse width modulation Note1 Note2	• Adjustment Pulse width modulation (PWM) method works, when PWSEL signal is Low and PWM signal (BRTP signal) is inputted into BRTP terminal. The luminance is controlled by duty ratio of BRTP signal. • Luminance ratio Note3 Duty ratio Note4: 0.3 → Luminance ratio: 30% (Minimum) Duty ratio Note4: 1.0 → Luminance ratio: 100% (Maximum)	Low	PWM signal

(6) *page* 15/46

4.6.3 External pulse timing (PWSEL = Low)

• Timing diagram



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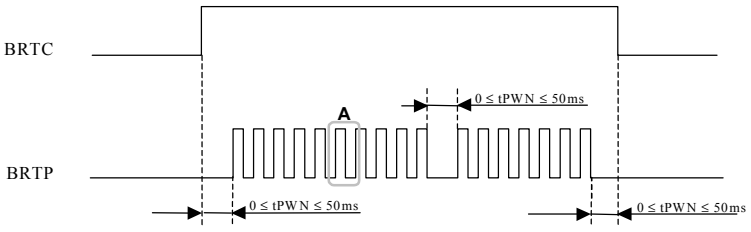
***page* 15/53**

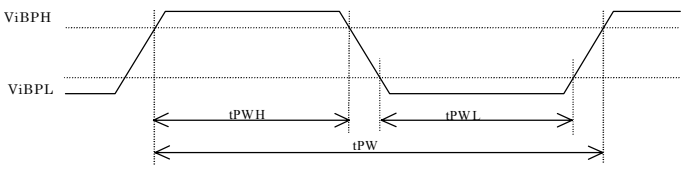
4.6.3 PWM timing

(1) Timing diagrams

• Outline chart



• Detail of **A** part



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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
5th edition	DOD - M - 0412	Jun. 26, 2001	**(7)** ***page*** **15/46** 4.6.3 External pulse timing (PWSEL = Low) • Each parameter

Parameter		Symbol	Min.	Typ.	Max.	Unit	Remarks
Input pulse frequency		1/tPW	202	-	290	Hz	Note1
Low period		tLPW	-	-	50	ms	Note2
Duty ratio		tHPW/tPW	30	-	100	%	Note3
Luminance ratio		-	-	30 to 100	-	%	-
Input voltage	Low	ViBL1, ViBL2, ViBL3	0	-	0.8	V	-
	High	ViBH1, ViBH2, ViBH3	2.0	-	5.0	V	-

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page **15/53**

4.6.3 PWM timing

(2) Each parameter

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Luminance control frequency	1/tPW	202	280	290	Hz	Note1
Duty ratio	tPWH/tPW	0.3	-	1.0	-	Note2
Non signal period	tPWN	0	-	50	ms	Note3

(8) ***page*** **22/46**

4.10.5 Timing characteristics (DE mode: default)

Parameter Note1			Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency		1/tc	21	25.175	29	MHz	39.722 ns (Typ.)
	Duty		tch/tc	0.5	0.5	0.6	-	-
	Rise, fall		tcrf	-	-	10	ns	
Hsync	Period		th	30.0	31.778	33.6	μs	31.468 kHz (Typ.)
					800		CLK	
	Display period		thd		640		CLK	-
	Front-porch	Fixed mode	thf		16		CLK	
		DE mode	thf	2	16	-	CLK	
	Pulse width	Fixed mode	thp	10	96	-	CLK	
		DE mode	thp	10	96	-	CLK	
	Back-porch	Fixed mode	thb	-	48	134	CLK	
		DE mode	thb	7	48	-	CLK	
	Total both pulse width and back-porch	Fixed mode	thp + thb		144		CLK	Note2
		DE mode	thp + thb	17	144	158	CLK	
	CLK- Hsync timing		thch	12	-	-	ns	-
	Hsync-CLK timing		thcs	8	-	-	ns	
	Hsync-Vsync timing		thv	1	-	-	CLK	
	Vsync-Hsync timing		tvh	30	-	-	ns	
	Rise, fall		thrf	-	-	10	ns	
Vsync	Period		tv	16.1	16.683	17.2	ms	59.94 Hz (Typ.)
					525		H	
	Display period		tvd		480		H	-
	Front-porch	Fixed mode	tvf		12		H	
		DE mode	tvf	1	12	-	H	
	Pulse width	Fixed mode	tvp	1	2	-	H	
		DE mode	tvp	1	2	-	H	
	Back-porch	Fixed mode	tvb		31		H	
		DE mode	tvb	4	31	-	H	
	Total both pulse width and back-porch	Fixed mode	tvp + tvb		33		H	Note2
		DE mode	tvp + tvb	5	33	44	H	
	Rise, fall		tvrf	-	-	10	ns	-
DATA	CLK-DATA timing		tds	8	-	-	ns	-
	DATA-CLK timing		tdh	12	-	-	ns	
	Rise, fall		tdrf	-	-	10	ns	
DE	DE-CLK timing		tes	8	-	-	ns	-
	CLK-DE timing		the	12	-	-	ns	
	Rise, fall		terf	-	-	10	ns	

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REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and writer
5th edition	DOD - M - 0412	Jun. 26, 2001	

(This part continues from the front page.)

→

***page* 21/53**

4.10.4 Timing characteristics

• Common to DE mode and fixed mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency		1/tc	21.0	25.2	29.0	MHz	39.7 ns (typ.)
	Duty		tch/tc	0.5	-	0.6	-	
	Rise time and fall time		tcrf	-	-	10	ns	
DATA	CLK-DATA	Setup time	tds	8	-	-	ns	-
		Hold time	tdh	12	-	-	ns	
	Rise time, Fall time		tdrf	-	-	10	ns	

• DE mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
DE	Horizontal	Cycle	th	-	800	-	CLK	Note1
		Display period	thd	640			CLK	
	Vertical (One frame)	Cycle	tv	-	525	-	H	
		Display period	tvd	480			H	
	CLK-DE	Setup time	tdes	8	-	-	ns	-
		Hold time	tdeh	12	-	-	ns	
	Rise time, Fall time		tderf	-	-	10	ns	

• Fixed mode

Parameter			Symbol	Min.	Typ.	Max.	Unit	Remarks
Hsync	Cycle		th	30.0	31.8	33.6	μs	31.4 kHz (typ.)
				800			CLK	Note1
	Display period		thd	640			CLK	
	Front-porch		thf	16			CLK	
	Pulse width		thp	10	96	-	CLK	
	Back-porch		thb	-	48	134	CLK	
	Total of pulse width and back-porch		thp + thb	144			CLK	Note1, Note2
	CLK- Hsync	Setup time	ths	8	-	-	ns	-
		Hold time	thh	12	-	-	ns	
	Rise time, Fall time		thrf	-	-	10	ns	
Vsync	Cycle		tv	16.1	16.7	17.2	ms	59.9 Hz (typ.)
				525			H	Note1
	Display period		tvd	480			H	
	Front-porch		tvf	12			H	
	Pulse width		tvp	1	-	2	H	
	Back-porch		tvb	31	-	32	H	
	Total of pulse width and back-porch		tvp + tvb	33			H	Note1, Note2
	Vsync-Hsync	Setup time	tvhs	1	-	-	CLK	Note1
		Hold time	tvhh	30	-	-	ns	-
	Rise time, Fall time		tvrf	-	-	10	ns	

(9) ***page* 25/46**

4.12.5 Appearance specifications

Bubbles, Wrinkles, Dent	$\phi < 0.5$	Allowed
	$\phi \geq 0.5$	≤ 2 points

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***page* 25/53**

4.12.4 Appearance specification

Bubbles, Wrinkles, Dent	$d \leq 0.2$	Allowed
	$0.2 < d \leq 0.5$	≤ 2 points
	$d > 0.5$	0 point

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