



ENH038QD1-450/600/650 Color TFT-LCD Module Features

GENERAL DESCRIPTION

WEDC provides optically enhanced solutions to the standard Sharp LQ038Q1DR01 color active matrix LCD module. The first enhancement is an index matching (IM) film lamination to the front surface of the display polarizer. The IM film is available in two surface treatments - IM/Clear and IM/110 (a 10% diffusion).

The second enhancement is the incorporation of a reflective polarizer (RP) to improve brightness by up to 40%. The third enhancement is the addition of prism films (RPP) further increasing the brightness of the display.

This module is composed of a color TFT-LCD panel, driver ICs, control PWB, FPC, frame, front shielding case, backlight unit.

Graphics and text can be displayed on a 320 x 3 x 240 dots panel with 262,144 colors.

The 3.8 screen produces a high resolution image that is composed of 76,800 pixel elements in a stripe arrangement.

Wide viewing angle technology is employed. (The most suitable viewing angle is in the 6 o'clock direction.)

By adopting an active matrix drive, a picture with high contrast is achieved.

Through the use of TN normally white mode, an image with high natural color image is achieved.

It uses the Low reflection (LR) and an antiglare (AG) surface polarization plate.

An inverted video display in the vertical and horizontal directions is possible.

WEDC assumes no responsibility for any damage resulting from the use of the device which does not comply with the instructions and the precautions specified in these specification sheets. WEDC does assume the responsibility for the warranty of the enhanced product.

MECHANICAL SPECIFICATIONS

Parameter	Specifications	Units	Remarks
Display Format	76,800	pixels	-
	320 (W) x RGB x 240 (H)	dots	-
Active Area	78.72 (W) x 53.64 (H)	mm	-
Screen Size (Diagonal)	9.6 [3.8"]	cm	-
Dot Pitch	0.082 (W) x 0.2235 (H)	mm	-
Pixel Configuration	RGB Stripe configuration	-	-
Outline Dimension	117.6 x 69.45 x 13.45	mm	(1)
Mass	125 ± 10	g	-
Surface Treatment	IM/Clear (glossy) or IM/110 and hardcoat 3H	-	-

Note: Typical values are given. For detailed measurements and tolerances, please refer to Fig. 1.



INPUT TERMINAL
TTL-LCD Panel Driving Part

Used connector: KX14-40K5D1 (JAE Co., Ltd)
Fit connector: KX15-40K*D1 (JEA Co., Ltd)
*: 2, 3, ...

CN1 (4-6)

Pin No.	Symbol	Description	Remarks
1	GND	Ground	
2	V _{CC}	Power Supply Voltage	
3	H _{SYNC}	Horizontal Synchronous Signal	(1)
4	G3	GREEN Data Signal	
5	T0	Thermistor Output 1	
6	G4	GREEN Data Signal	
7	T1	Thermistor Output 2	
8	G5	GREEN Data Signal (MSB)	
9	HVR	Selection for horizontal and vertical scanning direction	(3)
10	GND	Ground	
11	GND	Ground	
12	B0	BLUE Data Signal (LSB)	
13	CK	Clock signal for sampling each data signal	
14	B1	BLUE Data Signal	
15	GND	Ground	
16	B2	BLUE Data Signal	
17	R0	RED Data Signal (LSB)	
18	GND	Ground	
19	R1	RED Data Signa	
20	B3	BLUE Data Signal	
21	R2	RED Data Signal	
22	B4	BLUE Data Signal	
23	GND	Ground	
24	B5	BLUE Data Signal (MSB)	
25	R3	RED Data Signal	
26	GND	Ground	
27	R4	RED Data Signal	
28	V _{SYNC}	Vertical Synchronous Signal	(1)
29	R5	RED Data Signal (MSB)	
30	TEST	Open use only	
31	GND	Ground	
32	TEST	Open use only	
33	G0	GREEN Data Signal (LSB)	
34	TEST	Open use only	
35	G1	GREEN Data Signal	
36	TEST	Open use only	
37	G2	GREEN Data Signal	
38	ENAB	Signal to settle the horizontal display position	(2)
39	V _{CC}	Power supply voltage	
40	GND	Ground	

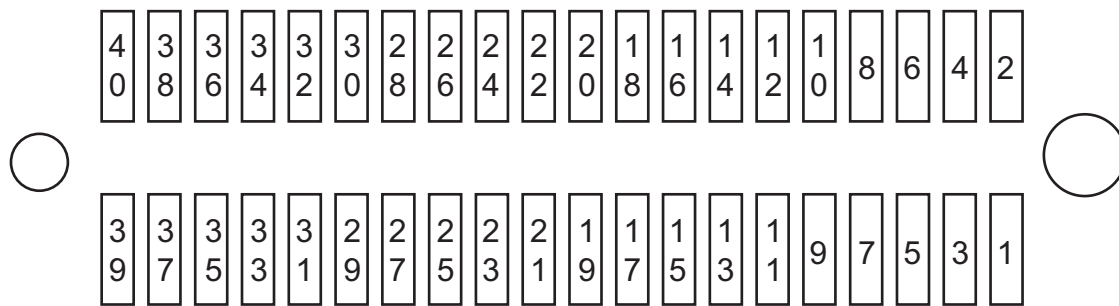


Notes:

1.

H _{SYNC}	positive
V _{SYNC}	positive

- The horizontal display start timing is settled in accordance with a rising timing of ENAB signal. In case ENAB is fixed "Low", the horizontal start timing is determined as described in Fig 3-A (Don't keep ENAB "High" during operation. (Fig. 3-B).)
- HVR = "Low" :Regular video
HVR = "High" :Horizontally and Vertically inverted video
- The position of pin number



BACKLIGHT FLUORESCENT TUBE DRIVING PART

No.	Symbol	I/O	Function	Color of FL cable
1	VLI	I	input terminal (High Voltage)	RED
2	VL2	I	input terminal (Low Voltage)	BLACK

Used connector:BHR-02(8.0)VS-1N(JST Co. Ltd)

Fit connector:SM02(8.0)B-BHS-IN(JST Co. Ltd)

Used thermistor :20:3GT-1(Ishizuka Electronics Corporation)=20.0k Ω ± 3%

ABSOLUTE MAXIMUM RATINGS*

Parameter	Symbol	MIN	MAX	Unit	Note
Input voltage	V _I	-0.3	V _{CC} +0.3	V	t _A =25°C(1)
+3.3V power supply	V _{CC}	0	5.5	V	t _A =25°C
Storage temperature	t _{STG}	-40	+95	°C	(2)
Operating temperature (panel surface)	t _{OPR1}	-30	+85	°C	(2)
Operating temperature (Ambient temperature)	t _{OPR2}	-30	+60	°C	(2)

Notes:

- CK, R0~R5, G0~G5, B0~B5, H_{SYNC}, V_{SYNC}, ENAB, HVR
- Humidity: 95%RH Max. at t_A ≤ 65°C
Maximum wet-bulb temperature at 39°C or less at t_A ≥ 40°C.
No condensation.



ELECTRICAL CHARACTERISTICS

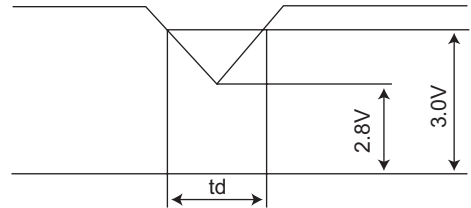
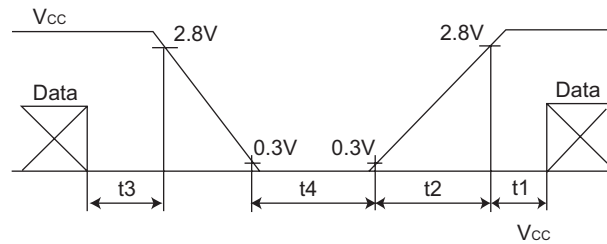
TFT-LCD Panel Driving Section

GND=0V, t_A=25°C

	Parameter	Symbol	MIN	TYP	MAX	Unit	Remarks
+3.3V	Supply voltage	V _{CC}	+2.9	+3.3	+3.7	V	(1)
	Current dissipation	I _{CC}	-	140	180	mA	(2, 3)
Permissive input ripple		V _{REF}	-	-	100	mV _{PP}	-
Input Low voltage		V _{IL}	-	-	0.3V _{CC}	V	(4)
Input High voltage		V _{IH}	0.7V _{CC}	-	-	V	
Input current (Low)		I _{IL}	-	-	1.0	μA	V _I =0V (5)
Input current (High)		I _{IH}	3.0	-	75	μA	V _I =V _{CC} (5)
Input current (Low)		I _{IL}	3.0	-	75	μA	V _I =0V (6)
Input current (High)		I _{IH}	-	-	1.0	μA	V _I =V _{CC} (6)
Input current (Low)		I _{IL}	6.0	-	150	μA	V _I =0V (7)
Input current (High)		I _{IH}	-	-	2.0	μA	V _I =V _{CC} (7)

Notes:

- On-Off conditions for supply voltage
 $0 < t_1 \leq 10\text{ms}$
 $0 < t_2 \leq 10\text{ms}$
 $0 < t_3 \leq 1\text{s}$
 $t_4 \geq 1\text{s}$
 V_{CC}-dip conditions
 - $2.8 \leq V_{CC} < 3.0\text{V}$
 $t_d \leq 2.8\text{V}$
 - $V_{CC} < 2.8\text{V}$
 V_{CC}-dip conditions should also follow the On-Off conditions.
- Typical current situation: Black (GS0) pattern
 Timing: typical
 V_{CC} = +3.3V
- Maximum current situation: Vertical stripe pattern alternating 21 gray scale (GS21), with 42 gray scale (GS42) every 1 dot.
 Timing: Typical
 V_{CC} = +3.3V
- CK, R0~R5, G0~G5, B0~B5, H_{SYNC}, V_{SYNC}, ENAB, HVR
- CK, R0~R5, G0~G5, B0~B5, H_{SYNC}, V_{SYNC}
- ENAB
- HVR

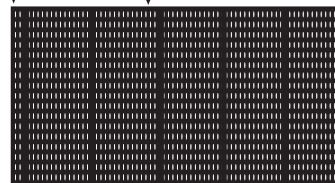


Black (GS0)



GS21

GS42





BACKLIGHT DRIVING SECTION

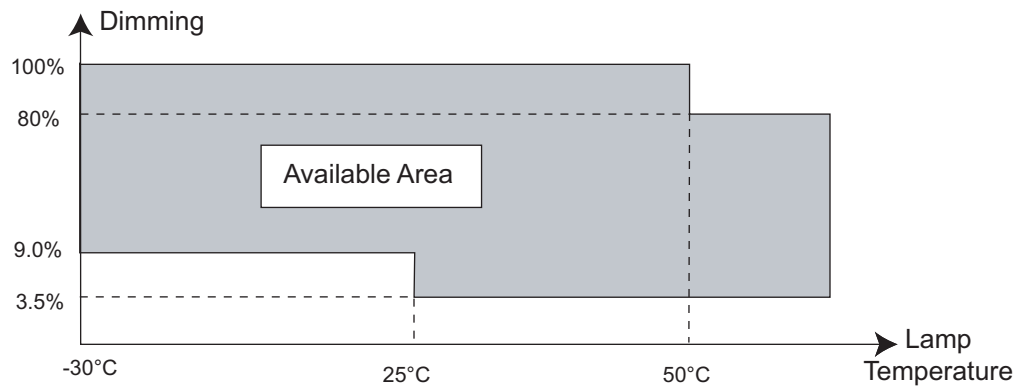
The backlight system is an edge-lighting type with single CCFT (Cold Cathode Fluorescent Tube). The characteristics of the lamp are shown in the following table.

Parameter	Symbol	MIN	TYP.	MAX	Unit	Remarks
Lamp Voltage	V_{L7}	470	530	590	Vrms	$I_L = 5.5\text{mA}_{\text{rms}}$
Lamp Current	I_L	5.0	5.5	6.0	mA _{rms}	Ordinary State
	I_{LB}	-	-	9.0	mA _{rms}	PWM dimming state (8)
Lamp Frequency	f_L	30	-	60	kHz	
Kick-Off Voltage	V_S	-	-	1650	Vrms	$t_A = +25^\circ\text{C}$
		-	-	1700	Vrms	$t_A = -30^\circ\text{C}$

Inverter: HIU-288 [Harison Electric Co., Ltd] (Output capacitor: 22pF, frequency: 49kHz)

Note:

8. Available area



TIMING CHARACTERISTICS OF INPUT SIGNALS

Timing diagrams of input signal are shown in Fig.3-A, Fig.3-B.

Parameter	Symbol	MIN	TYP	MAX	Unit.	
Clock	Frequency	$1/t_c$	4.5	6.3	6.8	MHz
	High Time	t_{CH}	50	-	-	ns
	Low Time	t_{CL}	50	-	-	ns
Data	Setup Time	t_{DS}	50	-	-	ns
	Hold Time	t_{DH}	50	-	-	ns
$H_{\text{SYNC}}\text{-Clock}$ phase difference	t_{HC}	50	-	120	ns	
$H_{\text{SYNC}}\text{-}V_{\text{SYNC}}$ phase difference	t_{VH}	0	-	TH-10	μs	

Note:

1. In case of lower frequency, the deterioration of display quality, flicker etc., may occur.



HORIZONTAL DISPLAY POSITION

When ENAB is Active, the horizontal display position is determined by ENAB signal and the input data corresponding to the rising edge of ENAB signal is displayed at the left end of the active area.

Parameter		Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Signal	Cycle	TH	50	63.5	80	μs
			THe+308	400	440	clock
	Pulse Width	THp	4	12	30	clock
Enable signal	Set-up Time	Tes	50	-	Tc-10	ns
	Pulse width	Tep	-	320	-	clock
H _{SYNC} Enable signal phase difference		THe	14	-	72	clock
Horizontal display period		THd	320	320	320	clock

When ENAB is Low (as shown in Vertical Display Position)

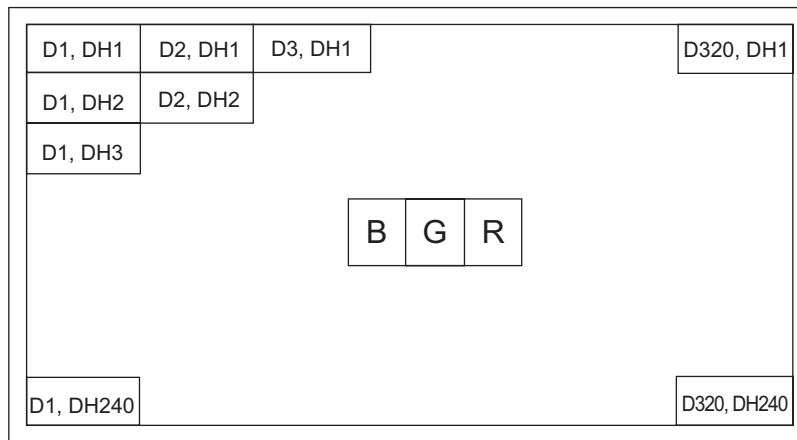
Parameter		Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Signal	Cycle	TH	56	63.5	80	μs
			380	400	440	clock
	Pulse Width	THp	4	12	30	clock
H _{SYNC} -data signal phase difference		THe	72	72	72	clock
Horizontal display period		THd	320	320	320	clock

VERTICAL DISPLAY POSITION

Parameter		Symbol	Min.	Typ.	Max.	Unit
Vertical Sync. Signal	Cycle	TV	246	263	330	line
	Pulse Width	TVp	1	-	-	line
Vertical Display Start Position		TVs	6	6	6	line
Vertical display period		TVd	240	240	240	line

ENAB signal has no relation to the vertical display position.

INPUT DATA SIGNALS AND DISPLAY POSITION ON THE SCREEN



Display position of input data (H, V)



INPUT SIGNALS, BASIC DISPLAY COLOR AND GRAY SCALE OF EACH COLOR

	Colors & Grayscale	Data signal																		
		Gray Scale	R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	B4	B5
Basic Color	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
	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
	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
	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	
Gray Scale of Red	Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	↑ Darker	GS1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		GS2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	↓ Brighter																			
	GS61	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0		
	GS62	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0		
Red	GS63	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0		
Gray Scale of Green	Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	↑ Darker	GS1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
		GS2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
	↓ Brighter																			
	GS61	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0		
	GS62	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0		
Green	GS63	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0		
Gray Scale of Blue	Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	↑ Darker	GS1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
		GS2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
	↓ Brighter																			
	GS61	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1		
	GS62	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1		
Blue	GS63	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1		

Note:

- 0: Low level voltage 1: High level voltage
- Each basic color can be displayed in 64 gray scales from 6 bit data signals. According to the combination of total 18 bit data signals, the 262, 144-color display can be achieved on the screen.

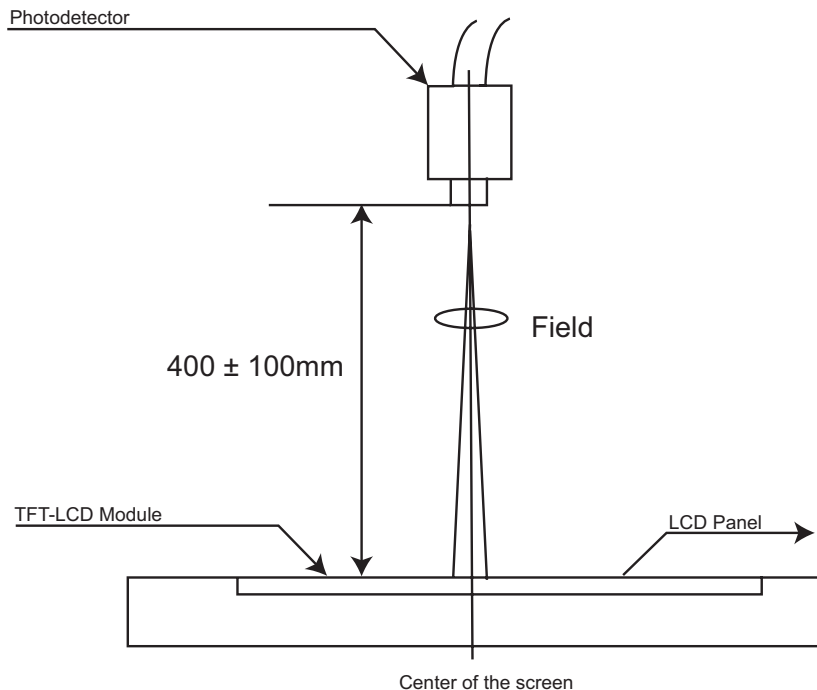


OPTICAL CHARACTERISTICS

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Remarks	
Viewing Angle Range	$\Delta\theta_{11}$	$CR_{\geq 5}$	60	65	-	° (degree)	(1,4)	
	$\Delta\theta_{12}$		35	40	-			
	$\Delta\theta_2$		60	65	-			
Contrast Ratio	CRmax	Optimal	100	-	-	-	(2,4)	
Response Time	Rise	τ_r	-	30	60	ms	(3,4)	
	Fall	τ_d	-	50	100	ms		
Luminance	IM	$I_L=5.5mArms$	350	450	-	cd/m ²	(5)	
	IM+RP		450	600	-			
	IM+RPp		500	650	-			
White Chromaticity	x	$I_L=5.5mVms$	0.263	0.313	0.363	-		
	y	$I_L=5.5mArms$	0.279	0.329	0.379	-		
Lamp Life Time	+25°C	-	Continuation	10,000	-	-	hour	(6)
	-30°C	-	Intermission	2,000	-	-	time	(7)

DC/AC inverter for external connection shown in following.

Inverter: HIU-288 [Harison Electric Co., Ltd] (Output capacitor: 22pF, frequency: 49kHz) measuring after operating during 30 minutes.

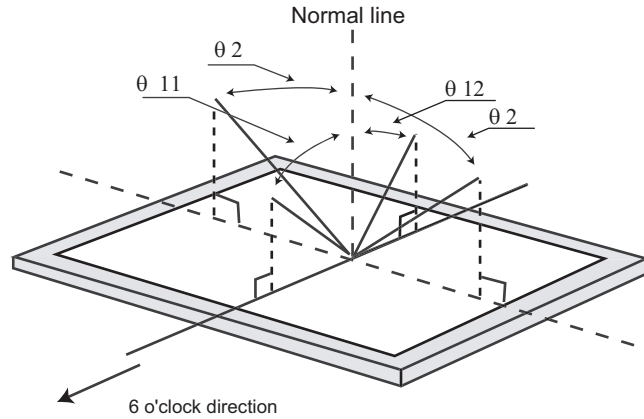


Optical characteristics measurements method.



Notes:

1. Viewing angle range is defined as follows.

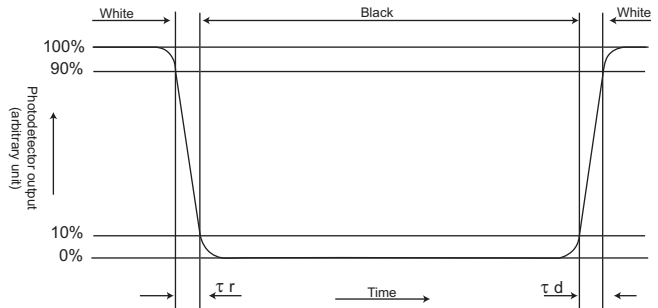


definition for viewing angle

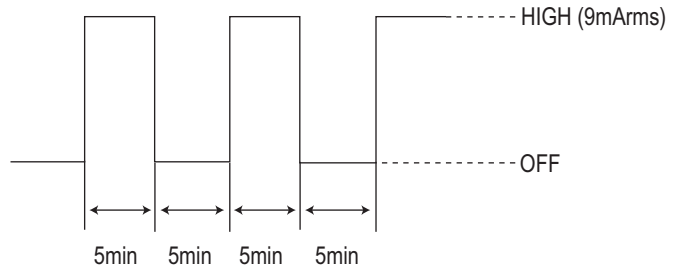
2. Contrast ratio is defined as follows:

$$\text{Contrast ratio (CR)} = \frac{\text{Photo detector output with LCD being "white"}}{\text{Photo detector output with LCD being "black"}}$$

3. Response time is obtained by measuring the transition time of photo detector output, when input signals are applied so as to make the area "black" to and from "white".



4. Measured on the center area of the panel at a viewing cone 2° (= Filed) by TOPCON luminance meter BM-5A or ELDIM luminance meter EZ Contrast. (After 30 minutes operation). DC/AC inverter driving frequency: (49 kHz)
5. Measured on the center area of the panel at a viewing cone 1° (= Filed) by TOPCON luminance meter BM-7. (After 30 minutes operation) DC/AC inverter driving frequency: (49 kHz)
6. Lamp lifetime is defined as the time when either one or the other of the following occurs in the continuous operation under the condition of lamp current. IL=5.5mArms and PWM dimming 80%~5 % (IL=9.0mArms Ta=25°C). Brightness becomes 50% of the original value.
7. The intermittent cycles are defined as a time when brightness becomes 50% of the original value under the condition of following cycle. Ambient temperature:-30° C.



* Turn on the lamp with symmetrical (negative and positive) voltage and current wave form.



MECHANICAL CHARACTERISTICS

By applying pressure on the active area it is possible to cause damage to the display.

Input/output connector performance

I/O connector of backlight driving circuit (JST)

Lamp connector

Symbol	Used Connector	Corresponding Connector
CNA, B	BHR-02(8.0)VS-1N	SM02 (8.0)B-BHS-1N (assembled on PWB)
		SM02 (8.0)B-BHS-TB (assembled on PWB)
		BHMR-03V (interconnector)

DISPLAY QUALITY

The display quality of the color TFT-LCD module shall be in compliance with the Incoming Inspection Standards for TFT-LCD.

HANDLING INSTRUCTIONS

Mounting the module

The TFT-LCD module is designed to be mounted on equipment using the mounting tabs in the four corners of the module at the rear side. Make certain to fix the module on the same plane, taking care not to warp or twist the module. Power off the module when you connect the input/output connector. Connect the metallic shielding cases of the module and the ground pattern of the inverter circuit securely. If that connection is not secure, the following possibilities may happen.

- a) Increased backlight noise.
- b) The output from inverter circuit will become unstable.
- c) Parts of the module will heat up.

MOUNTING PRECAUTIONS

The polarizer is made of soft material and must be handled carefully. Protective film (Laminator) is applied on the surface to protect it against scratches and dirt. It is recommended to peel off the laminator immediately before use, taking care of static electricity.

Follow the precautions below when peeling off the laminator:

Working environment

When the laminator is peeled off, static electricity may cause dust to stick to the polarizer surface. To avoid this from occurring, the following working environment is desirable.

Floor: Conductive treatment of 1M or more on the tile (conductive mat or conductive paint on the tile)

Clean room should be free from dust and have an adhesive mat at the doorway. Advisable humidity: 50%~70%
Advisable temperature: 15°C~27°C
Workers should wear conductive shoes, work clothes and gloves and an earth band.

MODULE ADJUSTING PRECAUTIONS

Adjusting volumes on the rear face of the module have been set optimally before shipment. Therefore, do not change any adjusted values. If adjusted values are changed, the specifications described here may not be satisfied.

PRODUCT DESIGN CAUTION

The LCD module shall be protected against water by the waterproof cover.

OTHERS

Do not expose the module to direct sunlight or intensive ultraviolet rays for many hours; liquid crystal is deteriorated by ultraviolet rays. Store the module at a temperature near room temperature. At lower than the rated storage temperature, liquid crystal solidifies, causing the panel to be damaged. At higher than the rated storage temperature, liquid crystal turns into isotropic liquid and may not recover. If LCD panel breaks, there may be a possibility that the liquid crystal escapes from the panel. Since the liquid crystal is injurious do not put it into the eyes or mouth. When liquid crystal sticks to hands, feet or clothes, wash it out immediately with soap. Observe all other precautionary requirements in handling general electronic components.



PACKING FORM

Piling number of cartons: MAX 10

Package quantity in one carton: 50 pcs

Carton size: 483 (W) x 166 (H) x 314 (D) mm

Total mass of one carton filled with full modules: 7.7kg

Conditions for storage:

Environment

(1) Temperature: 0~40°C

(2) Humidity: 60%RH or less (at 40°C)

No dew condensation at low temperature and high humidity,

(3) Do not subject display to harmful gases.

(4) Period: about 3 months

(5) Opening of the package: In order to prevent the LCD module from breakdown by electrostatic charges, control room humidity over 50%RH and when opening the package, make certain that one is grounded.

RELIABILITY TEST

Reliability test conditions for the TFT-LCD module are shown in the table on page 13.

OTHERS

Volume adjustment has been set optimally prior to shipment, do not change any adjusted value. If adjusted value is changed, the specification may not be satisfied.

Disassembling the module may cause permanent damage and should be strictly avoided. Image retention may occur when a fixed pattern is displayed for a long time.



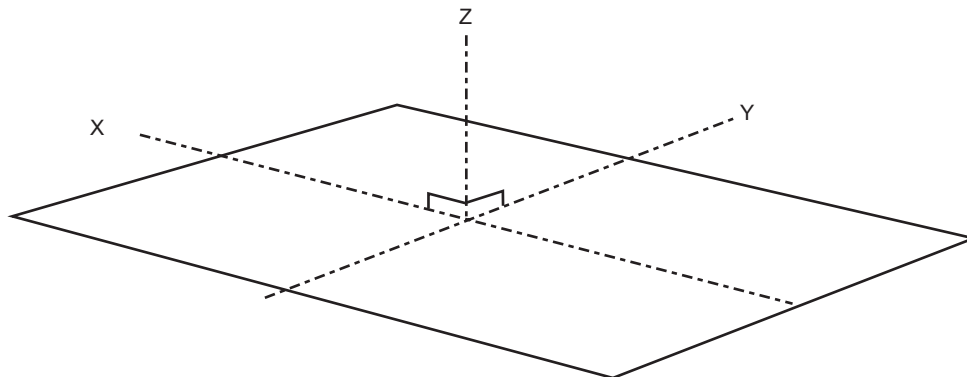
RELIABILITY TEST CONDITIONS FOR TFT-LCD MODULE

(Temperature condition is based on operating temperature conditions on 5 Table 5.)

No.	Test items	Test conditions
1	High temperature storage test	$t_a=+95^{\circ}\text{C}$ 240h
2	Low temperature storage test	$t_a=-40^{\circ}\text{C}$ 240h
3	High temperature and high humidity operating test	$t_p=+60^{\circ}\text{C}$, 95%RH 240h
4	High temperature operating test	$t_p=+85^{\circ}\text{C}$ 240h
5	Low temperature operating test	$t_p=-30^{\circ}\text{C}$ 240h
6	Electrostatic discharge test	$\pm 200\text{V} \cdot 200\text{pF}(\text{O}\Omega)$ 1 time for each terminal
7	Shock test	980m/s^2 6mx, $\pm X$; $\pm Y$ $\pm Z$ (JIS C0041, A-7 Conditions C) 3 times for each direction
8	Vibration test	Frequency Range: 8~33.3Hz Stroke: 1.3mm Sweep: 33.3Hz~400Hz Acceleration: 28.4m/s^2 Cycle: 15 minutes X,Z 2 hours [caution] (JIS D1601)
9	Heat shock test	$t_a=-40^{\circ}\text{C} \sim +95^{\circ}\text{C}/200$ cycles (0.5h) (0.5h)

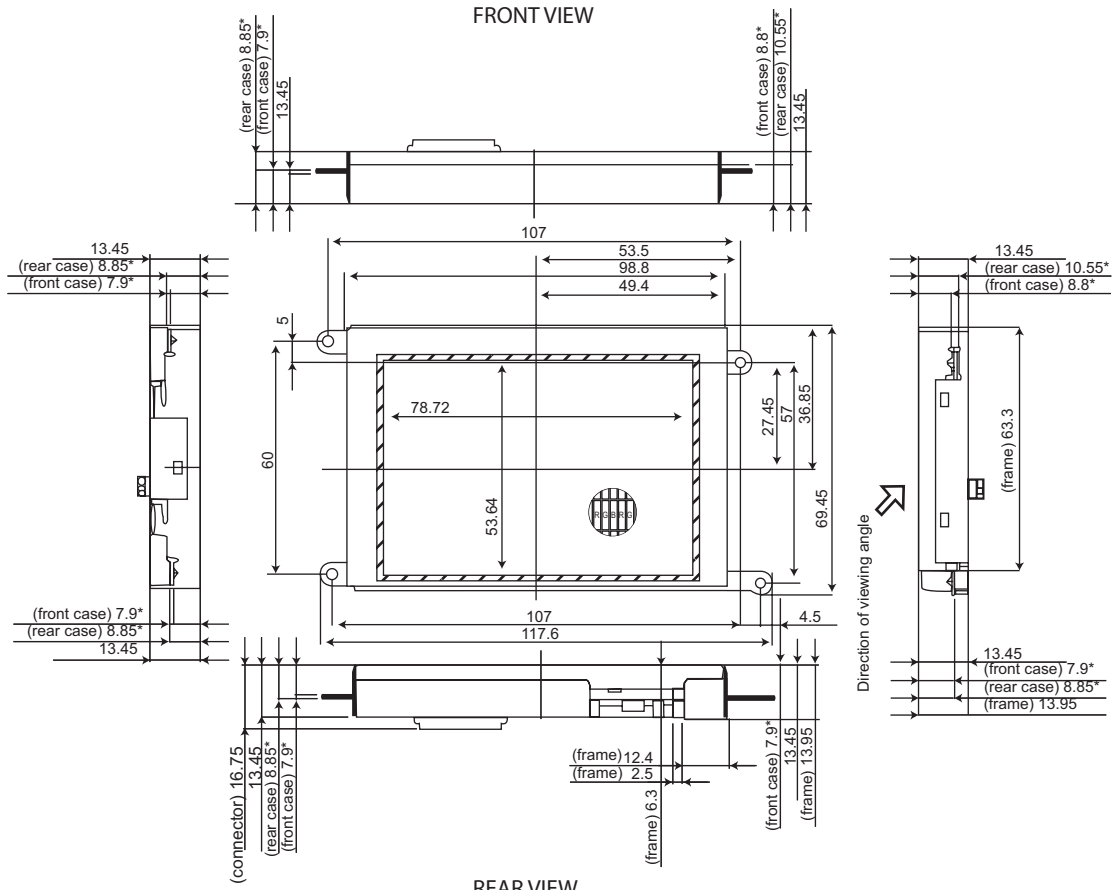
Notes:

- t_a =Ambient temperature, t_p =Panel temperature
X,Y,Z directions are shown as follows:

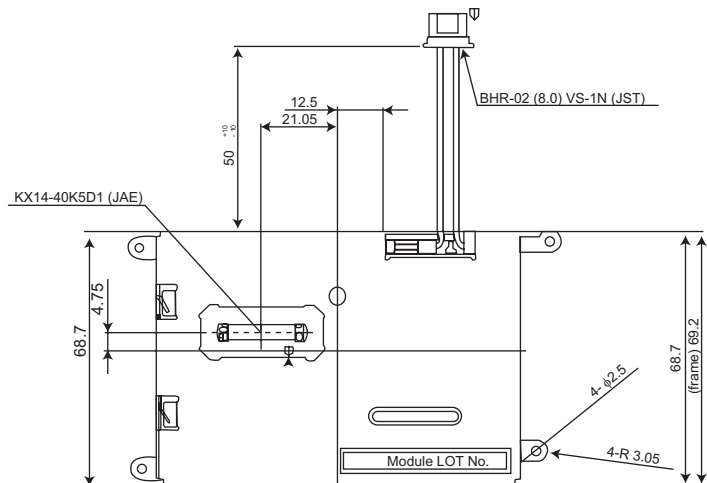




OUTLINE DIMENSIONS



- Notes:
1. General tolerance is ± 0.3
 2. Unit is mm
 3. The dimension marked "*" shows the base of the mounting tab



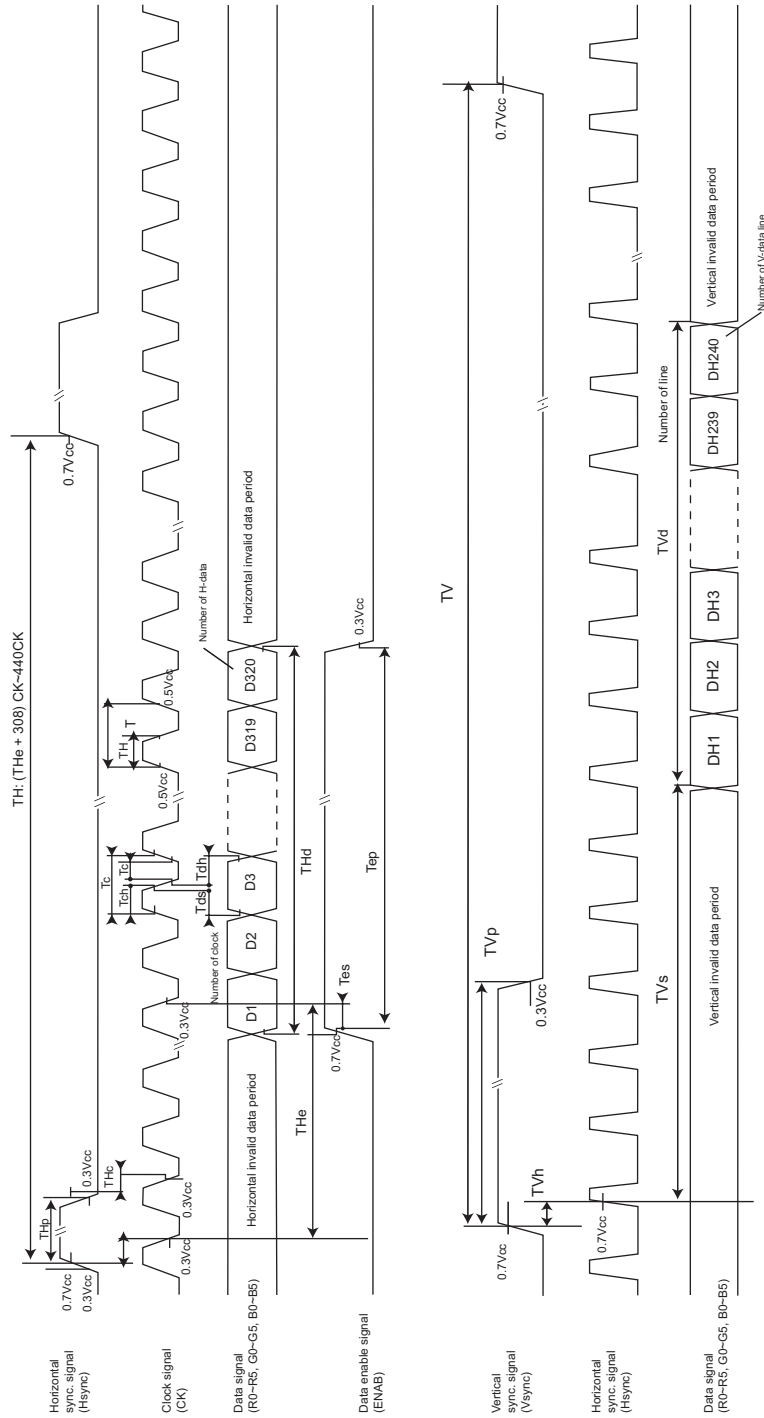


Fig. 3-A Input signal waveform

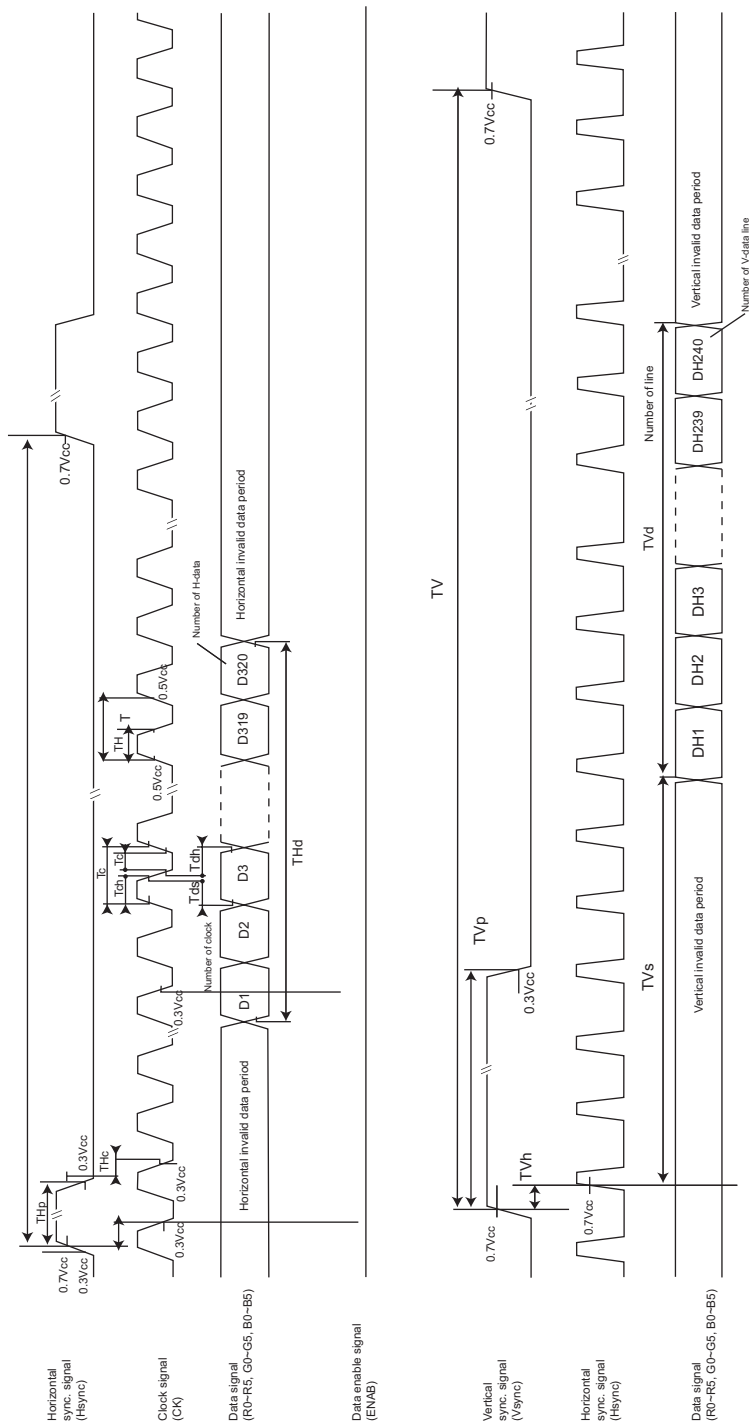


Fig. 3-B Input signal waveform