NEC

TFT COLOR LCD MODULE

NL3224AC35-01

14 cm (5.5 Type), 320 × 240 Pixels, Full color
NTSC/PAL mode, Incorporated backlight with inverter

NL3224AC35-01 is a TFT (thin film transistor) active matrix color liquid crystal display (LCD) comprising amorphous silicon TFT attached to each signal electrode, a driving circuit and a backlight. NL3224AC35-01 has a built-in backlight.

The 14 cm diagonal display area contains 320×240 pixels and can display full-color simultaneously.

1. FEATURES

- Analog RGB interface
- Low reflection
- High luminance
- NTSC/PAL mode
- Reversible horizontal and vertical scanning
- 234/240 line display
- Incorporated edge type backlight
- Designed viewing direction: 10 and 2 o'clock

2. APPLICATIONS

- Car navigations
- TV monitors
- Video games
- Monitors for process controller

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3. STRUCTURE AND FUNCTIONS

A TFT color LCD module comprises a TFT LCD panel, LSIs for driving liquid crystal, and a backlight. The TFT LCD panel is composed of a TFT array glass substrate superimposed on a color filter glass substrate with liquid crystal filled in the narrow gap between two substrates. The backlight apparatus is located on the backside of the LCD panel.

RGB (Red, Green, Blue) data signals are sent to LCD panel drivers after modulation into suitable forms for active matrix addressing through signal processor.

Each of the liquid crystal cells acts as an electro-optical switch that controls the light transmission from the backlight by a signal applied to a signal electrode through the TFT switch.

4. OUTLINE OF CHARACTERISTICS (at room temperature)

Display area	111.36 (H) × 83.52 (V) mm
Drive system	a-Si TFT active matrix
Display colors	Full-color
Number of pixels	320 × 240
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.348 (H) × 0.348 (V) mm
Module size	134.0 (H) × 110.0 (V) × 23.0 max.(D) mm
Weight	315 g (typ.)
Contrast ratio	85:1 (typ.)

Viewing angle (more than the contrast ratio of 10:1)

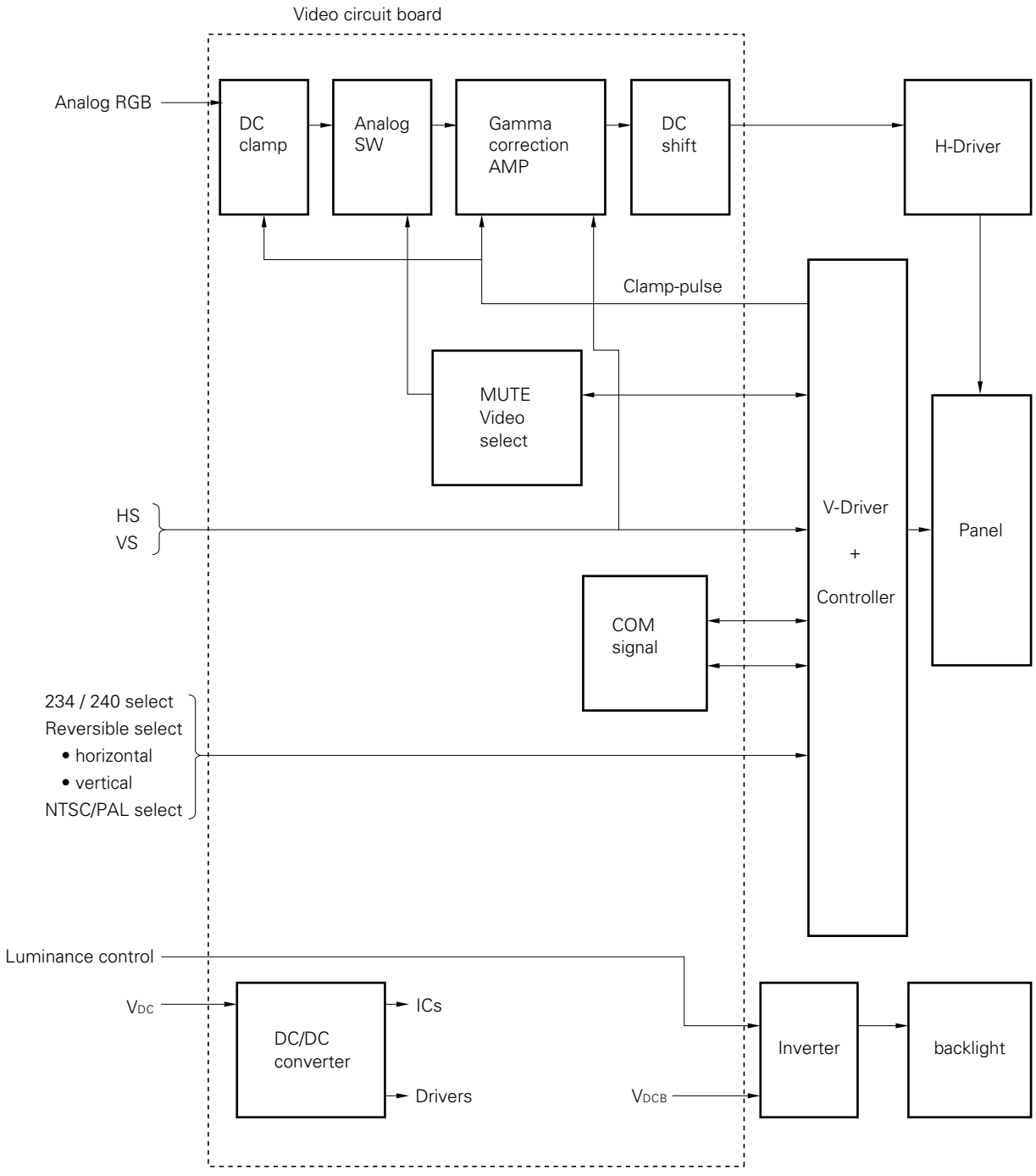
- Horizontal: 45° (typ. left side, right side)
- Vertical: 30° (typ. up side), 15° (typ. down side)

Designed viewing direction

- wider viewing angle with contrast ratio : 10 and 2 o'clock
- wider viewing angle without image reversal : down side (6 o'clock)
- optimum grayscale (γ=2.2) : perpendicular

Color gamut	50% (typ. center, to NTSC)
Response time	50 ms (max.), "white" to "black"
Luminance	250 cd/m^2 (typ.)
Signal system	Analog RGB signals, synchronous signals (CLK, HS, VS)
Supply voltage	9.5 V (LCD power supply), 9.5 V (Backlight power supply)
Backlight	Edge light type, one fluorescent lamp (cold cathode type)
Power consumption	6.6 W (typ.)

5. BLOCK DIAGRAM



6. SPECIFICATION

6.1 GENERAL SPECIFICATIONS

Item	Specifications	Unit
Module size	134.0±0.5 (H) × 110.0±0.5 (V) × 23.0 max. (D)	mm
Display area	111.36 (H) × 83.52 (V)	mm
Number of dots	320 ×3 (H) × 240 (V)	dot
Dot pitch	0.116 (H) × 0.348 (V)	mm
Pixel pitch	0.348 (H) × 0.348 (V)	mm
Pixel arrangement	RGB (Red, Green, Blue) vertical stripe	–
Display colors	Full-color	color
Weight	330 (max.)	g

note : An inverter is incorporated with the module.

6.2 ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Ratings	Unit	Remarks	
Supply voltage	V_{DC}	–0.5 to 20.0	V	Ta=25˚C	
	V_{DCB}	–0.5 to 20.0	V		
Analog RGB input signal	$V_{IN}1$	–2.5 to 2.5	V	Ta=25˚C V_{DC}=9.5 V	
Logic input voltage	$V_{IN}2$	–0.5 to 5.5	V		
Storage temp.	T_{ST}	–40 to 95	˚C	—	
Operating temp.	T_{OP}	–30 to 85	˚C	Module surface*	
Humidity		95% relative humidity		Ta=40˚C	no condensation
		85% relative humidity		Ta=50˚C	
		Absolute humidity shall not exceed Ta=50˚C, 85% relative humidity level.		Ta>50˚C	

* measured at the center of the display area

6.3 ELECTRICAL CHARACTERISTICS

(1) Power supply, logic input

Ta = 25˚C

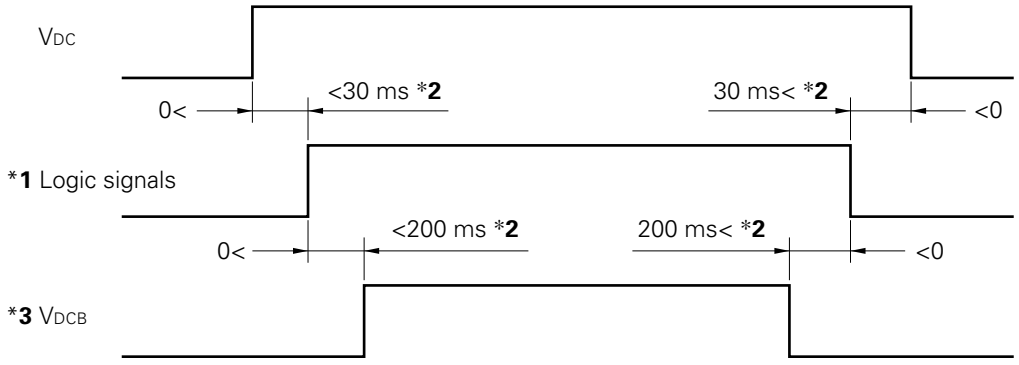
Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Supply voltage	V_{DC}	8.0	9.5	13.0	V	For processor, controller and driver
	V_{DCB}	8.0	9.5	13.0	V	For backlight
Logic input "L" voltage	V_{IL}	0	–	0.9	V	—
Logic input "H" voltage	V_{IH}	3.15	–	5.0	V	
Logic output "L" voltage	V_{OL}	0	–	0.3	V	
Logic output "H" voltage	V_{OH}	4.5	–	5.0	V	
Supply current	I_{DC}	–	(147)	200	mA	At dot-checkered pattern (V_{DC} = 9.5 V)
	I_{DCB}	–	(541)	600	mA	Maximum luminance (V_{DCB} = 9.5 V)

(2) Analog RGB signals

Ta = 25˚C

Parameter	min.	typ.	max.	Unit	Remarks
Analog RGB input voltage (white - black)	0	–	0.7	Vp-p	Zi = 75 Ω
DC input level (black level)	–1.0	–	1.0	V	

6.4 SUPPLY VOLTAGE SEQUENCE



* **1** When the V DC is off, please keep whole logic signals low level
* **2** Reference value
* **3** Apply V DCB within the LCD operation period. When the backlight turns on before LCD operation or the LCD operation turns off before the backlight turns off, the display may momentarily become white.

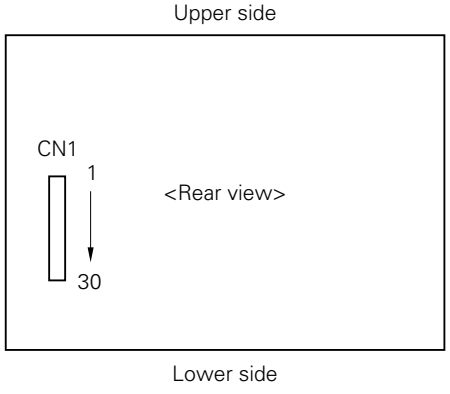
6.5 INTERFACE PIN CONNECTION

(1) Connector (CN1)

Part no. : 52610-3017
Supplier : Molex
Adaptable cable : SUMI-CARD 1.0 mm pitch 30 wick 85˚C quality
Supplier : SUMITOMO ELECTRIC INDUSTRIES, LTD.

Pin No.	Symbol	Pin No.	Symbol	Pin No.	Symbol
1	GNDD	11	EXTCSL	21	GNDD
2	EXTCLK	12	GNDD	22	GNDD
3	GNDD	13	N/P	23	GNDD
4	HS	14	MTSL	24	GNDA
5	VS	15	U/D	25	R
6	HOUT	16	R/L	26	GNDA
7	VOUT	17	GNDD	27	G
8	B_{PLS}	18	V_{DCB}	28	GNDA
9	GNDD	19	V_{DCB}	29	B
10	GNDD	20	V_{DC}	30	GNDA

<Connector location>



6.6 PIN DESCRIPTION

Symbol	In/Out	Logic	Description
R	In	–	Analog Red signal 0.7 Vp-p Zi=75 Ω
G	In	–	Analog Green signal 0.7 Vp-p Zi=75 Ω
B	In	–	Analog Blue signal 0.7 Vp-p Zi=75 Ω
EXTCLK	In *1	Negative	External clock EXTCLK becomes active, when EXTCSL is "H".
HS	In *1	Negative	Horizontal synchronous signal
VS	In *1	Negative	Vertical synchronous signal
HOUT	Out *1	Negative	Horizontal synchronous signal output
VOUT	Out *1	Negative	Vertical synchronous signal output
EXTCSL	In *1	–	Clock select signal { H : external clock Default value is L { L : internal clock
R/L	In *1	–	Horizontal scanning select signal { H : Right scanning Default value is L { L : Left scanning
U / D	In *1	–	Vertical scanning select signal { H : down scanning Default value is L { L : up scanning
N / P	In *1	–	Display mode select { H : PAL mode Default value is L { L : NTSC mode
MTSL	In *1	–	Vertical display area select signal { H : 240 lines Default value is L { L : 234 lines
B_{PLS}	In *1	–	Luminance control signal (pulse input) Luminance is controlled by the pulse width. Duty 100%: luminance max. Refer to P13.
V_{DC}	In	–	Power supply for processor, controller and driver (+9.5 V)
V_{DCB}	In	–	Power supply for backlight (+9.5 V)
GNDA	–	–	Ground for analog RGB signal
GNDD	–	–	Ground for logic and backlight

*1 : CMOS level

6.7 SIGNALS

No.	Functions	Description
1	Reversible horizontal scanning	R/L signal is able to reverse scanning direction. (Right → Left or Left → Right)
2	Reversible vertical scanning	U/D signal is able to reverse scanning direction. (Up → Down or Down → Up)
3	NTSC/PAL mode	N/P signal is able to change operating mode. (NTSC → PAL or PAL → NTSC) Scanning line is thinned out at the rate of seven to six lines in the PAL mode.
4	234/240 line display	MTSL signal is able to change scanning line. (234 lines → 240 lines or 240 lines → 234 lines)

6.8 INPUT SIGNAL TIMING

(1) mode: NTSC, internal CLK

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1 / tc	– –	6.36 157.32	– –	MHz ns	–
	Rise/fall	tcrf	–	–	70	ns	–
	Duty	tch / tc	0.4	0.5	0.6	–	–
HS	Frequency	th	60.38 –	63.56 404	66.74 –	μs CLK	15.734 kHz (typ.)
	Display	thd	– –	50.34 320	– –	μs CLK	–
	Pulse-width	thp	1.0 –	4.7 30	– –	μs CLK	–
	Pulse-width +back-porch	thpb	– –	11.01 70	– –	μs CLK	234 line
			– –	12.11 77	– –	μs CLK	240 line
	CLK-Hsync timing hold/setup time	thch	10.0	–	–	ns	–
		thcs	10.0	–	–	ns	–
	V-Hsync timing hold/setup time	thvh	1	–	–	CLK	–
		thvs	10.0	–	–	ns	–
	Rise/fall	thrf	–	–	10.0	ns	–
VS	Frequency	tv	15.85 –	16.68 262.5	17.51 –	ms H	59.94 Hz (typ.)
	Display	tvd	– –	14.87 234	– –	ms H	234 line
			– –	15.25 240	– –	ms H	240 line
	Pulse-width	tvp	158.89 –	190.67 3	– –	μs H	–
	Pulse-width +back-porch	tvpb	– –	1.33 21	– –	ms H	–
	Rise/fall	tvrf	–	–	10.0	ns	–

note 1 : In the display start period (pulse-width + back-porch), analog RGB signals should be blanking level.

(2) mode: PAL, internal CLK

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1 / tc	– –	6.45 154.96	– –	MHz ns	–
	Rise/fall	tcrf	–	–	70	ns	–
	Duty	tch / tc	0.4	0.5	0.6	–	–
HS	Frequency	th	60.80 –	64.00 413	67.20 –	μs CLK	15.625 kHz (typ.)
	Display	thd	– –	49.60 320	– –	μs CLK	–
	Pulse-width	thp	1.0 –	4.7 30	– –	μs CLK	–
	Pulse-width +back-porch	thpb	– –	11.93 77	– –	μs CLK	234 line
			– –	12.71 82	– –	μs CLK	240 line
	CLK-Hsync timing hold/setup time	thch	10.0	–	–	ns	–
		thcs	10.0	–	–	ns	–
	V-Hsync timing hold/setup time	thvh	1	–	–	CLK	–
		thvs	10.0	–	–	ns	–
	Rise/fall	thrf	–	–	10.0	ns	–
VS	Frequency	tv	19.00 –	20.00 312.5	21.00 –	ms H	50.00 Hz (typ.)
	Display	tvd	– –	17.47 273	– –	ms H	234 line
			– –	17.92 280	– –	ms H	240 line
	Pulse-width	tvp	153.60 –	192.00 2.5	– –	μs H	–
	Pulse-width +back-porch	tvpb	– –	1.86 29	– –	ms H	234 line
			– –	1.66 26	– –	ms H	240 line
	Rise/fall	tvrf	–	–	10.0	ns	–

note 1 : In the display start period (pulse-width + back-porch), analog RGB signals should be blanking level.

(3) mode : NTSC, external CLK

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
EXTCLK	Frequency	1 / tc	– 118.75	8.0 125.00	– 131.25	MHz ns	–
	Rise/fall	tcrf	–	–	10	ns	–
	Duty	tch / tc	0.4	0.5	0.6	–	–
HS	Frequency	th	60.38 –	63.56 508	66.74 –	μs CLK	15.734 kHz (typ.)
	Display	thd	– –	40.00 320	– –	μs CLK	–
	Pulse-width	thp	1.0 –	4.7 38	– –	μs CLK	–
	Pulse-width +back-porch	thpb	– –	8.75 70	– –	μs CLK	234 line
			– –	9.63 77	– –	μs CLK	240 line
	CLK-Hsync timing hold/setup time	thch	10.0	–	–	ns	–
		thcs	10.0	–	–	ns	–
	V-Hsync timing hold/setup time	thvh	1	–	–	CLK	–
		thvs	10.0	–	–	ns	–
	Rise/fall	thrf	–	–	10.0	ns	–
VS	Frequency	tv	15.85 –	16.68 262.5	17.51 –	ms H	59.94 Hz (typ.)
	Display	tvd	– –	14.87 234	– –	ms H	234 line
			– –	15.25 240	– –	ms H	240 line
	Pulse-width	tvp	158.89 –	190.67 3	– –	μs H	–
	Pulse-width +back-porch	tvpb	– –	1.33 21	– –	ms H	–
	Rise/fall	tvrf	–	–	10.0	ns	–
Analog R, G, B	Setup time	tdas	10.0	–	–	ns	–
	Hold time	tdah	10.0	–	–	ns	–

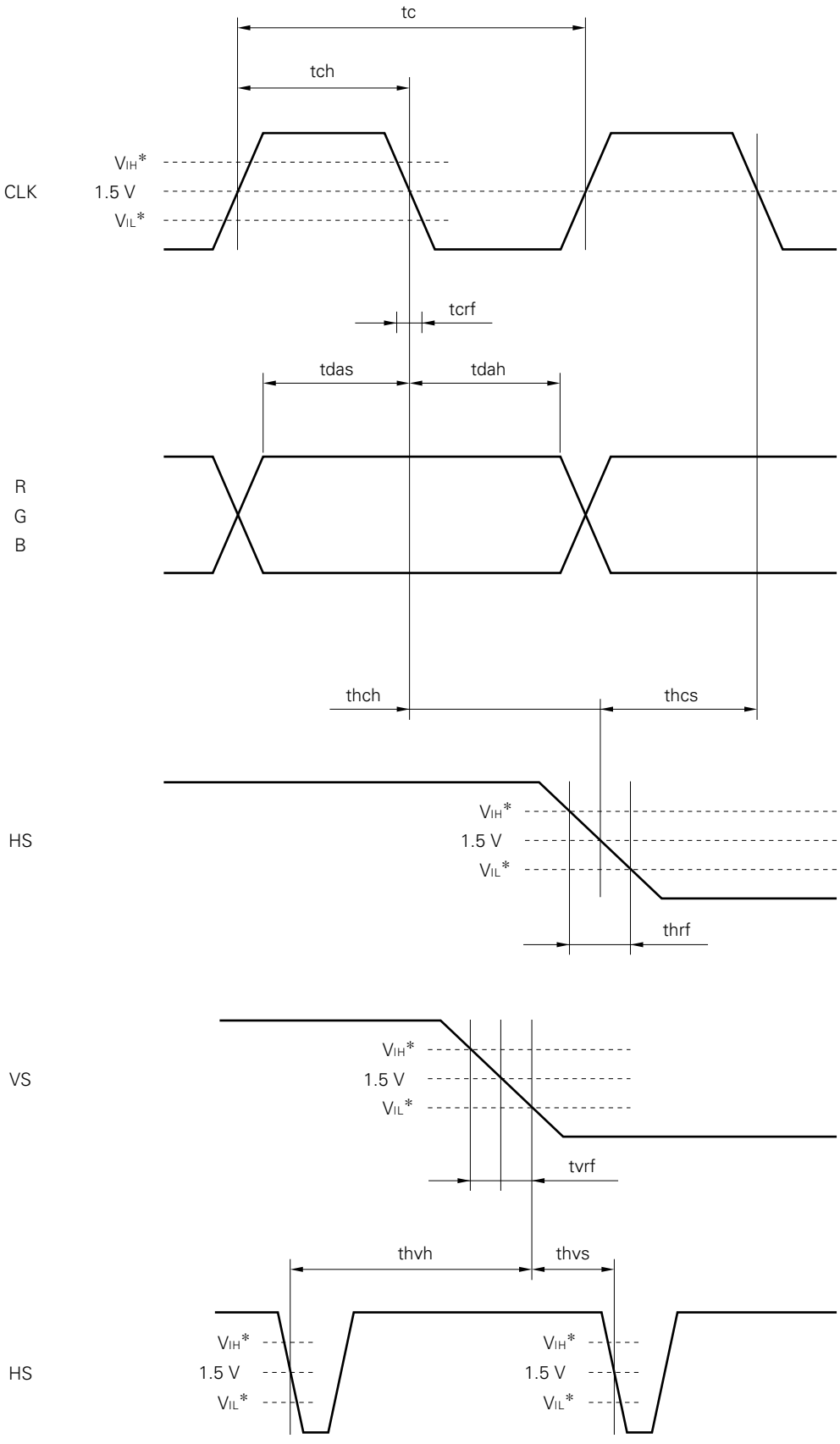
note 1 : In the display start period (pulse-width + back-porch), analog RGB signals should be blanking level.

(4) mode : PAL, external CLK

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
EXTCLK	Frequency	1 / tc	– 118.75	8.0 125.00	– 131.25	MHz ns	–
	Rise/fall	tcrf	–	–	10	ns	–
	Duty	tch / tc	0.4	0.5	0.6	–	–
HS	Frequency	th	60.80 –	64.00 512	67.20 –	μs CLK	15.625 kHz (typ.)
	Display	thd	– –	40.00 320	– –	μs CLK	–
	Pulse-width	thp	1.0 –	4.7 38	– –	μs CLK	–
	Pulse-width +back-porch	thpb	– –	9.63 77	– –	μs CLK	234 line
			– –	10.25 82	– –	μs CLK	240 line
	CLK-Hsync timing hold/setup time	thch	10.0	–	–	ns	–
		thcs	10.0	–	–	ns	–
	V-Hsync timing hold/setup time	thvh	1	–	–	CLK	–
		thvs	10.0	–	–	ns	–
	Rise/fall	thrf	–	–	10.0	ns	–
VS	Frequency	tv	19.00 –	20.00 312.5	21.00 –	ms H	50.00 Hz (typ.)
	Display	tvd	– –	17.47 273	– –	ms H	234 line
			– –	17.92 280	– –	ms H	240 line
	Pulse-width	tvp	153.60 –	192.00 2.5	– –	μs H	–
	Pulse-width +back-porch	tvpb	– –	1.86 29	– –	ms H	234 line
			– –	1.66 26	– –	ms H	240 line
	Rise/fall	tvrf	–	–	10.0	ns	–
Analog R, G, B	Setup time	tdas	10.0	–	–	ns	–
	Hold time	tdah	10.0	–	–	ns	–

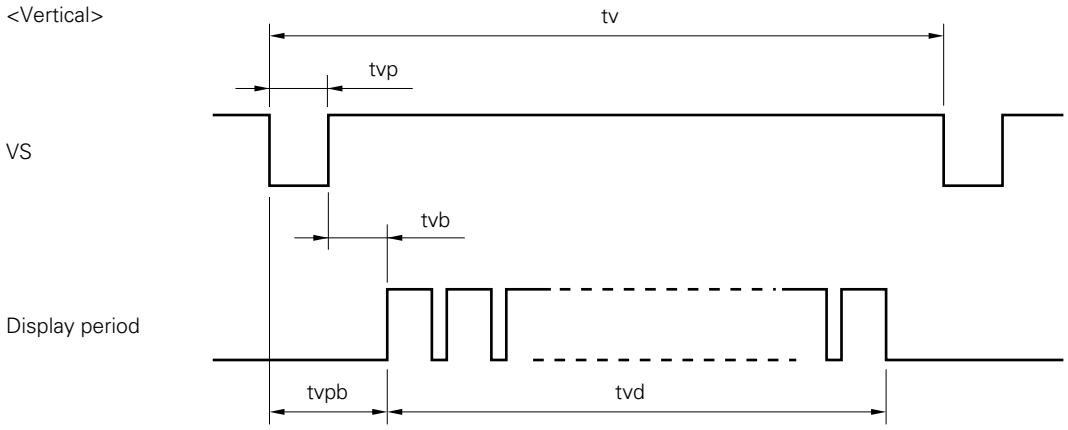
note 1 : In the display start period (pulse-width + back-porch), analog RGB signals should be blanking level.

6.9 DEFINITION OF INPUT SIGNAL TIMING

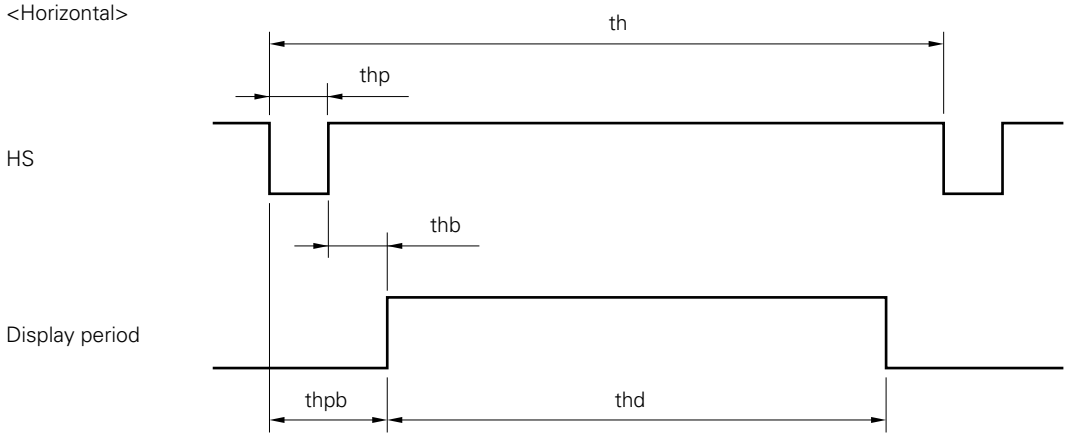


* V_{IH} = 3.15 V (min.) to 5.00 V (max.)
V_{IL} = 0.00 V (min.) to 0.90 V (max.)

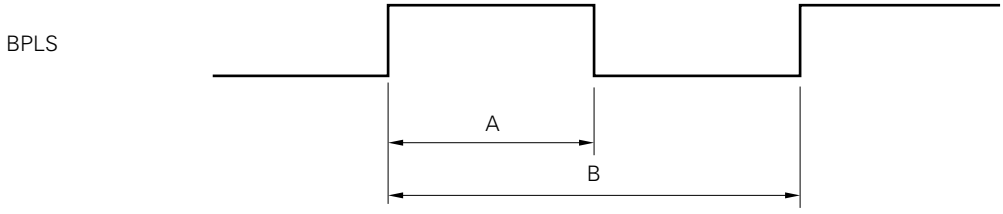
<Vertical>



<Horizontal>



<Luminance control signal >



Pulse A duty 100%: Relative luminance 100%
Pulse A duty 20%: Relative luminance 10% (reference value)

A : 800 μs to 3.7 ms
B : 3.7 ms±10%

7. GENERAL CAUTION

WARNING

Do not remove the rear case while the LCD module is operating, because dangerous high voltage is generating.

(1) Caution when taking out the module
   ① Pick the pouch only, when taking out module from a shipping package.

(2) Cautions for handling the module
   ① As the electrostatic discharges may break the LCD module, handle the LCD module with care. Peel a protection sheet off from the LCD panel surface as slowly as possible.
   ② As the LCD panel and back-light element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.
   ③ As the surface of polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
   ④ Do not pull the interface connectors in or out while the LCD module is operating.
   ⑤ Put the module display side down on a flat horizontal plane.
   ⑥ Handle connectors and cables with care.

(3) Cautions for the operation
   ① When the module is operating,do not lose CLK, HS, or VS signals. If any one of these signals is lost, the LCD panel would be damaged.
   ② Obey the supply voltage sequence. If wrong sequence is applied, the module would be damaged.
   ③ Should not intermittently operate the module. It will be the cause of a short life.

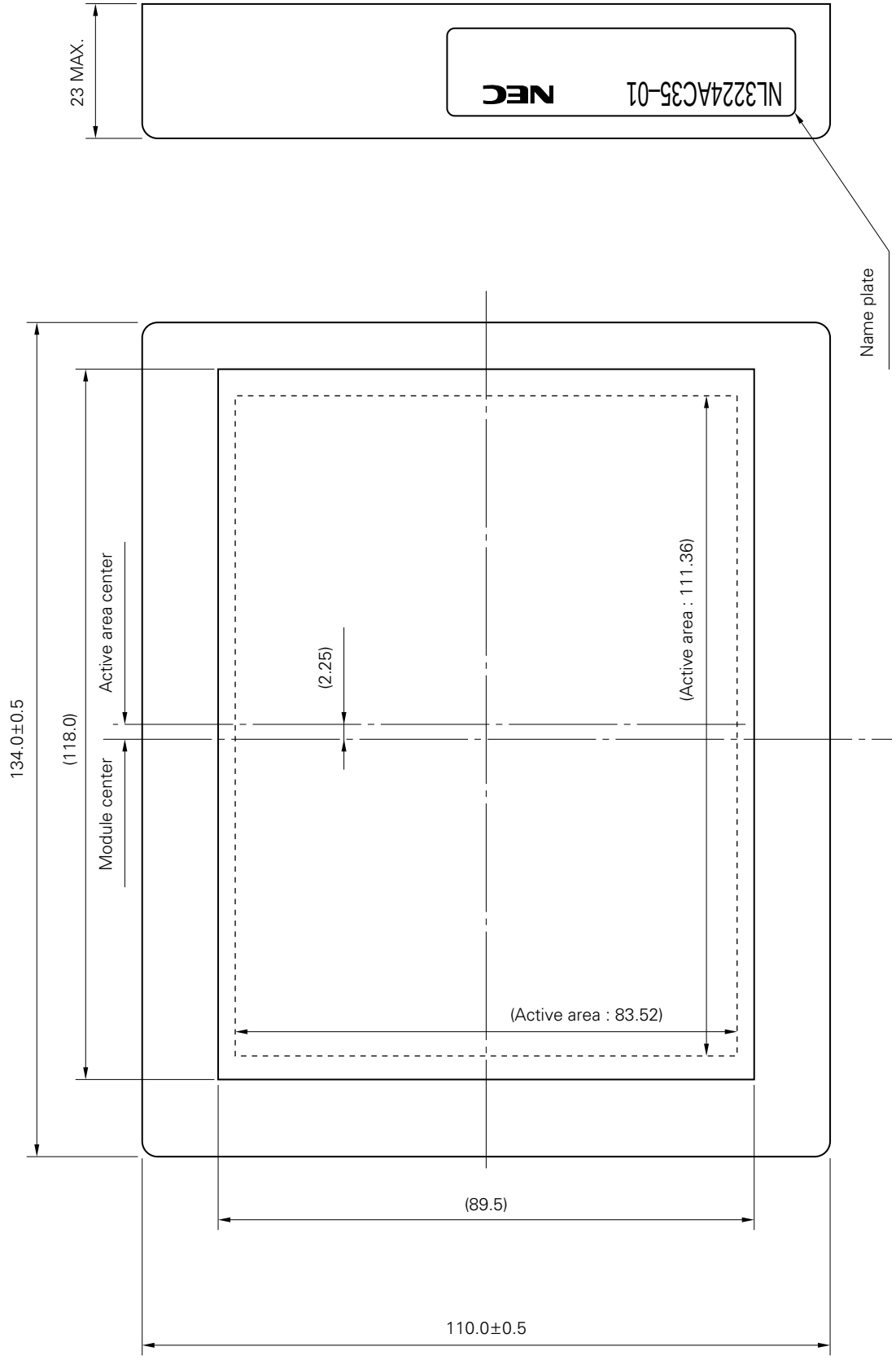
(4) Cautions for the atmosphere
   ① Dew drop atmosphere should be avoided.
   ② Do not store and/or operate the LCD module in a high temperature and/or humidity atmosphere. Storage in an electro-conductive polymer packing pouch and under relatively low temperature atmosphere is recommended.
   ③ Backlight lamp tend to increase the turn on voltage in a cold atmosphere. And the life of module will become short.

(5) Cautions for the module characteristics
   ① Do not apply fixed pattern data signal to the LCD module at product aging. Applying fixed pattern for a long time may cause image sticking.

(6) Other cautions
   ① Do not disassemble and/or re-assemble LCD module.
   ② Do not re-adjust variable resistor or switch etc.
   ③ When returning the module for repair or etc., Please pack the module not to be broken. We recommend to use the original shipping packages.

Liquid Crystal Display has the following specific characteristics. There are not defects or malfunctions.
The display condition of LCD module may be affected by the ambient temperature.
The LCD module uses cold cathode tubes for backlighting. Optical characteristics, like luminance or uniformity, will change during time.
Uneven brightness and/or small spots may be noticed depending on different display patterns.

OUTLINE DRAWING (Unit in mm) Front view



OUTLINE DRAWING (Unit in mm) Rear view