LM64P89
Passive Matrix Color LCD

FEATURES

- Display Format: 640 × 480
- Overall Dimensions:
  268 (W) × 190 (H) × 7 (D) mm
- Active Area: 215.2 (W) × 162.4 (D) mm
- Dot Pitch: 0.30 (W) × 0.30 (H) mm
- Response/Contrast Ratio: 150 ms/18:1
- Viewing Mode: Transmissive

DESCRIPTION

The SHARP LM64P89 Passive Matrix Color LCD is a 640 × 480 dot color display unit consisting of an LCD panel, a printed wiring board (PWB) with electric components mounted on it, tape automated bonding (TAB) to connect the LCD panel and PWB electrically, and plastic chassis with CCFT backlight and bezel to fit them mechanically.

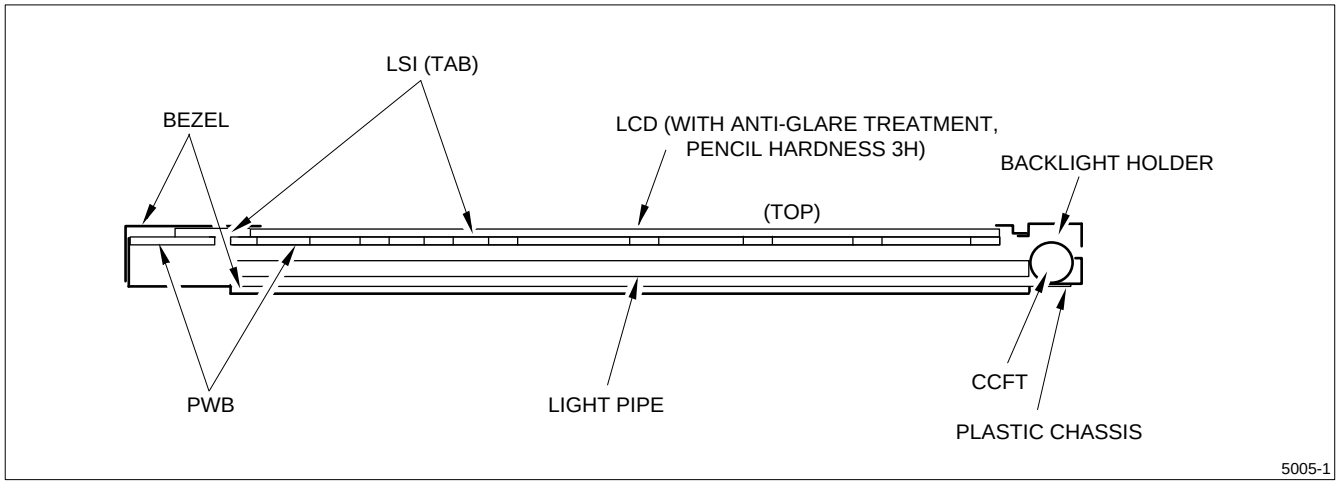


Figure 1. LM64P89 Construction

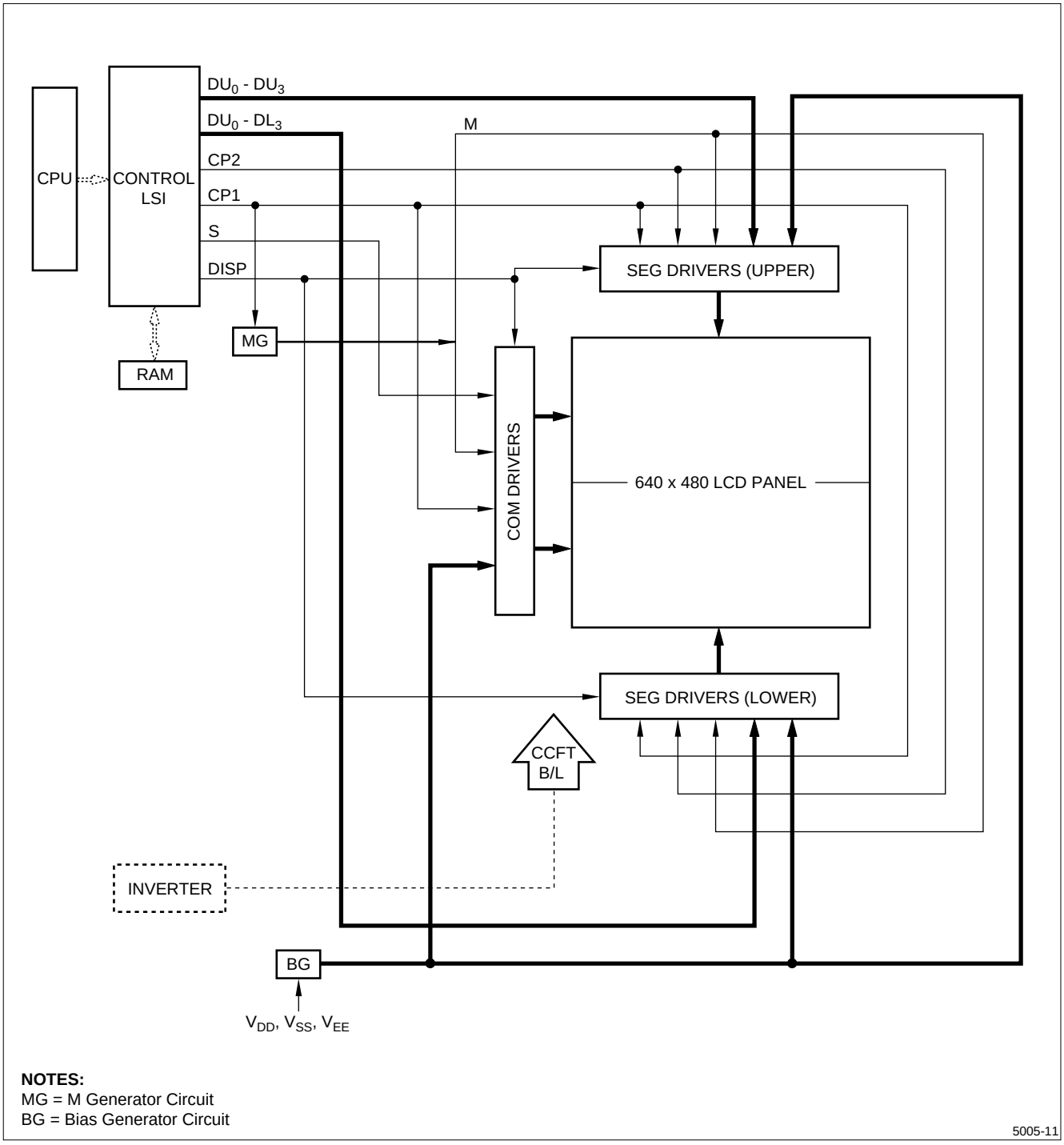


Figure 2. LM64P89 Block Diagram

MECHANICAL SPECIFICATIONS

PARAMETER	SPECIFICATIONS	UNIT	NOTE
Outline Dimensions	268 (W) × 190 (H) × 7 max (D)	mm	1
Effective Viewing Area	215.2 (W) × 162.4 (H)	mm	–
Display Format	640 (W) × 480 (H) Full Dots	–	–
Dot Size	0.30 × 0.30	mm	–
Dot Spacing	0.03	mm	–
Base Color	White	–	2, 3
Background Color	Black		2, 3
Weight	Approximately 450	g	–

NOTES:

1. Excludes the allowance of deformation.
2. Due to the characteristics of the LC material, the colors vary with environmental temperature.
3. Negative-type display
   Display data 'H': Dots ON: White
   Display data 'L': Dots OFF: Black

ABSOLUTE MAXIMUM RATINGS (t_A = 25°C)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$V_{DD} – V_{SS}$	Supply Voltage (Logic)	0	6.0	V
V_{DD} - V_{EE}	Supply Voltage (LCD Drive)	0	30.0	V
V_{IN}	Input Voltage	0	V_{DD}	V

ENVIRONMENTAL CONDITIONS

ITEM	Tstg		Topr		CONDITION	NOTE
	MIN.	MAX.	MIN.	MAX.		
Ambient Temperature	–25°C	+60°C	0°C	+45°C		1
Humidity	–		–		No condensation	2
Vibration	–		–		3 Directions (X/Y/Z)	3
Shock	–		–		6 Directions (±X ±Y ±Z)	4

NOTES:

1. Do not subject the LCD unit to temperatures out of this specification.
2. $t_A \leq 40°C$, 95% RH maximum.
   $t_A > 40°C$, Absolute humidity less than $t_A = 40°C$/95% RH.
3. These test conditions are in accordance with IXC 68-2-6.
   Two hours for each direction of X/Y/Z (six hours total).

Frequency	10 Hz to 57 Hz	57 Hz to 500 Hz
Vibration Level	–	9.8 m/s^2
Vibration Width	0.075 mm	–
Interval	10 Hz to 500 Hz to 10 Hz/11.0 min.	

4. Acceleration: 490 m/s^2
   Pulse width: 11 ms
   Three times for each direction of ±X/±Y/±Z.

ELECTRICAL CHARACTERISTICS (t_A = 25°C, V_{DD} - V_{SS} = 5.0 V)

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT	NOTE
$V_{DD} – V_{SS}$	Supply Voltage (Logic)	4.75	5.0	5.25	V	1, 2
$V_{DD} – V_{EE}$	Supply Voltage (LCD Drive)	20.1	23.9	28.2	V	3, 4, 5
V_{IN}	Input Signal Voltage	0.8 V_{DD}	–	V_{DD}	V	'H' Level
		0	–	0.2 V_{DD}	V	'L' Level
I_{IL}	Input Leakage Current	–	–	250	µA	'H' Level
		–250	–	–	µA	'L' Level
I_{DD}	Supply Current (Logic)	–	24	36	mA	6
I_{EE}	Supply Current (LCD Drive)	–	17	25	mA	6
P_D	Power Consumption	–	450	680	mW	6

NOTES:

1. Avoid fluctuation of V_{DD}, even within the specifications.
2. V_{EE} is ground potential.
3. The viewing angle θ at which the optimum contrast is obtained can be set by adjusting V_{DD} - V_{EE}. Refer to Figure 7 for definition of θ.
4. Maximum and Minimum values are specified as the Maximum and Minimum voltage within the condition of operational temperature range (0°C to 45°C). Typical values are specified as the typical voltage at 25°C.
5. V_{EE} is minus potential.
6. Display high frequency pattern.
   V_{DD} - V_{SS} = 5.0 V, V_{DD} - V_{EE} = 23.9 V, Frame frequency = 85 Hz, Display pattern = 1-bit checker.

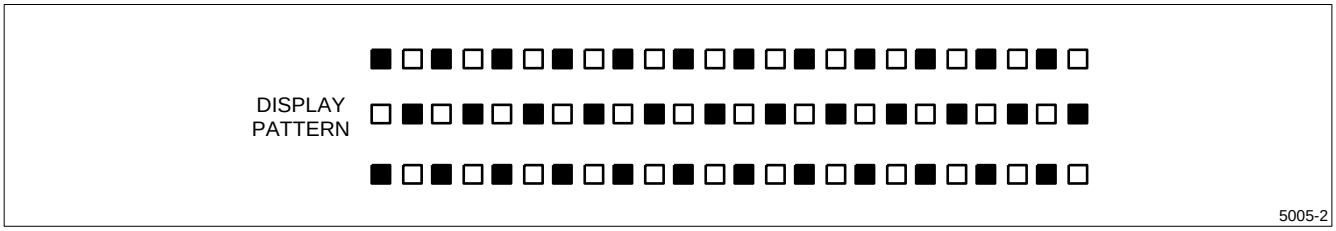


Figure 3. Display High Frequency Pattern

INPUT CAPACITANCE

SIGNAL	INPUT CAPACITANCE (TYPICAL)
S	40 pF
CP1, DISP	250 pF
CP2	200 pF
DU_0 - DU_3	200 pF
DL_0 - DL_3	200 pF

INTERFACE SIGNALS

LCD [1]

PIN NUMBER	SYMBOL	PARAMETER	LEVEL
1	S	Scan Start-Up Signal	'H'
2	CP1	Input Data Latch Signal	H → L
3	CP2	Data Input Clock Signal	H → L
4	DISP	Display Control Signal	Display on 'H' Display on 'L'
5	V_{DD}	Power Supply For Logic and LCD (+)	–
6	V_{SS}	Ground Potential	–
7	V_{EE}	Power Supply For LCD (-)	–
8	DU_0	Display Data Signal (Upper Half)	H (ON), L (OFF)
9	DU_1		
10	DU_2		
11	DU_3		
12	DL_0	Display Data Signal (Lower Half)	H (ON), L (OFF)
13	DL_1		
14	DL_2		
15	DL_3		

NOTE:

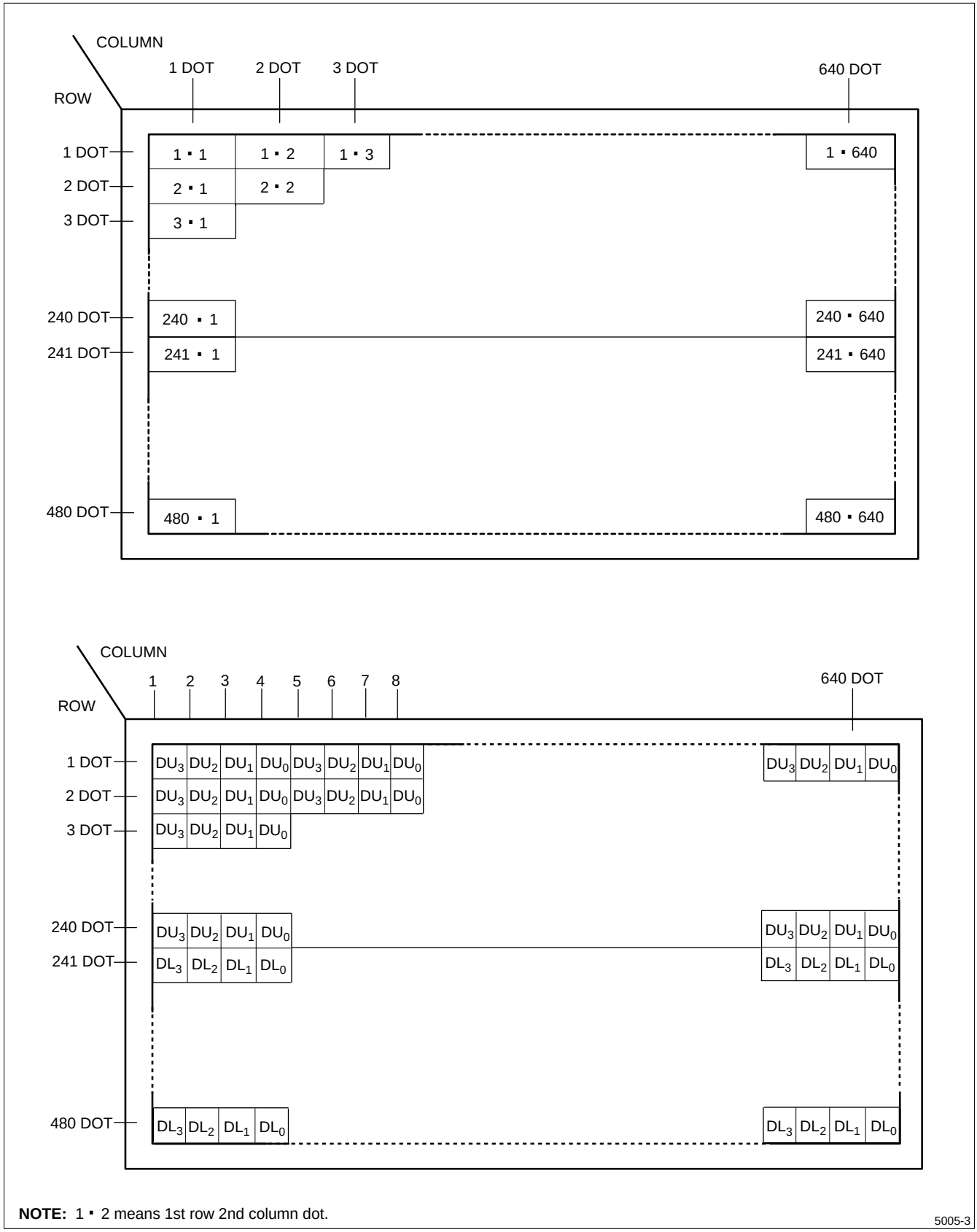
1. Used connector: 53261-1510 (MOLEX)
   Mating connector: 51021 - 1500 (MOLEX)

CCFT [1]

PIN NUMBER	SYMBOL	PARAMETER	LEVEL
1	GND	Ground Line (From Inverter)	–
2	NC	–	–
3	NC	–	–
4	HV	High Voltage Line (From Inverter)	–

NOTE:

1. Used connector: M63M83-04 (MITSUMI)
   Mating connector: M60-04-30-114P (MITSUMI), M60-04-30-134P (MITSUMI), M61M73-04 (MITSUMI)



NOTE: 1 ▪ 2 means 1st row 2nd column dot.

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Figure 4. Dot Chart of Display Area

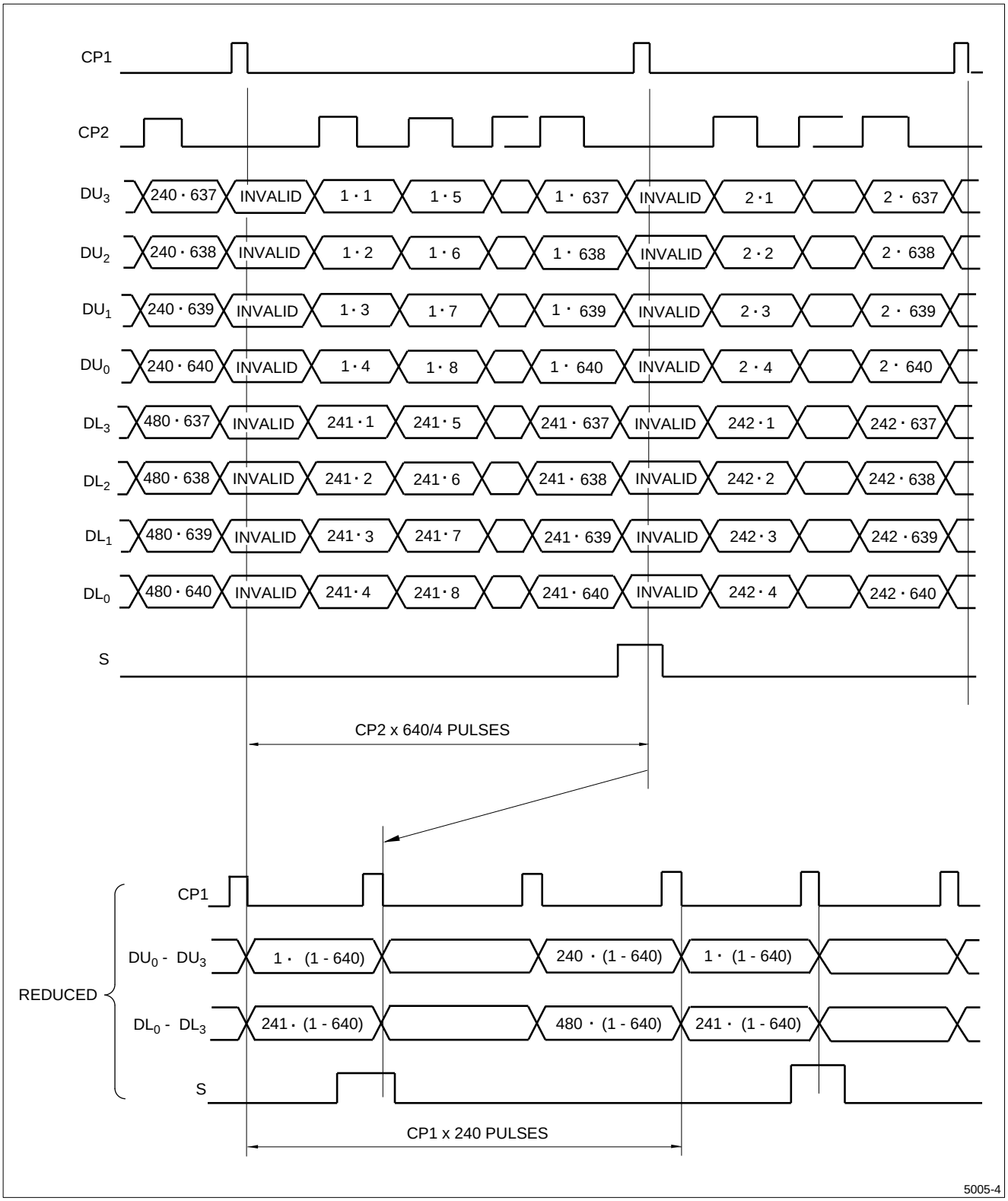


Figure 5. Data Input Timing

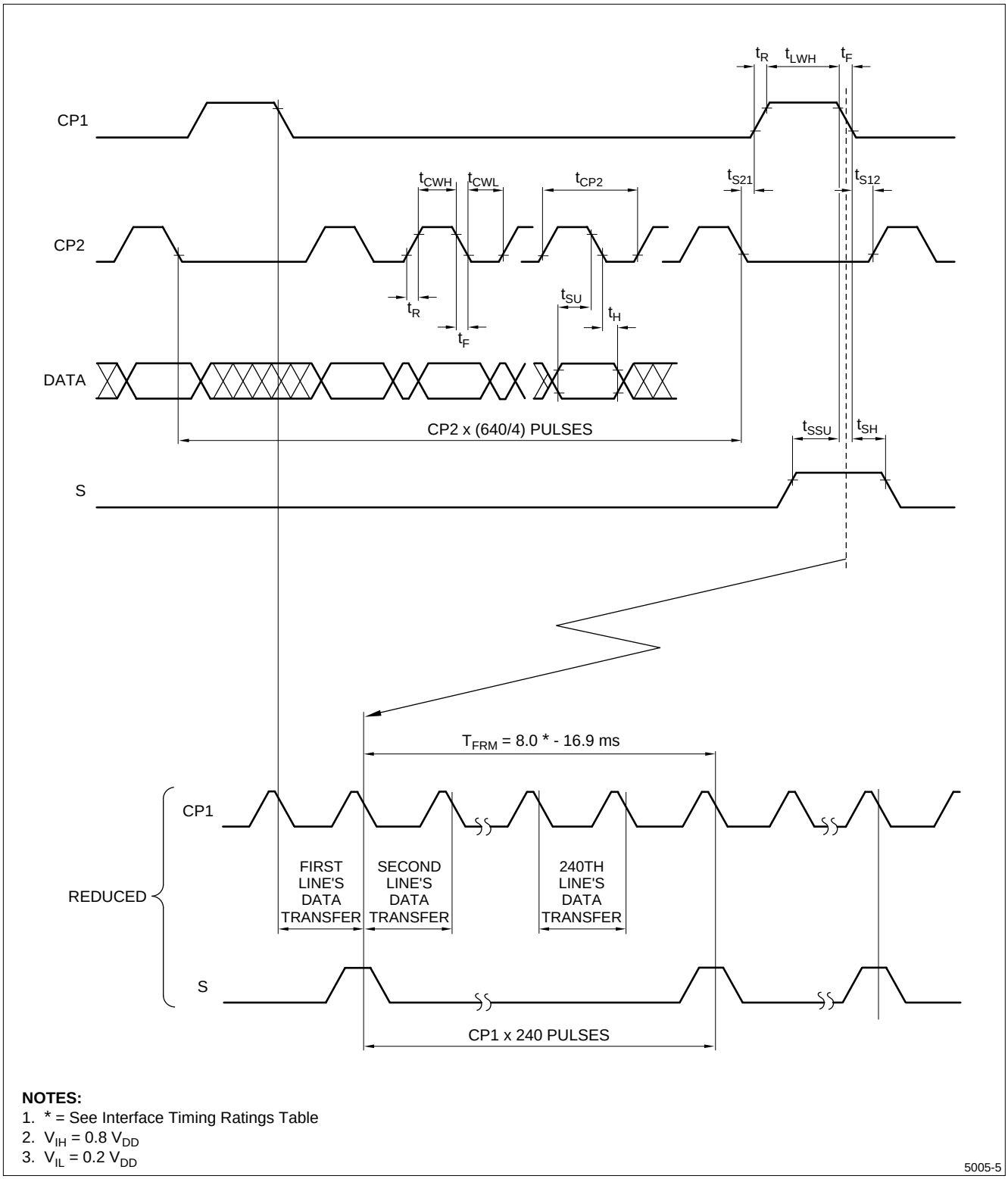


Figure 6. Interface Timing Chart

INTERFACE TIMING RATINGS

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNITS	NOTE
t_{FRM}	Frame Cycle	8.0	–	16.9	ms	1
t_{CP2}	CP2 Clock Cycle	152	–	–	ns	–
t_{CWH}	'H' Level Clock Width	65	–	–	ns	–
t_{CWL}	'L' Level Clock Width	85	–	–	ns	–
t_{LWH}	'H' Level Latch Clock Width	70	–	–	ns	–
t_{DS}	Data Setup Time	50	–	–	ns	–
t_{DH}	Data Hold Time	40	–	–	ns	–
t_{SSU}	S Set Up Time	100	–	–	ns	–
t_{SH}	S Hold Time	100	–	–	ns	–
t_{s21}	CP2 ↑ Clock Allowance Time From CP1 ↓	0	–	–	ns	–
t_{s12}	CP1 ↑ Clock Allowance Time From CP2 ↓	0	–	–	ns	–
t_R, t_F	Clock Rise/Fall Time	–	–	tRF	ns	2

NOTE:

1. LCD unit functions at the minimum frame cycle of 8 ms (Maximum frame frequency of 125 Hz). Due to the characteristics of LCD unit, 'shadowing' becomes more eminent as frame frequency goes up, while flicker is reduced. According to our experiments, frame cycle of 11.7 ms minimum or frame frequency of 85 Hz maximum demonstrates optimum display quality in terms of flicker and 'shadowing.' Since judgment of display quality is subjective and display quality such as 'shadowing' is pattern dependent, decide frame cycle or frame frequency, to which power consumption of the LCD unit is proportional, based on thorough testing of the LCD unit with every possible pattern displayed on it.
2. $t_{RF} = 50$ in case $t_{CT} = (t_{CP2} - t_{CWH} - t_{CWL})/2 \geq 50$
   $t_{RF} = t_{CT}$ in case $t_{CT} = (t_{CP2} - t_{CWH} - t_{CWL})/2 < 50$

UNIT DRIVING METHOD

CIRCUIT CONFIGURATION

Figure 2 shows the block diagram of the Unit's circuity.

DISPLAY FACE CONFIGURATION

The display face electrically consists of two (upper and lower) display segments so that the unit may offer higher contrast by reducing drive duty ratio. Each display segment (640 × 240 dots) is driven at 1/240 duty ratio.

INPUT DATA AND CONTROL SIGNAL

The LCD driver is 80 bits LSI, consisting of shift register, latch circuits and LCD driver circuits.

Display data, which is externally divided into data for each row (640 dots), is sequentially transferred in the form of 4-bit parallel data through shift registers by Clock Signal CP2 from the left top of the display face.

When data of one row (640 dots) is input, they are latched in the form of parallel data for 640 lines of signal electrodes by latch signal CP1. Then the corresponding drive signal is transmitted to the 640 lines of column electrodes of the LCD panel by the LCD drive circuits.

Scan start-up signal S is transferred from the scan signal driver to the first row of scan electrodes, and the contents of the data signals are displayed on the first row of the upper and lower half of the display face according to the combinations of voltages applied to the scan and signal electrodes of the LCD.

While the first rows of data are displayed, the second rows of data are entered. When 640 dots of data have been transferred then latched on the falling edge of CP1 clock, the display face proceeds to the second rows of display.

Such data input is repeated up to the 240th row of each display segment, from upper to lower rows, to complete one frame of display by the time-sharing method. Data input then proceeds to the next display face.

Scan start-up signal S generates scan signal to drive horizontal electrodes.

Since DC voltage, if applied to the LCD panel, causes a chemical reaction which deteriorates the LCD panel, drive waveform shall be inverted at a proper cycle to prevent the generation of such DC voltage. Control Signal M plays such a role.

Because of the characteristics of the CMOS driver LSI, the power consumption of the unit goes up as the operating frequency CP2 increases. Thus, the driver LSI applies the system of transferring 4-bits parallel data through the four lines of shift registers to reduce the data transfer speed of CP2. The power consumption of the unit will be minimized because of the LSI.

In this circuit configuration, 4-bit display data is input to data input pins DU_0 – DU_3 (upper display segment) and DL_0 – DL_3 (lower display segment).

The LCD unit also adopts a bus line system for data input to minimize the power consumption. In this system, data input terminal of each driver LSI activates only when relevant data input is fed.

Data input for column electrodes of both the upper and the lower display segment and chip select of driver LSI are made as follows:

The driver LSI at the left end of the display face is first selected, and the adjacent driver LSI of the right side is selected when 80 dots data (20 CP2) is fed. This process continues sequentially until data is fed to the driver LSI at the right end of the display face.

This process is immediately followed at the column driver's LSIs of both the upper and the lower display segments. Data input for both the upper and the lower display segments must be fed through 4-bit bus line sequentially from the left end of the display face.

Since this graphic display unit contains no refresh RAM, it requires data and timing pulse inputs even for static display.

OPTICAL CHARACTERISTICS (t_A = 25°C, V_{DD} - V_{SS} = 5 V, V_{DD} - V_{EE} = V_{MAX})

The following specifications are based on the electrical measuring conditions, on which the contrast of perpendicular direction (θx = θy = 0°) is maximum.

SYMBOL	PARAMETER	CONDITION		MIN.	TYP.	MAX.	UNIT	NOTE
θx	Viewing Angle Range	C_0 > 4.0	θy = 0°	-25	–	20	–	1
θy			θx = 0°	-10	–	20	–	1
C_0	Contrast Ratio	θx = θy = 0°		10	18	–	–	2
t_R	Response Time – Rise	θx = θy = 0°		–	80	130	ms	3
t_D	Response Time – Decay	θx = θy = 0°		–	70	120	ms	3

NOTES:

1. The viewing angle is defined below.
2. Contrast Ratio is defined as follows:

$$Co = \frac{\text{Luminance (brightness) all pixels 'white' at } V_{MAX}}{\text{Luminance (brightness) all pixels 'dark' at } V_{MAX}}$$

   V_{MAX} is defined in Figure 9.
3. The response characteristics of photo-detector output are measured as shown in Figure 10, assuming that input signals are applied so as to select and deselect the dots to be measured and in the Optical Characteristics Test Method shown in Figure 11.

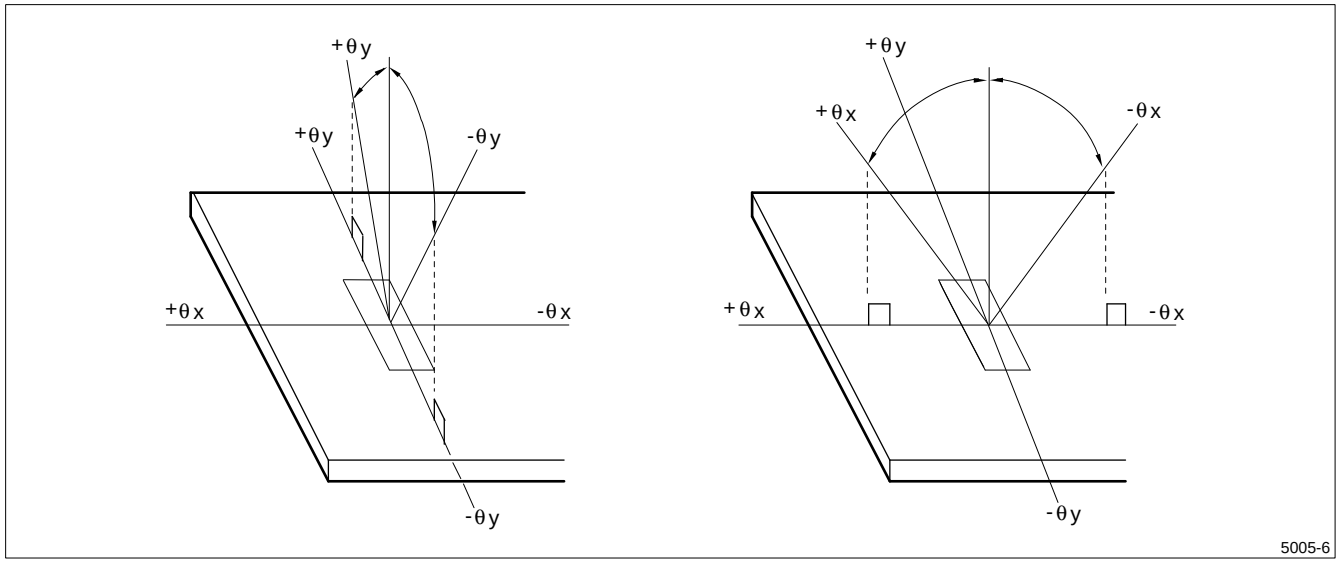


Figure 7. Definition of Viewing Angle

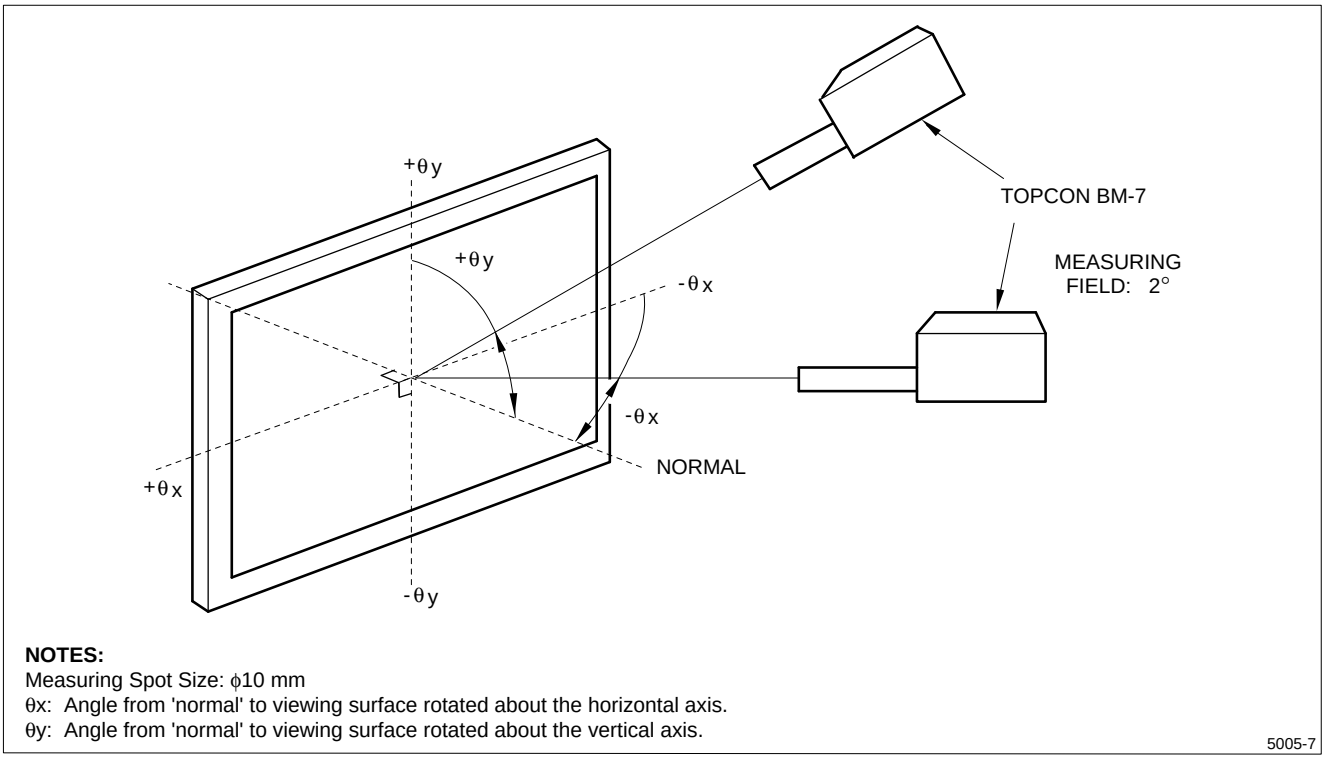


Figure 8. Optical Characteristics Test Method I

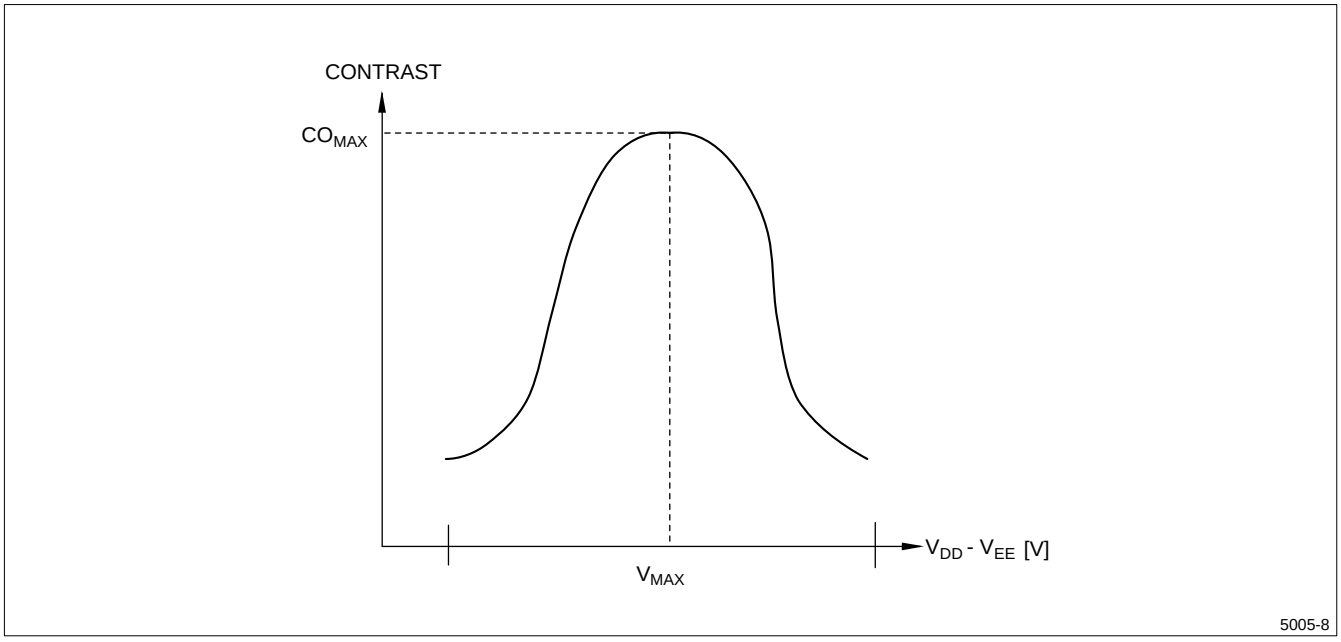


Figure 9. Definition of V_{MAX}

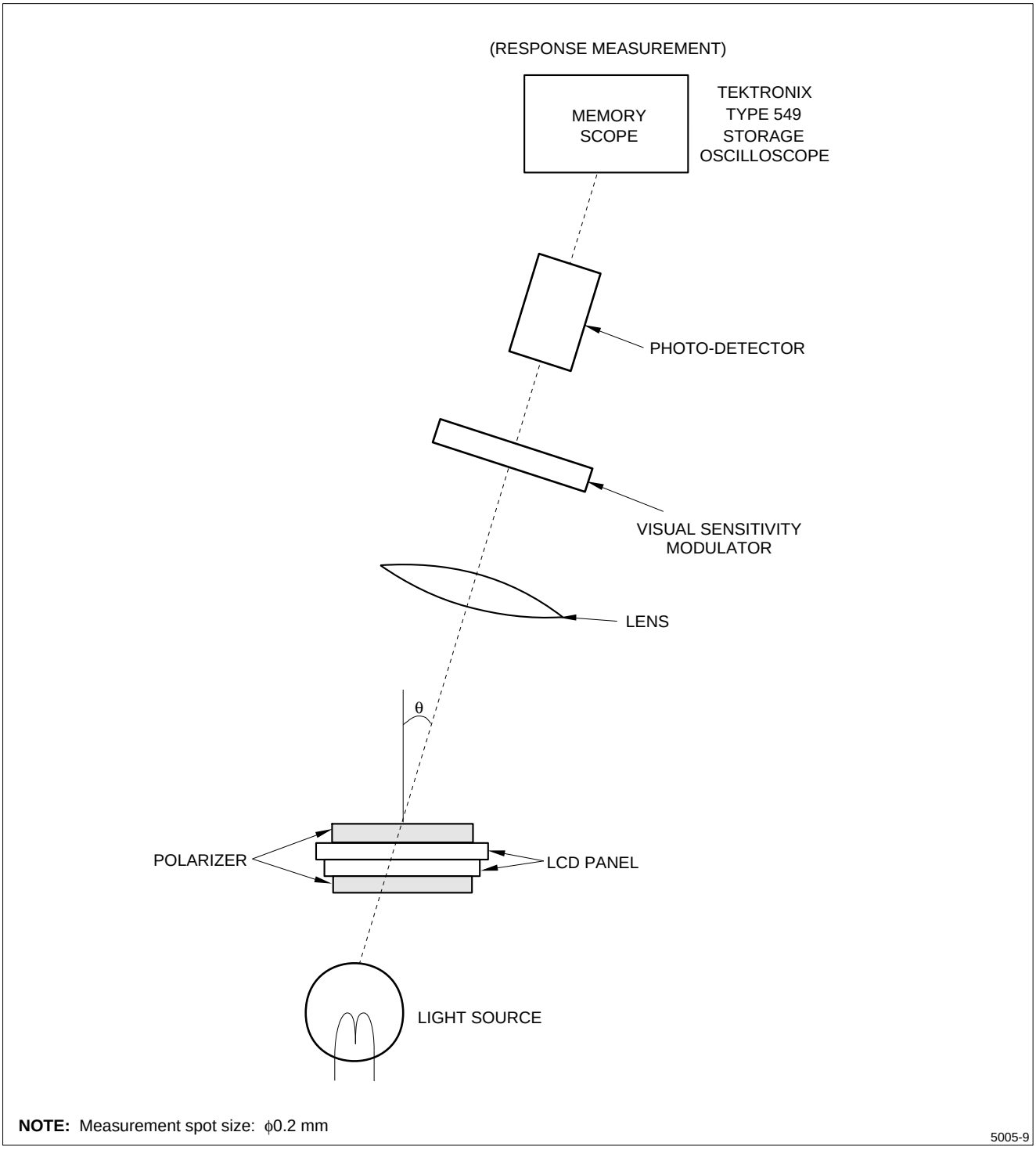


Figure 10. Optical Characteristics Test Method II

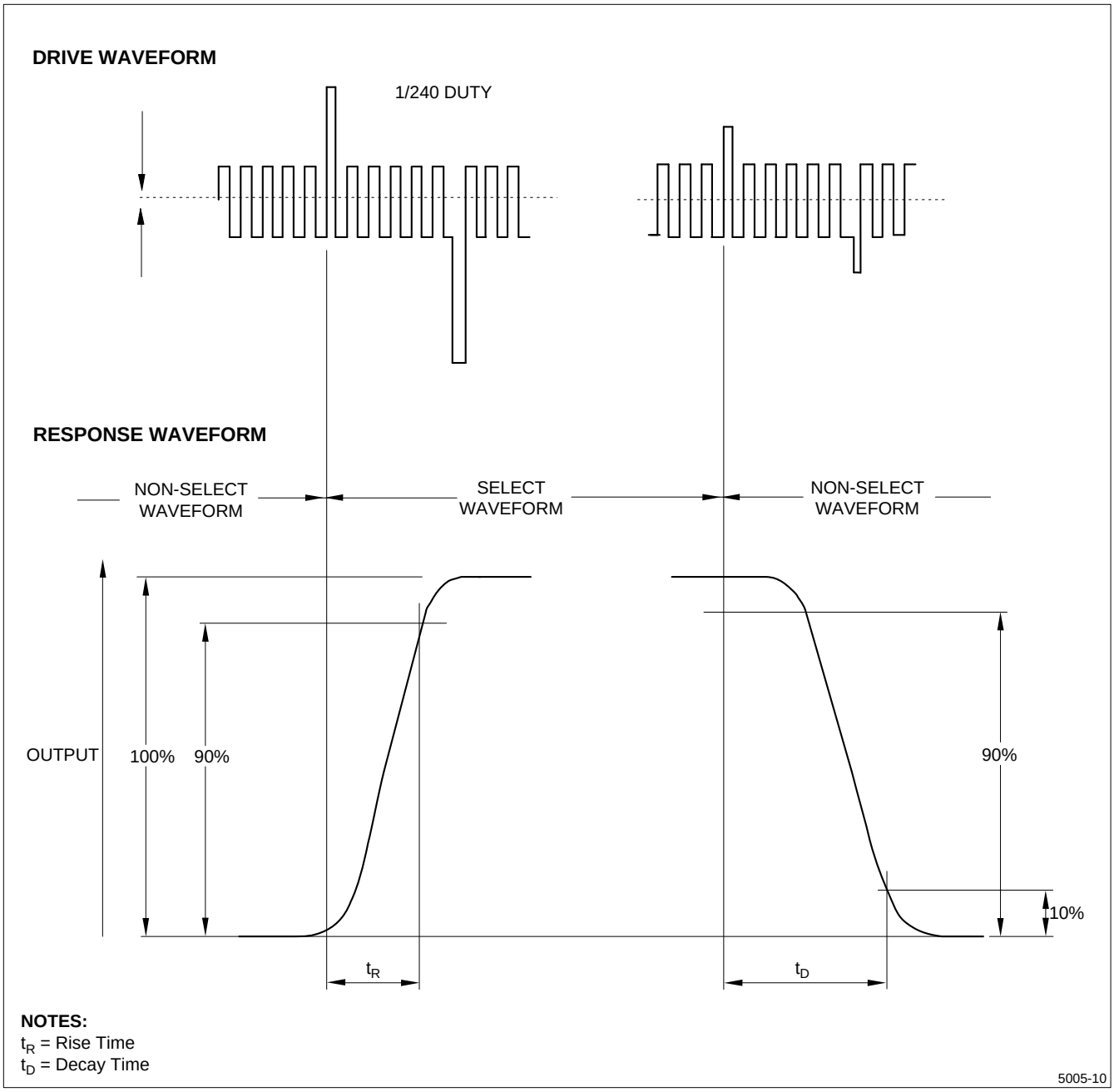


Figure 11. Definition of Response Time

CHARACTERISTICS OF BACKLIGHT

The ratings are given for the following conditions.

Rating

PARAMETER	MIN.	TYP.	MAX.	UNIT
Brightness	60	75	–	cd/m^2

Measurement Circuit

LM000106 (SHARP) (at IL = 5 mA)

Measurement Equipment

BM-7 (TOPCON)

Measurement Conditions

- Measurement circuit voltage: DC = 12 V at primary side.
- LCD: All digits WHITE, V_{DD} - V_{SS} = 5.0 V, $V_{DD} – V_{EE} = V_{MAX}$, $DU_0 – DU_3$, $DL_0 – DL_3$ = 'H' (WHITE)
- Ambient temperature: 25°C. Make measurement 30 minutes after turning on the unit.

Used Lamp (Rating, 1 pc.)

PARAMETER		MAXIMUM ALLOWABLE VALUE	NOTE
Circuit Voltage (VS)	1,000 V (minimum)	500 V	–
Discharging Tube Current (IL)	5 mA (typical)	7 mA	1
Power Consumption (P)	2.0 W	–	–
Discharging Tube Voltage (VL)	385 V (typical)	–	–
Brightness (B)	28,000 cd/m^2 (typical)	–	–

NOTE:

1. It is recommended that IL not be more than 5 mA so that heat radiation of CCFT backlight least affects the display quality.

Operating Life

The operating lifetime is 10,000 hours or more at 5 mA. (Operating life with LM000106 or equivalent).

The inverter should meet the following conditions to keep the specified lifetime of the used lamp:

- Sine, symmetric waveform without spike in positive and negative.
- The voltage at the secondary side is 1,000 V or more.
- Illuminance frequency range: 25 kHz - 45 kHz.

The operating lifetime is defined as having ended when any of the following conditions occur (25 ±5°C):

- When the voltage required for initial discharge has reached 900 V or when it has reached 10.8 V when used as an inverter.
- When the illuminence or quantity of light has decreased to 50% of the initial value.

NOTE: Rating is defined as the average brightness inside the viewing area specified in Figure 12.

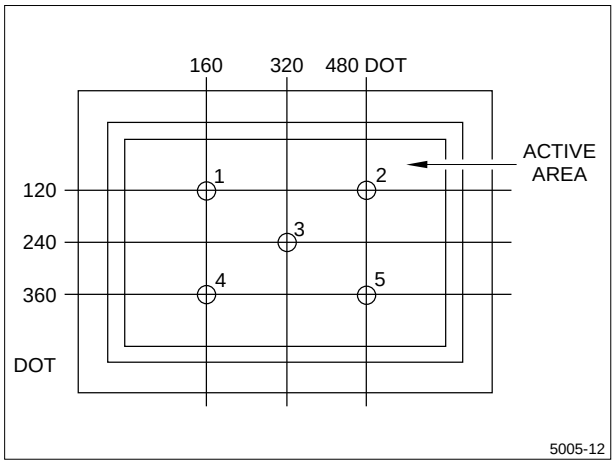


Figure 12. Measuring Points (1 - 5)

PRECAUTIONS

- Industrial (Mechanical) design of the product in which this LCD unit will be incorporated must be made so that the viewing angle characteristics of the LCD are optimized. This unit's viewing angle is illustrated in Figure 13 and as follows:
  - θy MIN < viewing angle < θy MAX
    (θy MIN < 0, θy MAX ≥ 0)
    (For the specific values of θy MIN, θy MAX, refer to the Optical Characteristics table.) Consider the optimum viewing conditions according to the purpose when installing the unit.

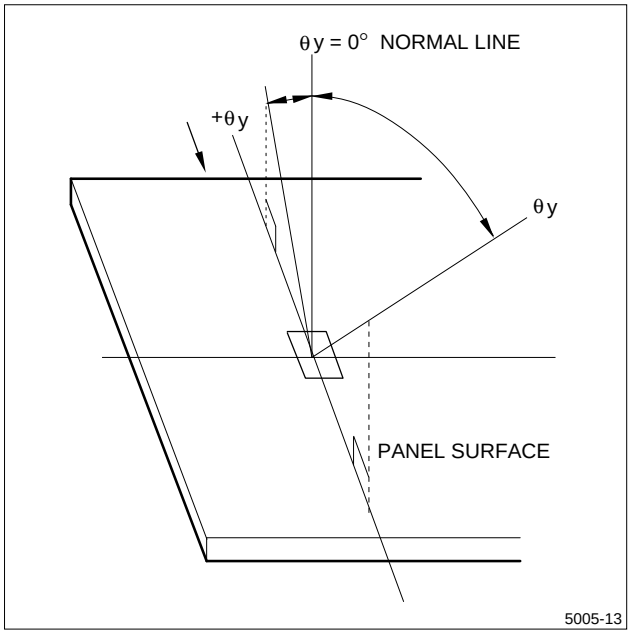
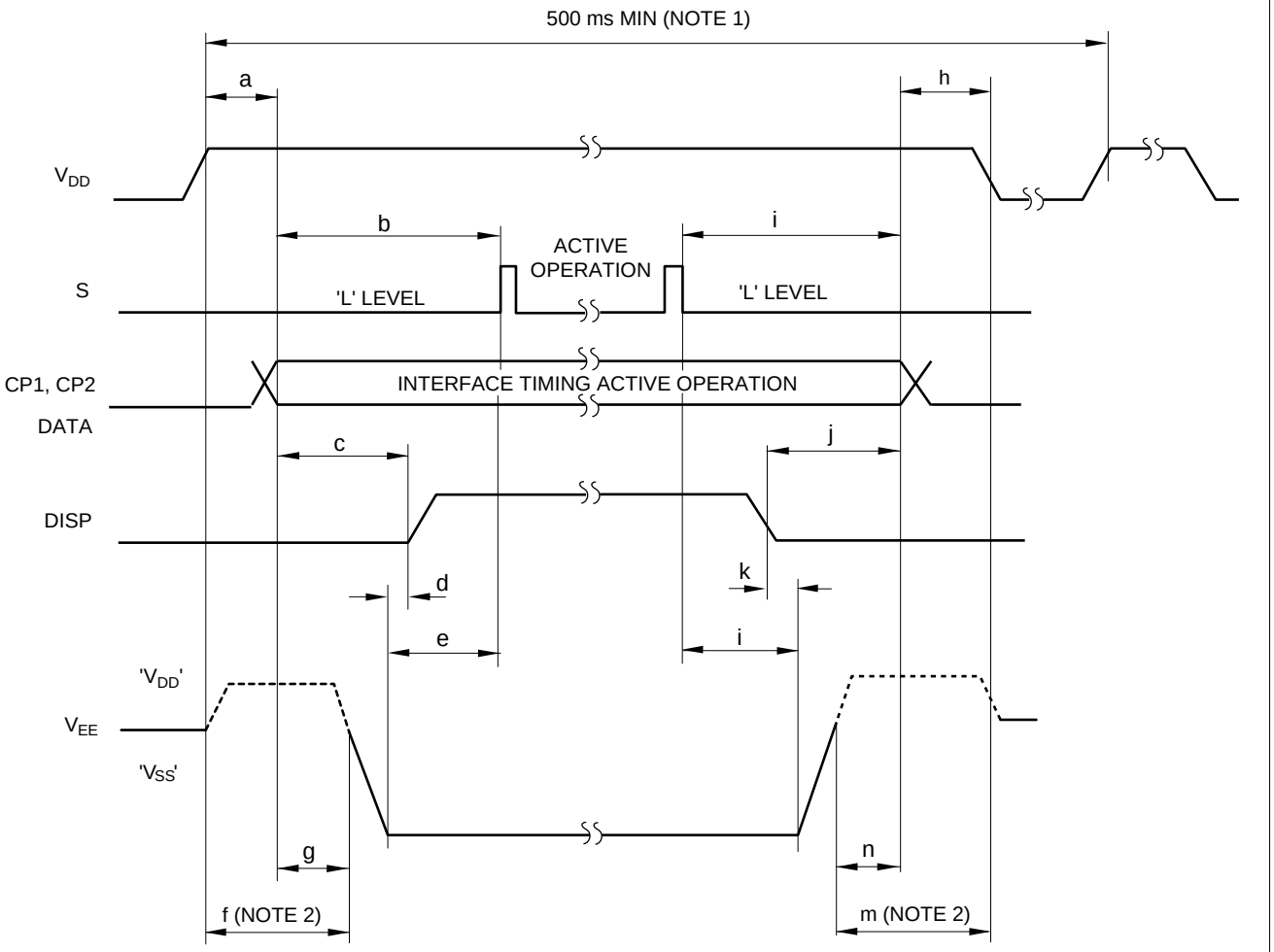


Figure 13. Dot Matrix LCD Viewing Angle

- This unit is installed using mounting tabs at the four corners of PCB or bezel. During installation, avoid undue stress on the unit such as twisting or bending.
- Since the front polarizer is easily damaged, use care to not scratch the face.
- If the surface of the LCD cells needs cleaning, wipe it with a soft cloth.
- Wipe liquid off immediately since it can cause color changes and staining.
- The LCD is made of glass plates. Use care when handling it to avoid breakage.
- This unit contains CMOS LSIs which are sensitive to electrostatic charges. The following measures should be taken to protect the unit from the electrostatic discharge:
  - Ground the metallic case of the main system (contact of the unit and main system).
  - Insulate the unit and main system by attaching insulating washers made of bakelite or nylon.
- The unit should be driven according to the specified ratings to avoid malfunction or permanent damage. DC voltage drive leads to rapid deterioration of LC, so ensure that the drive is alternating waveform by continuous application of the signal M. Avoid latch-up of driver LSIs and application of DC voltage to LCD panel by following the ON/OFF sequence shown in Figure 14.
- Do not expose the unit to direct sun light, strong ultraviolet light, etc., for prolonged periods.
- Store the unit at normal room temperature to prevent the LC from converting to liquid (due to excessive temperature changes).
- Do not disassemble the unit.

WARNING: Don't use any materials which emit gas from epoxy resin (Amines' hardener) and silicone adhesive agent (dealcohol or deoxym) to prevent polarizer color owing to gas.



NOTES:
1. Power ON/OFF cycle time. All signals and power line shall be in accordance with above sequence in case of power ON/OFF.
2. V_{EE} to be set at 'V_{DD} level' or 'open.' V_{EE} should be in accordance with the dotted line when DISP (display control signal) is not used.

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Figure 14. Supply Voltage Sequence Condition

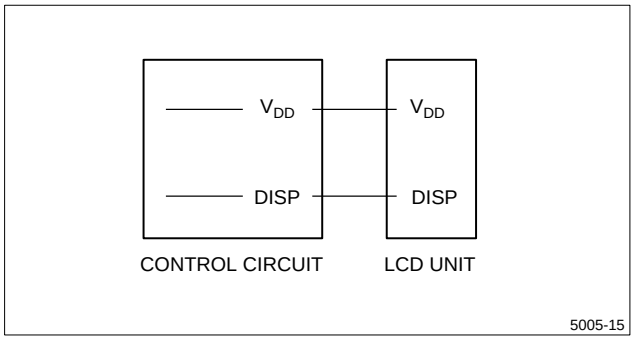


Figure 15. With DISP Control

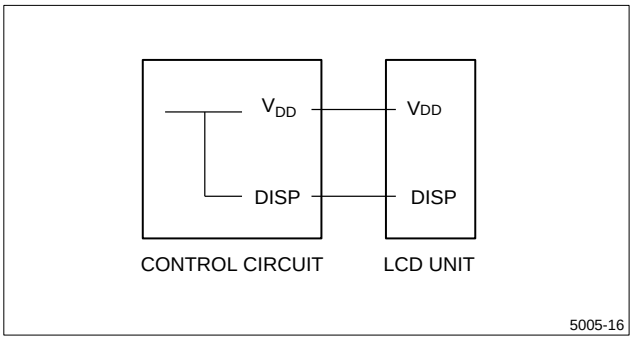


Figure 16. Without DISP Control

POWER ON		
SYMBOL	**WITH DISP CONTROL**	**WITHOUT DISP CONTROL**
a	0 ms (minimum)	0 ms (minimum) 20 ms (maximum)
b	0 ms (minimum)	20 ms (minimum)
c	20 ms (minimum)	–
d	0 ms (minimum)	–
e	–	0 ms (minimum)
f	0 ms (minimum)	Note 1
g	–	0 ms (minimum) 100 ms (maximum)

POWER OFF		
SYMBOL	**WITH DISP CONTROL**	**WITHOUT DISP CONTROL**
h	0 ms (minimum)	0 ms (minimum) 20 ms (maximum)
i	0 ms (minimum)	20 ms (minimum)
j	20 ms (minimum)	–
k	0 ms (minimum)	–
l	–	0 ms (minimum)
m	0 ms (minimum)	Note 1
n	–	100 ms (minimum)

NOTE:

1. V_{EE} to be set at 'V_{DD} level' or 'open.' V_{EE} should be in accordance with the dotted line when DISP (display control signal) is not used.

LOT NUMBER

Lot number is in accordance with the numbering rule provided in Figure 17.

APPLICABLE INSPECTION STANDARD

The LCD unit shall meet the following inspection standard: S-U-012-01

DISPLAY QUALITY

This specification describes display quality in case of no gray scale. Since display quality can be affected by gray scale methods, display quality shall be carefully evaluated for the usability of the LCD Unit in case gray scale is displayed on the LCD Unit.

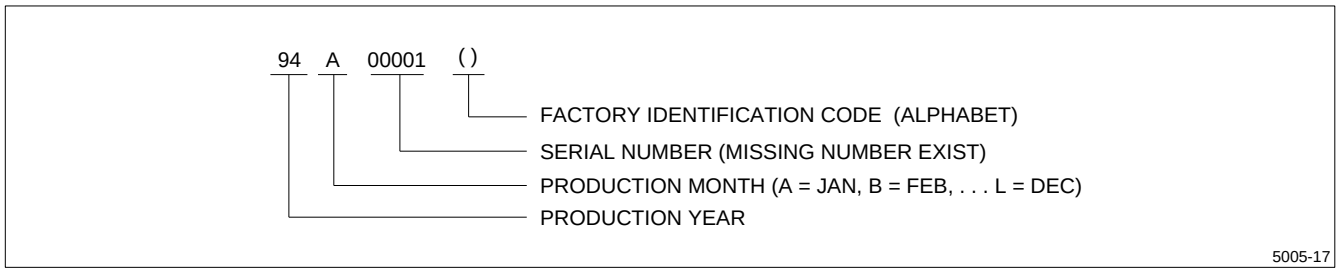
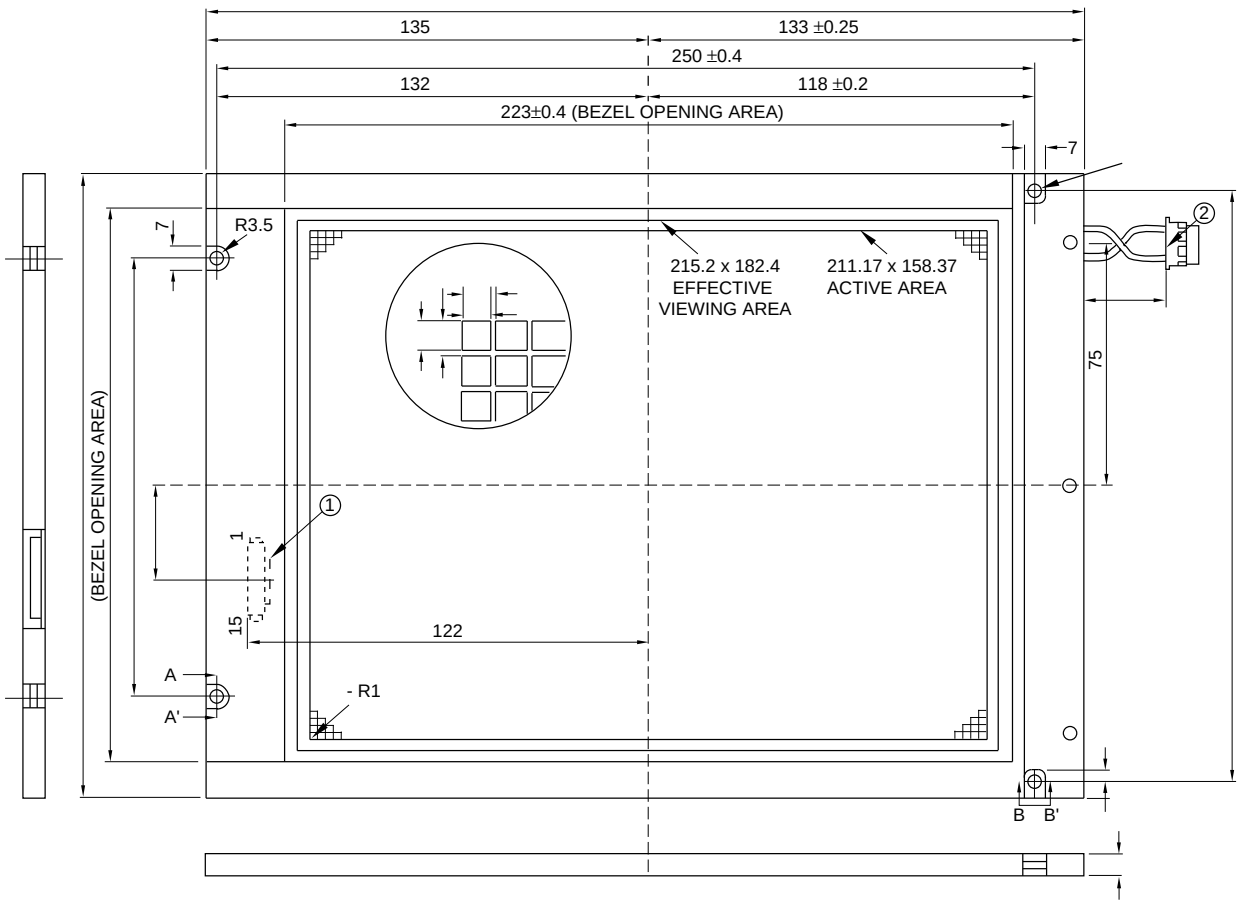


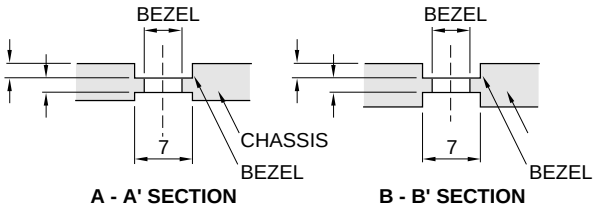
Figure 17. Numbering Rule

OUTLINE DIMENSIONS

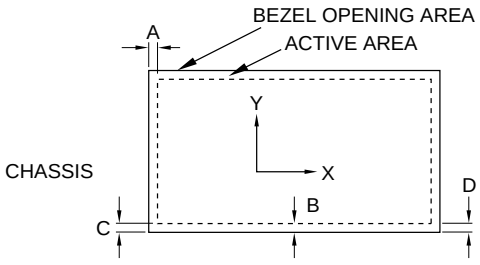


INTERFACE PIN LAYOUT

PIN #	SIGNAL	PIN #	SIGNAL
1	S	9	DU_1
2	CP1	10	DU_2
3	CP2	11	DU_3
4	DISP	12	DL_0
5	V_{DD}	13	DL_1
6	V_{SS}	14	DL_2
7	V_{EE}	15	DL_3
8	DU_0		



BEZEL/DISPLAY POSITION



NOTES:
1. Tolerance X-Direction A:
2. Tolerance Y-Direction B:
3. Obliquity of Display Area: IC-DI < 0.8

①Interface Connector (15 pins)

②CCFT connector

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