SHARP

LQ9P021

LCD Data Sheet

TFT-LCD Module

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 × 129.6 (H) mm
- Dot Pitch: 0.267 (W) × 0.27 (H) mm
- Viewing Angle: 6:00 (12:00 Optional)
- Bits Per Color: 3

DESCRIPTION

The SHARP LQ9P021 color TFT-LCD module is an active matrix Liquid Crystal Display (LCD) module incorporating amorphous silicon Thin Film Transistor (TFT). It 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 512 colors by supplying a 9-bit data signal, four kinds of timing signals, and a +5 VDC supply voltage for TFT-LCD panel driving. 400-line and 350-line modes, in addition to the 480-line mode, can also be applied to this module.

NOTE: Built-in horizontal display reverse function makes this module suitable for projection use.

MECHANICAL SPECIFICATIONS

PARAMETER	SPECIFICATIONS	UNIT	NOTE
Outline Dimensions	242.5 (W) × 179.4 (H) × 8.2 (D)	mm	1
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	–	–
Weight	360 ±20	g	–
Surface Treatment	Anti-Glare and Hard Coating 2 H	–	2

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°C	–0.3 to V_{CC} + 0.3	V	1
V_{CC}	+5 V Supply Voltage	t_A = 25°C	0 to +7	V	
Tstg	Storage Temperature	–	–25 to +60	°C	2
Topa	Operating Temperature (Ambient)	–	0 to +50		
T_P	Panel Surface Temperature	–	0 to +50		
λ_I	Light Source Wavelength	–	≥ 400	nm	–
I_I	Light Source Illumination Intensity	–	≤ 300,000	1×	3, 4

NOTES:

1. CK, R0 – R2, G0 – G2, B0 – B2, Hsync, Vsync, ENAB, NBH.
2. Humidity: 95% RH maximum at $t_A \leq 40°C$. Maximum wet-bulb temperature ≤39°C at $t_A > 40°C$. No condensation.
3. Measurement point: panel surface (Figure 1).
4. Light source shall be placed at incoming light side. Refer to the Outline Dimensions diagram.

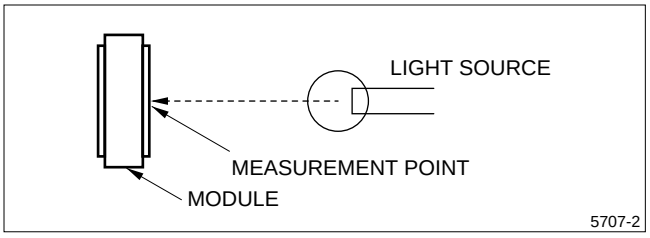


Figure 1. Measurement Point

INPUT TERMINALS – CN1 (INTERFACE SIGNAL)[1]

PIN NUMBER	SYMBOL	FUNCTION	NOTE
1	TST	This should be electrically opened during operation	–
2	GND	–	–
3	R0	RED Data Signal (LSB)	–
4	Vsync	Vertical Sync Signal	2
5	R1	RED Data Signal	–
6	Hsync	Horizontal Sync Signal	2
7	R2	RED Data Signal (MSB)	–
8	GND	–	–
9	GND	–	–
10	CK	Clock Signal for sampling each data signal	–
11	TST	This should be electrically opened during operation	–
12	GND	–	–
13	G0	GREEN Data Signal (LSB)	–
14	NBH	Horizontal Display Mode Select Signal	3
15	GND	–	–
16	TST	This should be electrically opened during operation	–
17	G1	GREEN Data Signal	–
18	TST	This should be electrically opened during operation	–
19	G2	GREEN Data Signal (MSB)	–
20	GND	–	–
21	GND	–	–
22	V_{CC}	+5 V Power Supply	–
23	TST	This should be electrically opened during operation	–
24	V_{CC}	+5 V Power Supply	–
25	B0	BLUE Data Signal (LSB)	–
26	TST	This should be electrically opened during operation	–
27	GND	–	–
28	ENAB	Data Enable Signal (to settle the viewing area)	4
29	B1	BLUE Data Signal	–
30	GND	–	–
31	B2	BLUE Data Signal (MSB)	–

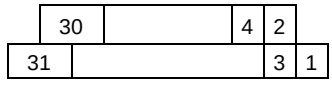
NOTES:

The shielding case is connected with GND.

1. Connector used: DF9BA-31P-1V (Hirose Electric Co. Ltd.)
   Mating connector: DF9B-31S-1V (Hirose Electric Co., Ltd.)
2. 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:



3. See Figure 2 for Display Mode.
4. 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.

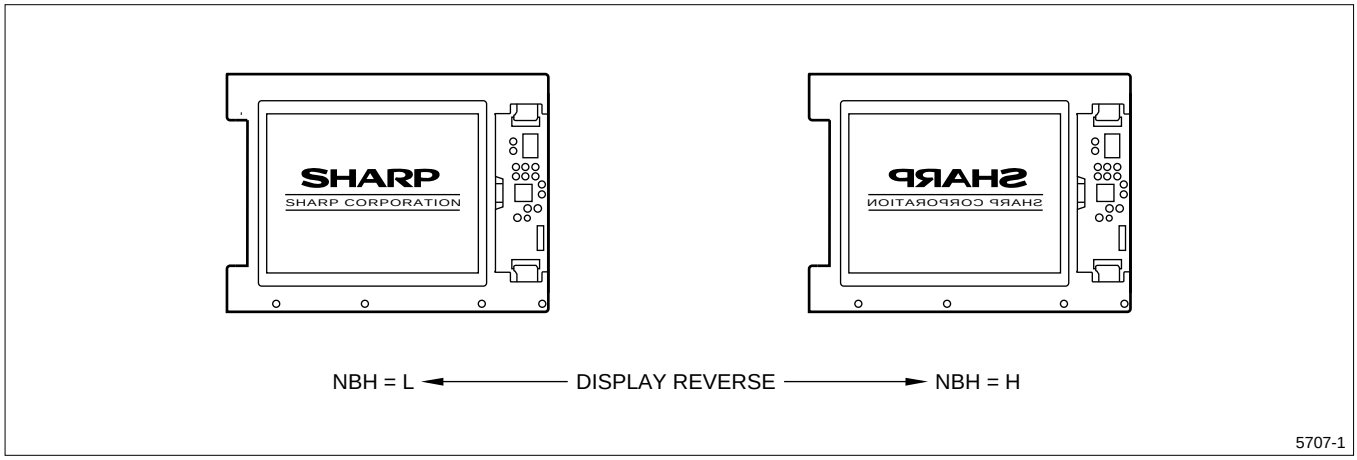


Figure 2. Display Mode

ELECTRICAL CHARACTERISTICS AND CURRENT DISSIPATION (t_A = 25°C)

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT	CONDITION	NOTE
V_{CC}	+5 V Supply Voltage	+4.5	+5.0	+5.5	V	–	1
I_{CC}	+5 V Current Dissipation	–	200	350	mA	–	2
V_{RP}	Permissive Input Ripple Voltage	–	–	100	mV_{P-P}	V_{CC}	
V_{IL}	Input Voltage (Low)	–	–	1.5	V	V_{CC} = +5 V	3
V_{IH}	Input Voltage (High)	+3.5	–	–	V		
I_{IL1}	Input Current (Low)	–	–	1.0	µA	V_I = 0 V	4
I_{IL2}		–	–	60	µA	V_I = 0 V	5
I_{IH1}	Input Current (High)	–	–	1.0	µA	$V_I = V_{CC}$	6
I_{IH2}		–	–	60	µA	$V_I = V_{CC}$	7

NOTES:

1. V_{CC} turn-on conditions:
   t_1: rise time (≤ 10 ms)
   t_2: data input allowance time (≤ 10 ms)
   t_3: fall time (> 0 ms)
   V_{CC} dip conditions:
   a. 2.7 V ≤ V_{CC} < 4.5 V
      td = 10 ms maximum
   b. V_{CC} < 2.7 V (V_{CC} dip conditions are the same as the V_{CC} turn-on conditions).
2. Typical current situation is defined 8-gray-bar pattern (at 480 line mode, V_{CC} = 5 V).
3. CK, R0 – R2, G0 – G2, B0 – B2, Hsync, Vsync, ENAB, NBH
4. CK, R0 – R2, G0 – G2, B0 – B2, Hsync, Vsync, ENAB
5. NBH
6. CK, R0 – R2, G0 – G2, B0 – B2, Hsync, Vsync, NBH
7. ENAB

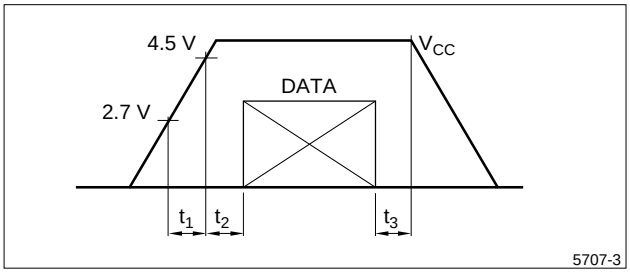


Figure 3. V_{CC} Turn-On Conditions

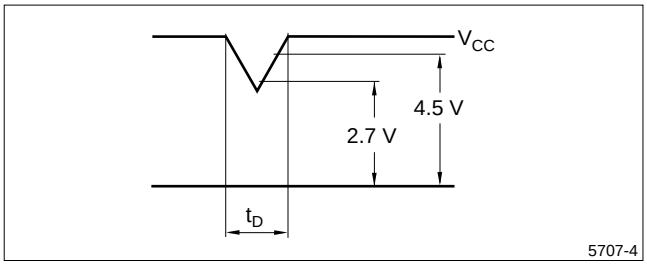


Figure 4. V_{CC} Dip Conditions

TIMING CHARACTERISTICS OF INPUT SIGNALS [1]

Input signal waveforms are shown in Figures 5a, 5b, and 5c.

Timing Characteristics

SYMBOL	PARAMETER	MODE	MIN.	TYP.	MAX.	UNITS
$1/t_C$	Clock Frequency	All	–	25.18	28.33	MHz
t_{CH}	Clock High Time		5	–	–	ns
t_{CL}	Clock Low Time		10	–	–	ns
t_{DS}	Data Setup Time	All	5	–	–	ns
t_{DH}	Data Hold Time		10	–	–	ns
t_H	Horizontal Sync Signal Cycle	All	30.00	31.78	–	µs
			770	800	900	Clock
t_{HP}	Horizontal Sync Signal Pulse Width		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 Display Period	All	640	640	640	Clock
t_{HC}	Hsync-Clock Phase Difference	All	10	–	t_C –10	ns
t_{VH}	Hsync-Vsync Phase Difference	All	0	–	tH – t_{HP}	ns

NOTE:

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

Horizontal Display Position and Data Enable Signal [1]

When the data enable signal is input, the horizontal display starts from rising of the data enable signal.

SYMBOL	PARAMETER	MODE	MIN.	TYP.	MAX.	UNITS
t_{ES}	Enable Signal Setup Time	All	5	–	t_C –10	ns
t_{EP}	Enable Signal Pulse Width		2	640	640	Clock
t_{HE}	Hsync-Enable Signal Phase Difference		44	–	164	Clock

NOTE:

1. In case the data enable terminal (ENAB) is fixed ‘Low,’ the horizontal display starts from the data of C104 (clock) as shown in Figure 5a.

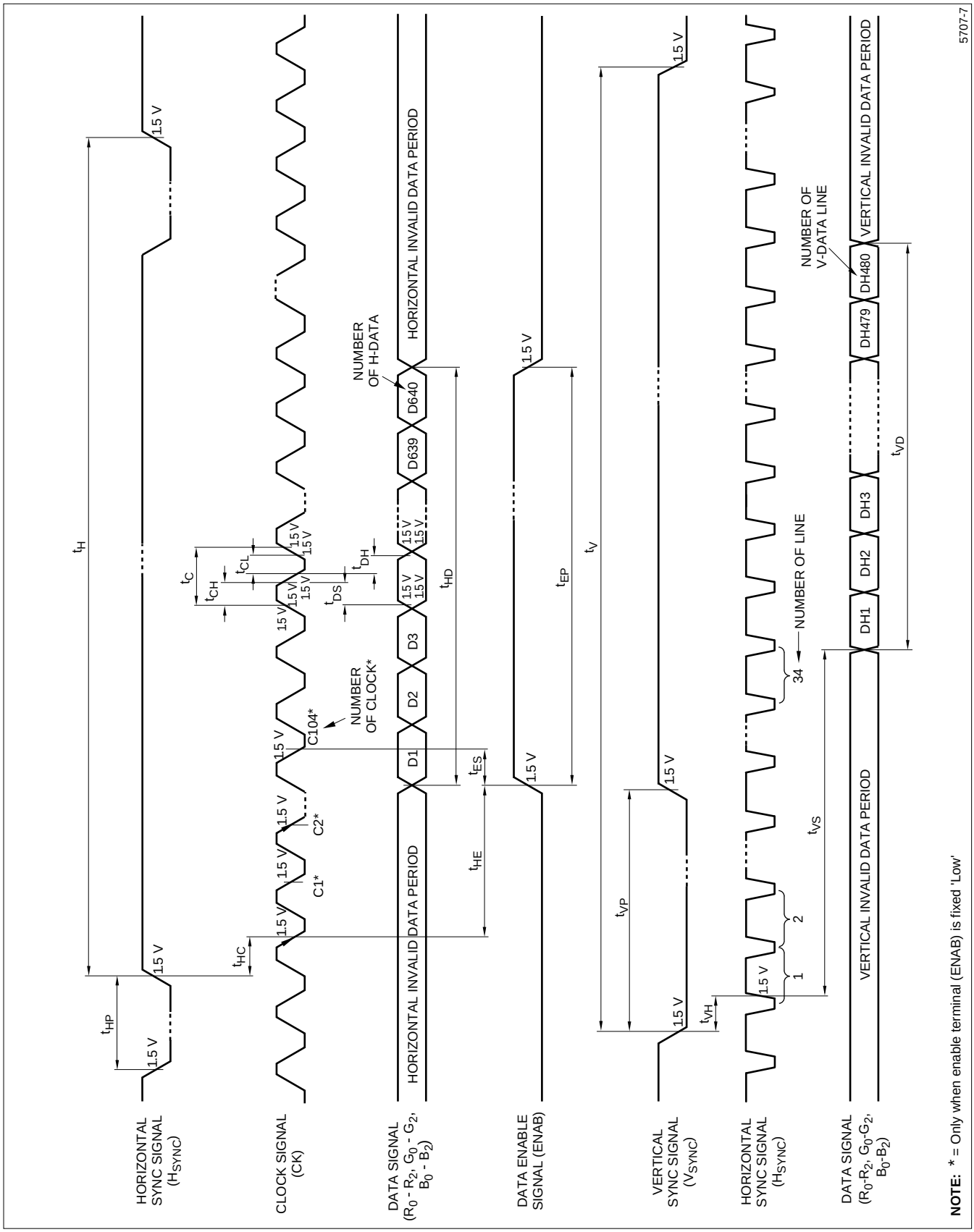


Figure 5a. Input Signal Waveforms (480-Line Mode)

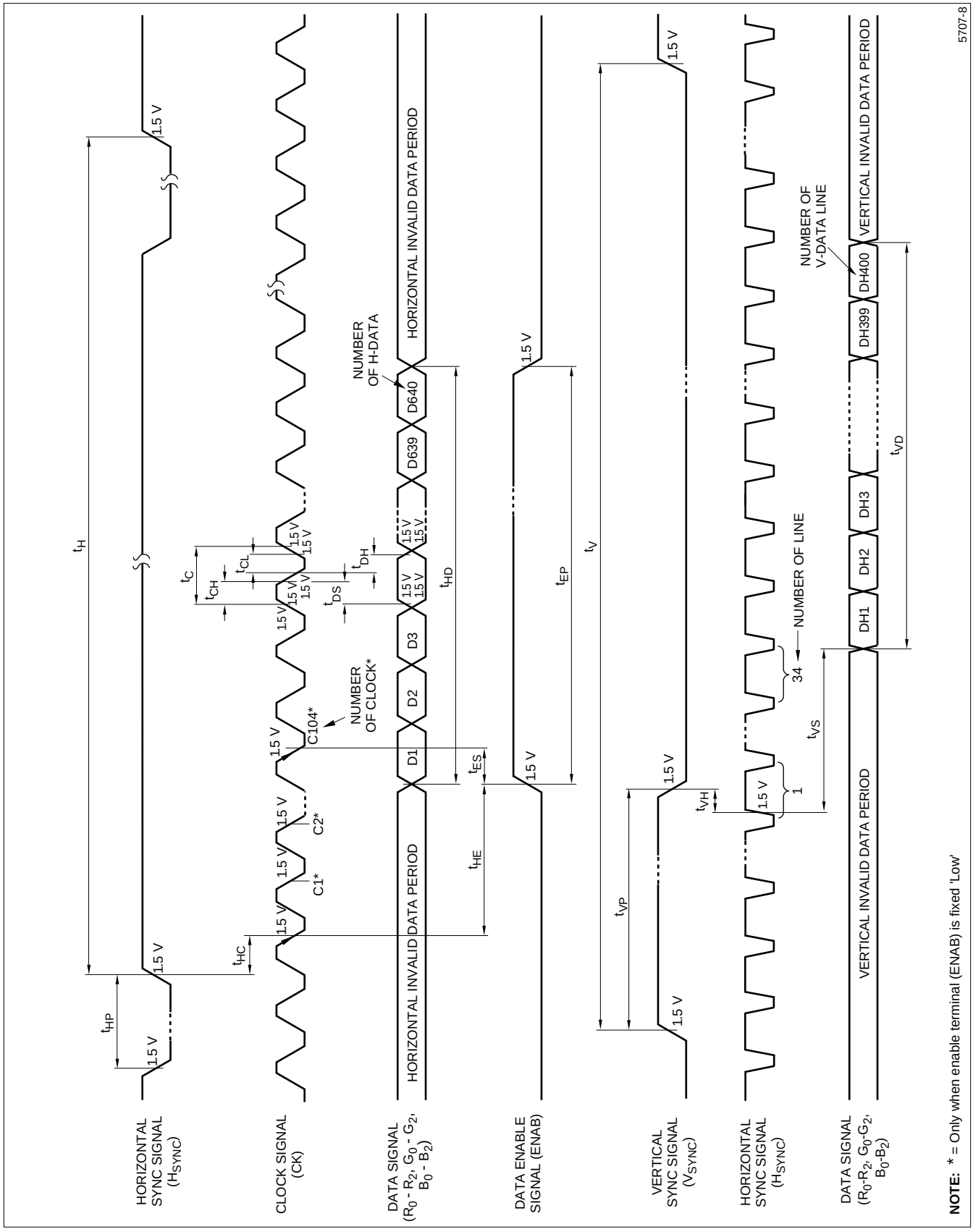


Figure 5b. Input Signal Waveforms (400-Line Mode)

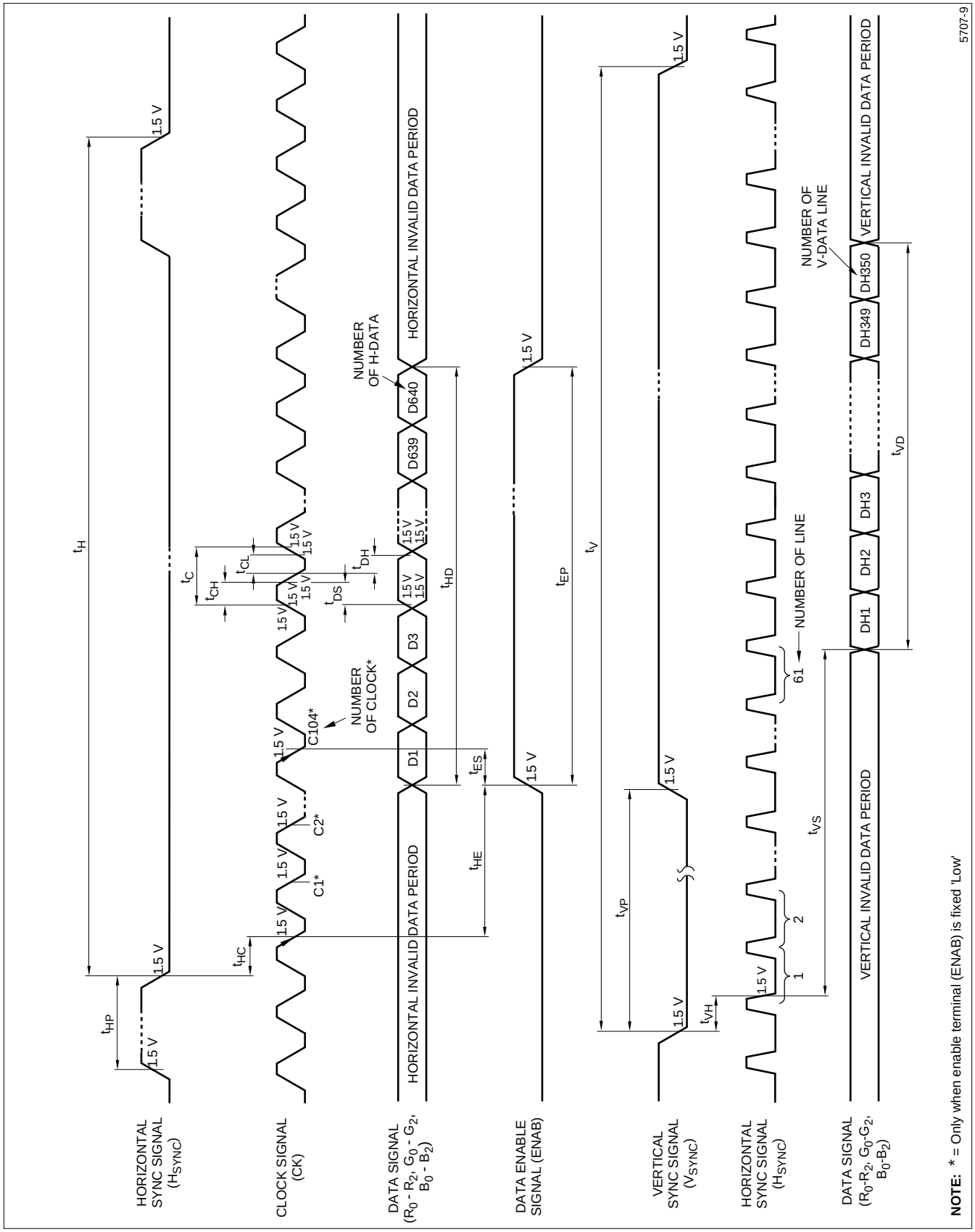


Figure 5c. Input Signal Waveforms (350-Line Mode)

Vertical Display Position

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 as shown in Table 1.

The data enable signal doesn't effect the vertical display position.

Table 1. Vertical Display Position

MODE	V-DATA START (TV_S)	V-DATA PERIOD (TV_D)	V-DISPLAY START	V-DISPLAY PERIOD	UNIT	NOTE
480	34	480	34	480	Line	–
400	34	400	443-TV	480	Line	1
350	61	350	445-TV	480	Line	

NOTE:

1. Since the vertical data invalid period is displayed in 400-line and 350-line modes, inputting all data '0' is recommended during vertical data invalid period. (Refer to Figure 6). In 400-line and 350-line modes, the display position won't be centered on the screen if the vertical sync TV doesn't have above typical values.

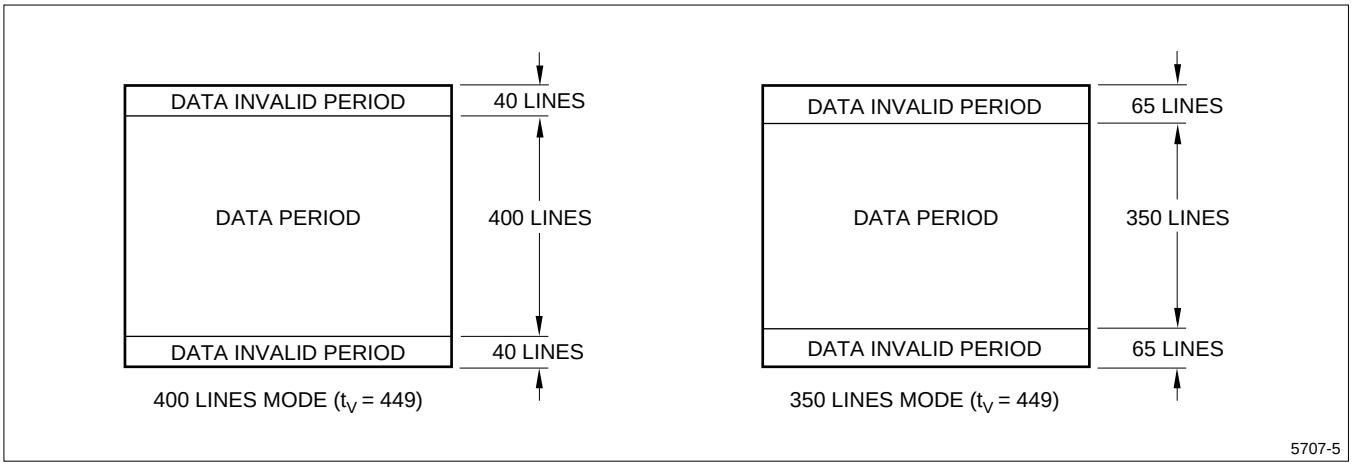


Figure 6. 400-Line and 350-Line Modes

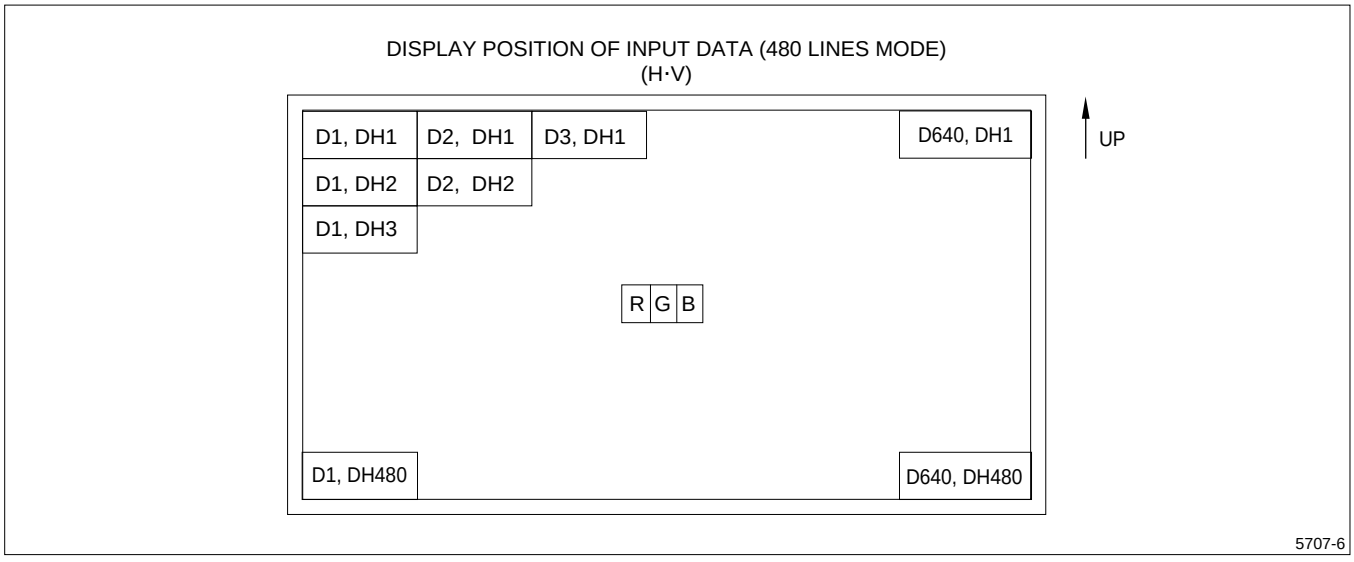


Figure 7. Display Position of Input Data – 480-Line Mode (H • V)

INPUT SIGNALS, BASIC DISPLAY COLORS, AND GRAY SCALE OF EACH COLOR [1]

COLOR AND GRAY SCALE		DATA SIGNAL [2]								
		R_0	R_1	R_2	G_0	G_1	G_2	B_0	B_1	B_2
Basic Color	Black	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	1	1	1
	Green	0	0	0	1	1	1	0	0	0
	Light Blue	0	0	0	1	1	1	1	1	1
	Red	1	1	1	0	0	0	0	0	0
	Purple	1	1	1	0	0	0	1	1	1
	Yellow	1	1	1	1	1	1	0	0	0
	White	1	1	1	1	1	1	1	1	1
Gray Scale of Red	Black	0	0	0	0	0	0	0	0	0
	↑	1	0	0	0	0	0	0	0	0
	Darker	0	1	0	0	0	0	0	0	0
	↑	1	1	0	0	0	0	0	0	0
	↓	0	0	1	0	0	0	0	0	0
	Brighter	1	0	1	0	0	0	0	0	0
	↓	0	1	1	0	0	0	0	0	0
	Red	1	1	1	0	0	0	0	0	0
Gray Scale of Green	Black	0	0	0	0	0	0	0	0	0
	↑	0	0	0	1	0	0	0	0	0
	Darker	0	0	0	0	1	0	0	0	0
	↑	0	0	0	1	1	0	0	0	0
	↓	0	0	0	0	0	1	0	0	0
	Brighter	0	0	0	1	0	1	0	0	0
	↓	0	0	0	0	1	1	0	0	0
	Green	0	0	0	1	1	1	0	0	0
Gray Scale of Blue	Black	0	0	0	0	0	0	0	0	0
	↑	0	0	0	0	0	0	1	0	0
	Darker	0	0	0	0	0	0	0	1	0
	↑	0	0	0	0	0	0	1	1	0
	↓	0	0	0	0	0	0	0	0	1
	Brighter	0	0	0	0	0	0	1	0	1
	↓	0	0	0	0	0	0	0	1	1
	Blue	0	0	0	0	0	0	1	1	1

NOTES:

1. Each color is displayed in eight gray scales from 3-bit Data Signal Input. According to the combination of total 9-bit data, 512 colors are displayed.
2. 0 = Low-Level Voltage.
   1 = High-Level Voltage.

OPTICAL CHARACTERISTICS (t_A = 25°C, V_{CC} = +5 V) [1]

Backlight

Luminance: ≥ 3500 cd/m^2, Wavelength: ≥ 400 nm

SYMBOL	PARAMETER	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
θ21.22	Viewing Angle Range – Horizontal	CR > 10	35	–	–	degrees	2, 3
θ11	Viewing Angle Range – Vertical		30	–	–		
θ12			10	–	–		
CR	Contrast Ratio	Optimum Viewing Angle	60	–	–	–	3, 4
t_R	Response Time – Rise	θ = 0°	–	30	–	ms	3, 5
t_D	Response Time – Fall		–	50	–	ms	
tr	Transmissivity	θ = 0°	4.3	5.8	–	%	3, 6
ΔX	Chromaticity Shift	θ = 0°	–0.029	+0.001	+0.031	–	3, 7
ΔY			–0.027	+0.003	+0.033	–	

NOTES:

1. Make the measurement 15-20 minutes after the module has been lit at the proper rating. Measure the optical characteristics in a dark room or equivalent state with the method shown in Figure 8.
2. Figure 9 shows the definition of the viewing angle range.
3. Make measurements at the center of the screen.
4. The Contrast Ratio is defined as follows: $\text{Contrast Ratio} = \frac{\text{Luminance (brightness) with all pixels white}}{\text{Luminance (brightness) with all pixels black}}$
5. The Response Time is measured as shown in Figure 10 by switching the input signals for 'black' ON and OFF.
6. Definition of Transmissivity: $\text{Transmissivity} = \frac{\text{Light–detected level of the transmission through the LCD panel}}{\text{Light–detected level of the Original light source}}$
7. Chromaticity shift is the difference between the light source and the module placed on it. The values are measured with standard illuminant: C(x = 0.310, y = 0.316).

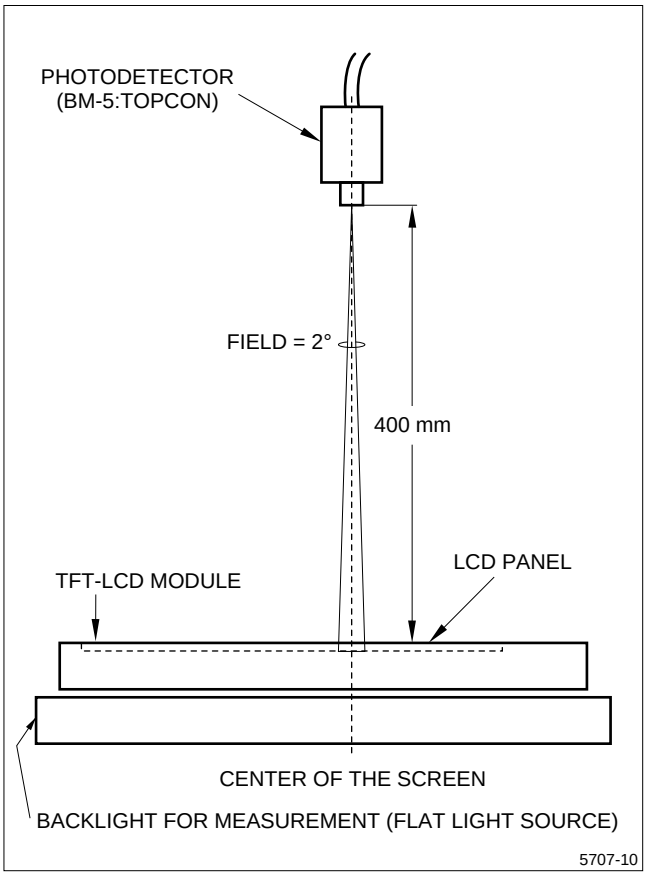


Figure 8. Optical Characteristics Measurement Method

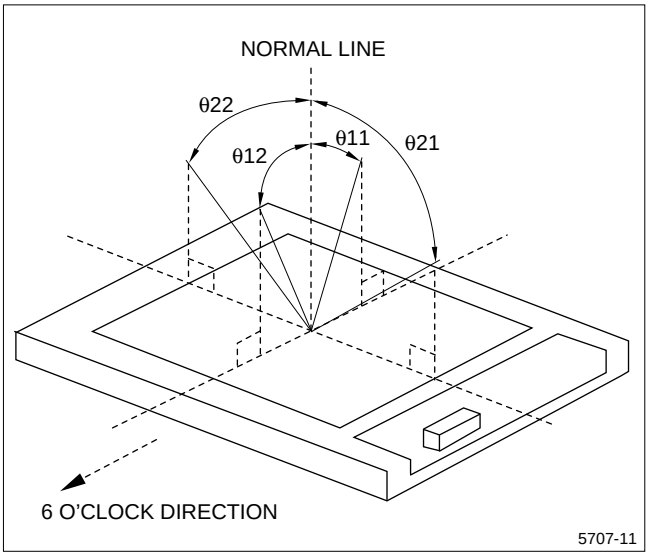


Figure 9. Definition of Viewing Angle Range

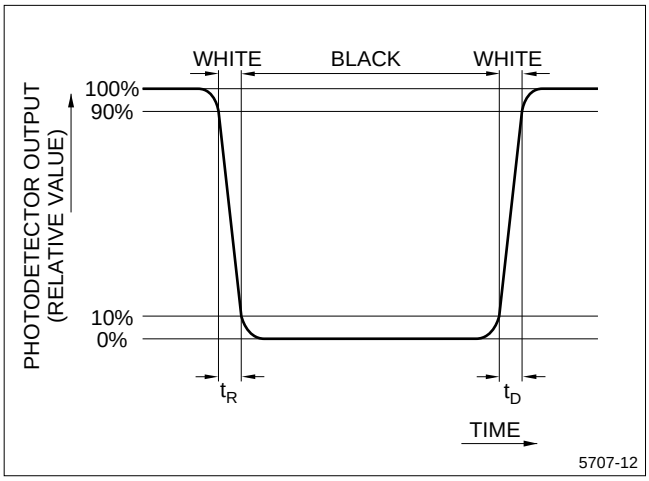


Figure 10. Definition of Response Time

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.
- When installing the module, be sure to fix the module on the same plane, taking care not to warp or twist the module.
- Since the polarizer is made of soft material, be careful not to scratch the surface. Protective laminated film is attached on the outgoing light side surface glass to protect it from scratches or dirt. Peel off this film just before use while taking precautions to protect the unit from electrostatic charges.

Precautions When Peeling Off the Laminater

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 MΩ on the tile.
  - Spread an adhesive mat at the doorway to the clean room.
  - Humidity: 50% to 70%
  - Temperature: 15°C to 27°C
  - Workers need anti-static shoes, clothing, gloves, and grounding straps.

Working Procedure

- 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 11a).
- Attach an adhesive tape to a corner of the laminated film near the heated ionized air blower (Figure 11b).
- 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.

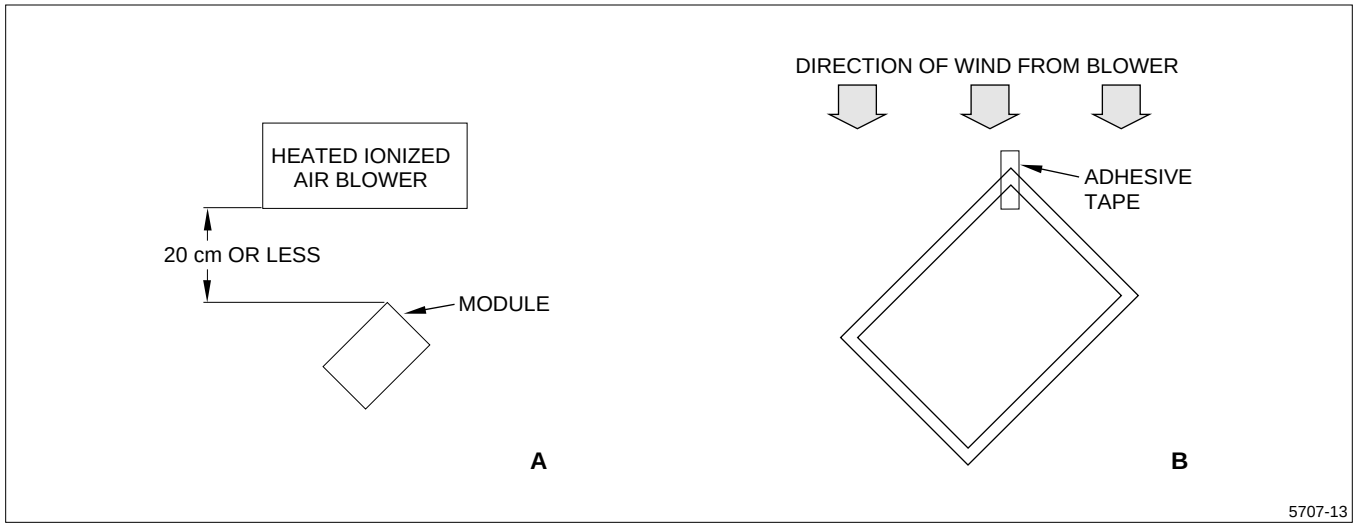


Figure 11. Proper Use of Discharging Blower

Other Precautions

- Adjusting volumes have been set optimally before shipment, so do not change any adjusted values. If adjusted values are changed, the specifications described here may not be satisfied.
- 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 13.

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

RESULT EVALUATION CRITERIA

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

OTHER INFORMATION

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

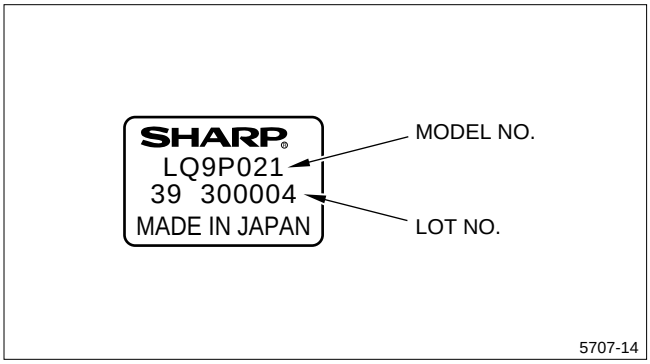


Figure 12. Lot Number Label

RELIABILITY TEST ITEMS

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

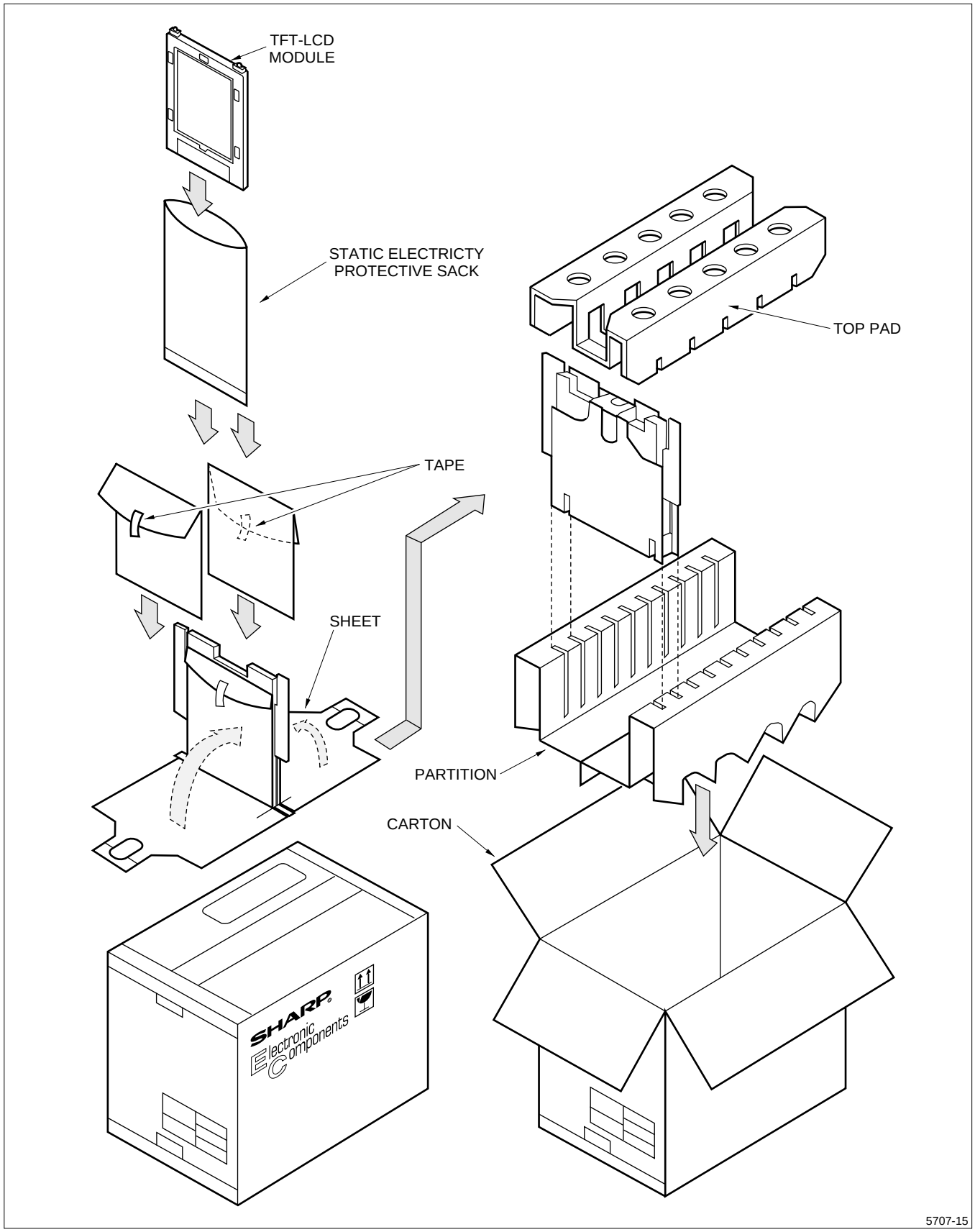
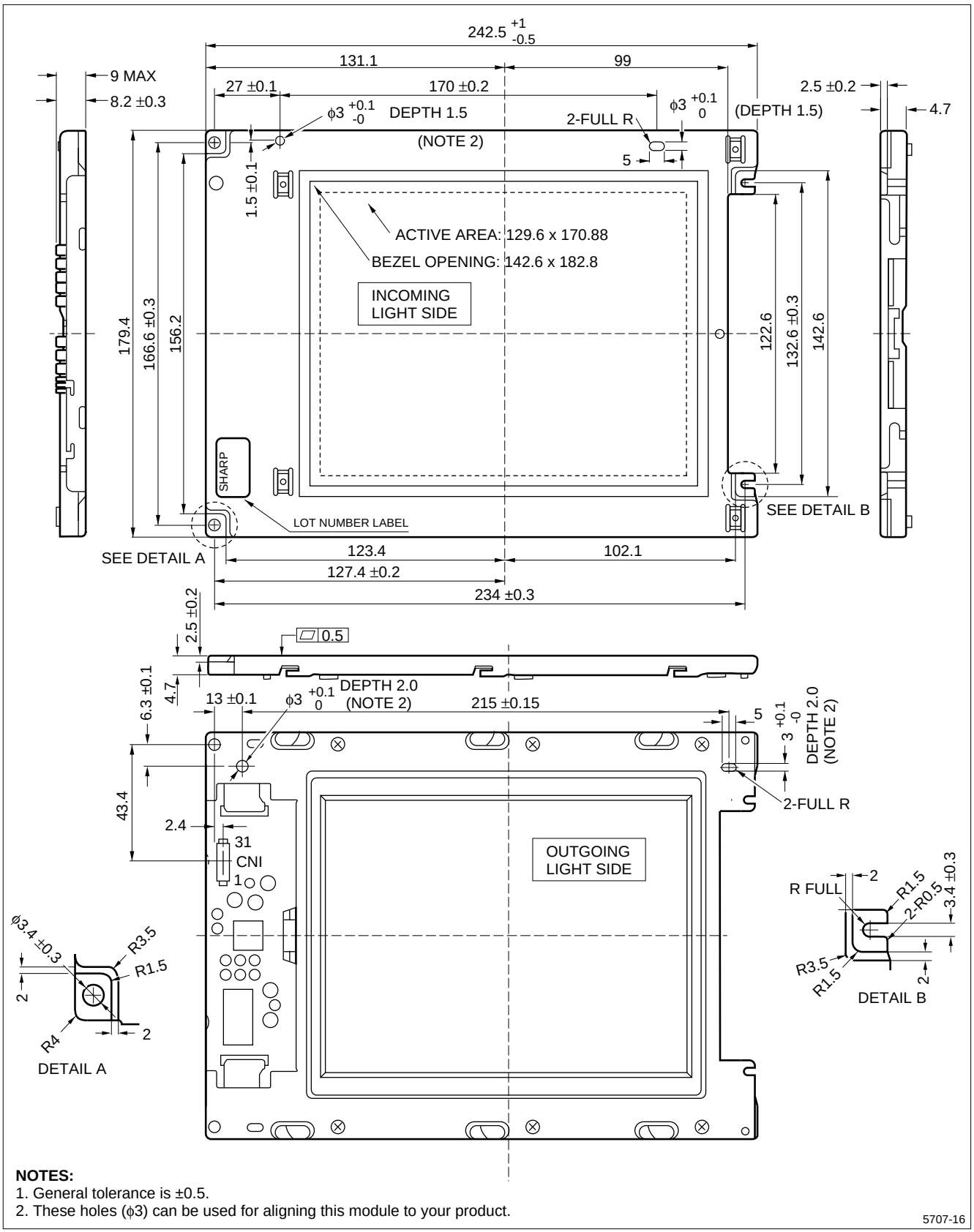


Figure 13. Packing Form

OUTLINE DIMENSIONS



NOTES:
1. General tolerance is ±0.5.
2. These holes (φ3) can be used for aligning this module to your product.

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