

TFT COLOR LCD MODULE
NL8060BC26-17

26 cm (10.4 inches), 800 × 600 pixels, 262,144 colors
high luminance, wide viewing angle

DESCRIPTION

The NL8060BC26-17 is a TFT (thin film transistor) active-matrix color liquid crystal display (LCD) module comprising an amorphous silicon TFT attached to each signal electrode, a driving circuit, and a backlight.

The NL8060BC26-17 has a built-in backlight. The backlight includes long-life lamps, which are replaceable, and a holder.

The 26 cm diagonal display area contains 800 × 600 pixels and can display 262,144 colors simultaneously.

The NL8060BC26-17 is suitable for industrial application use because the viewing angle is wide and the luminance is high. The viewing direction is selectable for either the upper or the lower side by changing the scan direction.

FEATURES

- High luminance (280 cd/m², typ.)
- Wide viewing angle (with retardation film)
- Low reflection
- Reversible scan direction
- 6-bit digital RGB signals
- Data enable (DE) function
- Edge-type backlight with two long-filetime lamps (one lamp holder)
- Replaceable lamp holder
- Recommendation inverter for a backlight: Part No. 104PWBR1

APPLICATIONS

- Display terminals for control systems
- Monitors for process controllers



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.

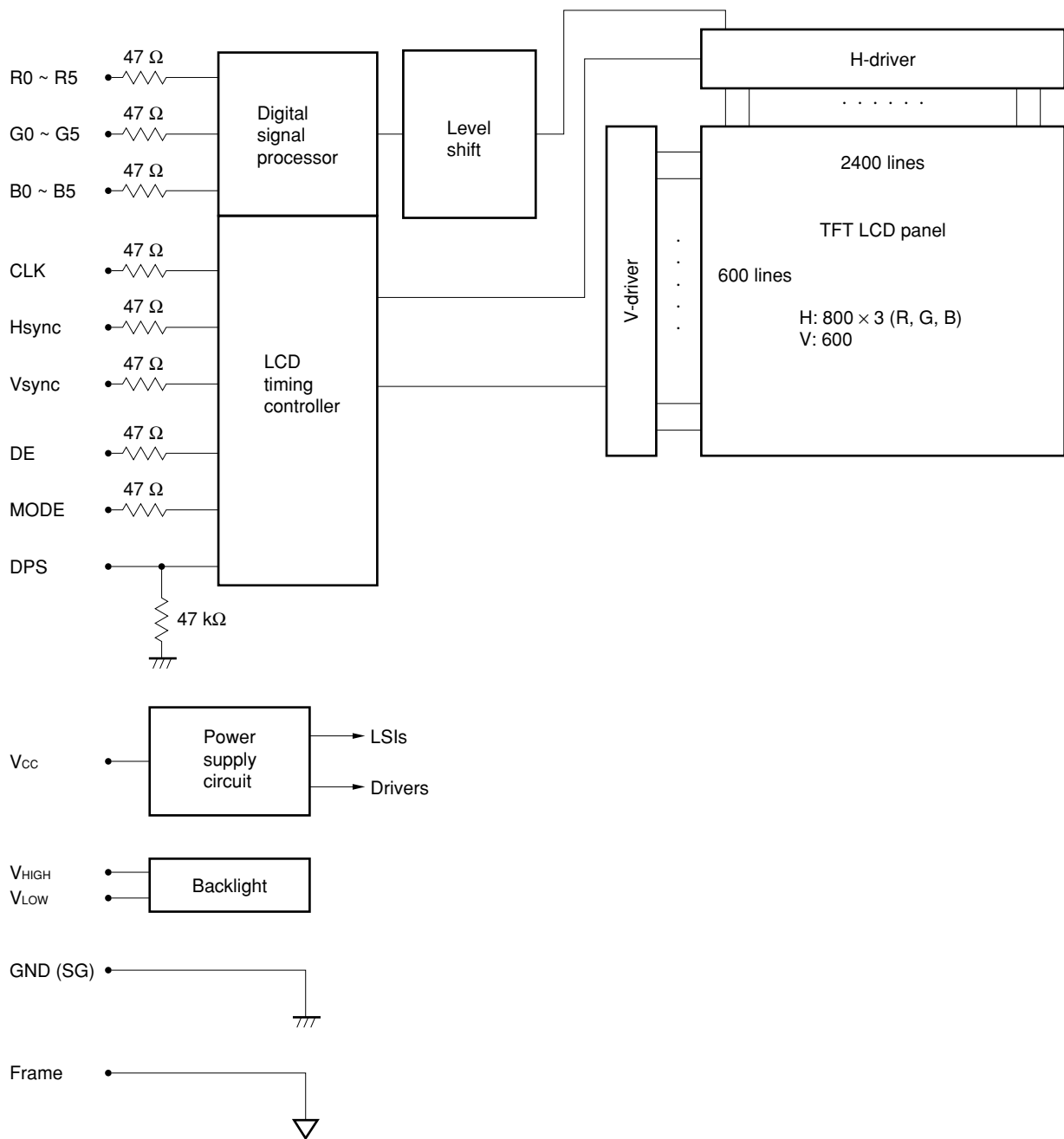
RGB (red, green, blue) data signals from a source system are modulated into a form suitable for active-matrix addressing by the onboard signal processor and sent to the driver LSIs, which in turn address the individual TFT cells.

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)

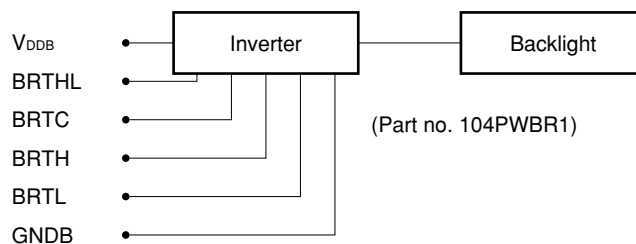
Display area	211.2 (H) × 158.4 (V) mm
Drive system	a-Si TFT active matrix
Display colors	262,144 colors
Number of pixels	800 × 600 pixels
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.264 (H) × 0.264 (V) mm
Module size	243.0 (H) × 185.1 (V) × 11.5 max. (D) mm
Weight	520 (typ.)
Contrast ratio	300:1 (typ.)
Viewing angle (more than the contrast ratio of 10:1)	Horizontal: 50° (typ. left side, right side) Vertical: 35° (typ. up side), 45° (typ. down side)
Designed viewing direction	<ul style="list-style-type: none"> • Wider viewing angle with contrast ratio: <ul style="list-style-type: none"> down side (6 o'clock, normal scan) up side (12 o'clock, reverse scan) • Wider viewing angle without image reversal: <ul style="list-style-type: none"> up side (12 o'clock, normal scan) down side (6 o'clock, reverse scan) • Optimum gray-scale ($\gamma = 2.2$): <ul style="list-style-type: none"> perpendicular
Color gamut	43% (typ. center, to NTSC)
Response time	15 ms (max.), "white 100%" to "black 10%"
Luminance	280 cd/m ² (typ.) (lamp current: $I_L = 5$ mA rms per lamp)
Signal system	6-bit digital signals for each of the RGB primary colors, synchronous signals (Hsync, Vsync), dot clock (CLK)
Supply voltage	3.3 V [5.0 V] (logic, LCD driving)
Backlight	Edge light type, two cold cathode fluorescent lamps in a holder, attached inverter <ul style="list-style-type: none"> • Lamp holder set: Part no.104LHS31 • Recommended inverter: Part no. 104PWBR1
Power consumption	7.0 W (typ. at 3.3 V, with recommended inverter)

BLOCK DIAGRAM



Note: Frame is not connected with GND (SG).

If connecting the NEC-recommended inverter



GENERAL SPECIFICATIONS

Item	Specification	Unit
Module size	243.0 ± 0.5 (H) × 185.1 ± 0.5 (V) × 11.5 max. (D)	mm
Display area	211.2 (H) × 158.4 (V)	mm
Number of pixels	800 (H) × 600 (V)	pixel
Dot pitch	0.088 (H) × 0.264 (V)	mm
Pixel pitch	0.264 (H) × 0.264 (V)	mm
Pixel arrangement	RGB (red, green, blue) vertical stripe	
Display colors	262,144	color
Weight	520 (typ.) 550 (max.)	g

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Remarks
Supply voltage	V _{CC}	-0.3 to 6.5	V	V _I - V _{CC} < 3.0
Input voltage	V _I	-0.3 to 6.5	V	T _a = 25 °C
Lamp voltage	V _L	2000	V _{rms}	T _a = 25 °C
Storage temp.	T _{ST}	-20 to 60	°C	
Operating temp.	T _{OP}	0 to 50	°C	Module surface ^{Note}
Relative humidity (RH)		≤ 95	%	T _a ≤ 40 °C
		≤ 85	%	40 < T _a ≤ 50 °C
Absolute humidity		Absolute humidity shall not exceed T _a = 50 °C, RH = 85 %	g/m ³	T _a > 50 °C

Note: Measured at the panel surface (including self-heat)

ELECTRICAL CHARACTERISTICS

(1) Logic, LCD Driving

T_a = 25 °C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V _{CC}	3.0 (4.75)	3.3 (5.0)	3.6 (5.25)	V	V _{CC} = 3.3 V (V _{CC} = 5.0 V)
Logic input "L" voltage	V _{IL}	0	-	V _{CC} × 0.3	V	CMOS level
Logic input "H" voltage	V _{IH}	V _{CC} × 0.7	-	V _{CC}	V	
Supply current	I _{CC}	-	360 (270) ^{Note}	550 (500)	mA	V _{CC} = 3.3 V (V _{CC} = 5.0 V)

Note: Checker flag pattern (in EIAJ ED-2522)

(2) Backlight

Ta = 25 °C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Lamp current	I _L	2.0	5.0	5.5	mA rms	with one lamp
Lamp voltage	V _L	–	510	–	V rms	–
Lamp turn-on voltage	V _s	840	–	–	V rms	Ta = 25 °C *2
		1265	–	–		Ta = 0 °C *2
Oscillator frequency	F _t	50	54	58	kHz	*1

Notes: 1. Recommended value of Ft.

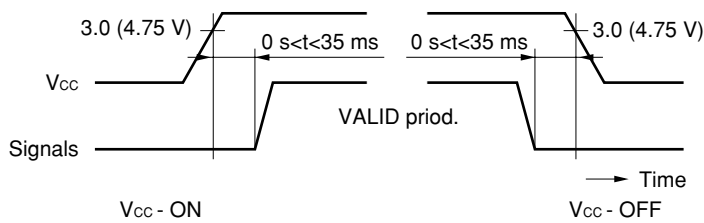
- Ft is within the specification.
and

- $F_t = 1/4Th \times (2n - 1)$ Th: Hsync period
n: a natural number (1, 2, 3...)

If Ft is out of the recommended value, interference between the Ft frequency and Hsync frequency may cause a beat on the display.

2. When Vs is less than the minimum value, the lamp might be not turned on.
3. Recommended inverter: Part no. 104PWBR1

SUPPLY VOLTAGE SEQUENCE



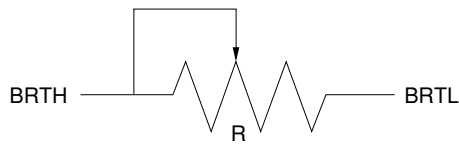
Signals: CLK, Hsync, Vsync, DE, R0 ~ R5, G0 ~ G5, B0 ~ B5

Notes: 1. The supply voltage for input signals should be the same as Vcc.

2. 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.
3. When the power is off, please keep whole signals (Hsync, Vsync, CLK, DE, R0 ~ R5, G0 ~ G5, B0 ~ B5) at low level or high impedance.
4. The wrong power sequence may damage the module.
5. The signal should not be down during operation. Even if the signal could recover, the LCD module cannot be operated correctly and the display may be non-uniform. If the signal is down, Vcc should be turned off, and then Vcc and the signal should be turned on as in the sequence above.

2. <1> Luminance control by a variable resistor

This way works when BRTHL (the no. 5 pin) of CN3 is opened.



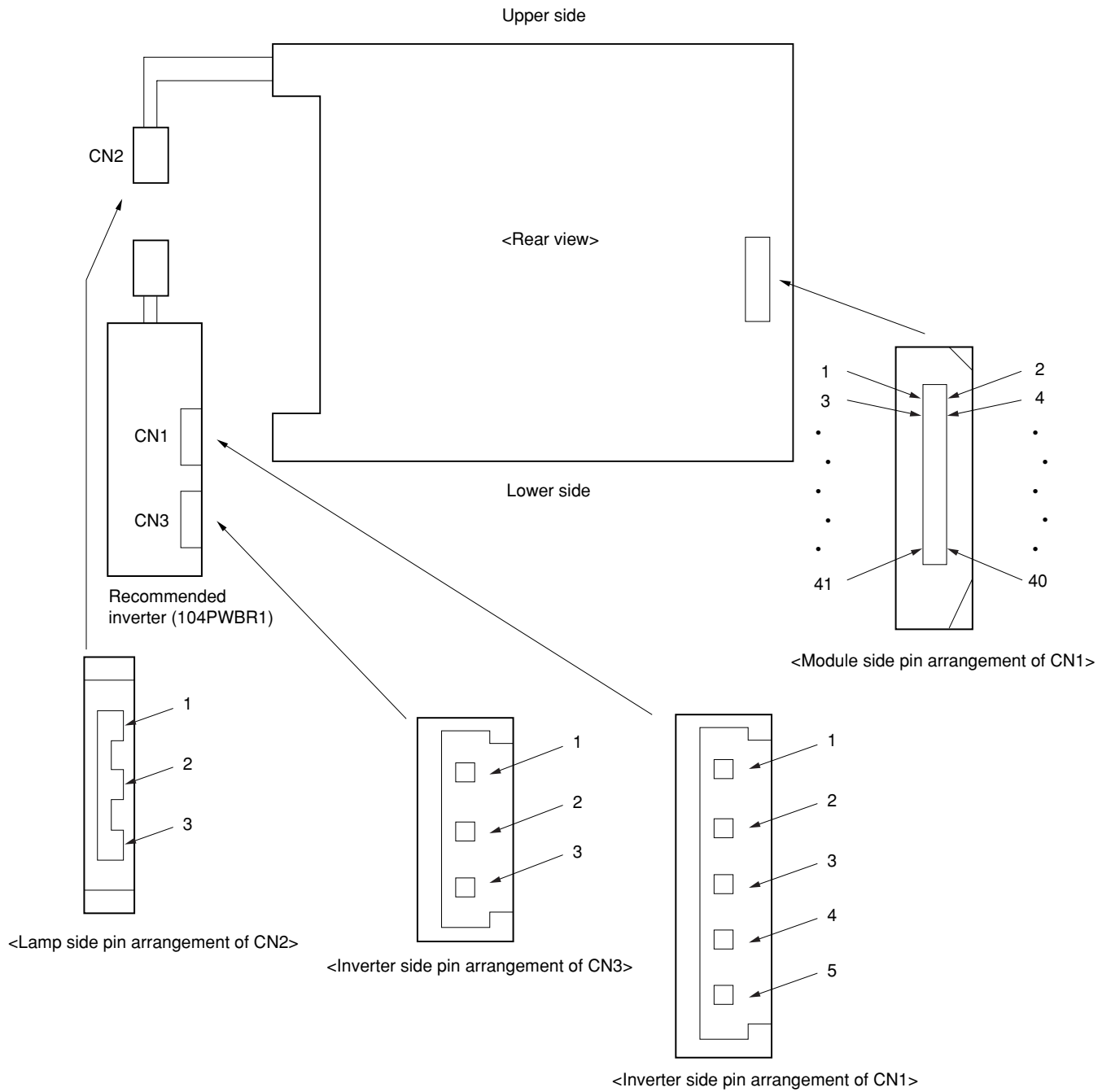
Mating variable resistor: 10 KΩ ±5 %
 Minimum luminance (50%): R = 0 Ω
 Maximum luminance (100%): R = 10 KΩ

<2> Luminance control by voltage

This way works when BRTL is opened. The range of input voltage between BRTH and GNDB is as follows.

Minimum luminance (50%): 2.5 V
 Maximum luminance (100%): ≤ 1.2 V

(3) Connector Location



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
	Dark	0	0	0	0	0	1	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
Red	1	1	1	1	1	0	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
	Dark	0	0	0	0	0	0	0	0	0	0	0	1	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
Green	0	0	0	0	0	0	1	1	1	1	1	0	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
	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
Blue	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 TIMING

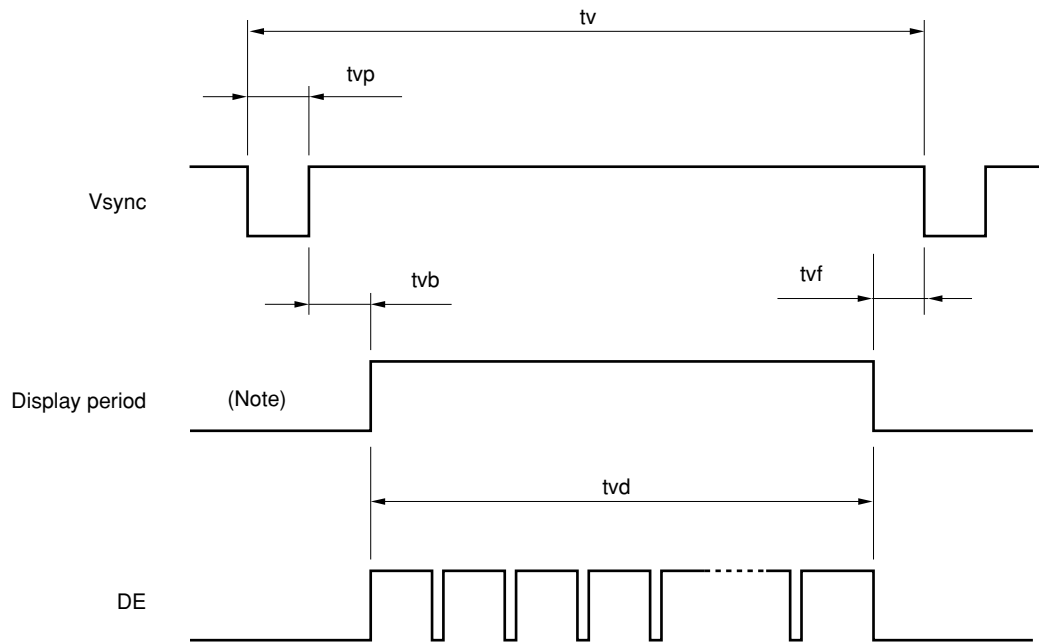
(1) Input Signal Specifications

Parameter		Symbol	Min.	Typ.	Max.	Unit	Remarks
CLK	Frequency	1/tc	34.0	38.362	40.0	MHz	26.067 ns (typ.)
	Duty	tch/tc	0.4	0.5	0.6	–	–
	Rise, fall	trf	–	–	10	ns	–
Hsync	Period	th	24.3	26.693	–	μs	37.468 kHz (typ.)
			–	1024	–	CLK	
	Display period	thd	800			CLK	–
	Front porch	thf	–	24	–	CLK	Fixed mode
			4	24	–	CLK	DE mode
	Pulse width	thp	2	72	127	CLK	Fixed mode
			2	72	–	CLK	DE mode
	Back porch	thb	2	128	198	CLK	Fixed mode
			2	128	–	CLK	DE mode
	thp + thb		200			CLK	Fixed mode
			15	200	–	CLK	DE mode
	CLK-Hsync timing	thch	10	–	–	ns	–
	Hsync-CLK timing	thcs	8	–	–	ns	–
	Hsync-Vsync timing	thv	1	–	–	CLK	–
	Vsync-Hsync timing	tv	15	–	–	ns	–
Rise, fall	thrf	–	–	10	ns	–	
Vsync	Period	tv	16.1	16.683	17.2	ms	59.94 Hz (typ.)
			–	625	–	H	
	Display period	tv	600			H	
	Front porch	tvf	–	1	–	H	Fixed mode
			–	1	–	H	DE mode
	Pulse width	tvp	1	2	23	H	Fixed mode
			1	2	–	H	DE mode
	Back porch	tvb	1	22	23	H	Fixed mode
			1	22	–	H	DE mode
	tvp + tvb		24			H	Fixed mode
2			24	254	H	DE mode	
Rise, fall	tvrf	–	–	10	ns	–	
DATA R0 ~ R5 G0 ~ G5 B0 ~ B5	CLK-DATA timing	tds	8	–	–	ns	–
	DATA-CLK timing	tdh	12	–	–	ns	–
	Rise, fall	tdrf	–	–	10	ns	–
DE	DE-CLK timing	tes	8	–	–	ns	–
	CLK-DE timing	teh	12	–	–	ns	
	Rise, fall	terf	–	–	10	ns	

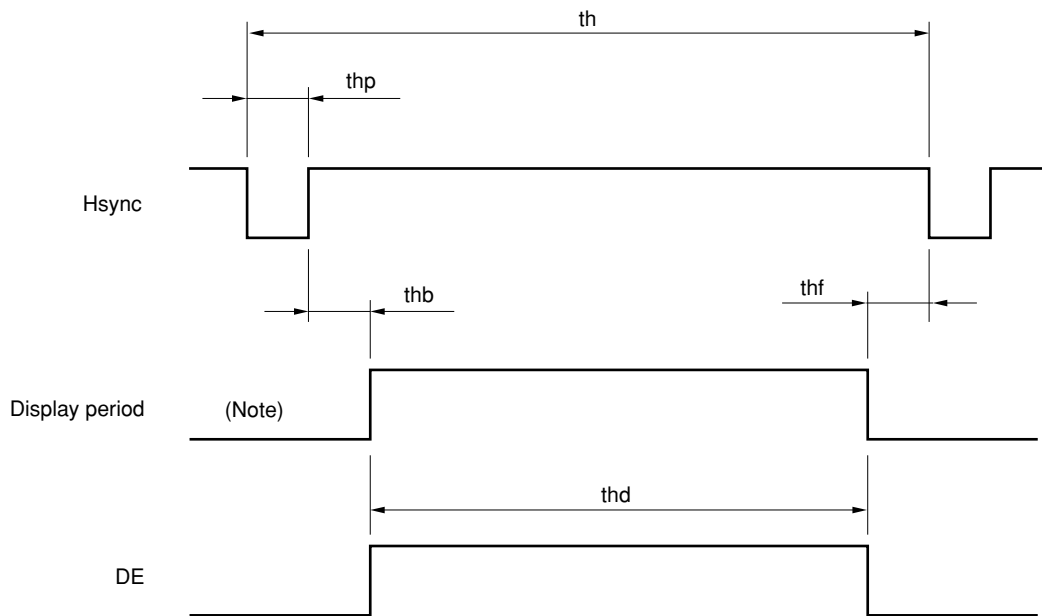
Note: All parameters should be kept in the specified range.

(2) Input Signal Timing

<Vertical>

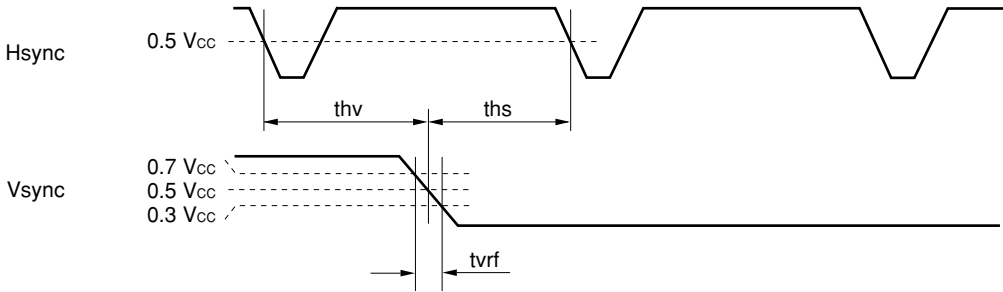
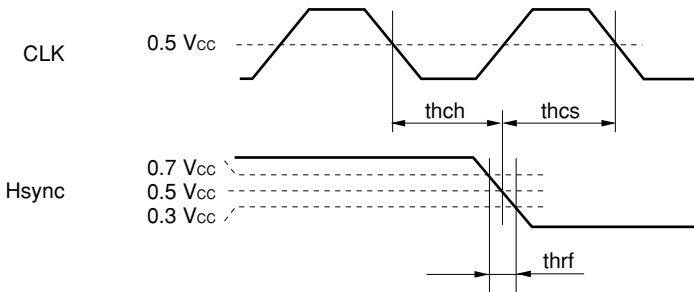
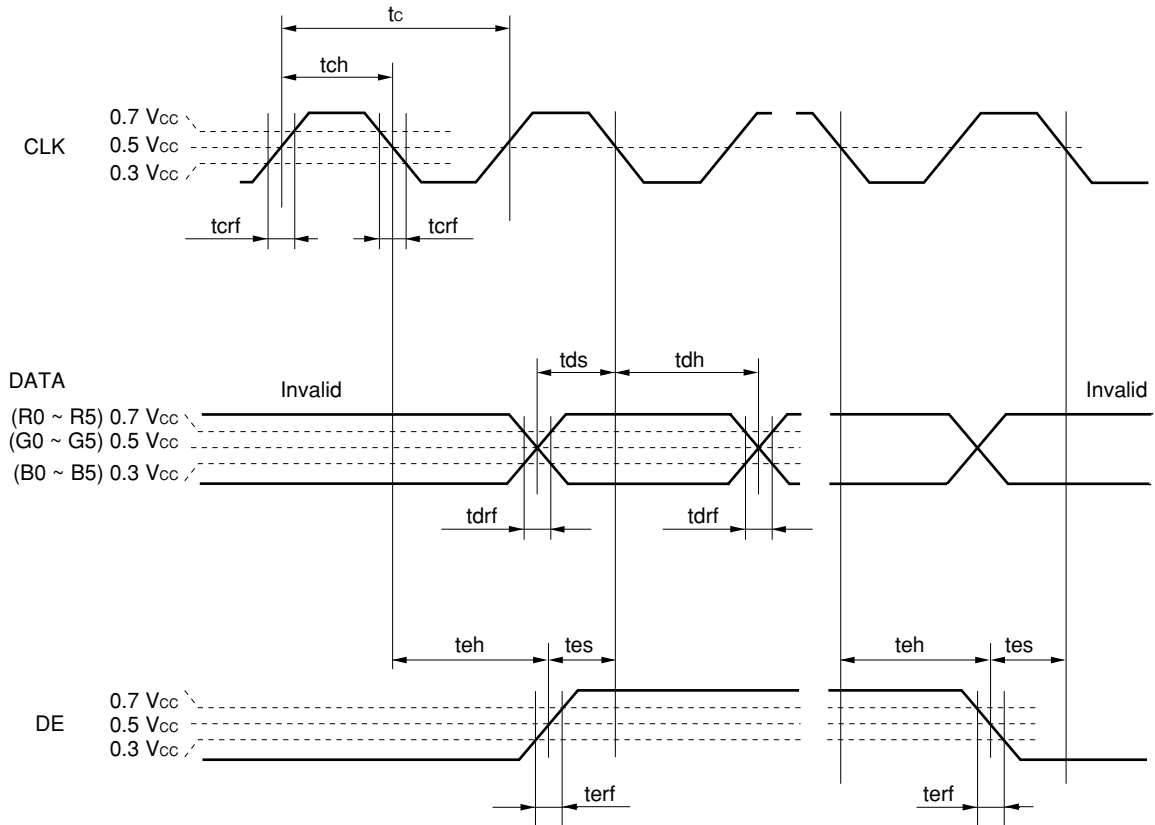


<Horizontal>

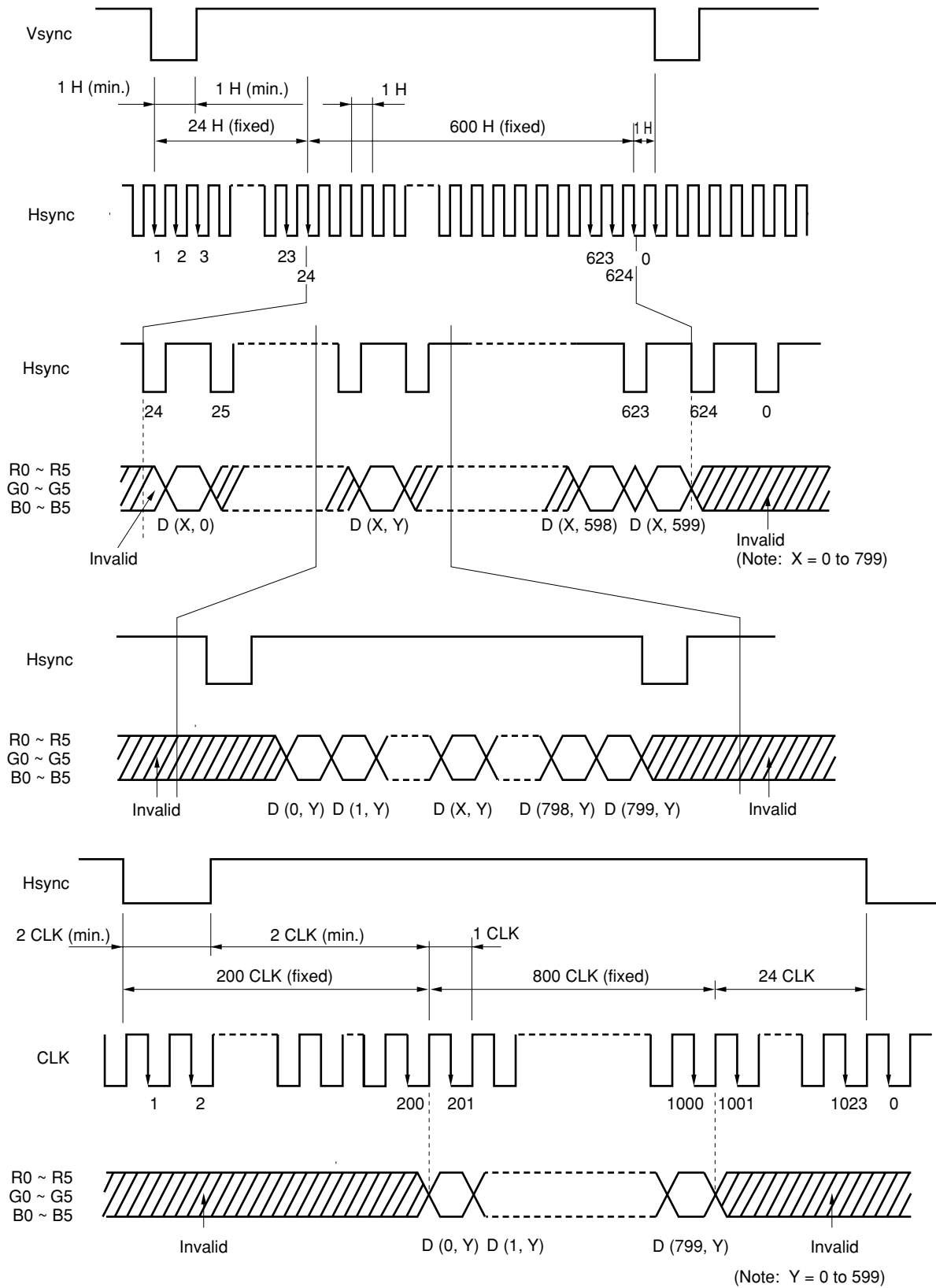


Note: These do not exist as signals.

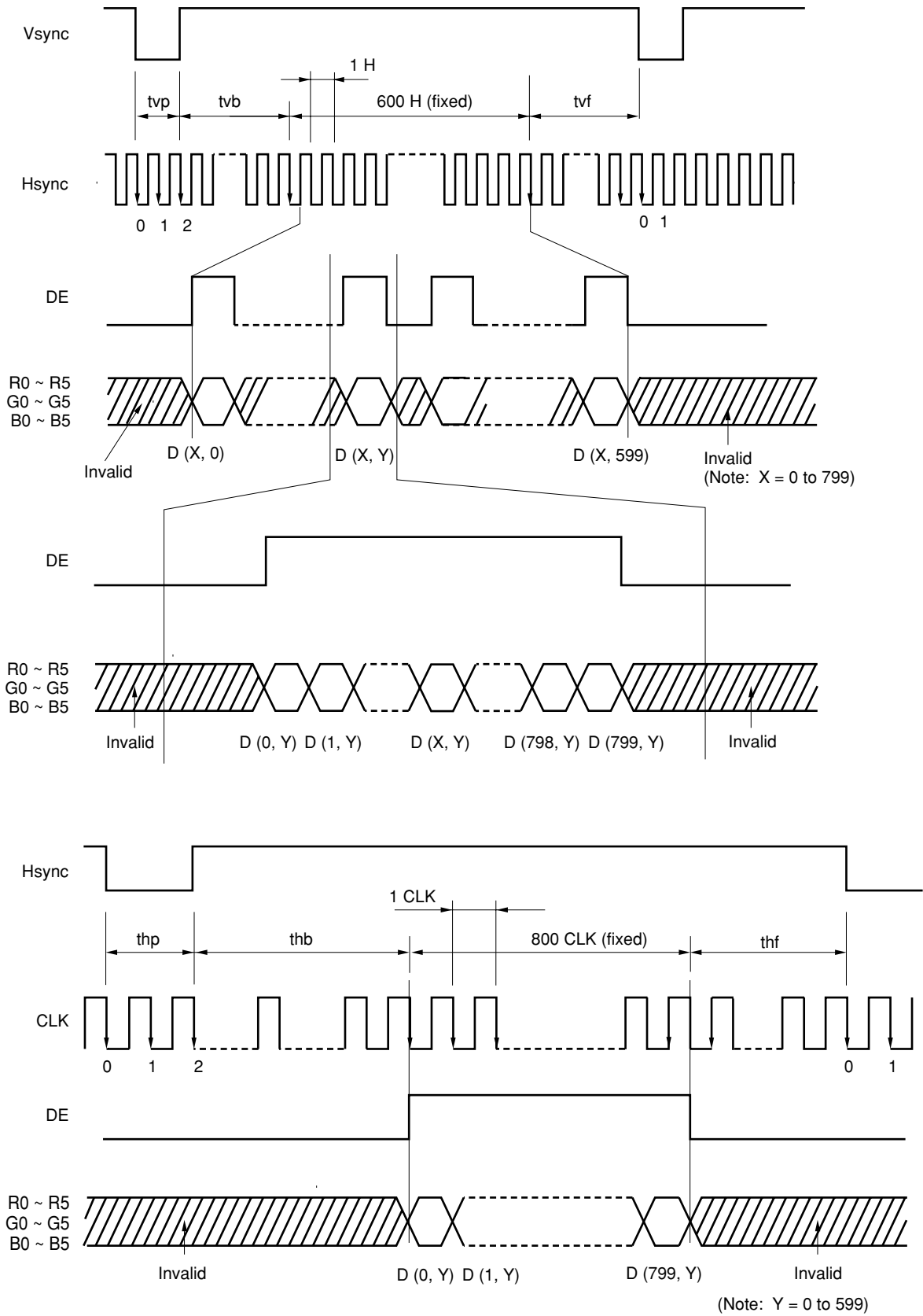
(3) Input Signal Timing Chart



a) Fixed timing mode



b) DE mode



DISPLAY POSITION

Normal scan (DPS = "Vcc")

D (0, 1)	D (1, 1)	-----	D (X, 1)	-----	D (798, 1)	D (799, 1)
D (0, 1)	D (1, 1)	-----	D (X, 1)	-----	D (798, 1)	D (799, 1)
⋮	⋮	-----	⋮	-----	⋮	⋮
D (0, Y)	D (1, Y)	-----	D (X, Y)	-----	D (798, Y)	D (799, Y)
⋮	⋮	-----	⋮	-----	⋮	⋮
D (0, 598)	D (1, 598)	-----	D (X, 598)	-----	D (798, 598)	D (799, 598)
D (0, 599)	D (1, 599)	-----	D (X, 599)	-----	D (798, 599)	D (799, 599)

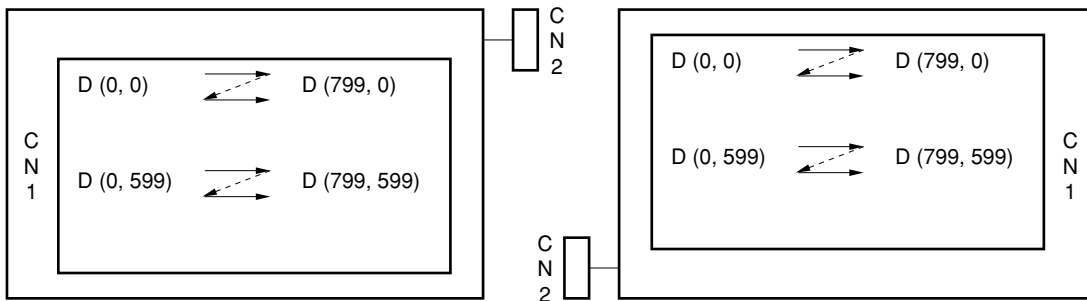
Reverse scan (DPS = "GND" or "Open")

D (799,599)	D (798,599)	-----	D (X, 599)	-----	D (1,599)	D (0,599)
D (799,598)	D (798,598)	-----	D (X, 598)	-----	D (1,598)	D (0,598)
⋮	⋮	-----	⋮	-----	⋮	⋮
D (799, Y)	D (798, Y)	-----	D (X, Y)	-----	D (1, Y)	D (0, Y)
⋮	⋮	-----	⋮	-----	⋮	⋮
D (799, 1)	D (798, 1)	-----	D (X, 1)	-----	D (1, 1)	D (0, 1)
D (799, 0)	D (798, 0)	-----	D (X, 0)	-----	D (1, 0)	D (0, 0)

The drawings below show the relationship between the scan direction and the viewing direction.

Normal scan

Reverse scan



OPTICAL CHARACTERISTICS

Ta = 25°C **Note 1**

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Contrast ratio	CR	Note 2	150	300	–	–	Note 3
Luminance	Lu max	Note 2	200	280	–	cd/m ²	Note 4
Luminance uniformity	–	max./min.	–	–	1.4	–	Note 5

Reference data

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks	
Response time	ton	White to black 100% → 10%	–	15	50	ms	Note 6	
	toff	Black to white 0% → 90%	–	65	80	ms		
Color gamut	C	at center, to NTSC	–	43	–	%	–	
Viewing angle range	Horizontal	θ_{x+}	CR > 10, $\theta_y = \pm 0^\circ$	45	50	–	deg.	Note 7
		θ_{x-}	CR > 10, $\theta_y = \pm 0^\circ$	45	50	–	deg.	
	Vertical	θ_{y+}	CR > 10, $\theta_x = \pm 0^\circ$	30	35	–	deg.	
		θ_{y-}	CR > 10, $\theta_x = \pm 0^\circ$	40	45	–	deg.	

Notes: 1. V_{CC} = 3.3 V; I_L = 5.0 mA rms; DPS = High at normal scan with recommended inverter.

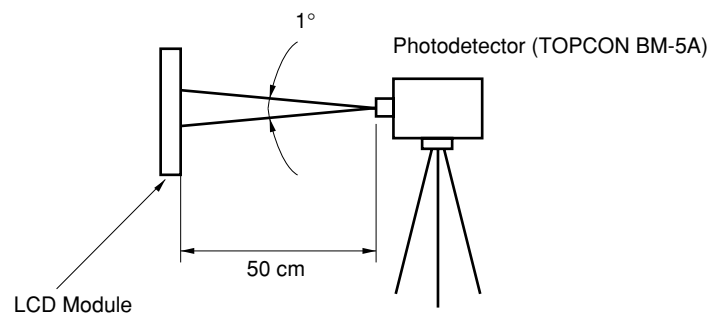
2. Viewing angle: $\theta_x = \pm 0^\circ$, $\theta_y = \pm 0^\circ$, at center.

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.

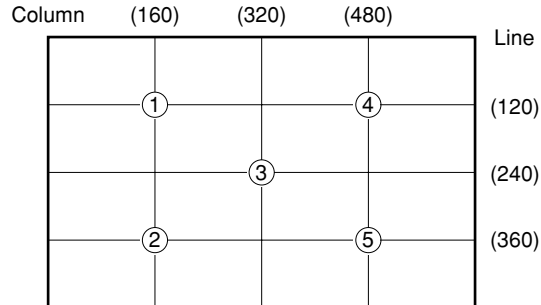
4. The luminance is measured after 20 minutes from the module works, with all pixels in "white". Typical value is measured after luminance saturation. The luminance is measured in darkroom.



5. The luminance uniformity is calculated by using following formula.

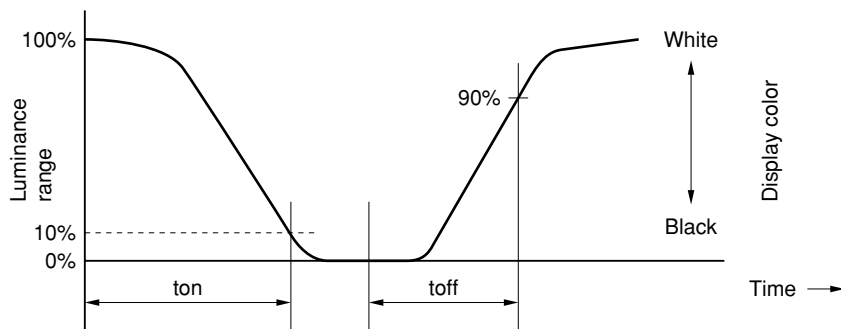
$$\text{Luminance uniformity} = \frac{\text{Maximum luminance}}{\text{Minimum luminance}}$$

The luminance is measured at or near the five points shown below.

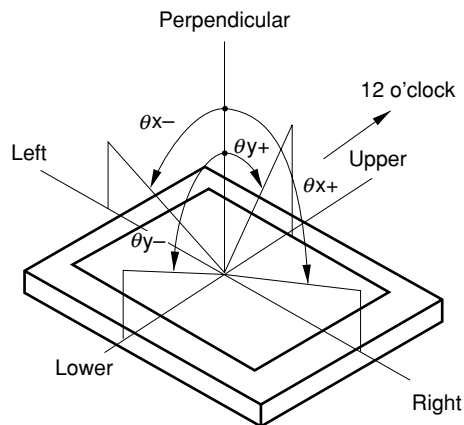


6. Definition of response time is as follows.

The photodetector output signal is measured when the luminance changes from white to black or from black to white.



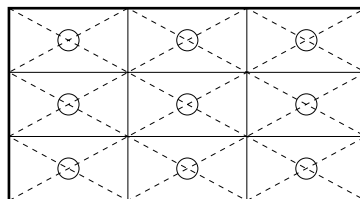
7. Definitions of viewing angles are as follows.



RELIABILITY TEST


Test Items	Test Conditions	Notes
High temperature/humidity operation	50 ± 2°C, 85% relative humidity 240 hours Display data is black.	Note 1
Heat cycle (operation)	<1> 0°C ± 3°C ... 1 hour 55°C ± 3°C ... 1 hour <2> 50 cycles, 4 hours/cycle <3> Display data is black.	Note 1
Thermal shock (nonoperation)	<1> -20°C ± 3°C ... 30 minutes 60°C ± 3°C ... 30 minutes <2> 100 cycles <3> Temperature transition time within 5 minutes	Note 1
Vibration (nonoperation)	<1> 5 - 100 Hz, 19.6 m/s ² (2G) 1 minute/cycle, X, Y, Z direction <2> 120 times each direction	Note 1 Note 2
Mechanical shock (nonoperation)	<1> 539 m/s ² (55G), 11 ms X, Y, Z direction <2> 5 times each direction	Note 1 Note 2
ESD (operation)	150 pF, 150 Ω, ±10 kV 9 places on a panel 10 times each place at one-second intervals	Note 1 Note 3
Dust (operation)	15 kinds of dust (JIS Z 8901) Hourly 15 seconds stir, 8 times repeat	Note 1


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



GENERAL CAUTIONS

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

	<p>CAUTION</p> <p>This mark indicates that you will get hurt and/or the module will be damaged if you make a mistake in operation.</p>
---	---


	<p>This figure indicates that you will get hurt if you make a mistake in operation.</p>
---	---

 **CAUTION**

(1) Caution when taking out the module

- <1> Pick up the pouch only, when removing the module from a carrier box.

(2) Cautions for handling the module

- <1> As electrostatic discharges may break the LCD module, handle the LCD module with care against electrostatic discharges.
- <2>  As the LCD panel and backlight element are made from fragile glass material, impact and pressure to the LCD module should be avoided.
- <3> As the surface of the polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
- <4> Do not pull the interface connectors in or out while the LCD module is operating.
- <5> Put the module display side down on a flat horizontal plane.
- <6> Handle connectors and cables with care.
- <7> When the module is operating, do not lose the CLK, Hsync, or Vsync signal. If any one of these signals is lost, the LCD panel will be damaged.
- <8> The torque for mounting screws should never exceed 0.294 N·m (3 kgf·cm).
- <9> Don't push or rub the surface of the LCD module.
If you do, scratches or rubbing marks may be left on the surface of the module.
- <10> Do not give any stress to the interface connector.

(3) Cautions regarding atmosphere

- <1> Dew-drop atmosphere must be avoided.
- <2> Do not store and/or operate the LCD module in a high-temperature and/or high-humidity atmosphere. Storage in an electro-conductive polymer packing pouch and in a relatively low-temperature atmosphere is recommended.
- <3> This module uses cold cathode fluorescent lamps. Therefore, the lifetime of the lamp is shortened conspicuously at very low temperatures.
- <4> Do not operate the LCD module in a high magnetic field.

(4) Cautions about module characteristics

- <1> Do not apply any fixed-pattern data signals to the LCD module at product aging. Applying a fixed pattern for a long time may cause image sticking.
- <2> This module has retardation film, which may cause variation of the color hue at different viewing angles. Nonuniformity may appear on the screen during high-temperature operation.
- <3> A light vertical stripe may be observed, depending on the display pattern. This is not a defect or a malfunction.
- <4> Noise from the inverter circuit may be observed in the luminance control mode. This is not a defect or a malfunction.

(5) Other cautions

- <1> Do not disassemble and/or reassemble the LCD module.
- <2> Do not readjust variable resistors or switches, etc.
- <3> When returning the module for repair, etc., please pack the module properly so as to avoid damages. We recommend using the original shipping packages.
- <4> If a scan converter is used to convert the VGA signal to NTSC, it is recommended to use the frame memory type, not the line memory.

The liquid crystal display has the following specific characteristics. These are not defects or malfunctions.

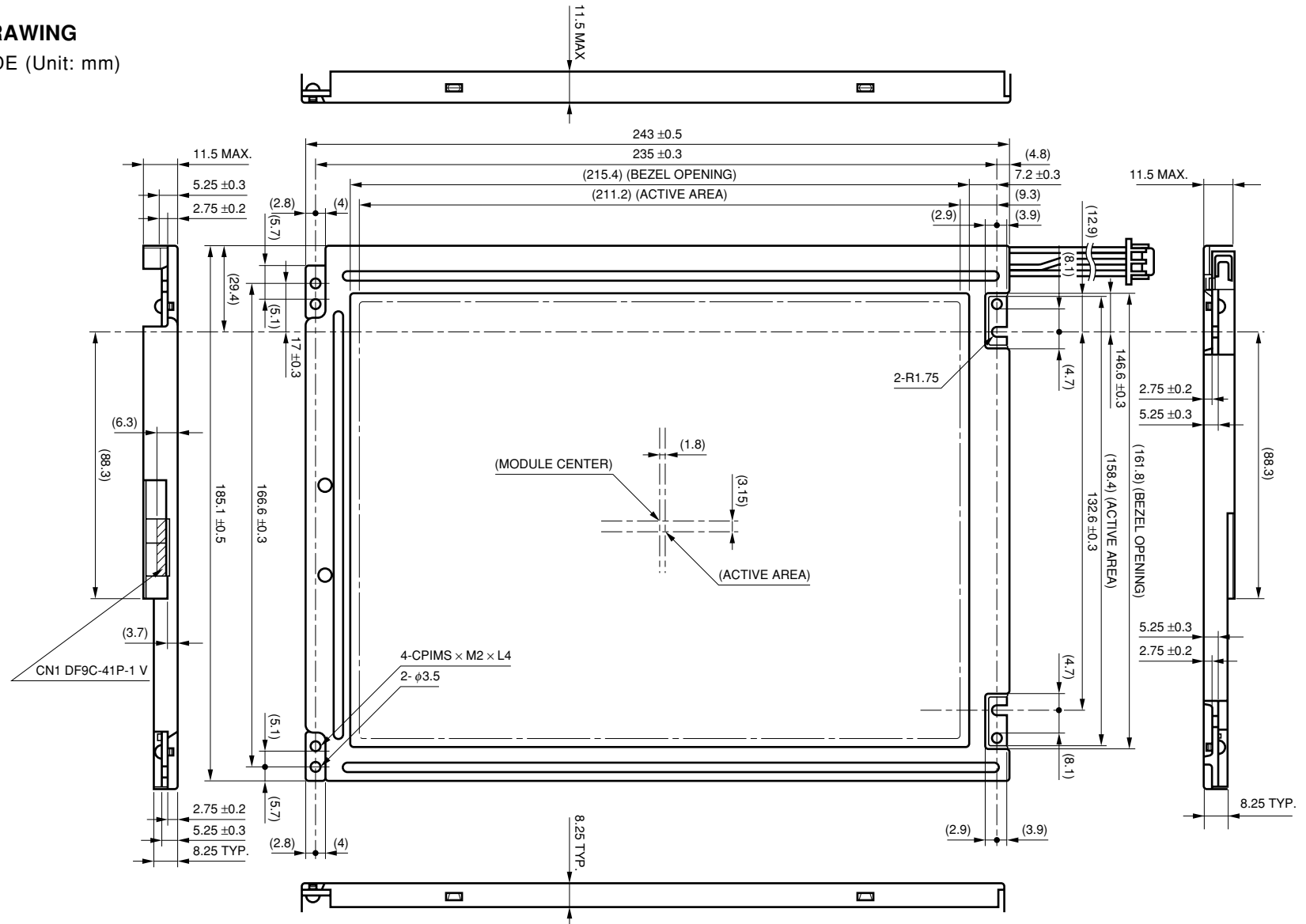
The display condition of the LCD module may be affected by the ambient temperature.

The LCD module uses a cold cathode tube for backlighting. Optical characteristics, like luminance or uniformity, will change over time.

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

OUTLINE DRAWING

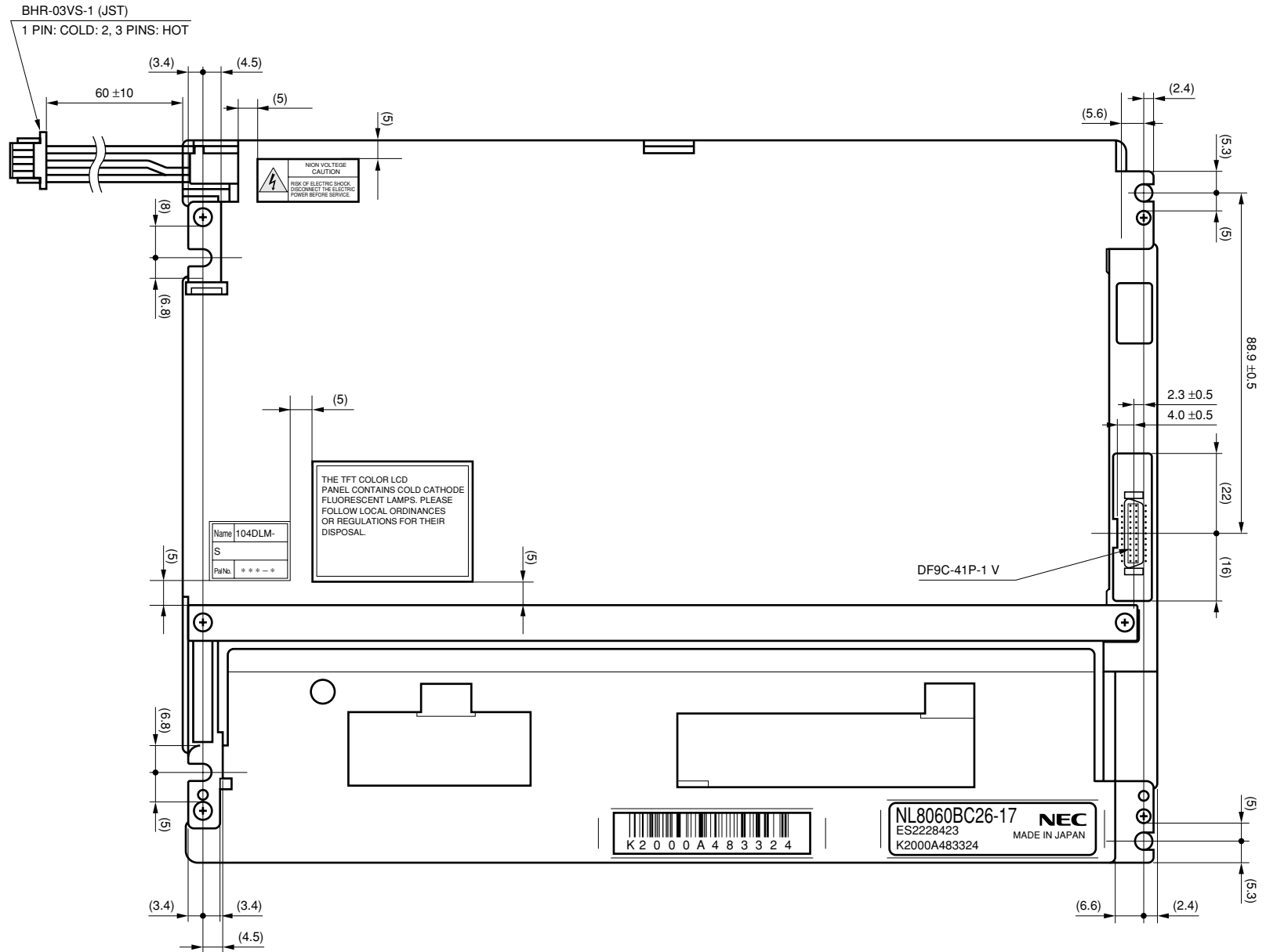
FRONT SIDE (Unit: mm)



- Notes :**
1. The torque on mounting screws should never exceed 0.294 N·m (3Kgf·cm).
 2. The values in parentheses are for reference.

OUTLINE DRAWING

REAR SIDE (Unit: mm)



No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Corporation. NEC Corporation assumes no responsibility for any errors which may appear in this document.

NEC Corporation does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from use of a device described herein or any other liability arising from use of such device. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Corporation or others.

While NEC Corporation has been making continuous effort to enhance the reliability of its electronic components, the possibility of defects cannot be eliminated entirely. To minimize risks of damage or injury to persons or property arising from a defect in an NEC electronic component, customers must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features. NEC devices are classified into the following three quality grades:

"Standard," "Special," and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

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

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

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

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

(Note)

- (1) "NEC" as used in this statement means NEC Corporation and also includes its majority-owned subsidiaries.
- (2) "NEC electronic component products" means any electronic component product developed or manufactured by or for NEC (as defined above).