

FEATURES

- Display Diagonal: 8.4"
- Display Format: 640 × 480
- Overall Dimensions:
243.5 (W) × 180.0 (H) × 12.0 (D) mm
- Active Area: 170.8 (W) × 129.6 (D) mm
- Dot Pitch: 0.267 (W) × 0.27 (H) mm
- Viewing Angle: 6 O'Clock (12 O'Clock Optional)
- Bits Per Color: 4

DESCRIPTION

The SHARP LQ9P031 Color TFT-LCD module is an active matrix Liquid Crystal Display (LCD) incorporating amorphous silicon Thin Film Transistor (TFT). The module is composed of a color TFT-LCD panel, driver ICs, a control circuit, and a power supply circuit. Graphics and text can be displayed on a 640 × 3 × 480 dot panel in 4096 colors by supplying a 12-bit (4-bit × 3) data signal, four kinds of timing signals, +5 VDC supply voltage for TFT-LCD panel driving.

Two modes of operation are available: the 400-line mode and the 350-line mode. Also, a built-in horizontal display reverse function suitable for projector applications is provided.

MECHANICAL SPECIFICATIONS

PARAMETER	SPECIFICATIONS	UNIT	NOTE
Screen Size (Diagonal)	21 (8.4 inch)	cm	–
Active Area	170.9 (H) × 129.6 (V)	mm	–
Display Pixels	640 (H) × 480 (V) (1 Pixel = R + G + B Dots)	pixel	–
Pixel Pitch	0.267 (H) × 0.270 (V)	mm	–
Pixel Configuration	RGB Vertical Stripe	–	–
Display Mode	Normally White	–	–
Outline Dimensions	242.5 (W) × 179.4 (H) × 8.2 (D)	mm	1
Mass	360 ±20	g	–
Surface Treatment	Anti-Glare and Hard-Coating 2H	–	2
Haze Value	25 ±5	%	–

NOTES:

1. Excludes component height (9.0 mm maximum).
2. Incoming light side.

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	CONDITION	RATINGS	UNIT	NOTE
V_I	Input Voltage	$t_A = 25^\circ\text{C}$	-0.3 to $V_{CC} + 0.3$	V	1
V_{CC}	+5 V Supply Voltage	$t_A = 25^\circ\text{C}$	-0.3 to +7	V	
T_{stg}	Storage Temperature	–	-25 to +60	$^\circ\text{C}$	2
T_{opa}	Operating Temperature (Ambient)	–	0 to +50	$^\circ\text{C}$	
T_P	Panel Surface Temperature	–	0 to +50	$^\circ\text{C}$	
l_l	Light Source Wave Length	–	≥ 400	nm	
I_l	Light Source Illumination Intensity	–	$\leq 300,000$	lx	3, 4

NOTES:

1. CK, R0 to R3, G0 to G3, B0 to B3, Hsync, Vsync, ENAB, NBH.
2. Humidity: 95% RH maximum at $t_A \leq 40^\circ\text{C}$. Maximum wet-bulb temperature 39°C or less at $t_A > 40^\circ\text{C}$. No condensation.
3. Measurement point: panel surface. See Figure 1.
4. Light source shall be placed at incoming light side.

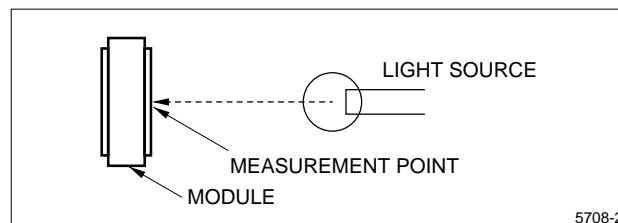


Figure 1. Measurement Point: Panel Surface

INPUT TERMINALS – TFT-LCD PANEL DRIVER - CN1 (Interface Signal)²

PIN NUMBER	SYMBOL	FUNCTION	NOTES
1	R0	RED Data Signal (LSB)	–
2	GND	–	–
3	R1	RED Data Signal	–
4	Vsync	Vertical Sync Signal	2
5	R2	RED Data Signal	–
6	Hsync	Horizontal Sync Signal	2
7	R3	RED Data Signal (MSB)	–
8	GND	–	–
9	GND	–	–
10	CK	Clock Signal for Sampling Each Data Signal	–
11	G0	GREEN Data Signal (LSB)	–
12	GND	–	–
13	G1	GREEN Data Signal	–
14	NBH	Horizontal Display Mode Select Signal	3
15	GND	–	–
16	TST	This Should be Electrically Opened During Operation	–
17	G2	Green Data Signal	–
18	TST	This Should be Electrically Opened During Operation	–
19	G3	GREEN Data Signal (MSB)	–
20	GND	–	–
21	GND	–	–
22	V _{CC}	+5 V Power Supply	–
23	B0	BLUE Data Signal (LSB)	–
24	V _{CC}	+5 V Power Supply	–
25	B1	BLUE Data Signal	–
26	TST	This Should be Electrically Opened During Operation	–
27	GND	–	–
28	ENAB	Data Enable Signal (to Settle the Viewing Area)	4
29	B2	Blue Data Signal	–
30	GND	–	–
31	B3	BLUE Data Signal (MSB)	–

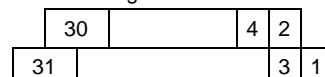
NOTES:

The shielding case is connected with GND.

- Connector used: DF9BA-31P-1V (Hirose Electric Co. Ltd.)
Mating connector: DF9B-31S-1V (Hirose Electric Co., Ltd.)
- 480-line, 400-line, or 350-line mode is selected by the polarity combination of both synchronous signals:

MODE	480 LINES	400 LINES	350 LINES
Hsync	Negative	Negative	Positive
Vsync	Negative	Positive	Negative

CN1 Pin arrangement:



- See Figure 2 for Display Mode.
- The horizontal display start timing is settled with a rising timing of this signal. In case ENAB is fixed 'low,' the horizontal start timing is determined in the module. Refer to the 'Timing Characteristics of Input Signals' table.

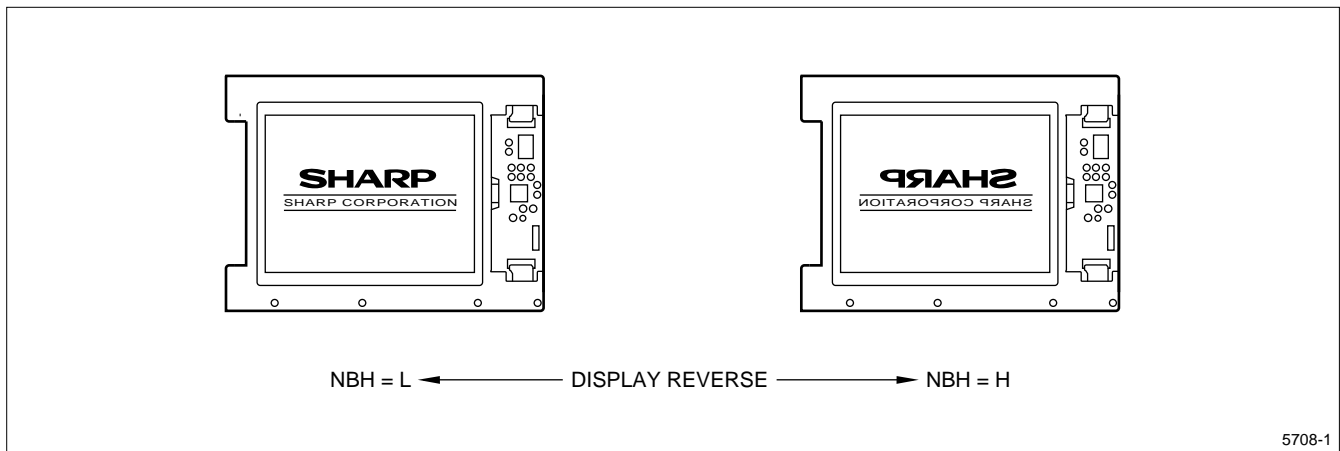


Figure 2. Horizontal Display Mode Select Signal

ELECTRICAL CHARACTERISTICS AND CURRENT DISSIPATION ($t_A = 25^\circ\text{C}$)

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
V_{CC}	+5 V Supply Voltage	–	+4.5	+5.0	+5.5	V	1
I_{CC}	+5 V Current Dissipation	–	–	270	400	mA	2
V_{RP}	Permissive Input Ripple Voltage	V_{CC}	–	–	100	mV _{P-P}	–
V_{IL}	Input Voltage (Low)	$V_{CC} = +5\text{ V}$	–	–	1.5	V	3
V_{IH}	Input Voltage (High)		+3.5	–	–	V	3
I_{IL1}	Input Current (Low)	$V_I = 0\text{ V}$	–	–	1.0	μA	4
I_{IL2}			–	–	60	μA	5
I_{IH1}	Input Current (High)	$V_I = V_{CC}$	–	–	1.0	μA	6
I_{IH2}			–	–	60	μA	7

NOTE:

- V_{CC} Turn-On Conditions:
 t_1 : Rise Time ($\leq 10\text{ ms}$)
 t_2 : Data Input Allowance Time ($\leq 10\text{ ms}$)
 t_3 : Fall Time ($> 0\text{ ms}$) (Figure 2)
 V_{CC} Dip Conditions: $2.7\text{ V} \leq V_{CC} < 4.5\text{ V}$, $t_d = 10\text{ms Max}$,
 $V_{CC} < 2.7\text{ V}$, (V_{CC} dip conditions are the same as the V_{CC} turn-on conditions) (Figure 3).
- Typical current situation is defined as 16-gray-bar pattern (at 480-line mode, $V_{CC} = 5\text{ V}$).
- CK, R0 – R3, G0 – G3, B0 – B3, Hsync, Vsync, ENAB, NBH
- CK, R0 – R3, G0 – G3, B0 – B3, Hsync, Vsync, ENAB
- NBH
- CK, R0 – R3, G0 – G3, B0 – B3, Hsync, Vsync, NBH
- ENAB

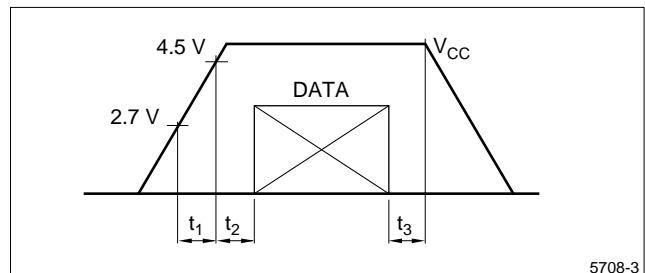


Figure 3. V_{CC} Turn-On Conditions

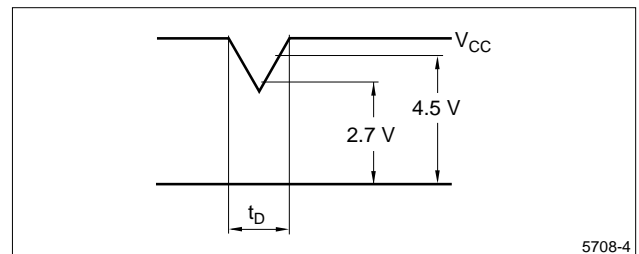


Figure 4. V_{CC} Dip Conditions

TIMING CHARACTERISTICS OF INPUT SIGNALS ¹

SYMBOL	PARAMETER	MODE	MIN.	TYP.	MAX.	UNIT
1/t _C	Clock Frequency	All	–	25.18	28.33	MHz
t _{CH}	Clock High Time	All	5	–	–	ns
t _{CL}	Clock Low Time	All	10	–	–	ns
t _{DS}	Data Setup Time	All	5	–	–	ns
t _{DH}	Data Hold Time	All	10	–	–	ns
t _H	Horizontal Sync Signal Cycle	All	30.00	31.78	–	μs
		All	770	800	900	Clock
t _{HP}	Horizontal Sync Signal Pulse Width	All	2	96	200	Clock
t _V	Vertical Sync Signal Cycle	480	515	525	560	Line
		400	445	449	480	Line
		350	447	449	510	Line
t _{VP}	Vertical Sync Signal Pulse Width	All	2	–	34	Line
t _{HD}	Horizontal Signal Display Period	All	640	640	640	Clock
t _{HC}	Hsync-Clock Phase Difference	All	10	–	TC-10	ns
t _{VH}	Hsync-Vsync Phase Difference	All	0	–	TH-T _{Hp}	ns

NOTE:

1. In case of lower frequency, flicker may occur and display quality may deteriorate.

HORIZONTAL DISPLAY POSITION AND DATA ENABLE SIGNAL ¹

SYMBOL	PARAMETER	MODE	MIN	TYP	MAX	UNIT
T _{ES}	Enable Signal – Setup Time	All	5	–	T _c - 10	ns
T _{EP}	Enable Signal – Pulse Width	All	2	640	640	Clock
T _{HE}	Hsync Enable Signal Phase Difference	All	44	–	164	Clock

NOTE:

1. If the data enable signal is input, the horizontal display starts from rising the data enable signal.
If the data enable terminal (ENAB) is fixed 'Low,' the horizontal display starts from the data of C104 (clock).

VERTICAL DISPLAY POSITION ¹

MODE	V-DATA START (T _{Vs})	V-DATA PERIOD (T _{Vd})	V-DISPLAY START	V-DISPLAY PERIOD	UNIT	NOTE
480	34	480	34	480	Line	–
400	34	400	443-T _V			2
350	61	350	445-T _V			

NOTES:

1. The vertical display position is centered in 480-line, 400-line, and 350-line modes of VGA with the polarity of the sync signals and values in the above table. The data enable signal does not effect the vertical display position.
2. During vertical data invalid period which is displayed in 400-line and 350-line modes, inputting all data '0' is recommended. In 400-line and 350-line modes, the display position will not be centered on the screen in the vertical sync signal. T_V does not have the above typical values.

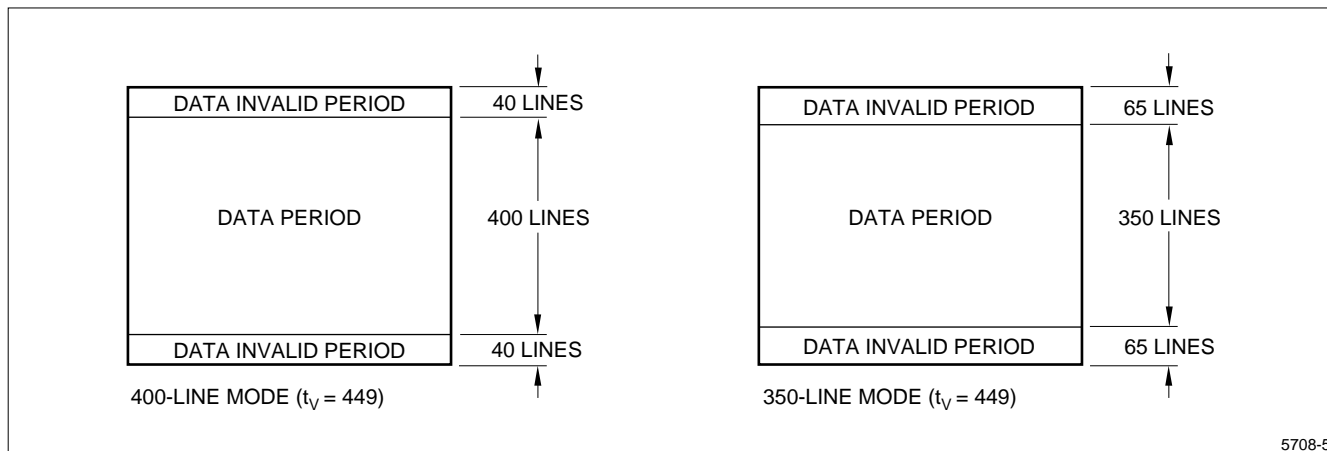


Figure 5. Vertical Data Invalid Period

INPUT DATA SIGNALS AND DISPLAY POSITION ON THE SCREEN

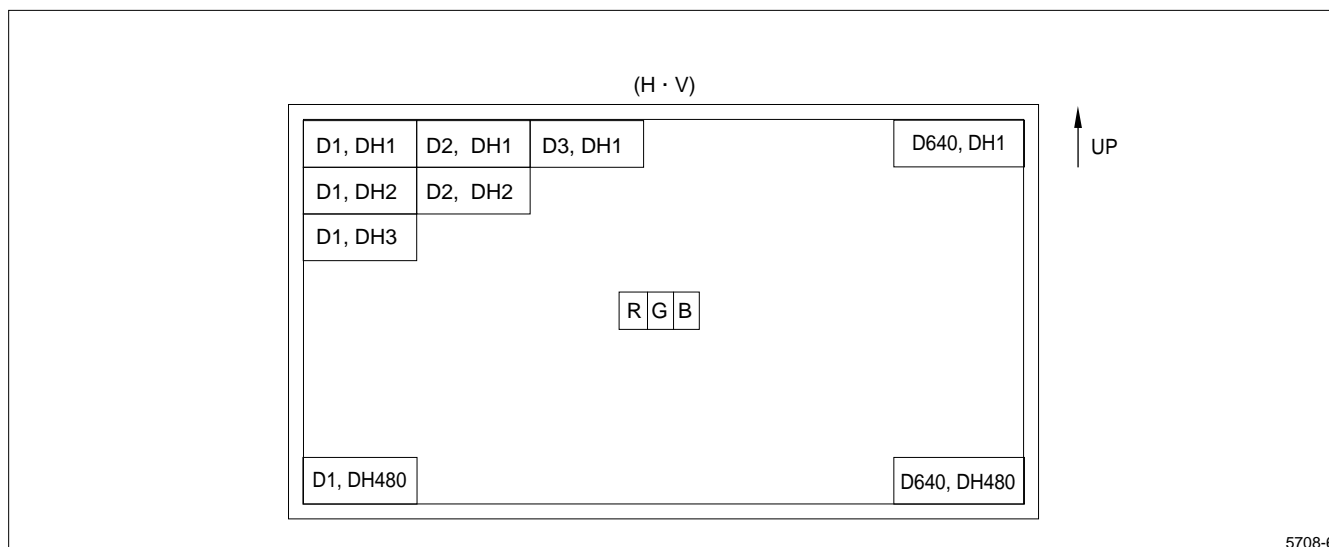
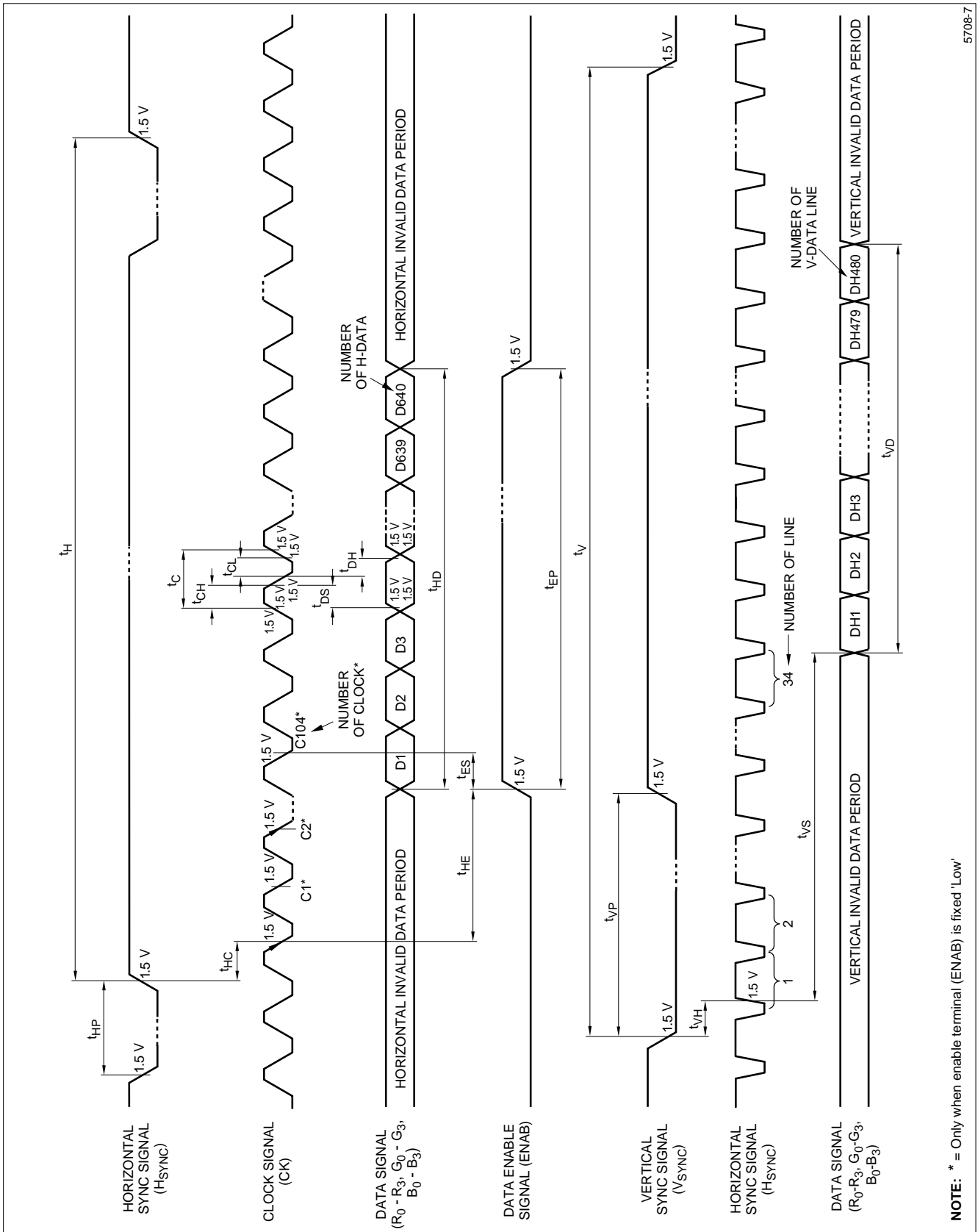
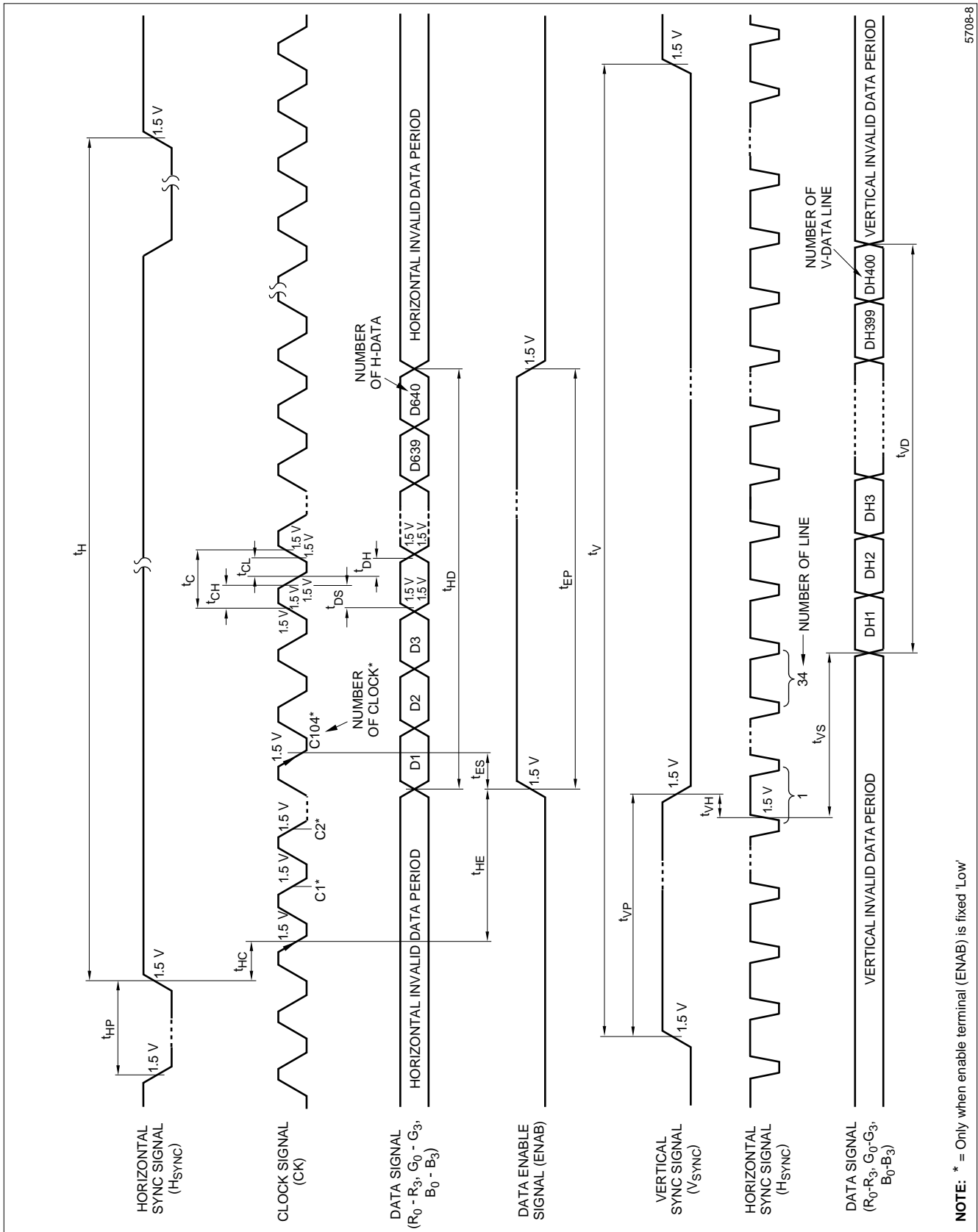


Figure 6. Display Position of Input Data (480-line Mode)



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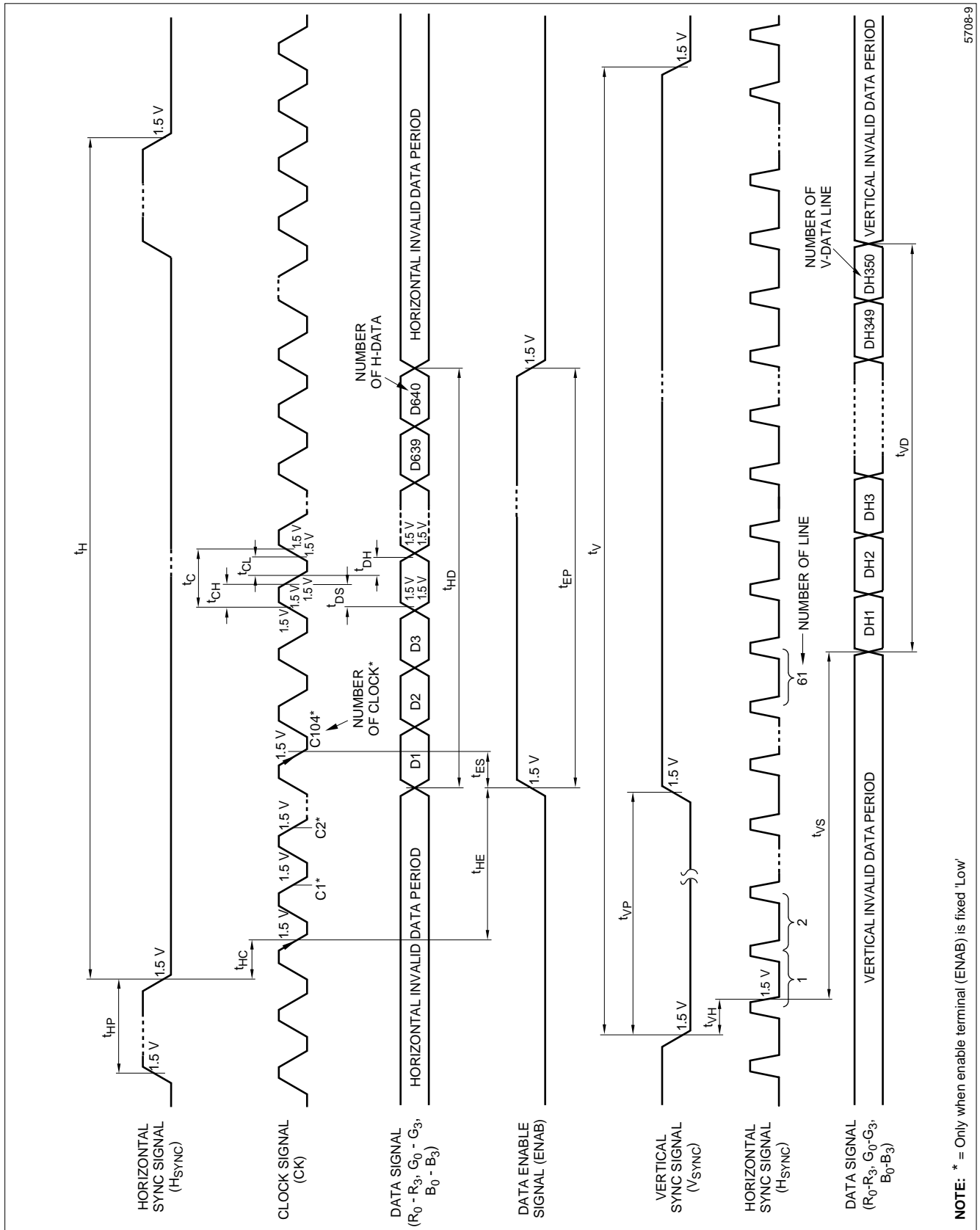
Figure 7. Input Signal Waveforms (480-Line Mode)



NOTE: * = Only when enable terminal (ENAB) is fixed 'Low'

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Figure 8. Input Signal Waveforms (400-Line Mode)



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Figure 9. Input Signal Waveforms (350-Line Mode)

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

COLOR AND GRAY SCALE		DATA SIGNAL											
		R ₀	R ₁	R ₂	R ₃	G ₀	G ₁	G ₂	G ₃	B ₀	B ₁	B ₂	B ₃
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	1	1	1	1
	Green	0	0	0	0	1	1	1	1	0	0	0	0
	Light Blue	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	0	0	0	0	0	0	0	0
	Purple	1	1	1	1	0	0	0	0	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1
Gray Scale of Red	Black	0	0	0	0	0	0	0	0	0	0	0	0
	↑	1	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	1	0	0	0	0	0	0	0	0	0	0
	↑	↓				Ä				↓			
	↓	↓				Ä				↓			
	Brighter	1	0	1	1	0	0	0	0	0	0	0	0
	↓	0	1	1	1	0	0	0	0	0	0	0	0
	Red	1	1	1	1	0	0	0	0	0	0	0	0
Gray Scale of Green	Black	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	1	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	1	0	0	0	0	0	0
	↑	↓				Ä				↓			
	↓	↓				Ä				↓			
	Brighter	0	0	0	0	1	0	1	1	0	0	0	0
	↓	0	0	0	0	0	1	1	1	0	0	0	0
	Green	0	0	0	0	1	1	1	1	0	0	0	0
Gray Scale of Blue	Black	0	0	0	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	0	0	1	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	1	0	0
	↑	↓				Ä				↓			
	↓	↓				Ä				↓			
	Brighter	0	0	0	0	0	0	0	0	1	0	1	1
	↓	0	0	0	0	0	0	0	0	0	1	1	1
	Blue	0	0	0	0	0	0	0	0	1	1	1	1

NOTES:

- Each color is displayed in 16 gray scales from 4-bit data signal input. According to the combination of the total 12-bit data, 4096 colors are displayed.
- 0 = Low-Level Voltage
1 = High-Level Voltage

OPTICAL CHARACTERISTICS ($t_A = 25^\circ\text{C}$, $V_{CC} = +5.0\text{ V}$)

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
$\theta_{21.22}$	Horizontal Viewing Angle Range	CR > 10	35	–	–	degrees	4
θ_{11}	Vertical Viewing Angle Range		30	–	–		
θ_{12}			10	–	–		
CR	Contrast Ratio	Optimum Viewing Angle	60	–	–	–	2, 4
t_R	Response Time – Rise	$\theta = 0^\circ$	–	30	–	ms	3, 4
t_D	Response Time – Decay		–	50	–	ms	
T_R	Transmissivity		4.3	6.0	–	%	4, 5
ΔX	Chromaticity Shift		-0.038	-0.008	+0.022	–	5, 6
ΔY			-0.024	+0.006	+0.036	–	

NOTES:

Optical characteristics of backlight for measurement: Luminance : $\geq 3500\text{ cd/m}^2$, Wave length: $\geq 400\text{ nm}$

- The measurement shall be executed 15 to 20 minutes after the module has been lit at the proper rating. The optical characteristics shall be measured in a dark room or equivalent state with the method shown in Figure 12.
- The Contrast Ratio is defined as follows: Contrast Ratio = $\frac{\text{Luminance (brightness) with all pixels white}}{\text{Luminance (brightness) with all pixels black}}$
- The Response Time is measured as shown in Figure 11 by switching the input signals for 'black' ON and OFF.
- The Definition of Transmissivity is defined as follows:
Transmissivity = $\frac{\text{Light detected level of the transmission through the LCD panel}}{\text{Light detected level of the Original light source}}$
- Measurements shall be taken at the center of the screen.
- Chromaticity shift is the difference between the light source and the module placed on it. The values are measured with standard illuminance: C ($x = 0.310$, $y = 0.316$).

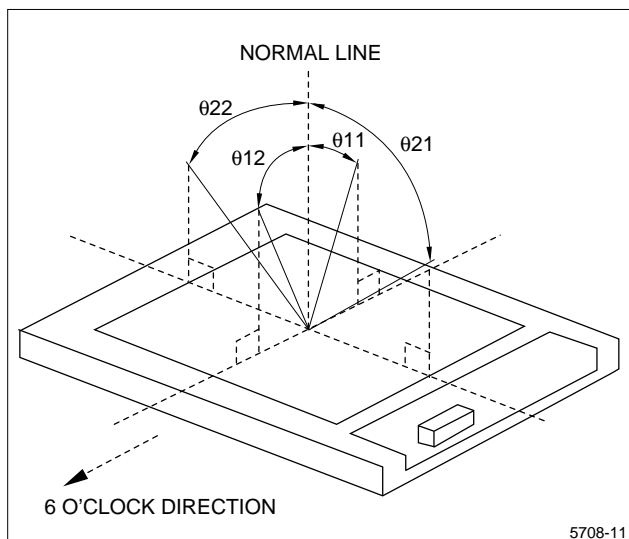


Figure 10. Definition of Viewing Angle Range

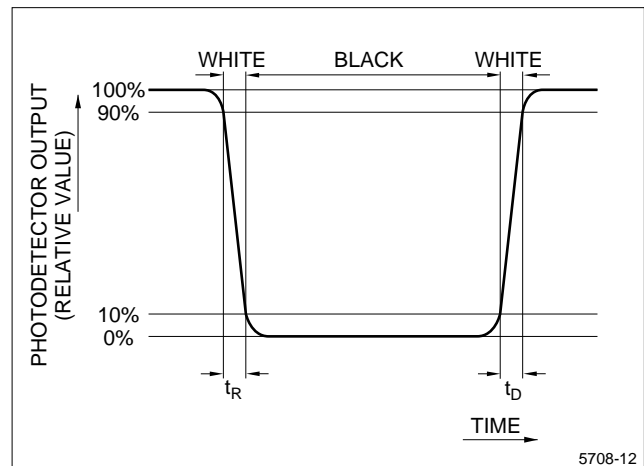


Figure 11. Definition of Response Time

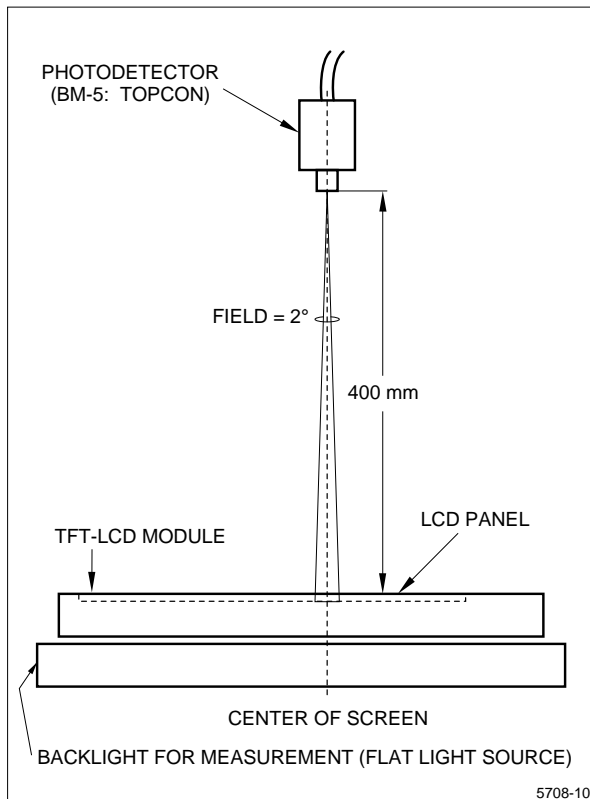


Figure 12. Optical Characteristics Measurement Method

DISPLAY QUALITY

The display quality of the color TFT-LCD module shall be in compliance with the Delivery Inspection Standard.

HANDLING PRECAUTIONS

- Be sure to insert the cable into the connector or remove it from the connector after turning off the power supply on the set side.
- Power ON/OFF sequential timing – To prevent the latch-up of the circuit in the module, keep the sequential timing between input signals and supply voltages.
- When installing the module, be sure to fix the module on the same plane, taking care not to warp or twist the module.
- Handle the front polarizer carefully since it scratches easily.
- Wipe off water drops immediately. Long contact with water may cause discoloration or spots.
- When the panel surface is soiled, wipe it with a soft cloth.
- The LCD module is made of glass. Use care when handling it to avoid breakage.
- This unit uses CMOS LSIs which are sensitive to electrostatic charges. Use care to protect the unit from electrostatic discharge.
- Do not disassemble the unit.
- Image retention may occur when a fixed pattern is displayed for a long period of time.

Precautions When Peeling off the Laminator

Working Environment

When the laminated film is peeled off, some dust particles might be stuck because of electrostatic charges, so the following working environment is recommended:

- Floor: Anti-static treatment, more than 1 M Ω on the tile.
- Spread an adhesive mat at a doorway in the clean room.
- Humidity: 50% to 70%.
- Temperature: 15°C to 27°C.
- Workers shall wear conductive shoes, conductive work clothes, and a ground strap.

Working Procedures

- Keep the distance between the module and the heated ionized air blower within 20 cm. The module shall be blown to the wind of the blower (Figure 13).
- Attach an adhesive tape to a corner of the laminated film near the heated ionized air blower (Figure 13).
- Peel the laminated film, pulling the adhesive tape to your side. It is important that it takes more than five seconds to peel off the laminated film.
- After peeling off the laminated film, immediately move the module to the next work area without getting it dusty.
- Methods of removing dust from polarizer:
 - Blow it off using a nitrogen blower that guards against electrostatic charges. An ionized air gun is recommended.

- Since the polarizer is easily damaged, wipe it off carefully with a soft cloth.
- Wipe liquid off immediately since it can cause discoloration or spots.
- When the metal panel surface is soiled, wipe it with an absorbent cotton or other soft cloth.
- The module is made of glass. Use care when handling it to avoid breakage.
- Since CMOS LSI is used in this module, avoid problems with static electricity by grounding yourself before handling the module.

Precautions in Adjusting Module

- Adjusting volumes have been set optimally before shipment, so do not change any adjusted values. If adjusted values are changed, the specifications described in this technical literature may not be satisfied.

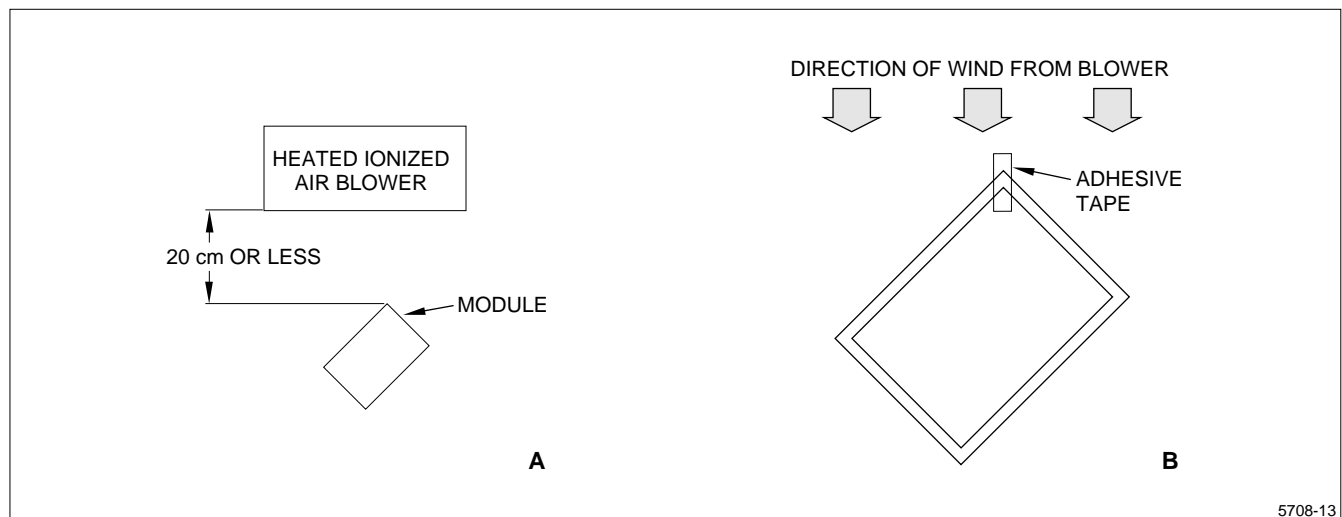
Other Precautions

- Do not disassemble the unit.
- Do not display a fixed pattern for prolonged periods of time since image retention may occur.
- Observe all other precautionary requirements in handling the components.

PACKING SPECIFICATIONS

Refer to the Packing Form shown in Figure 14.

- Piling number of cartons: 7 (MAX)
- Package quantity in one carton: 10 (MAX)
- Carton size: 413 (W) \times 288 (H) \times 351 (D) mm
- Total weight of 1 carton filled with full modules: 6,300 g



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Figure 13. Heated Ionized Air Blower Precautions

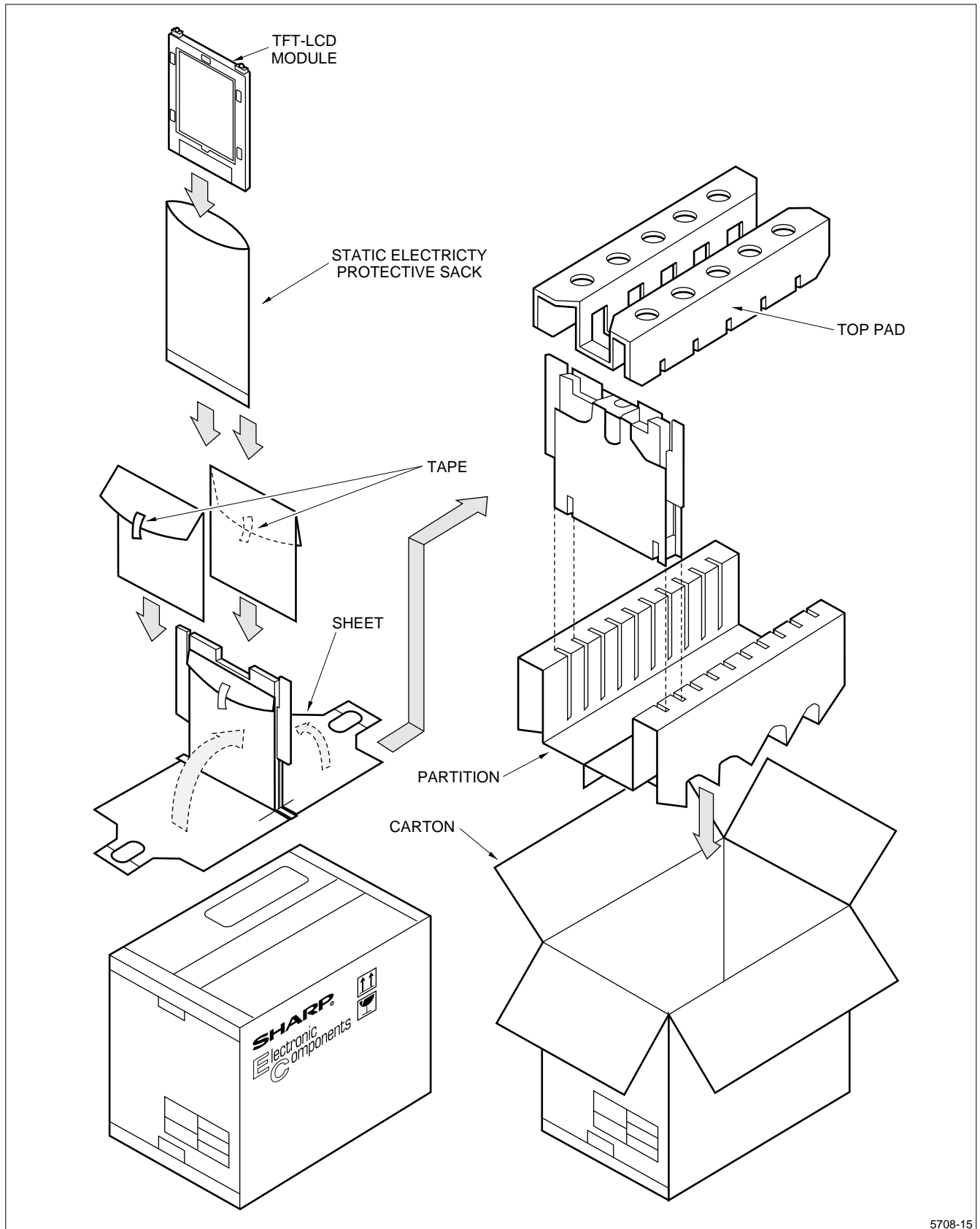


Figure 14. Packing Form

RELIABILITY TEST ITEMS

NUMBER	TEST ITEM	CONDITIONS
1	High Temperature Storage Test	$t_A = 60^\circ\text{C}$, 240 H
2	Low Temperature Storage Test	$t_A = -25^\circ\text{C}$, 240 H
3	High Temperature and High Humidity Operation Test	$t_A = 40^\circ\text{C}$, 95% RH, 240 H (No condensation)
4	High Temperature Operation Test	$t_A = 50^\circ\text{C}$, 240 H
5	Low temperature Operation Test	$t_A = 0^\circ\text{C}$, 240 H
6	Vibration Test (Non-Operating)	Frequency: 10 Hz to 57 Hz/Vibration width (one side): 0.075 mm 58 Hz to 500 Hz/Gravity: $+9.8 \text{ m/s}^2$ Sweep Time: 11 minutes Test Period: three hours total (one hour for each direction of X/Y/Z)
7	Shock Test (Non-Operating)	Maximum Gravity: 490 G Pulse Width: 11 ms, sine wave Direction: $\pm X$, $\pm Y$, $\pm Z$, once for each direction

RESULT EVALUATION CRITERIA

Under the display quality test conditions with normal operating state, there shall be no change which may affect practical display functions.

OTHER INFORMATION

If any problem should arise from this specification, the supplier and user should work out a mutually acceptable solution.

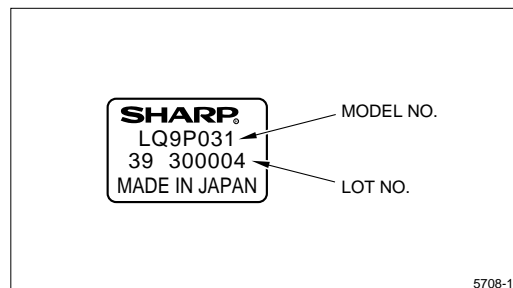


Figure 15. Lot No. Label

OUTLINE DIMENSIONS

