DATA SHEET

NEC

TFT COLOR LCD MODULE

NL128102AC28-07

46 cm (18.1 inches), 1280 × 1024 pixels, 16,777,216 colors,
LVDS interface, Ultra-wide viewing angle

DESCRIPTION

The NL128102AC28-07 is a TFT (thin film transistor) active-matrix color liquid crystal display (LCD) comprising an amorphous silicon TFT attached to each signal electrode, a driving circuit, and a backlight. The NL128102AC28-07 has a built-in backlight. Backlight includes long-life-lamps.

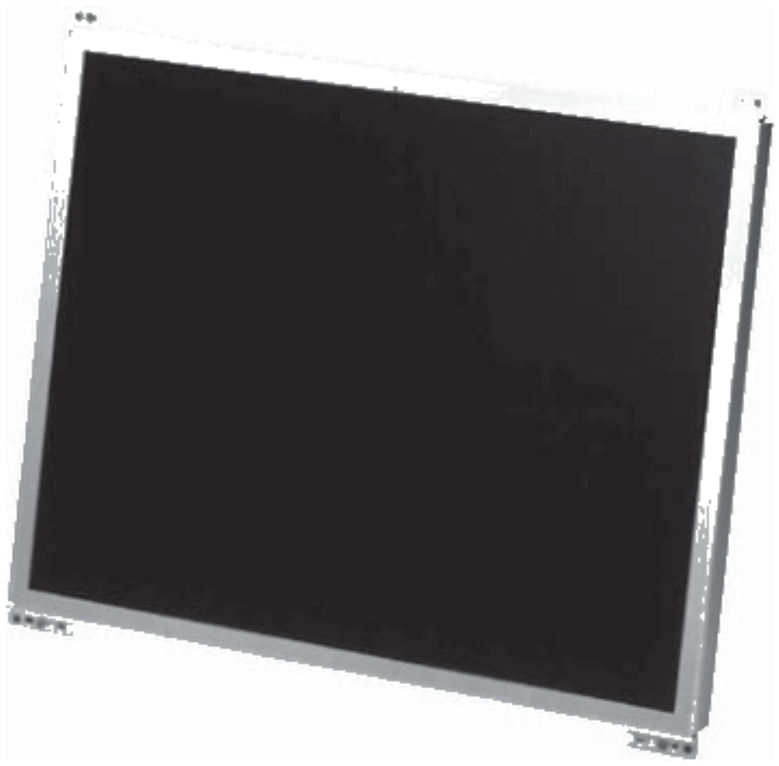
The 46 cm (18.1 inch) diagonal display area contains 1280 × 1024 pixels and can display 16,777,216 colors simultaneously.

APPLICATIONS

- Desk top PCs, Engineering work stations
- Display terminals for control systems
- Monitors

FEATURES

- LVDS interface (adapted THC63LVDF84A ×2, THine Electronics, Inc. as a receiver)
- Ultra-wide viewing angle (with lateral electric field)
- Fast response time
- High luminance (240 cd/m², TYP.)
- Wide color gamut
- Small foot print
- Light weight
- Slim type
- Low reflection
- Incorporated direct type backlight
- Replaceable backlight unit and inverter
- Approved by UL1950 Third Edition (File No. E170632) and CSA-C22.2 No. 950-95 (File No. E170632)



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Please confirm with the delivery specification before statting to design the system.

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STRUCTURE AND PRINCIPLE

NL128102AC28-07 module is composed of the driver LSIs for driving the TFT (Thin Film Transistor) array with an amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure and a backlight.

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

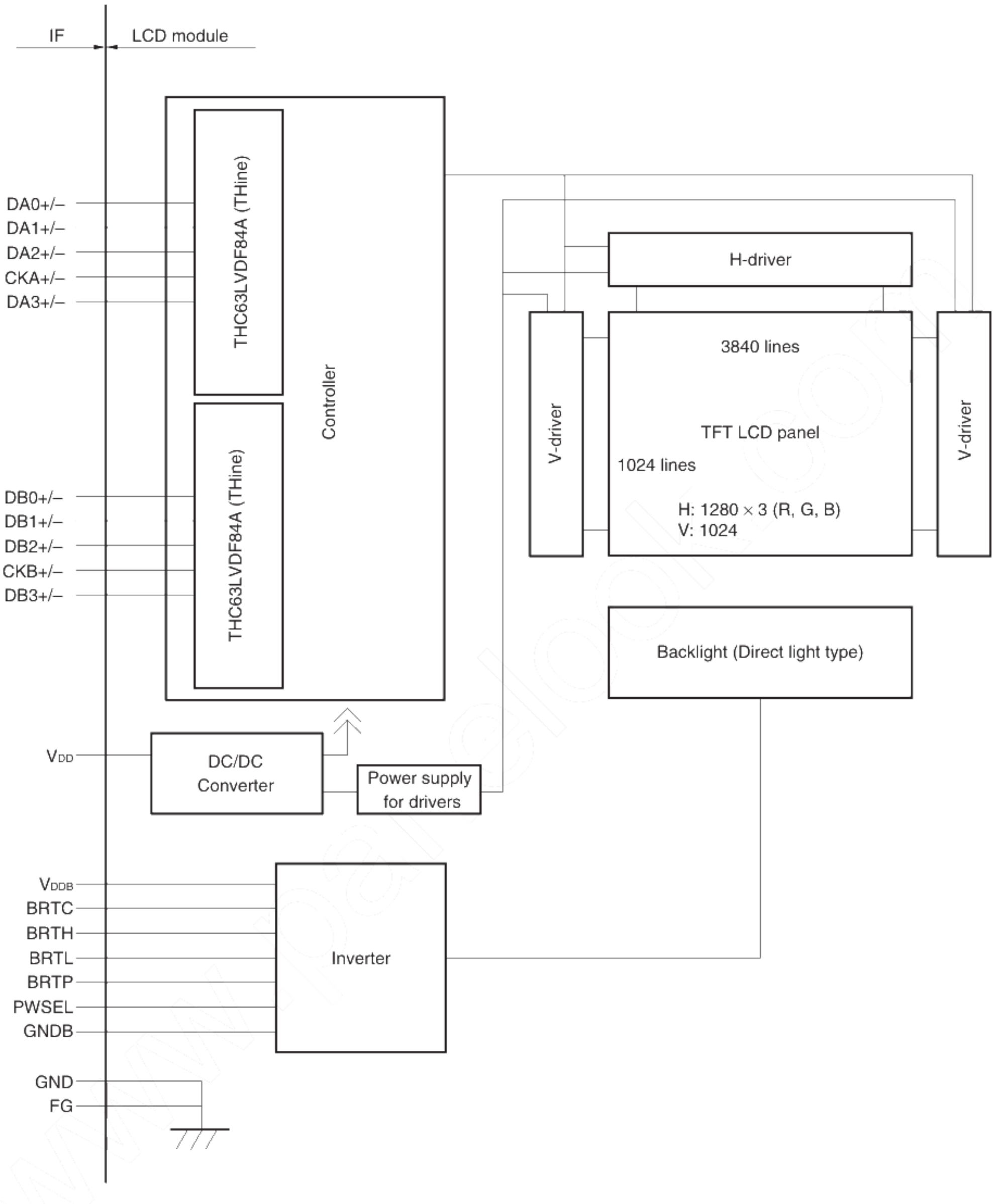
RGB (Red, Green, Blue) data signals from a source system are modulated into a form suitable for active matrix addressing by the onboard signal processor and sent to the driver LSIs which in turn address the individual TFT cells.

Working as an electro-optical switch, each TFT cell regulates transmitted light from the backlight assembly when worked by the data source. Color images are created by regulating the amount of transmitted light through the array of red, green and blue dots.

GENERAL SPECIFICATION

Display area	359.04 (H) × 287.232 (V) mm
Diagonal size of display	46 cm (18.1 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors
Number of pixels	1280 (H) × 1024 (V)
Pixel arrangement	RGB (Red, Green, Blue) vertical stripe
Dot pitch	0.0935 (H) × 0.2805 (V) mm
Pixel pitch	0.2805 (H) × 0.2805 (V) mm
Module size	389.0 Typ. (H) × 317.2 Typ. (V) × 30.3 Typ. (D) mm
Weight	1650 g (Typ.)
Contrast ratio	300:1 (Typ.)
Viewing angle (To be out of 10:1 for the contrast ratio)	• Horizontal: 85° (Typ., left side, right side) • Vertical: 85° (Typ., up side, down side)
Designed viewing direction	• Optimum grayscale (γ = 2.2): perpendicular
Color gamut	60% (Typ.) At center, to NTSC
Response time	15 ms (Typ.), black (10%) to white (90%)
Luminance	240 cd/m^2 (Typ.)
Signal system	LVDS interface (Receiver: THC63LVDF84A×2, THine Electronics, Inc.) RGB 8-bit signals, Synchronous signals (Hsync, Vsync), Data enable signal (DE) and Dot clock (CLK)
Supply voltages	12 V (for Logic, LCD driving) 12 V (for Backlight inverter)
Backlight	Direct light type: 12 cold cathode fluorescent lamps and an inverter [Replaceable parts] • Backlight unit: type No. 181LHS07 • Inverter: type No. 181PW051
Power consumption	38.7 W (Typ.)

BLOCK DIAGRAM



Note: GND is signal ground for logic and LCD driving. GND is connected to FG (frame ground) in the LCD module and neither GND nor FG are connected to GNDB (backlight ground). These grounds should be connected to system ground in customer equipment.

DETAILED SPECIFICATION

Item	Contents	Unit
Module size	389.0±1.0 (H) × 317.2*±1.0 (V) × 30.3±1.0 (D)	mm
Display area	359.04 (H) × 287.232 (V)	mm
Number of dots	1,280 × 3 (H) × 1024 (V)	dots
Pixel pitch	0.2805 (H) × 0.2805 (V)	mm
Dot pitch	0.0935 (H) × 0.2805 (V)	mm
Pixel arrangement	RGB (Red, Green, Blue) vertical stripe	–
Display colors	16,777,216	colors
Weight	1650 (Typ.), 1750 (Max.)	g

* Exclude the mounting space

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Remarks
Supply voltage	V_{DD}	–0.3 to +14	V	Ta = 25°C
	V_{DDB}	–0.3 to +14		
LVDS input voltage (LCD)	V_i	–0.3 to +3.6	V	Ta = 25°C V_{DD} = 12 V
Logic input voltage (BRTC, BRTP, PWSEL)	$V_{iB1,2}$	–0.3 to +5.5		Ta = 25°C V_{DDB} = 12 V
BRTL input voltage (BRTL)	V_{iB3}	–0.3 to +1.5		
Storage temperature	Tst	–20 to +60	°C	–
Operating temperature	Top1	0 to +55		Module front surface **Note 1**
	Top2	0 to +66		Module rear surface **Note 2**
Relative humidity (RH) **Note 3**		≤ 95	%	Ta ≤ 40 °C
		≤ 85		40°C < Ta ≤ 50°C
		≤ 70		50°C < Ta ≤ 55°C
Absolute humidity **Note 3**		Absolute humidity shall not exceed Ta = 55°C, RH = 70%	g/m^3	Ta > 55°C
Operating altitude		≤ 4,850	m	0°C ≤ Ta ≤ 55°C
Storage altitude		≤ 13,600	m	–20°C ≤ Ta ≤ 60°C

Note 1: Measure at the surface of display area (including self-heat)

Note 2: Measure at the rear shield (including self-heat)

Note 3: No condensation

ELECTRICAL CHARACTERISTICS

(1) Logic/LCD driving (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V_{DD}	10.8	12.0	13.2	V	–
Ripple voltage	V_{RP}	–	–	+100	mV	for V_{DD}
Differential input (H) Threshold voltage	V_{TH}	–	–	+100	mV	V_{CM} = 1.2 V
Differential input (L) Threshold voltage	V_{TL}	–100	–	–	mV	**Note 1**
Differential Input voltage	V_I	0	–	2.4	V	–
Terminating resistor	R_T	–	100	–	Ω	–
Supply current	I_{DD}	–	315 **Note 2**	600 **Note 3**	mA	V_{DD} = 12.0 V

Note 1: Common mode voltage in LVDS transmitter

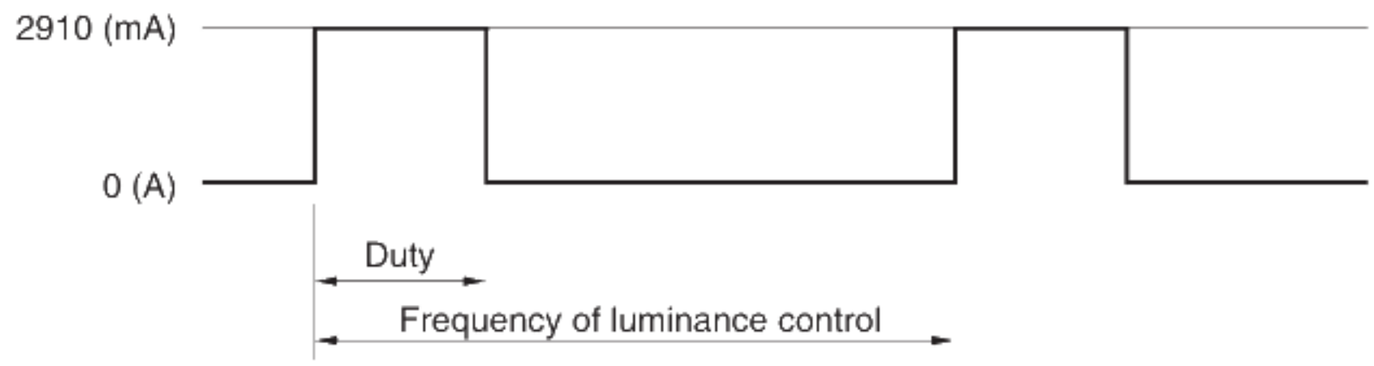
Note 2: Checker flag pattern (in EIAJ ED-2522)

Note 3: Theoretical maximum current pattern

(2) Backlight driving (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V_{DDB}	11.4	12.0	12.6	V	Backlight power supply
Logic input "L" level 1	V_{iBL1}	0	–	0.8	V	for BRTP
Logic input "H" level 1	V_{iBH1}	2	–	5	V	
Logic input "L" level 2	V_{iBL2}	0	–	0.8	V	for BRTC, PWSEL
Logic input "H" level 2	V_{iBH2}	2	–	5	V	
Logic input "L" current 1	I_{iBL1}	–1580	–	–	μA	for BRTP
Logic input "H" current 1	I_{iBH1}	–	–	3500	μA	
Logic input "L" current 2	I_{iBL2}	–810	–	–	μA	for BRTC, PWSEL
Logic input "H" current 2	I_{iBH2}	–	–	440	μA	
BRTL input current	I_{iB3}	–130	–	–	μA	for BRTL
Supply current	I_{DDB}	–	2910	3500	mA	V_{DDB} = 12.0 V (at Max. luminance)

(3) Inverter current wave



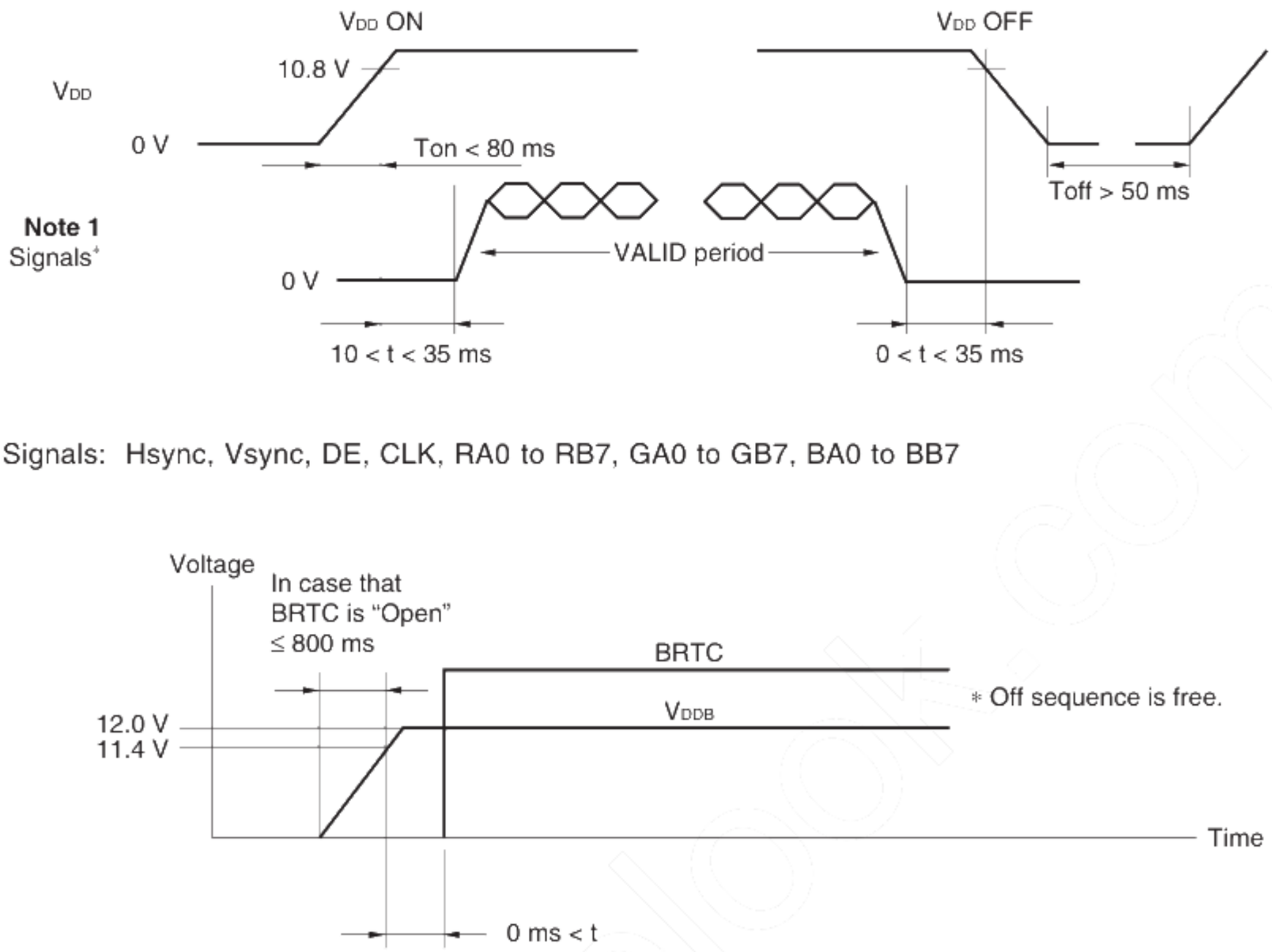
Maximum luminance : 100% (Duty)
Minimum luminance : 20% (Duty)
Luminance control frequency : 237 to 273 Hz, 255 Hz (TYP.)**Note 1**

Note 1: The power supply lines (V_{DDB} and GNDB) have large ripple voltage while dimming.
There is the possibility that the ripple voltage produces an acoustic noise and signal wave noise in a system circuit (e.g. audio circuit). If the noise occurred in a system circuit, put an aluminum electrolytic capacitor (5,000 to 6,000 μF) between the power source lines (V_{DDB} and GNDB), and the capacitor will be able to reduce the noise.

Note 2: Luminance control frequency indicates the input pulse frequency, when select the external pulse luminance control. See "**Luminance control with external pulse**".

SUPPLY VOLTAGE SEQUENCE

(1) Supply voltage sequence and backlight control sequence



* Signals: Hsync, Vsync, DE, CLK, RA0 to RB7, GA0 to GB7, BA0 to BB7

Note 1: The values of signals are measured at the termination of resistor of 100 Ω.

Note 2: Logic signals (Hsync, Vsync, DE, CLK, RA0 to RB7, GA0 to GB7, Ba0 to BB7) must be "0" voltage (V), exclude the VALID period (See above sequence diagram). If these input voltages are higher than 0.3 V, the internal circuit will be damages.

Note 3: When turn on the LCD module, if V_{DD} has the chance of fall-down during the rising period up to 11.4 V, the LCD module may not start to work because of the protection circuit.

Note 4: Backlight ON/OFF should be controlled, while logic signals are supplied. The backlight power supply (V_{DDB}) is not related to the power supply sequence. However, unstable data may be displayed when the backlight power is turned ON/OFF during logic signals out.

(2) Supply voltage ripple

This product works, even if the ripple levels are beyond the below values (See following the Table1.), but might have noise on the display image. Consider and evaluate enough before installing this product into customer's system.

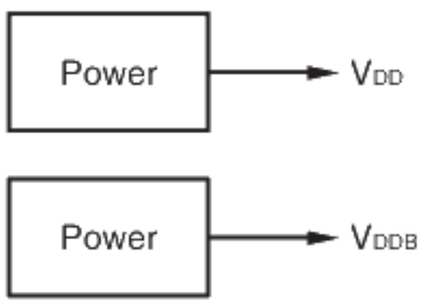
Table1: Ripple (Measurement to input terminal of power supply)

Supply voltage (Acceptable level)	
V_{DD} (for logic and LCD driver: 12 V)	V_{DDB} (for backlight: 12 V)
≤ 100 mVp-p **Note 1**	≤ 200 mVp-p **Note 1**

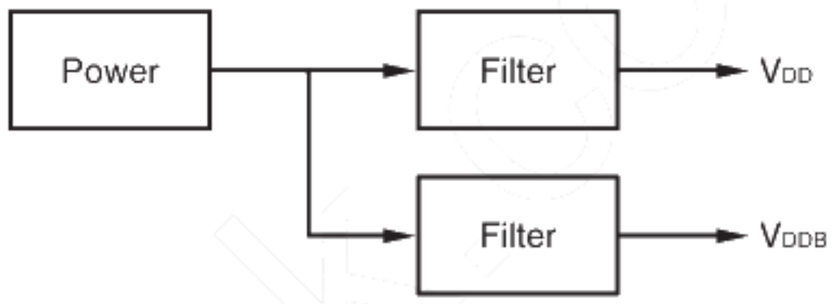
Note 1: The acceptable ripple voltage level includes spike noise.

Example of the power supply connections

a) Separate the power supplies



b) Put in the filters



(3) Fuses

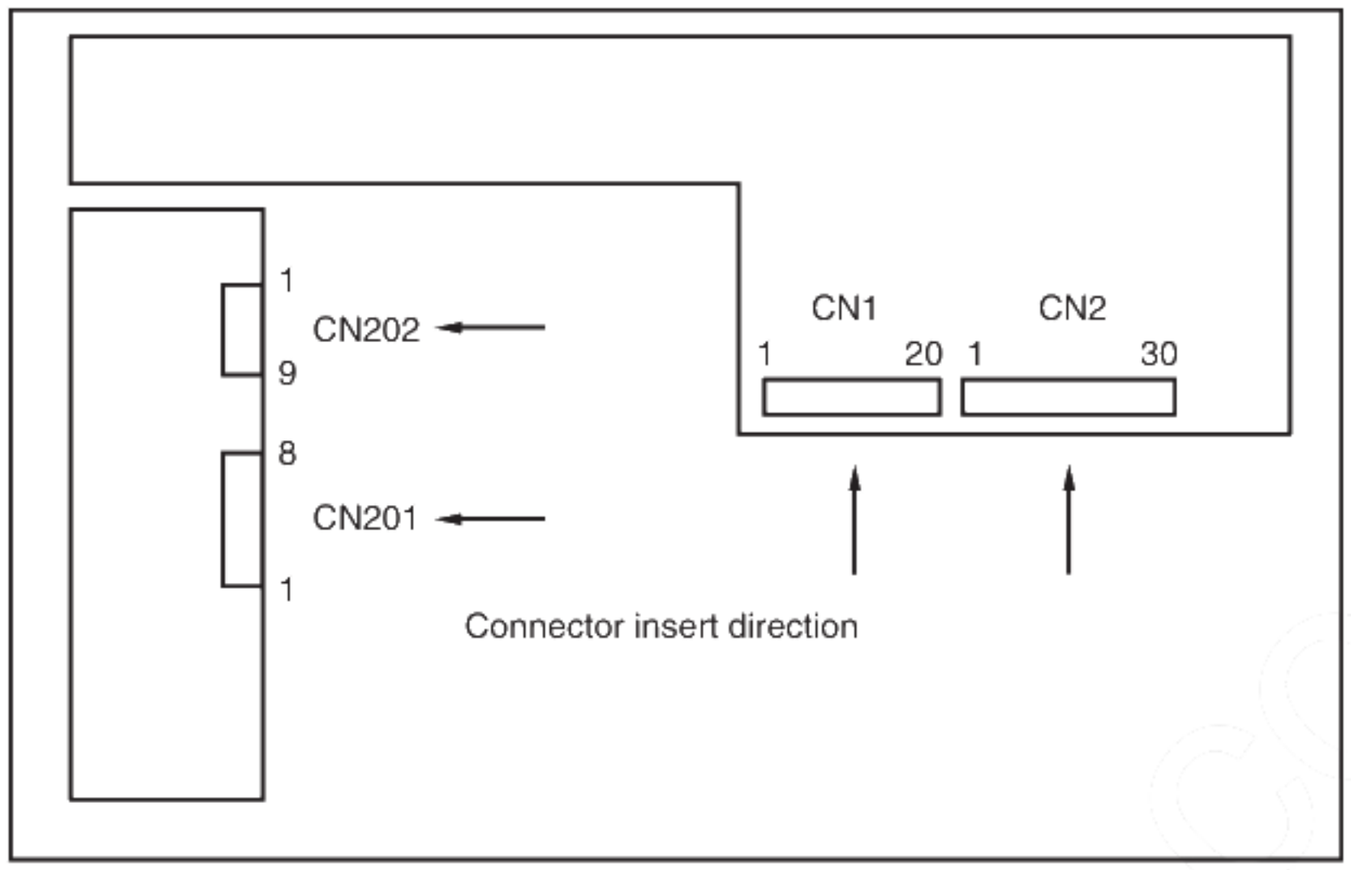
This product has fuses listed below. Check and evaluate power supplies of customer's system.

Supply voltage	Type	Supplier	Rating
V_{DD}	ICP-S1.8	ROHM	1.8 A
V_{DDB}	MMCT5A	SOC	5A

Note 1: The power capacitor should be more than 2 times of fuse ratings from safety point of view. If the power capacity of customer system in less than above request, check and evaluate it carefully.

CONNECTIONS AND FUNTIONS FOR INTERFACE PINS

(1) Interface connectors for signals and powers



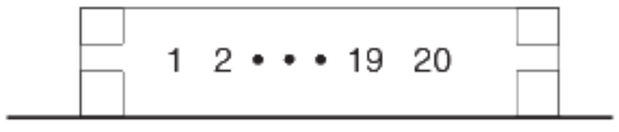
CN1 socket (module side): 53780-2010
Adaptable plug: 51146-2000
Supplier: Molex Incorporated.

Pin No.	Symbol	Function	Description
1	N.C.	Non-connection	Keep the terminal open
2	N.C.		
3	GND	Ground	Signal ground **Note 1**
4			
5	DA0–	Odd pixel data 0	LVDS differential signal **Note 2**
6	DA0+		
7	GND	Ground	Signal ground **Note 1**
8	DA1–	Odd pixel data 1	LVDS differential signal **Note 2**
9	DA1+		
10	GND	Ground	Signal ground **Note 1**
11	DA2–	Odd pixel data 2	LVDS differential signal **Note 2**
12	DA2+		
13	GND	Ground	Signal ground **Note 1**
14	CKA–	Odd pixel clock	LVDS differential signal **Note 2**
15	CKA+		
16	GND	Ground	Signal ground **Note 1**
17	DA3–	Odd pixel data 3	LVDS differential signal **Note 2**
18	DA3+		
19	GND	Ground	Signal ground **Note 1**
20	N.C.	Non-connection	Keep the terminal open

Note 1: Do not keep pins open (except 1, 2 and 20 pin) to avoid noise problem.

Note 2: Use 100Ω twist pair wires for the cable.

CN1: Figure of socket



CN2 socket (module side): 53780-3010
Adaptable plug: 51146-3000
Supplier: Molex Incorporated.

Pin No.	Symbol	Function	Description
1	N.C.	Non-connection	Keep the terminal open
2	N.C.		
3	GND	Ground	Signal ground **Note 1**
4	GND		
5	DB0–	Even pixel data 0	LVDS differential signal **Note 2**
6	DB0+		
7	GND	Ground	Signal ground **Note 1**
8	DB1–	Even pixel data 1	LVDS differential signal **Note 2**
9	DB1+		
10	GND	Ground	Signal ground **Note 1**
11	DB2–	Even pixel data 2	LVDS differential signal **Note 2**
12	DB2+		
13	GND	Ground	Signal ground **Note 1**
14	CKB–	Even pixel clock	LVDS differential signal **Note 2**
15	CKB+		
16	GND	Ground	Signal ground **Note 1**
17	DB3–	Even pixel data 3	LVDS differential signal **Note 2**
18	DB3+		
19	GND	Ground	Signal ground **Note 1**
20	Reserved	Reserved	Keep the terminal open.
21	Reserved		
22	Reserved		
23	Reserved		
24	GND	Ground	Signal ground **Note 1**
25	GND		
26	GND		
27	N.C.	Non-connection	Keep the terminal open
28	VDD	+12 V Power Supply	12 V ± 5%
29	VDD		
30	VDD		

Note 1: Do not keep pins open (except 1, 2, 20, 21, 22, 23 and 27 pin) to avoid noise problem.

Note 2: Use 100Ω twist pair wires for the cable.

CN2: Figure of socket

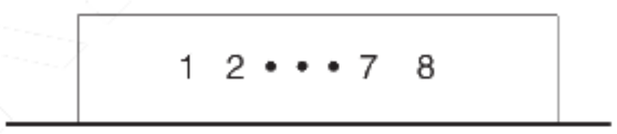
(2) Connectors for backlight unit

CN201 socket (Inverter side): DF3-8P-2H
Adaptable plug: DF3-8S-2C
Supplier: HIROSE ELECTRIC Co,. Ltd.

Pin No.	Symbol	Function	Description
1	GNDB	Ground for backlight	**Note 1, 2**
2	GNDB		
3	GNDB		
4	GNDB		
5	V_{DDB}	12 V power supply	+12 V ± 10%
6	V_{DDB}		
7	V_{DDB}		
8	V_{DDB}		

Note 1: GNDB should be connected to system ground in customer equipment.
Note 2: Do not keep pins open to avoid noise problem.

CN201: Figure of socket



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

Pin No.	Symbol	Function	Description
1	GNDB	Ground for backlight	**Note 1, 2**
2			
3	N.C.	Non-connection	Keep the terminal open
4	BRTC	Backlight ON/OFF control signal (TTL level)	"H" or "Open" : Backlight on "L" : Backlight off
5	BRTH	Luminance control	See "(3) luminance control"
6	BRTL	Luminance control	
7	BRTP	Luminance control signal (TTL level)	
8	GNDB	Ground for backlight	**Note 1, 2**
9	PWSEL	Luminance control select signal (TTL level)	See "(3) luminance control"

Note 1: GNDB should be connected to system ground in customer equipment.
Note 2: Do not keep pins open (except 3) to avoid noise problem.

CN202: Figure of socket

(3) Luminance Control

Control method	Function and adjustment	PWSEL	BRTP signal
PWM	Luminance controlled by BRTP signal. See "(4) External pulse control for luminance".	"L"	Input
Variable resistor **Note 1**	The variable resistor for luminance control should be 10 kΩ type, and zero point of the resistor corresponds to the minimum of luminance. Max. luminance (100%): R = 10 kΩ Min. luminance (30%): R = 0 Ω Mating variable resistor: 10 kΩ ± 5%, B curve, 1/10 W	"H" or "OPEN"	"OPEN"
Voltage **Note 1**	BRTH should be fixed to 0 V, and input to BRTL as follows. Max. Luminance (100%): 1 V (Typ.) Min. Luminance (30%): 0 V		

Note 1: Luminance control may be overlap noises on the display image depending on input signal timing. In this case, keep off the interference between input signal and backlight driving signal, by PWM method.

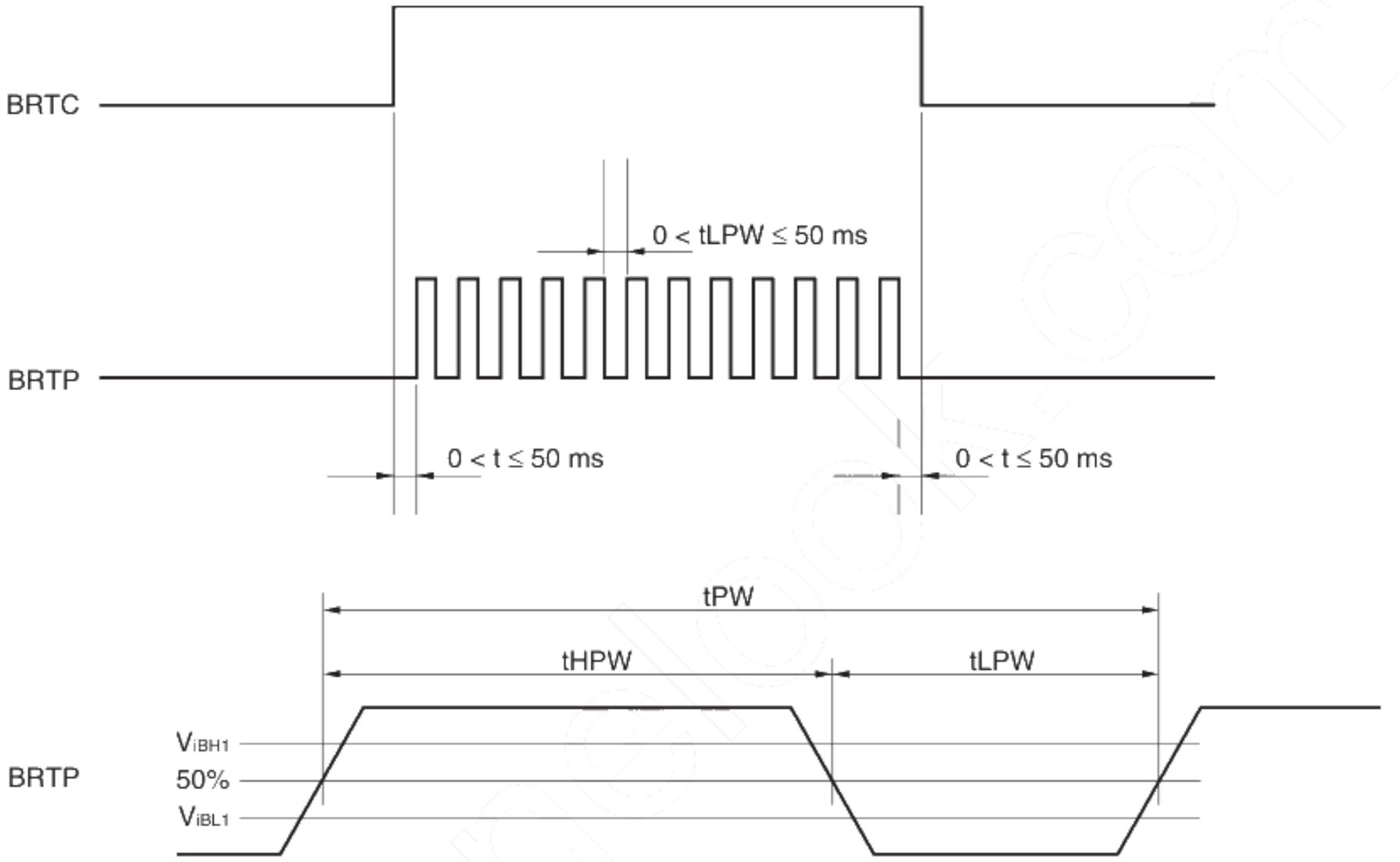
(4) Luminance control with external pulse

Luminance control with external pulse is valid, when PWSEL = "L" and external pulse signal is inputted to BRTP. This luminance control is controlled by duty ratio, and luminance is as follows.

Duty ratio = 100%: Max. luminance

Duty ratio = 20%: Min. luminance

In BRTC = "H" or "OPEN", the inverter will stop working when BRTP terminal is fixed to "L" in the condition of PWSEL = "L". In this case, backlight will not turn on, even if external pulse signal is inputted to BRTP again. This is not out of order. Inverter will start to work when power is supplied again.



Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Frequency	1/tPW	185	–	325	Hz	**Note 1**
"L" period	tLPW	–	–	50	ms	**Note 2**
Pulse-width	tHPW/tPW	20	–	100	%	**Note 3**
Luminance ratio	–	–	30 to 100	–	%	–
Input voltage	V_{iBL1}	0	–	0.8	V	–
	V_{iBH1}	2.0	–	5	V	–

Note 1: See the following formula for luminance control frequency.

Luminance control frequency = Vsync frequency × (n+0.25) [or (n+0.75)]

Note 2: In case tLPW is out of 50 ms, backlight will turn off by its protection circuits.

Note 3: Max. Luminance at 100%

The display image may be disturbed by luminance control with external pulse when set up frequency is interfered with internal signal frequency.

METHOD OF CONNECTION FOR THC63LVDM83A

			TRANSMITTER					I/F CN			RECEIVER					INPUT to LCD
			pin	THC63LVDF83A		pin		pin	CN1		pin	THC63LVDF84A		pin		
Odd pixel data and control signal	RA2	→	51	TA0				1	N.C.				RA0	27	→	RA2
	RA3	→	52	TA1				2	N.C.				RA1	29	→	RA3
	RA4	→	54	TA2				3	GND				RA2	30	→	RA4
	RA5	→	55	TA3				4	GND				RA3	32	→	RA5
	RA6	→	56	TA4	TA–	48	→	5	DA0–	→	9	RA–	RA4	33	→	RA6
	RA7	→	3	TA5	TA+	47	→	6	DA0+	→	10	RA+	RA5	35	→	RA7
	GA2	→	4	TA6				7	GND				RA6	37	→	GA2
	GA3	→	6	TB0	TB–	46	→	8	DA1–	→	11	RB–	RB0	38	→	GA3
	GA4	→	7	TB1	TB+	45	→	9	DA1+	→	12	RB+	RB1	39	→	GA4
	GA5	→	11	TB2				10	GND				RB2	43	→	GA5
	GA6	→	12	TB3	TC–	42	→	11	DA2–	→	15	RC–	RB3	45	→	GA6
	GA7	→	14	TB4	TC+	41	→	12	DA2+	→	16	RC+	RB4	46	→	GA7
	BA2	→	15	TB5				13	GND				RB5	47	→	BA2
	BA3	→	19	TB6	TCLK–	40	→	14	CKA–	→	17	RCLK–	RB6	51	→	BA3
	BA4	→	20	TC0	TCLK+	39	→	15	CKA+	→	18	RCLK+	RC0	53	→	BA4
	BA5	→	22	TC1				16	GND				RC1	54	→	BA5
	BA6	→	23	TC2	TD–	38	→	17	DA3–	→	19	RD–	RC2	55	→	BA6
	BA7	→	24	TC3	TD+	37	→	18	DA3+	→	20	RD+	RC3	1	→	BA7
	Hsync	→	27	TC4				19	GND				RC4	3	→	Hsync
	Vsync	→	28	TC5				20	N.C.				RC5	5	→	Vsync
	DE	→	30	TC6									RC6	6	→	DE
	RA0	→	50	TD0									RD0	7	→	RA0
	RA1	→	2	TD1									RD1	34	→	RA1
	GA0	→	8	TD2									RD2	41	→	GA0
	GA1	→	10	TD3									RD3	42	→	GA1
	BA0	→	16	TD4									RD4	49	→	BA0
Note 1	BA1	→	18	TD5									RD5	50	→	BA1
	RSVD	→	25	TD6									RD6	2	→	RSVD
	CLK	→	31	CLKIN				pin	CN2				CLKOUT	26	→	CLKA
Even pixel data	RB2	→	51	TA0				1	N.C.				RA0	27	→	RB2
	RB3	→	52	TA1				2	N.C.				RA1	29	→	RB3
	RB4	→	54	TA2				3	GND				RA2	30	→	RB4
	RB5	→	55	TA3				4	GND				RA3	32	→	RB5
	RB6	→	56	TA4	TA–	48	→	5	DB0–	→	9	RA–	RA4	33	→	RB6
	RB7	→	3	TA5	TA+	47	→	6	DB0+	→	10	RA+	RA5	35	→	RB7
	GB2	→	4	TA6			→	7	GND	→			RA6	37	→	GB2
	GB3	→	6	TB0	TB–	46	→	8	DB1–	→	11	RB–	RB0	38	→	GB3
	GB4	→	7	TB1	TB+	45	→	9	DB1+	→	12	RB+	RB1	39	→	GB4
	GB5	→	11	TB2				10	GND				RB2	43	→	GB5
	GB6	→	12	TB3	TC–	42	→	11	DB2–	→	15	RC–	RB3	45	→	GB6
	GB7	→	14	TB4	TC+	41	→	12	DB2+	→	16	RC+	RB4	46	→	GB7
	BB2	→	15	TB5				13	GND				RB5	47	→	BB2
	BB3	→	19	TB6	TCLK–	40	→	14	CKB–	→	17	RCLK–	RB6	51	→	BB3
	BB4	→	20	TC0	TCLK+	39	→	15	CKB+	→	18	RCLK+	RC0	53	→	BB4
	BB5	→	22	TC1				16	GND				RC1	54	→	BB5
	BB6	→	23	TC2	TD–	38	→	17	DB3–	→	19	RD–	RC2	55	→	BB6
	BB7	→	24	TC3	TD+	37	→	18	DB3+	→	20	RD+	RC3	1	→	BB7
	RSVD	→	27	TC4				19	GND				RC4	3	→	RSVD
Note 1	RSVD	→	28	TC5				20	Reserved				RC5	5	→	RSVD
	RSVD	→	30	TC6				21	Reserved				RC6	6	→	RSVD
	RB0	→	50	TD0				22	Reserved				RD0	7	→	RB0
	RB1	→	2	TD1				23	Reserved				RD1	34	→	RB1
	GB0	→	8	TD2				24	GND				RD2	41	→	GB0
	GB1	→	10	TD3				25	GND				RD3	42	→	GB1
	BB0	→	16	TD4				26	GND				RD4	49	→	BB0
	BB1	→	18	TD5				27	N.C.				RD5	50	→	BB1
Note 1	RSVD	→	25	TD6				28	V_{DD}: 12 V				RD6	2	→	RSVD
	CLK	→	31	CLKIN				29	V_{DD}: 12 V				CLKOUT	26	→	CLKB
								30	V_{DD}: 12 V							

Use 100Ω twist pair wires for the Cable.

Note 1: RSVD must connect to system GND.

DISPLAY COLORS TO INPUT DATA SIGNALS

Display colors		Data signal (0: Low level, 1: High level)																							
		RA7 RB7	RA6 RB6	RA5 RB5	RA4 RB4	RA3 RB3	RA2 RB2	RA1 RB1	RA0 RB0	GA7 GB7	GA6 GB6	GA5 GB5	GA4 GB4	GA3 GB3	GA2 GB2	GA1 GB1	GA0 GB0	BA7 BB7	BA6 BB6	BA5 BB5	BA4 BB4	BA3 BB3	BA2 BB2	BA1 BB1	BA0 BB0
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 grayscale	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 grayscale	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 grayscale	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: The combination of 8-bit signals (256-grayscale level) results in equivalent to 16,777,216 colors.

INPUT SIGNAL TIMINGS

(1) Input signal specifications for LCD controller

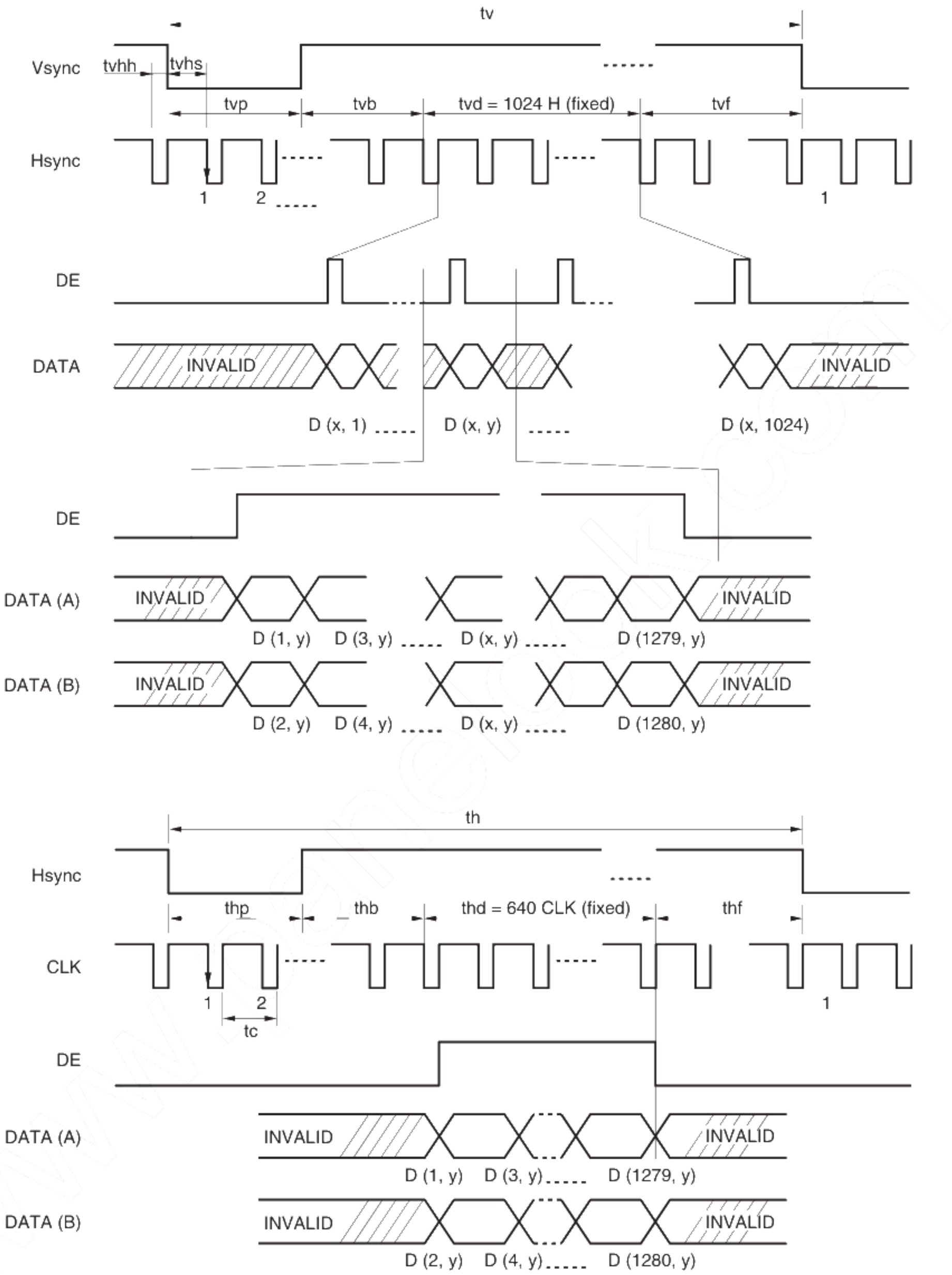
	Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	1/tc	51.5 –	54.0 18.52	56.5 –	MHz ns	–
	Duty	tc/tcl	**Note 1**			–	–
	Rise, fall	tcrf				ns	–
Hsync	Period	th	12.3 750	15.630 844	– –	μs CLK	Typ = 64.0 kHz **Note 2, 3**
	Display period	thd	–	640	–	CLK	–
	Front-porch	thf	–	–	–	CLK	–
	Pulse width	thp*	–	56	–	CLK	–
	Back-porch	thb*	–	124	–	CLK	–
	*thp + thb		110	–	–	CLK	–
Vsync	Period	tv	– 1028	16.661 1066	17.47 –	ms H	Typ = 60.0 Hz
	Display period	tvd	–	1024	–	H	–
	Front-porch	tvf*	–	1	–	H	–
	Pulse width	tvp*	–	3	–	H	–
	Back-porch	tvb*	–	38	–	H	–
	*tvf + tvp + tvb		4	–	–	H	–
	Vsync-Hsync timing	tvhs	1	–	–	CLK	for Hsync
	Hsync-Vsync timing	tvhh	1	–	–	CLK	for Hsync
DATA	DATA-CLK (Set up)	ts	**Note 1**			ns	–
	CLK-DATA (Hold)	th				ns	–
	Rise, fall	trf				ns	–

Note 1: Timing specifications are defined by the input signals of LVDS transmitter.
THC63LVDF83A (THine) or equivalent products are recommended for LVDS transmitter.

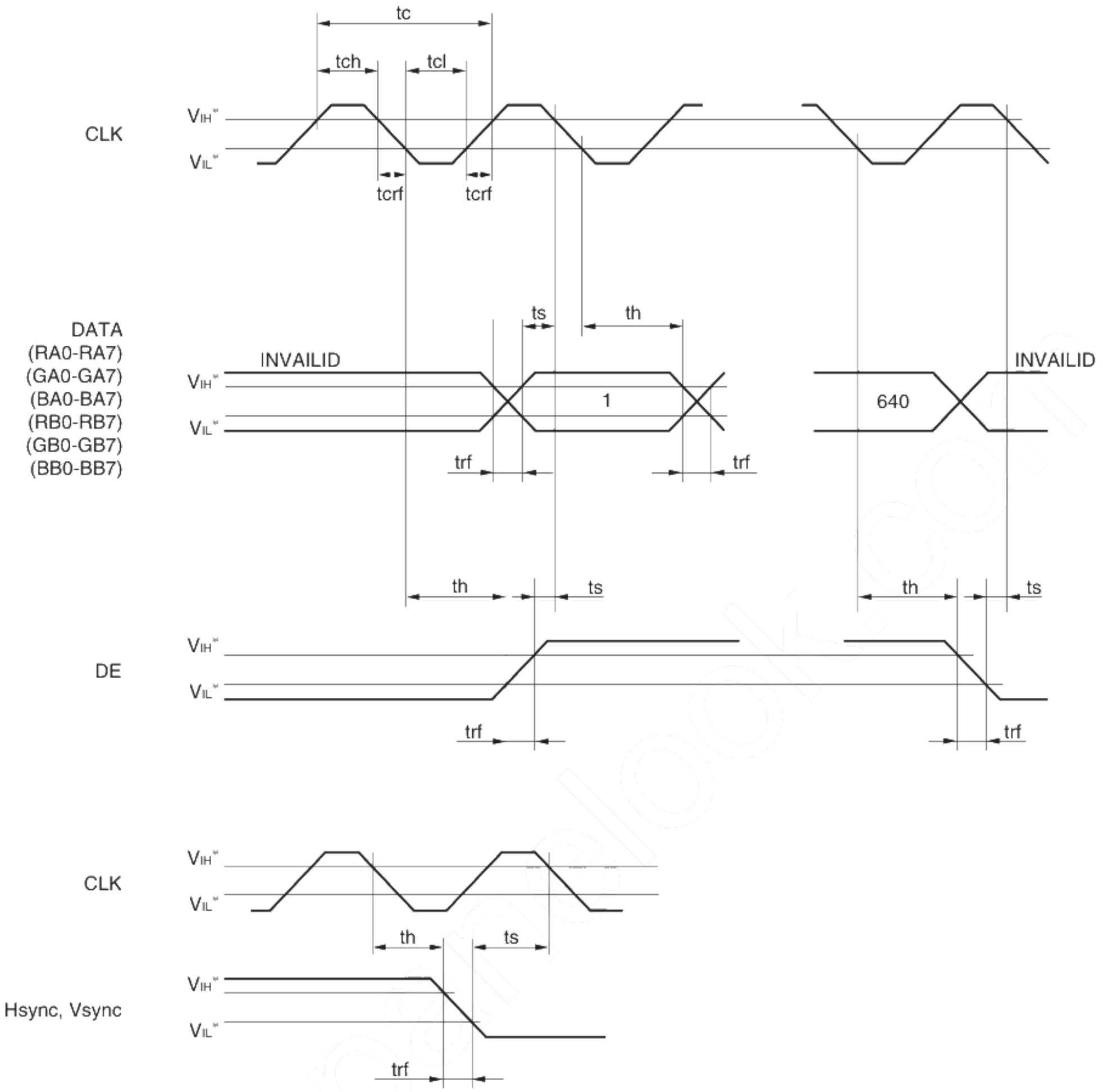
Note 2: Both of “time” and “CLK number” of the “th” must keep the Minimum value of specification.

Note 3: During operation, fluctuation of Hsync period must not exceed ±1 CLK. Otherwise function error will occur in LCD module.
e.g.: Acceptable fluctuation range is 799-801 CLK, when the Hsync period is 800 CLK.

(2) Input signals timing chart for LCD



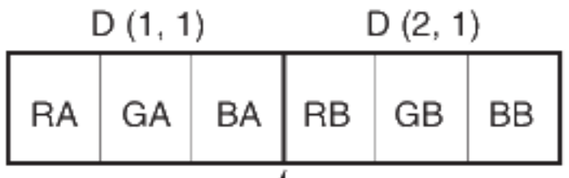
Note 1: DATA (A): RA0-RA7, GA0-GA7, BA0-BA7
DATA (B): RB0-RBA7, GB0-BG7, BB0-BB7



* V_{IH}, V_{IL}: Refer to LVDS transmitter specifications.

(3) Display positions of input data

Odd Pixel: RA = R DATA Even Pixel: RB = R DATA
Odd Pixel: GA = G DATA Even Pixel: GB = G DATA
Odd Pixel: BA = B DATA Even Pixel: BB = B DATA



D (1, 1)	D (2, 1)	D (3, 1)	• • •	• • •	D (1280, 1)
D (1, 2)	D (2, 2)	D (3, 2)	• • •	• • •	D (1280, 2)
D (1, 3)	D (2, 3)	D (3, 3)	• • •	• • •	D (1280, 3)
•	•	•	• • •	• • •	•
•	•	•	• • •	• • •	•
•	•	•	• • •	• • •	•
•	•	•	• • •	• • •	•
D (1, 1024)	D (2, 1024)	D (3, 1024)	• • •	• • •	D (1280, 1024)

OPTICAL CHARACTERISTICS

(Ta = 25°C, V_{DD} = 12 V, V_{DDB} = 12 V, **Note 1**)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio	CR	**Note 3**	200	300	–	–	**Note 2**
Luminance	Lumax	**Note 3**	180	240	–	cd/m^2	–
Luminance uniformity	–	Max./Min., **Note 3**	–	1.1	1.3	–	**Note 6**

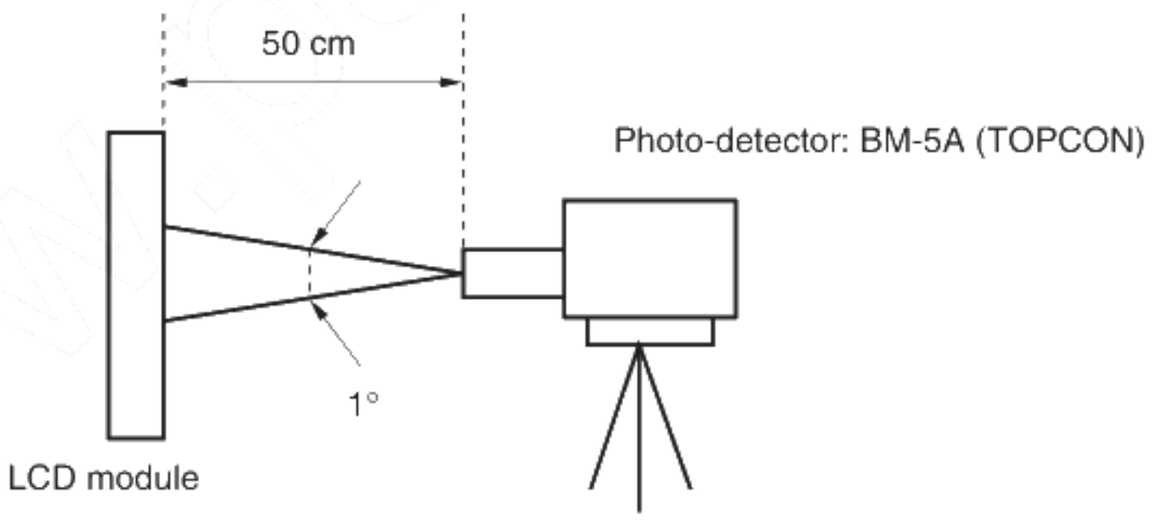
Reference data

(Ta = 25°C, V_{DD} = 12 V, V_{DDB} = 12 V, **Note 1**)

Parameter		Symbol	Condition		Min.	Typ.	Max.	Units	Remarks
Color gamut		C	To NTSC		50	60	–	%	**Note 3**
Chromaticity Coordinates		W	White (x, y)		–	0.300, 0.315	–	–	–
		R	Red (x, y)		–	0.609, 0.346	–	–	
		G	Green (x, y)		–	0.300, 0.597	–	–	
		B	Blue (x, y)		–	0.145, 0.097	–	–	
Viewing Angle Range (CR > 10)	Horizontal	θx+	CR > 10, θy = ±0°		70	85	–	Deg.	**Note 4**
		θx–			70	85	–	Deg.	
	Vertical	θx+	CR > 10, θy = ±0°		70	85	–	Deg.	
		θx–			70	85	–	Deg.	
Response time (Module front surface temperature = 33.9°C)		Ton	White to black	10%→90%	–	15	25	ms	**Note 5**
		Toff	Black to white	90%→10%	–	14	25		
Luminance control range		–	Maximum luminance: 100%		–	30 to 100	–	–	%

Note 1: Measurement conditions

Optical characteristics are measured after 20 minutes from lighting the backlight with all pixels in white, in the dark room. The typical value is measured after luminance saturation.

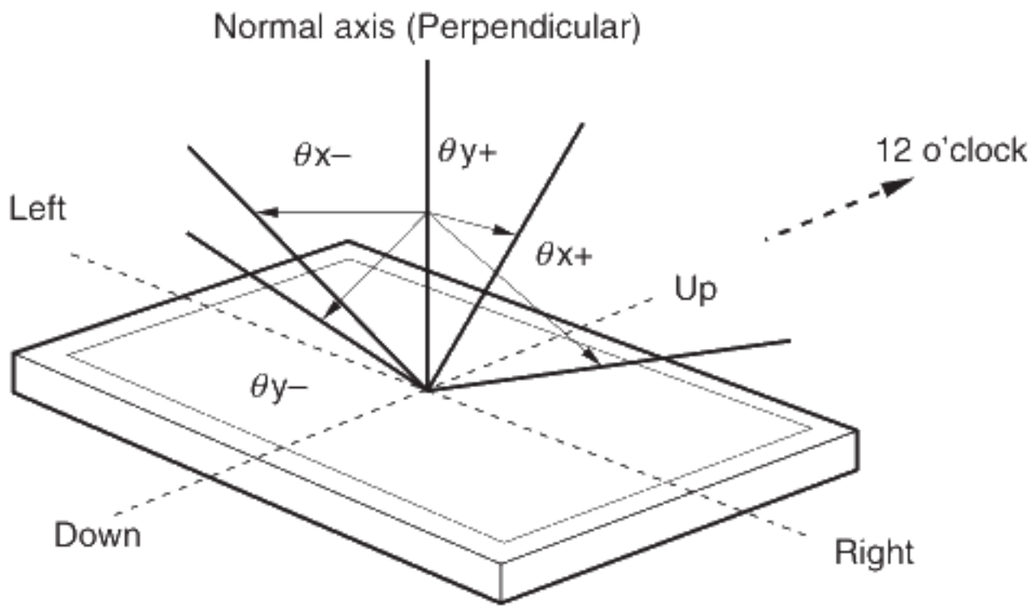


Note 2: The contrast ratio is calculated by using th following formula.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance with all pixels in “white”}}{\text{Luminance with all pixels in “black”}}$$

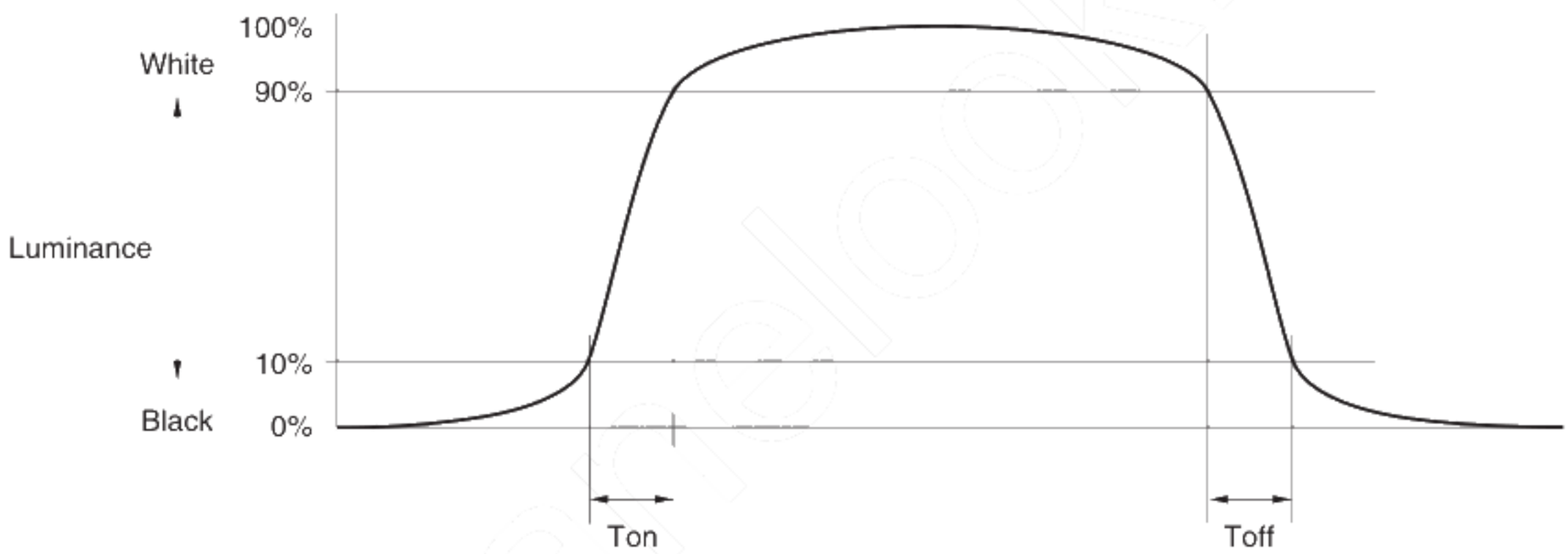
Note 3: Viewing angle is θx = ±0°, θy = ±0° and at center.

Note 4: Definitions of viewing angles are as follows



Note 5: Definitions of response times are as follows.

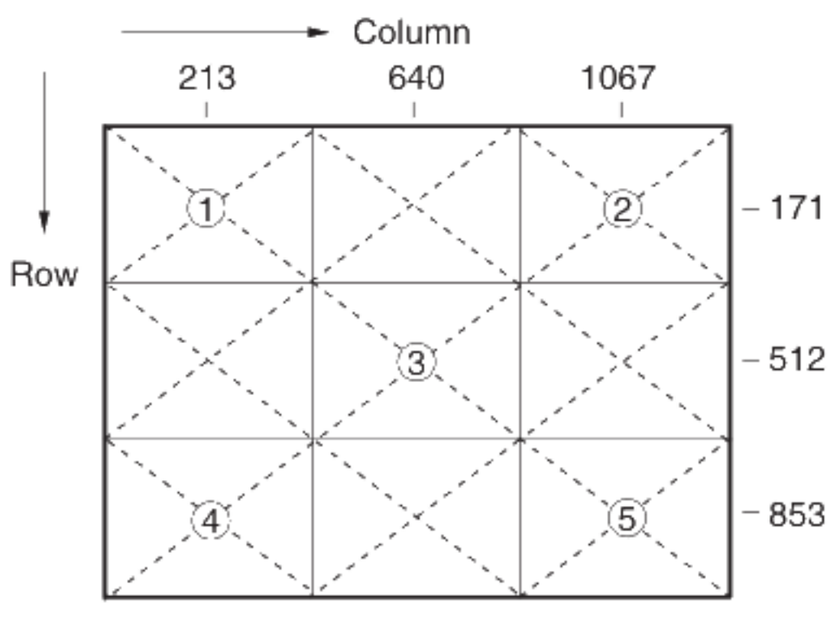
Response time is measured by photo-detector's out put level, when the luminance changes "white" to "black", or "black" to "white" on the same screen point. Ton is the time it takes the luminance to go from 10% on condition to 90% on condition. Toff is the reverse of Ton. (See the following diagram.)



Note 6: Luminance uniformity is calculated by using the following formula.

$$\text{Luminance uniformity} = \frac{\text{Maximum luminance}}{\text{Minimum luminance}}$$

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



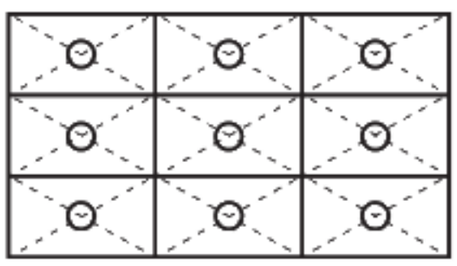
RELIABILITY TEST

Test item		Test condition	Judgment
High temperature/humidity operation		60±2°C, RH = 60% 240 hours, Display data is white.	**Note 1**
Heat cycle (operation)		① 0°C±3°C --- 1 hour 55°C±3°C --- 1 hour ② 50 cycles, 4 hours/cycle ③ Display data is white.	**Note 1**
Thermal shock (non-operation)		① –20°C±3°C --- 30 minutes 60°C±3°C --- 30 minutes ② 100 cycles ③ Temperature transition time is within 5 minutes.	**Note 1**
Vibration (non-operation)		① 5-100 Hz, 11.76 m/s^2 1 minute/cycle, X, Y, Z direction ② 10 times each direction	**Note 1** **Note 2**
Mechanical shock (non-operation)		① 294 m/s^2, 11 ms X, Y, Z direction ② 3 times each direction	**Note 1** **Note 2**
ESD (operation)		150 pF, 150 Ω, ±10 kV 9 places on a panel Note3 10 times each place at one-second intervals	**Note 1**
Dust (operation)		15 kinds of dust (JIS-Z 8901) Hourly 15 seconds stir, 8 times repeat	**Note 1**
Low pressure	Operation	53.3 kPa 0°C±3°C --- 24 hours 55°C±3°C --- 24 hours	**Note 1**
	non-operation	15 kPa –20°C±3°C --- 24 hours –60°C±3°C --- 24 hours	

Note 1: No display malfunctions (Display functions are checked under the same conditions as out-going inspection.)

Note 2: No physical damages

Note 3: See the following figure for discharge points



PRECAUTIONS

MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to understand following contents, respectively.**

⚠ CAUTION	This sign has a meaning that customer will be injured himself and/or the product will sustain a damage, if he makes a mistake in operations.

⚡	This sign has a meaning that customer will get an electric shock, if customer makes a mistake in operations.

✋	This sign has a meaning that customer will be injured oneself, if customer makes a mistake in operations.

CAUTIONS

⚡

Do not touch HIGH VOLTAGE PART of the inverter while turn on. Customer will be in danger of an electric shock.

✋

* **Pay attention to handling for the working backlight. It may be over 35°C from ambient temperature.**
* **Do not shock and press the LCD panel and the backlight. There will be in danger of breaking, because they are made of glass. (Shock: To be not greater 294 m/s^2 and to be not greater 11 ms, Pressure: To be not greater 19.6 N)**

ATTENTIONS

(1) Handling the product

① When customer pulls out products from carton box, take hold of both ends without touch the circuit board. If customer touches it, products may be broken down and/or out of adjustment, because of stress to mounting parts.

② If customer places products temporarily, turn down the display side and place on a flat table.

③ Handle products with care and avoid electrostatic discharge (e.g. Decrease with earth band, ionic shower, etc.), because products (LCD modules) may be damaged by electrostatic.

④ The torque for mounting screws should never exceed 0.45 N•m. Over torque may cause mechanical damage to the product.

⑤ Do not press or friction, because LCD panel surface is sensitive. If customer will clean the product surface, NEC Corporation or their supplier will recommended using the cloth with ethanolic liquid.

⑥ Do not push-pull the interface connectors while turn on, because wrong power sequence may break down the product.

⑦ Connection cables such as flexible cable, and so on, are danger of damage. Do not hook cables nor pull them.

(2) Environment

① Dewdrop atmosphere must be avoided.

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

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

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

(3) Specification for products

① Do not display the fixed pattern for a long time because it may cause image sticking. If the fixed pattern is displayed on the screen, use a screen saver.

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

③ The product may be changed of luminance by voltage variation, even if power source applied recommended voltage to backlight inverter.

④ Optical characteristics may be changed by input signal timings.

(4) Other

① All GND, GNDB, V_{DD} and V_{DDB} terminals should be connected without a non-connected signal line.

② Do not disassemble a product and/or adjust volume.

③ If customer would like to replace backlight lamps, see 'REPLACEMENT MANUAL FOR BACKLIGHT'.

④ If customer uses screwnails, pay attention not to insert waste materials in inside of products.

⑤ When customer returns product for repair and so on, pack it with original shipping package because of avoidance of some damages during transportation.

General specifications for the LCD

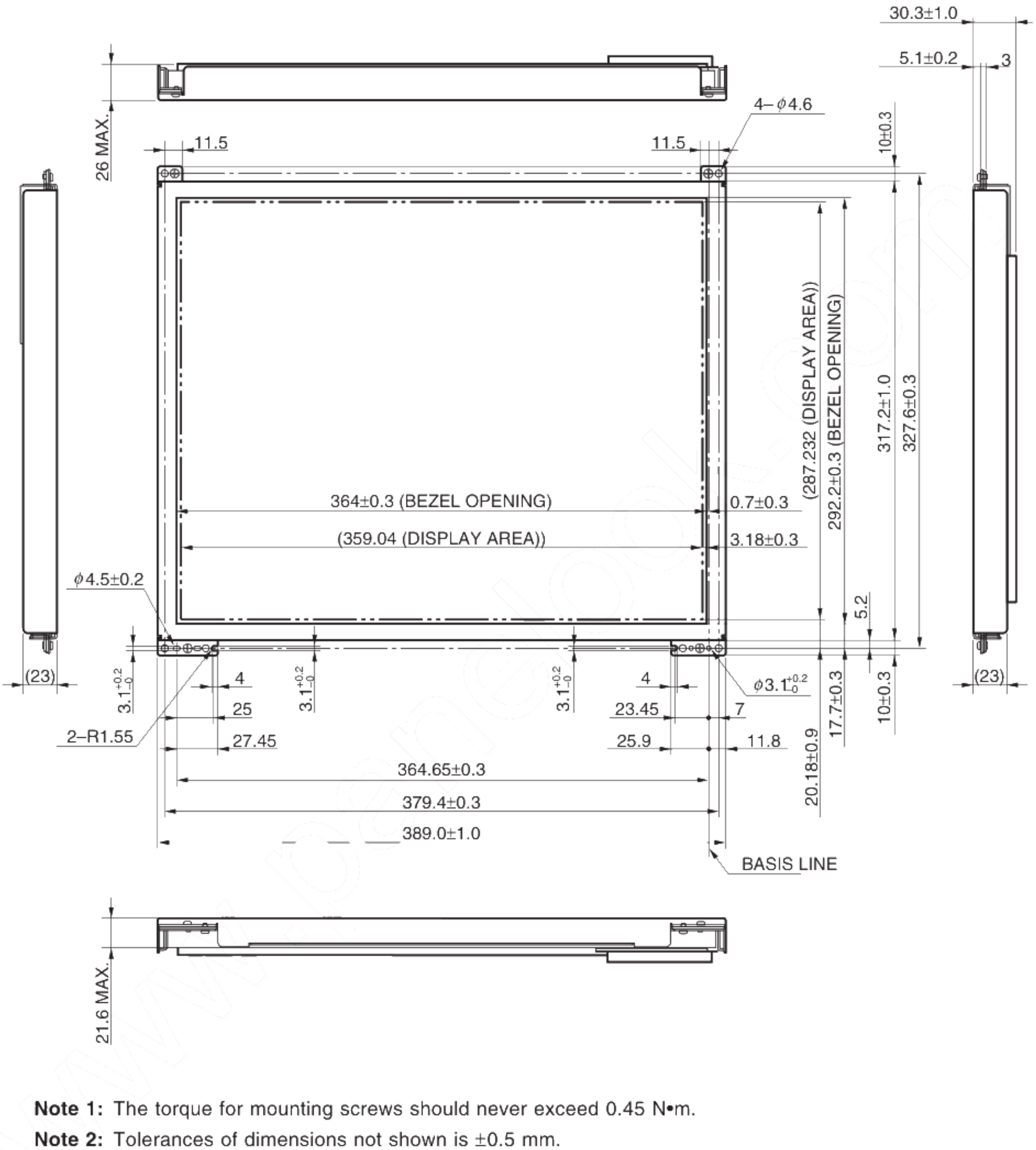
The following items are neither defects nor failures.

* **Response time, luminance and color gamut may be change by ambient temperature.**
* **The LCD may be seemed luminance uniformity, flicker, vertical seam and/or small sport 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.**

OUTLINE DRAWINGS (Unit: mm)

FRONT VIEW

(Unit: mm)

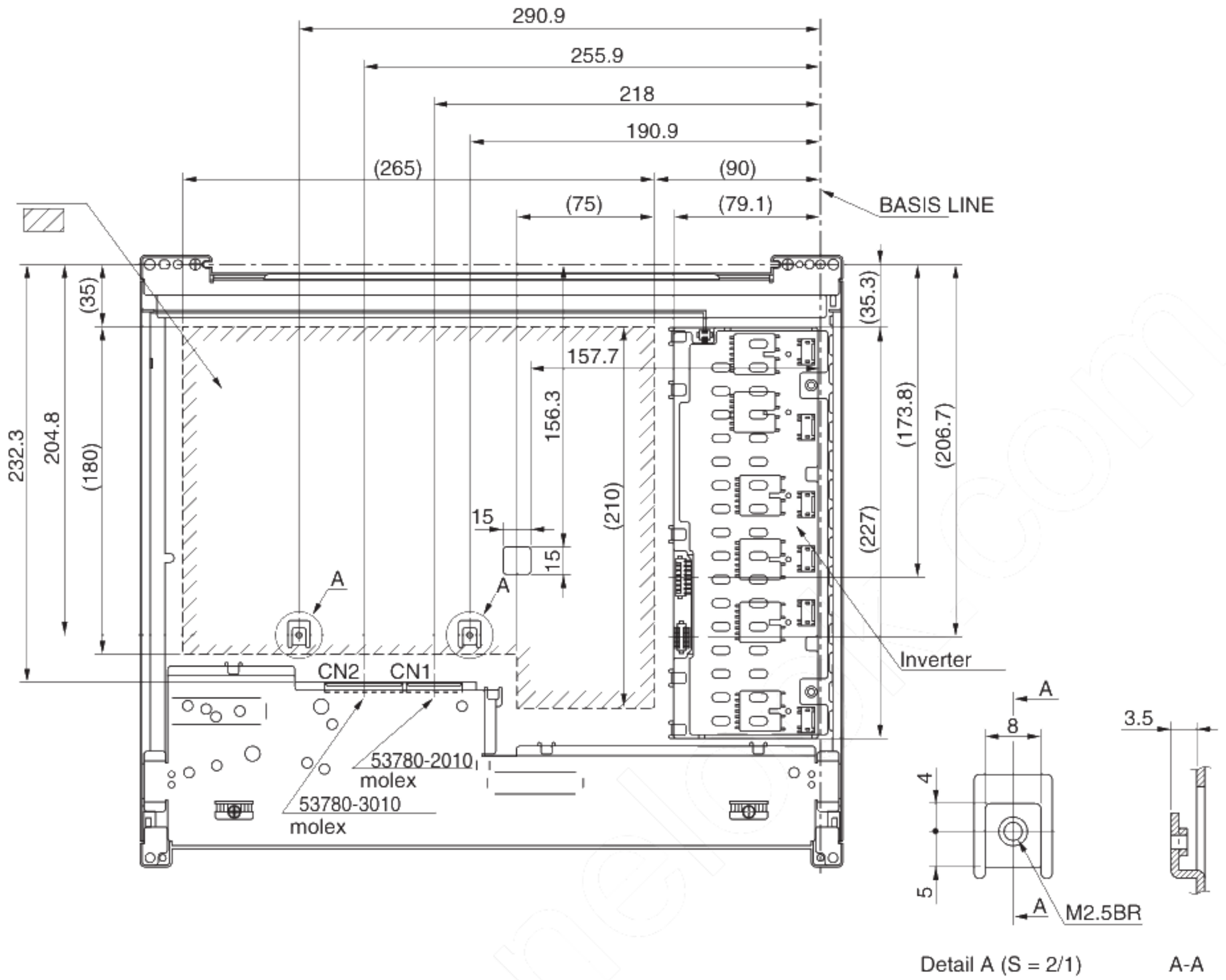


Note 1: The torque for mounting screws should never exceed 0.45 N•m.

Note 2: Tolerances of dimensions not shown is ±0.5 mm.

REAR VIEW

(Unit: mm)



Note 1: The torque for mounting screws should never exceed 0.45 N•m.

Note 2: Tolerances of dimensions not shown is ±0.5 mm.

[MEMO]