

**TFT COLOR LCD MODULE
NL10276BC30-04D**

**38 cm (15.0 inches), 1024 × 768 pixels, 262,144 colors,
LVDS interface, high luminance**

DESCRIPTION

The NL10276BC30-04D 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 NL10276BC30-04D has a built-in backlight. Backlight includes long-life-lamps and the lamps are replaceable with lamp holders.

The 38 cm (15.0 inch) diagonal display area contains 1024 × 768 pixels and can display 262,144 colors simultaneously.

FEATURES

- LVDS interface (adapted the THC63LVDF64A, Thine Electronics, Inc. as a receiver)
- Wide viewing angle (with Retardation Film)
- High luminance (350 cd/m² at I_L = 6 mArms/lamp)
- Low reflection
- Incorporated edge-type backlight (four lamps/two holders)
- Replaceable lamp holders (part No. 150LHS12)
- Recommended inverter: Part No. 150PW081

APPLICATIONS

- PC monitors



The information in this document is subject to change without notice.

Please confirm the delivery specification before starting to design your system.

STRUCTURE AND FUNCTION

A color TFT (thin film transistor) LCD module is comprised of a TFT liquid crystal panel structure, LSIs for driving the TFT array, and a backlight assembly. The TFT panel structure is created by sandwiching liquid crystal material in the narrow gap between a TFT array glass substrate and a color filter glass substrate. After the driver LSIs are connected to the panel, the backlight assembly is attached to the back side of the panel.

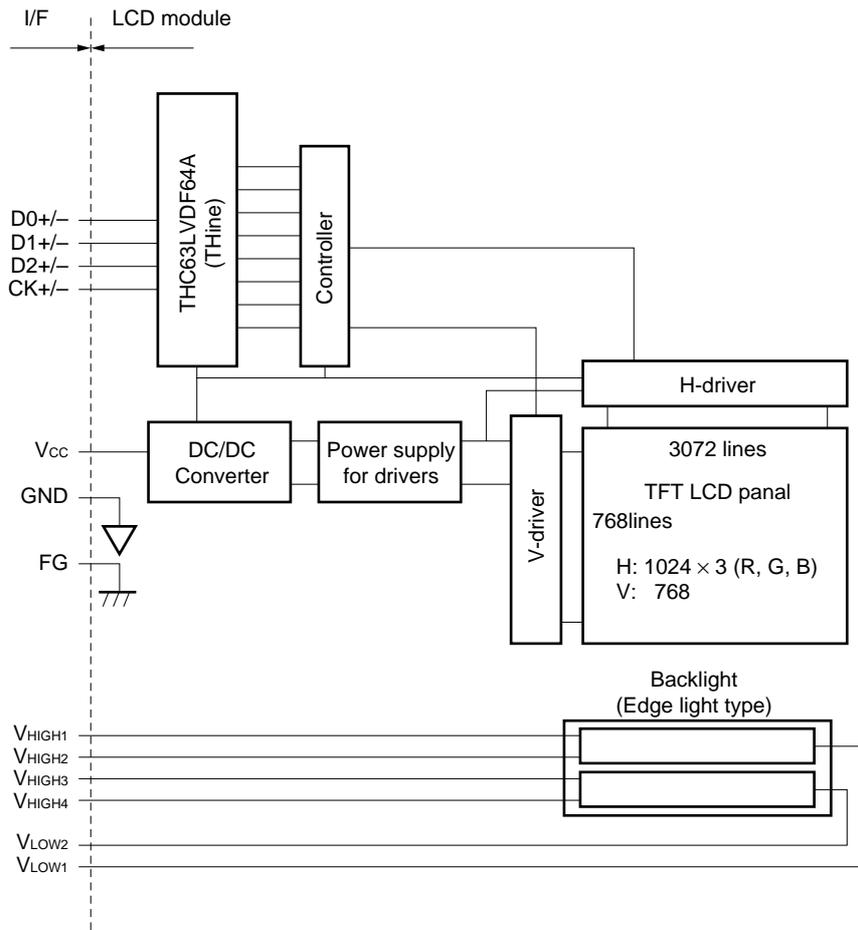
RGB (red, green, blue) data signals from a source system are modulated into a form suitable for active-matrix addressing by the onboard signal processor and sent to the driver LSIs, which in turn address the individual TFT cells.

Acting as an Electro-optical switch, each TFT cell regulates light transmission from the backlight assembly when activated by the data source. By regulating the amount of light passing through the array of red, green, and blue dots, color images are created with clarity.

CHARACTERISTICS (at room temperature)

Item	Description
Display area	304.128 (H) × 228.096 (V) mm
Drive system	a-Si TFT active matrix
Display colors	262,144 colors
Number of pixels	1024 × 768 pixels
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.297 (H) × 0.297 (V) mm
Module size	350.0 (H) × 265.0 (V) × 20.5 typ. (D) mm
Weight	1560 g (typ.)
Contrast ratio	200:1 (typ.)
Viewing angle (more than the contrast ratio of 10:1)	<ul style="list-style-type: none"> • Horizontal: 65° (typ., left side, right side) • Vertical: 45° (typ., up side); 60° (typ., down side)
Designed viewing direction	<ul style="list-style-type: none"> • Wider viewing angle without image reversal : up side • Wider viewing angle with contrast ratio: down side • Optimum gray-scale (r = 2.2): perpendicular
Color gamut	40% (typ., at center, to NTSC)
Response time	15 ms (typ.), "white 100%" to "black 10%"
Luminance	350 cd/m ² (typ., at IL = 6 mA rms/lamp)
Signal system	LVDS interface (receiver: THC63LVDF64A, THine Electronics, Inc.) RGB 6-bit signals, synchronous signals (Hsync, Vsync), dot clock (CLK) encoded with the THC63LVDF63A (THine Electronics, Inc.) are preferable.
Supply voltage	5 V (logic, LCD driving)
Backlight	Edge light type: Four cold cathode fluorescent lamps in two holders, Inverter-less Lamp holder: Part no. 150LHS12
Recommended inverter	Part no. 150PW081
Power consumption	17 W (typ., Checker flag pattern, at IL = 6 mA rms/lamp)

BLOCK DIAGRAM



Note GND is connected to FG (frame ground) in the LCD module. These grounds should be connected in customer equipment.

GENERAL SPECIFICATIONS

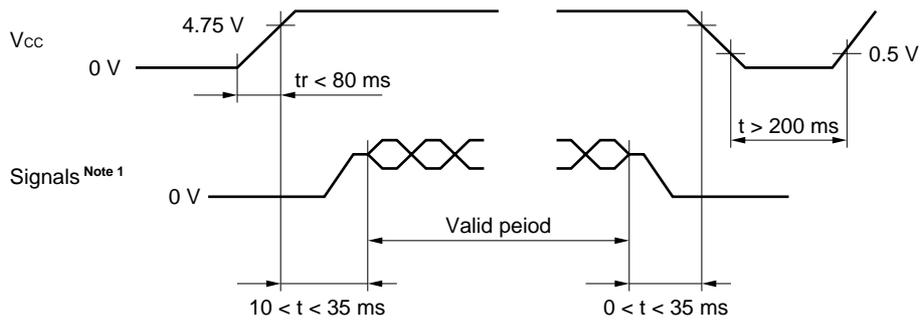
Items	Description	Unit
Module size	350 ± 0.6 (H) × 265.0 ± 0.6 (V) × 21.5 max. (D)	mm
Display area	304.128 (H) × 228.096 (V) [Diagonal display area: 38 cm (15 inches)]	mm
Number of pixels	1024 (H) × 768 (V)	pixel
Dot pitch	0.099 (H) × 0.297 (V)	mm
Pixel pitch	0.297 (H) × 0.297 (V)	mm
Pixel arrangement	RGB (red, green, blue) vertical stripe	–
Display colors	262,144 (RGB, 6 bit)	color
Weight	1560 (typ.), 1610 (max.)	g

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Remarks
Supply voltage	V _{CC}	–0.3 to +6.0	V	T _a = 25°C
Logic input voltage	V _I	–0.3 to V _{CC} +0.3	V	
Lamp voltage	V _L	2000	V _{rms}	
Storage temp.	T _{ST}	–20 to +60	°C	–
Operating temp.	T _{OP}	0 to +50	°C	Module surface Note 1
Relative humidity (RH)	Note 2	≤ 95	%	T _a ≤ 40°C
		≤ 85	%	40 < T _a ≤ 50°C
Absolute humidity	Note 2	Absolute humidity shall not exceed T _a = 50°C, RH = 85%	g/m ³	T _a > 50°C

- Notes:** 1. Measured at the panel surface (including self-heat)
2. No condensation

SUPPLY VOLTAGE SEQUENCE



Note: 1 Terminations of the signal lines are resistance 100 Ω.

- Remark:**
1. Logic signals (synchronous signals and control signals) must be “0” voltage (V), when V_{CC} is not input. If input voltage to signal lines is higher than 0.3 V, the internal circuit will be damaged.
 2. The supply voltage for input signals should be the same as V_{CC}.
 3. Turn on the backlight 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.
 4. When the power is off, please keep whole signals at low level or high impedance.
 5. This LCD module uses a fuse as follows.

Fuse

	Type name	Producer	Rating
V _{CC}	ICP-S1.2	Rohm	50 V/1.2 A

Before the power supply for the module is designed, a fuse protection should be considered. The power supply should be use more than 2.0 times of the fuse rating. In case of small power capacity, the module should be evaluate enough.

INTERFACE PIN CONNECTIONS

(1) Interface Connector for Signal and Power

CN1

Part no.: FI-SE20P-HF

Adaptable socket: FI-SE20M

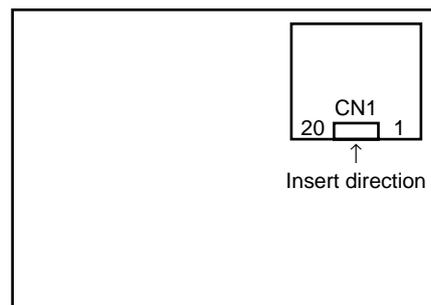
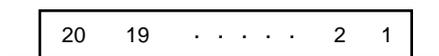
Supplier: Japan Aviation Electronics Industry Limited (JAE)

Pin No.	Symbol	Signal type	Function
1	GND	Ground	Note
2	GND		
3	NC	Nonconnection	-
4	NC		
5	GND	Ground	Note
6	CK+	Pixel clock	CLK for pixel data f = 65 MHz (typ.) (LVDS level)
7	CK-		
8	GND	Ground	Note
9	D2+	Pixel data	LVDS differential data input
10	D2-		
11	GND	Ground	Note
12	D1+	Pixel data	LVDS differential data input
13	D1-		
14	GND	Ground	Note
15	D0±	Pixel data	LVDS differential data input
16	D0-		
17	GND	Ground	Note
18	GND		
19	V _{cc}	+5.0 V power supply	Supply +5.0 V ±5%
20	V _{cc}		

Note: GND is a signal ground for logic and LCD driving. GND is not connected to FG (frame ground) in the LCD module. These grounds should be connected in customer equipment.

Remarks: Do not keep pins free (except 3 and 4) to avoid noise issue.
Use 100 Ω twisted-pair wires for the cable.

CN1: Figure from socket view



(2) Connector for Backlight Unit

CN21

Part no.: BHR-03VS-1

Adaptable socket: SM02 (8.0)B-BHS-TB

Supplier: J.S.T. Trading Company, Ltd.

Pin No.	Symbol	Function
1	V _{LOW1}	Up side lamp, Low-voltage terminal (The cable color is gray.)
2	NC	Nonconnection
3	V _{HIGH1}	Up side lamp, High-voltage terminal (The cable color is white.)

CN22

Part no.: BHR-02VS-1

Adaptable socket: SM02 (4.0)B-BHS-TB

Supplier: J.S.T. Trading Company, Ltd.

Pin No.	Symbol	Function
1	N.C.	Nonconnection
2	V _{HIGH2}	Up side lamp, High-voltage terminal (The cable color is white.)

CN23

Part no.: BHR-03VS-1

Adaptable socket: SM02 (8.0)B-BHS-TB

Supplier: J.S.T. Trading Company, Ltd.

Pin No.	Symbol	Function
1	V _{LOW2}	Down side lamp, Low-voltage terminal (The cable color is gray.)
2	N.C.	Nonconnection
3	V _{HIGH3}	Down side lamp, High-voltage terminal (The cable color is white.)

CN24

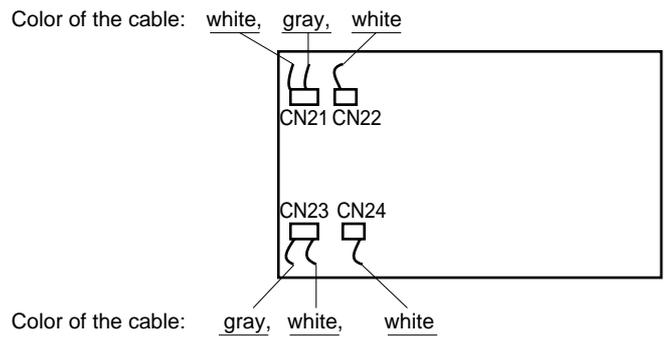
Part no.: BHR-02VS-1

Adaptable socket: SM02 (4.0)B-BHS-TB

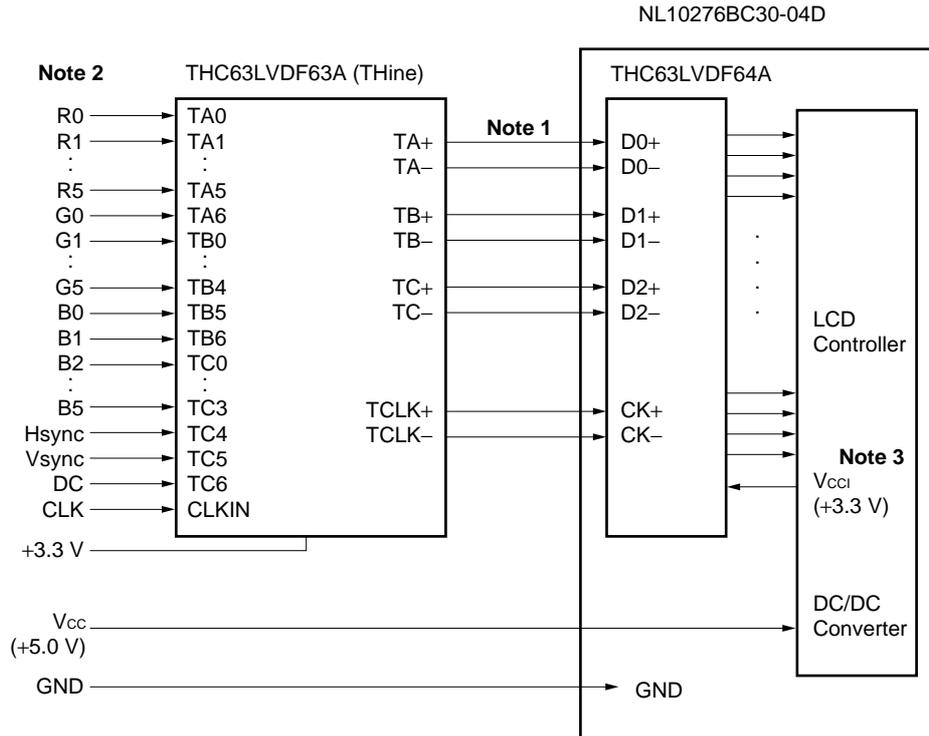
Supplier: J.S.T. Trading Company, Ltd.

Pin No.	Symbol	Function
1	N.C.	Nonconnection
2	V _{HIGH4}	Down side lamp, High-voltage terminal (The cable color is white.)

Note: V_{HIGH} and V_{LOW} must be connected correctly. If they are not connected correctly, the user may get hurt and the module may break.



CONNECTING THE THC63LVDF63A



- Notes:**
1. 100 Ω twisted pair
 2. These signals should be kept in the range specified in **Page 12 INPUT SIGNAL TIMINGS**.
 3. LCD inside voltage

DISPLAY COLORS vs. INPUT DATA SIGNALS

Display Colors		Data Signal (0: Low Level, 1: High Level)																	
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	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	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
Red gray-scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑																		
	↓																		
	bright	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Green gray-scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	↑																		
	↓																		
	bright	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
		0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Blue gray-scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	dark	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	1	1	1	1	0	1
		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

Note: Colors are developed in combination with 6-bit signals (64 steps in gray-scale) of each primary red, green, and blue color. This process can result in up to 262,144 (64 × 64 × 64) colors.

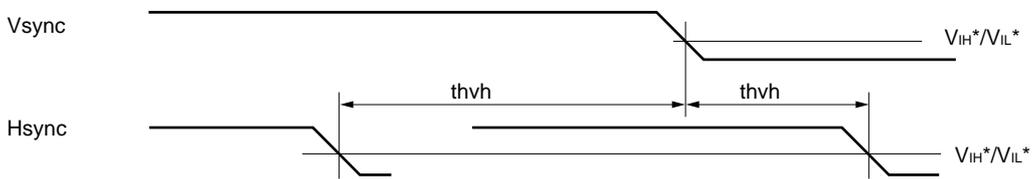
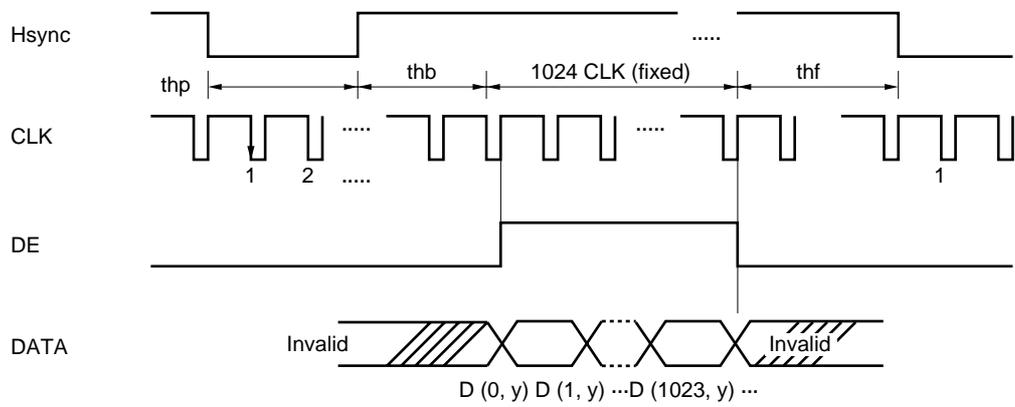
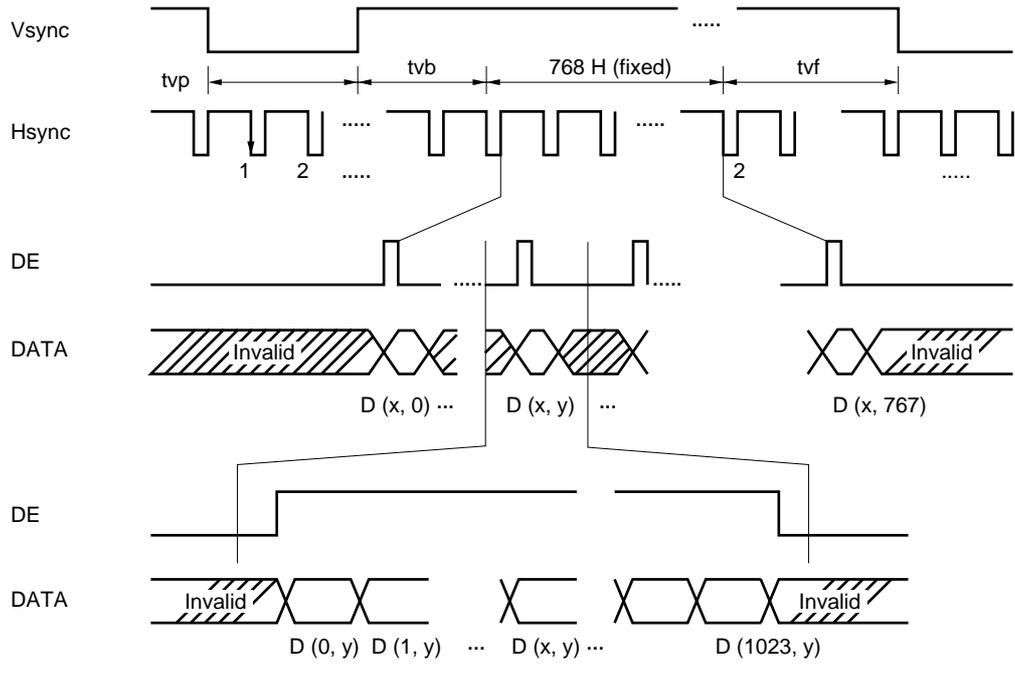
INPUT SIGNAL TIMINGS

(1) Input Signal Specifications for LCD Controller

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1/tc	60.0	65.0	68.0	MHz	-
			-	15.385	-	ns	
	Rise, fall	tcrf	Note			ns	-
	Duty	tch/tc	Note			-	-
Hsync	Period	th	16.0	20.676	22.7	μs	48.363 kHz (typ.)
			1110	1344	-	CLK	
	Display period	thd	-	1024	-	CLK	-
	Front porch	thf	0	-	-	CLK	-
	Pulse width	thp*	12	-	-	CLK	-
	Back Porch	thb	2	-	-	CLK	-
	*thp + thb		86	-	-	CLK	-
	Hsync-CLK timing	ths	Note			ns	-
	CLK-Hsync timing	thh	Note			ns	-
	DE-CLK timing	tes	Note			ns	-
	CLK-DE timing	teh	Note			ns	-
	Rise, fall	thrf, terf	-	-	10	ns	-
	Vsync	Period	tv	13.3	16.666	18.5	ms	60.004 Hz (typ.)
-				806	-	H	
Display period		tvd	-	768	-	H	-
Front porch		tvf	1	-	-	H	-
Pulse width		tvp*	1	3	36	H	-
Back porch		tvb*	1	-	36	H	-
*tvp + tvb		3	-	38	H	-	
Vsync-Hsync timing		tvS	Note			ns	-
Hsync-Vsync timing		tvh	Note			ns	-
Rise, fall		tvrf	Note			ns	-
Data (R0-R5) (G0-G5) (B0-B5)	Data-CLK (setup)	tds	Note			ns	-
	CLK-Data (hold)	tdh	Note			ns	Note
	Rise, fall	terf	-	-	10	ns	-

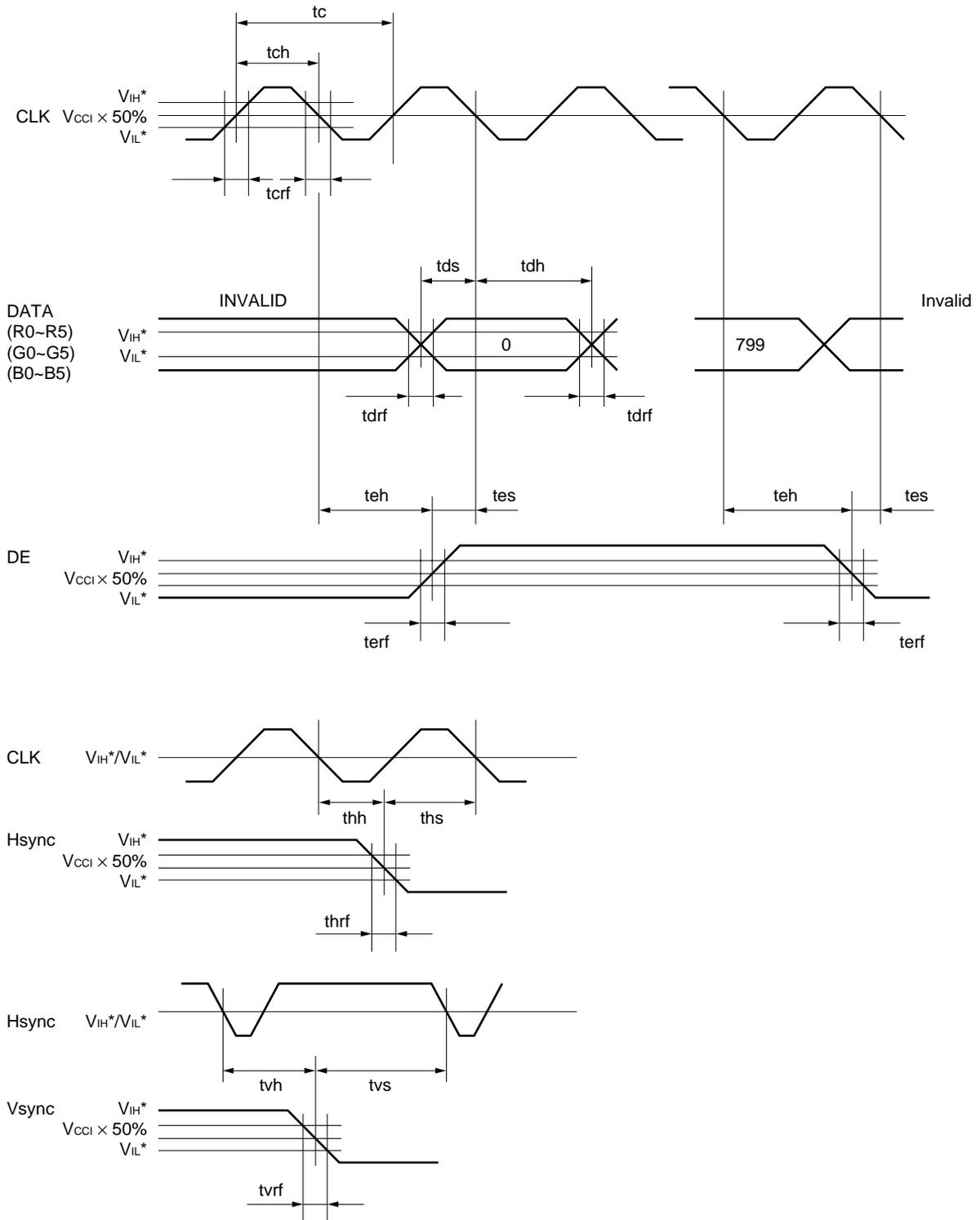
Notes: These values are specified at the inputs of the THC63LVDF64A (THine).
 The product equivalent of the THC63LVDF63A (THine) is recommended for the input of the LVDS transmitter.
 The input signal specifications are prescribed for LCD controller in the input of the LVDS transmitter.

(2) Definition of Input Signal Timings



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

(3) Input Signal Timing Chart



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

(4) Display Position of Input Data

D (0, 0)	D (1, 0)	D (2, 0)	...	...	D (1023, 0)
D (0, 1)	D (1, 1)	D (2, 1)	...	...	D (1023, 1)
D (0, 2)	D (1, 2)	D (2, 2)	...	...	D (1023, 2)
.
.
.
.
D (0, 767)	D (1, 767)	D (2, 767)	...	...	D (1023, 767)

LVDS RECEIVER

(1) Input Signal Specifications

Parameter	Symbol	Min	Typ.	Max.	Unit	Remarks
CLK frequency	TRCP	14.71	T	16.66	ns	-
Bit 0 position	TRIP1	-0.5	0	+0.5	ns	T = 15.38 ns
Bit 1 position	TRIP0	T/7-0.5	T/7	T/7+0.5	ns	
Bit 2 position	TRIP6	2T/7-0.5	2T/7	2T/7+0.5	ns	
Bit 3 position	TRIP5	3T/7-0.5	3T/7	3T/7+0.5	ns	
Bit 4 position	TRIP4	4T/7-0.5	4T/7	4T/7+0.5	ns	
Bit 5 position	TRIP3	5T/7-0.5	5T/7	5T/7+0.5	ns	
Bit 6 position	TRIP2	6T/7-0.5	6T/7	6T/7+0.5	ns	

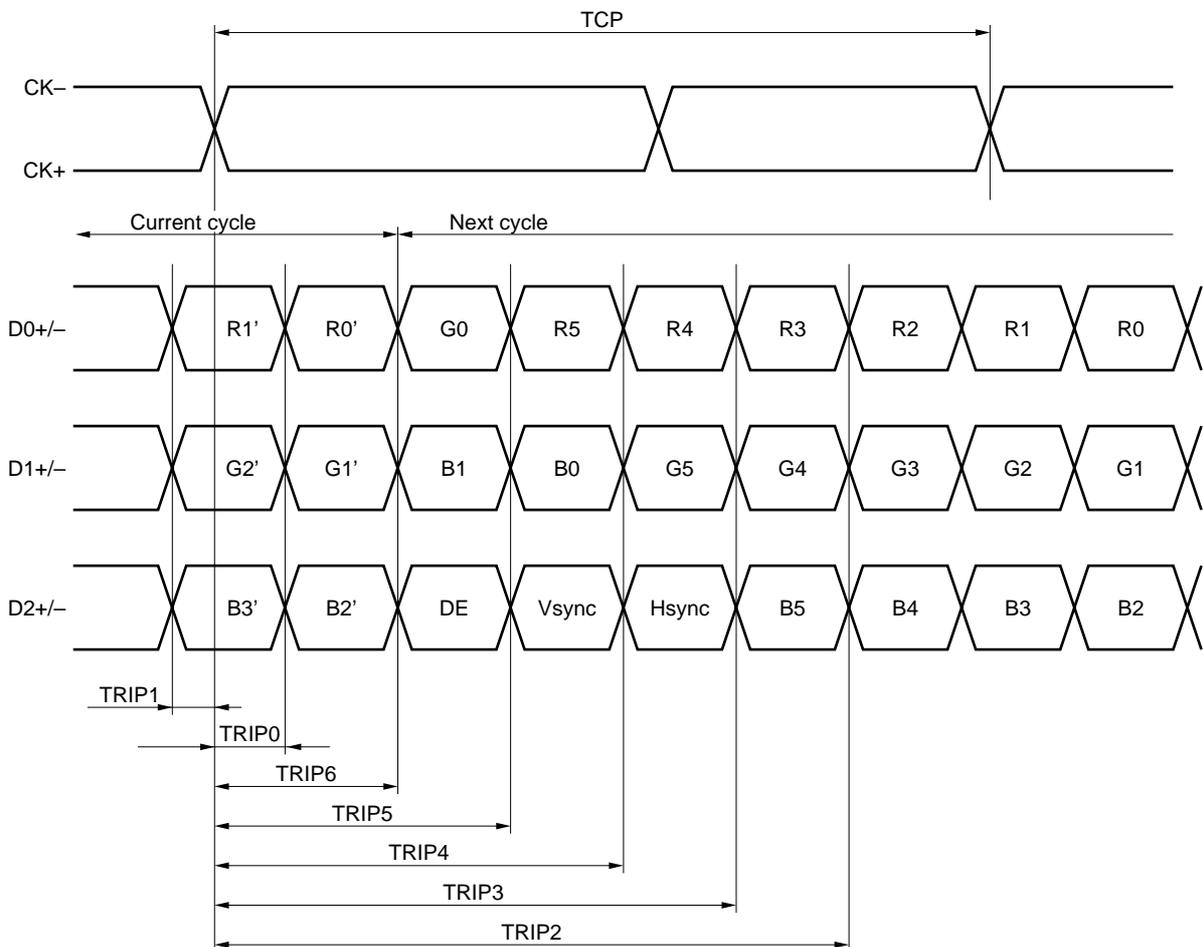
Remark See the specifications of the LVDS manufactures for detailed design.

In case that CLK jitter value between current cycle and next cycle is big, skew time of the next cycle decreases with the value of the jitter.

CLK jitter + LVDS output skew + cable skew ≤ 500 ps

e.g. LVDS output skew: ±200 ps } acceptable CLK jitter ±200 ps (500 - (200 + 100) = 200 ps)
 Cable skew: ±100 ps }

(2) Input Signal Timing Chart



OPTICAL CHARACTERISTICS

(T_a = 25°C; Notes 1, 2)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit	Remark
Contrast ratio	CR	Note 4	80	200	–	–	Note 3
Luminance	Lumax	"White", Note 4	220	350	–	cd/m ²	Note 2
Luminance uniformity	–	Maximum/Minimum	–	–	1.30	–	Note 7

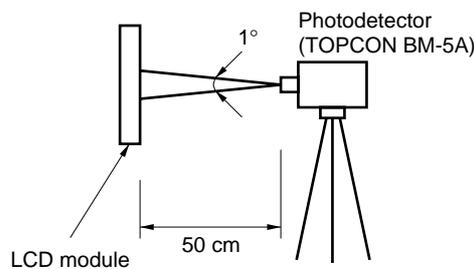
Reference Data

(T_a = 25°C; V_{CC} = 5 V; V_{DDB} = 12 V)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit	Remark	
Contrast ratio	CR	Best contrast angle, θ _X = ±0°, θ _Y = -5° to -10° at center	–	400	–	–	Note 3	
Color gamut	C	To NTSC	35	40	–	%	Note 4	
Viewing angle range (CR > 10)	Horizontal	θ _{x+}	CR > 10, θ _y = ±0°	50	65	–	deg.	Note 5
		θ _{x-}		50	65	–	deg.	
	Vertical	θ _{y+}	CR > 10, θ _x = ±0°	35	45	–	deg.	
		θ _{y-}		30	60	–	deg.	
Response time	ton	White 100% to black 10%	–	15	40	ms	Note 6	
	toff	Black 0% to white 90%	–	40	80	ms		

Notes: 1. V_{CC} = 5 V, I_L = 6.0 mA, with NEC recommended inverter 150PW081

2. Optical characteristics are measured after the module has been working for 20 minutes, with all pixels in "white." Typical values are measured after luminance saturation. The luminance is measured in dark room.



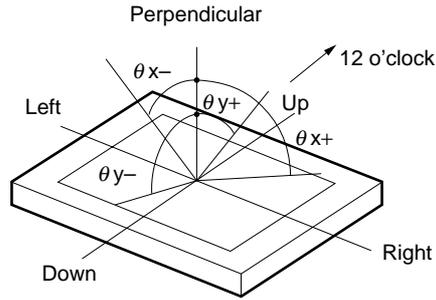
3. The contrast ratio is calculated by using the following formula.

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

The luminance is measured in darkroom.

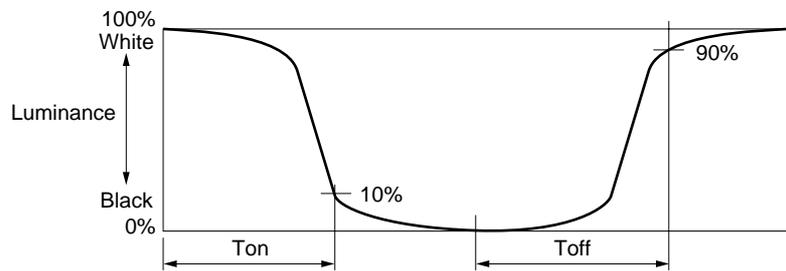
4. Viewing angle is θ_x = ±0°, θ_y = ±0° at center.

5. Definitions of viewing angles are as follows.



6. Definition of response time is as follows.

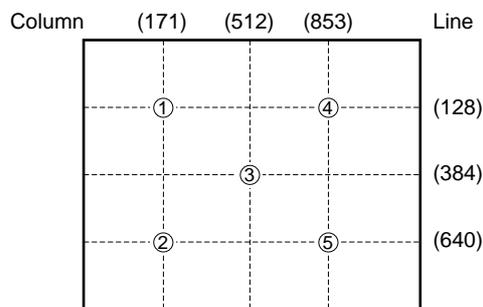
Photo-detector output signal is measured when the luminance changes “white” to “black” or “black” to “white.” Response time is the time between 10% and 100% of the photo-detector output amplitude.



7. Luminance uniformity is calculated by using the following formula.

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

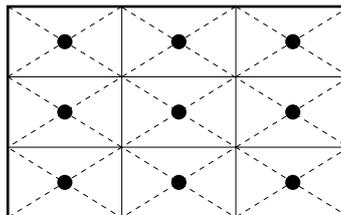
The luminance is measured at the five points shown below.



RELIABILITY TESTS

Test item	Test condition
High temperature/humidity operation Note 1	50 ± 2°C, 85% relative humidity 240 hours Display data is black.
Heat cycle (operation) Note 1	<1> 0°C ± 3°C ... 1 hour 55°C ± 3°C ... 1 hour <2> 50 cycles, 4 hours/cycle <3> Display data is black.
Thermal shock (nonoperation) Note 1	<1> -20°C ± 3°C ... 30 minutes 60°C ± 3°C ... 30 minutes <2> 100 cycles <3> Temperature transition time within 5 minutes
Vibration (nonoperation) Notes 1, 2	<1> 5 ~ 100 Hz, 19.6 m/s ² (2G) 1 minute/cycle X, Y, Z direction <2> 50 times each direction
Mechanical shock (nonoperation) Notes 1, 2	<1> 294 m/s ² (30 G), 11 ms X, Y, Z direction <2> 3 times each direction
ESD (operation) Notes 1, 3	150 pF, 150 Ω, ±10 kV 9 places on a panel 10 times each place at one-second intervals
Dust (operation) Note 1	15 kinds of dust (JIS Z 8901) Hourly 15 seconds stir, 8 times repeat

- Notes:**
1. Display function is checked by the same condition as the LCD module outgoing inspection.
 2. Physical damage.
 3. Discharge points (●) are shown in the figure.



GENERAL CAUTIONS

The next figures and statements below are very important. Please be sure you understand their contents completely.

 <p>CAUTION</p>	<p>This figure is a mark that you will get hurt and/or the module will be damaged if you make a mistake in operation.</p>
	<p>This figure is a mark that you will get an electric shock if you make a mistake in operation.</p>
	<p>This figure is a mark that you will get hurt if you make a mistake in operation</p>

 **CAUTIONS**

(1) Caution when taking out the module

- a) Pick up the pouch only, when removing the module from a carrier box.

(2) Cautions for handling the module

- a) As electrostatic discharges may break the LCD module, handle the LCD module with care against electrostatic discharges. Peel protection sheet out from the LCD panel surface as slowly as possible.
- b)  As the LCD panel and backlight element are made from fragile glass material, impact and pressure to the LCD module should be avoided.
- c) As the surface of the polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
- d) Do not pull the interface connectors in or out while the LCD module is operating.
- e) Put the module display side down on a flat horizontal plane.
- f) Handle connectors and cables with care.
- g) When the module is operating, do not lose the CLK, Hsync, or Vsync signal. If any one or more of these signals is lost, the LCD panel will be damaged.
- h) The torque for mounting screws should never exceed 0.39 N-m (4 kgf-cm).
- i) Don't push or rub the surface of LCD module.
If you do so, scratches or rubbing marks may be left on the surface of the modules.
- j) Do not give the stress to interface connectors. The module may become function deficiency by a contact defective and damages. Pay attention to handling at the time of matching connector connection and in the connection condition.

(3) Cautions regarding atmosphere

- a) Dewdrop atmosphere must be avoided.
- b) Do not store and/or operate the LCD module in a high-temperature and/or high-humidity atmosphere. Storage in an anti-static pouch at the room temperature is recommended.
- c) This module uses a cold cathode fluorescent lamps. Therefore, the lifetime of the lamps is shortened if the module is operated in a low-temperature environment.
- d) Do not operate the LCD module in high magnetic field.

(4) Cautions about module characteristics

- a) Do not apply a fixed-patterns data for a long time to the LCD module. It may cause image sticking. Please use screen savers if the display pattern is fixed for a long time.
- b) This module has retardation film, which may cause variation in the color hue at different viewing angles. A non-uniformity may appear on the screen during high-temperature operation.
- c) A light vertical stripe may be observed, depending on the display pattern. This is neither a defect nor a malfunction.
- d) Noise from the inverter circuit may be observed in the luminance control mode. This is neither a defect nor a malfunction.

(5) Cautions for assembling of an inverter

- a) Please insert an insulation sheet between the inverter and the mold chassis when the inverter is assembled to the mold chassis. If you do not insert the insulation sheet, electric discharge may occur from the inverter to the module.

Before an insulation sheet is adopted, the material and the thickness of an insulation sheet should be considered.

(Design example:

- Thickness of the inverter printed wiring board: 1.0 mm
- Thickness of the insulation sheet: 0.4 mm
- Material: Polyethylene terephthalate (UL class: 94 V-0)

(6) Other cautions

- a) Do not disassemble and/or reassemble the LCD module.
- b) Do not readjust variable resistors or switches in the module.
- c) When returning the module for repair, etc., please pack the module properly to avoid damage. We recommend the original shipping packages.
- d) In case that the scan converter is used to convert VGA signal to NTSC, it is recommended using the frame-memory type, not the line-memory.

The liquid crystal display has the following specific characteristics. These are neither a defect nor a malfunction.

The optical characteristics of this module may be affected by the ambient temperature. This module has a cold cathode tube for backlight. Optical characteristics, like luminance or uniformity, will change over time.

Uneven brightness and/or small spots may be observed, depending on different display patterns.

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Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

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Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

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(Note)

- (1) "NEC" as used in this statement means NEC Corporation and also includes its majority-owned subsidiaries.
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