PRELIMINARY

NEC LCD Technologies, Ltd.

TFT COLOR LCD MODULE

NL160120BC27-10

54cm (21.3 Type)
UXGA
LVDS Interface (2 ports)

PRELIMINARY DATA SHEET

DOD-PD-1068 (2nd edition)

This PRELIMINARY DATA SHEET is updated document from DOD-PD-0938(1).

All information is subject to change without notice. Please confirm the sales representative before starting to design your system.

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INTRODUCTION

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

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Examples: Military systems, aircraft control equipment, aerospace equipment, nuclear reactor control systems, medical equipment/devices/systems for life support, etc.

The quality grade of this product is the **"Standard"** unless otherwise specified in this document.

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

NL160120BC27-10 module is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. PC, signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATION

- Monitor for PC

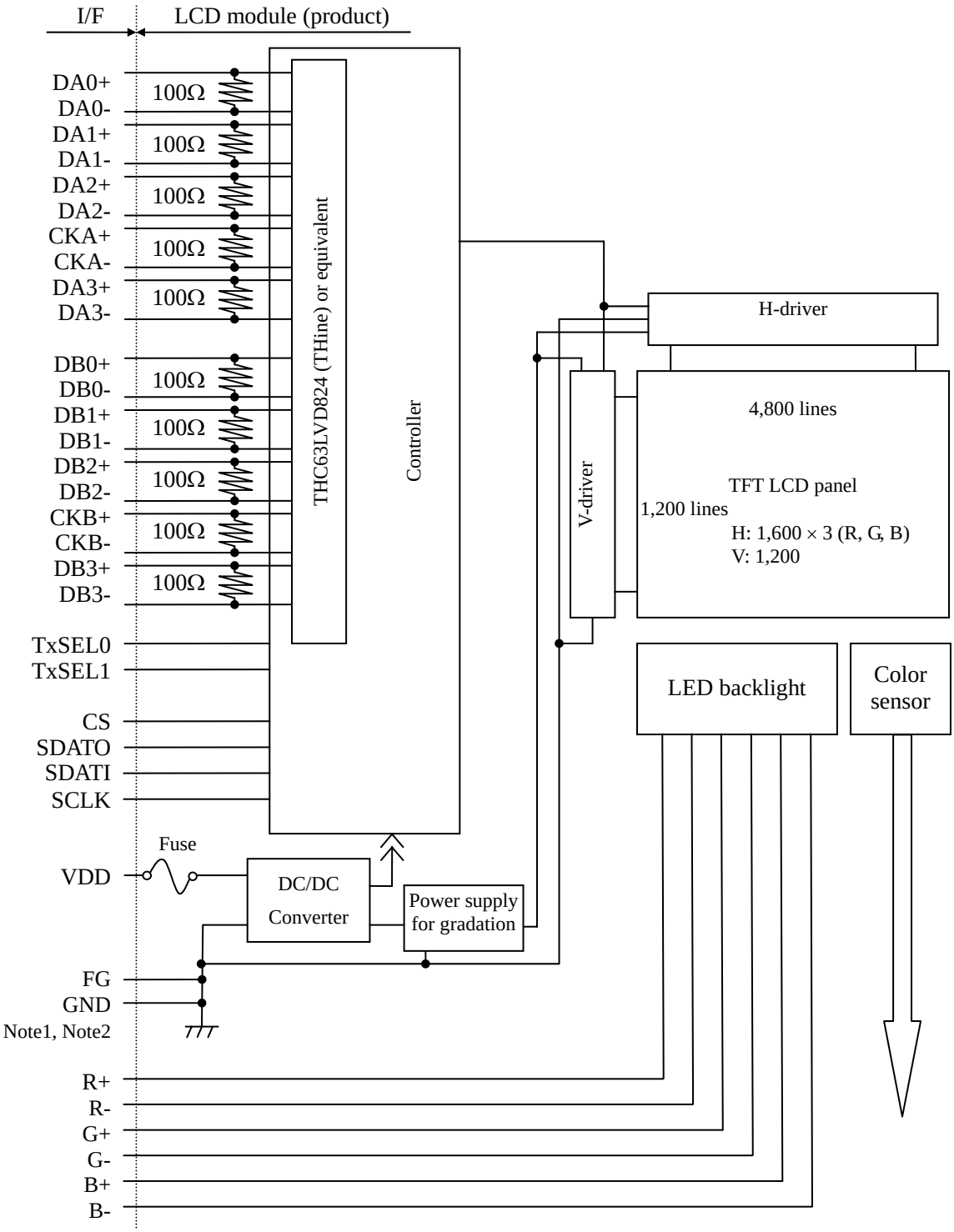
1.3 FEATURES

- Ultra-wide viewing angle (Adoption of Super-Advanced Super Fine TFT (SA-SFT))
- Ultra-wide color gamut
- High resolution
- LVDS interface
- Adjustable gamma characteristics by using built-in 10-bit LUT (look up table)
- Selectable LVDS data input map
- Small foot print
- RGB LED backlight

2. GENERAL SPECIFICATIONS

Display area	432.0 (H) × 324.0 (V) mm
Diagonal size of display	54cm (21.3 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors
Pixel	1,600 (H) × 1,200 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.090 (H) × 0.270 (V) mm
Pixel pitch	0.270 (H) × 0.270 (V) mm
Module size	457.0 (W) × 355.0 (H) × 47.4 (D) mm (typ.)
Weight	TBD g (typ.)
Contrast ratio	430:1 (typ.)
Viewing angle	*At the contrast ratio ≥ 10:1* • Horizontal: Right side 85° (typ.), Left side 85° (typ.) • Vertical: Up side 85° (typ.), Down side 85° (typ.)
Designed viewing direction	Viewing angle with optimum grayscale (γ=2.2): normal axis (perpendicular)
Polarizer surface	Antiglare
Polarizer pencil-hardness	2H (min.) [by JIS K5400]
Color gamut	NTSC ratio: 103% (typ.) Adobe (R) RGB ratio: Surface area= 109% (typ.), Cover ratio= 98.3% (typ.)
Response time	*Ton+Toff (10%←→ 90%)* 20ms (typ.)
Luminance	250cd/m^2 (typ.) (At IF-G= 600mAdc, White chromaticity: Wx= 0.314, Wy= 0.324)
Signal system	LVDS 2 ports (Receiver THC63LVD824 THine Electronics, Inc. or equivalent) RGB 8-bit signals, Data enable signal (DE), Dot clock (CLK)
Power supply voltage	LCD panel signal processing board: 12.0V
Backlight	RGB (Red, Green, Blue) LED array
Power supply current for backlight	IF-R= 0 to 385mA IF-G= 0 to 700mA IF-B= 0 to 700mA
Power consumption	72W (typ.) (At IF-G= 600mAdc, White chromaticity: Wx= 0.314, Wy= 0.324)

3. BLOCK DIAGRAM



Note1: Connections between GND (Signal ground) and FG (Frame ground) in the LCD module

GND - FG	Connected

Note2: GND and FG must be connected to customer equipment's ground, and it is recommended that GND and FG are connected together in customer equipment.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	457.0 ±0.5 (W) × 350.0 ±0.5 (H) × 47.4 ± TBD (D)	Note1, Note2	mm
Display area	432.0 (H) × 324.0 (V)	Note1	mm
Weight	TBD (typ.), TBD (max.)		g

Note1: This product has no heatsink.
Note2: See "**6. OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel signal processing board	VDD	-0.3 to +14.0	V	-
Backlight driving current		IF-R	0 to 410	mA	
		IF-G	0 to 1,000	mA	
		IF-B	0 to 1,000	mA	
Input signal voltage Note1		Vi	-0.3 to +2.8	V	VDD= 12.0V
Storage temperature		Tst	-20 to +60	°C	-
Operating temperature	Front surface	TopF	0 to +55	°C	Note2
	Rear surface	TopR	TBD	°C	-
	Red LED (Junction temperature)	-	≤ 120	°C	-
	Green LED (Junction temperature)	-	≤ 135	°C	-
	Blue LED (Junction temperature)	-	≤ 135	°C	-
Relative humidity Note3		RH	≤ 70	%	Ta ≤ 55°C
Absolute humidity Note3		AH	≤ 73 Note4	g/m^3	Ta > 55°C
Operating altitude		-	≤ 4,850	m	0°C≤ Ta ≤ 55°C
Storage altitude		-	≤ 13,600	m	-20°C≤ Ta ≤ 60°C

Note1: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CKB+/-
CS, SDATI, SCLK, TxSEL0, TxSEL1
Note2: Measured at center of LCD panel surface (including self-heat)
Note3: No condensation
Note4: Water amount at Ta= 55°C and RH= 70%

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Supply voltage		VDD	10.8	12.0	13.2	V	-
Supply current		IDD	-	310 Note1	700 Note2	mA	at VDD=12.0V
Ripple voltage		VRP	-	-	100	mVp-p	for VDD
Differential input Threshold voltage	High	VTH	-	-	+100	mV	at VCM=1.2V Note3, Note4
	Low	VTL	-100	-	-	mV	
Input voltage swing		VI	0	-	2.4	V	Note4
Terminating resistance		RT	-	100	-	Ω	-
Control signal input threshold voltage	High	VIH	High must be Open.			-	Note5
	Low	VIL	0	-	0.5	V	
Control signal input current	Low	IIL	-10	-	10	μA	
Serial communication signal input threshold voltage	High	V+	-	1.4	1.9	V	Note6
	Low	V-	0.4	0.7	-	V	
	Hysteresis	VH	0.3	-	-	V	
Output signal threshold voltage	High	VOH	1.9	-	-	V	Note7
	Low	VOL	-	-	0.4	V	
Output signal current	High	IOH	-4	-	-	mA	
	Low	IOL	-	-	4	mA	

Note1: Checkered flag pattern (by EIAJ ED-2522)
Note2: Pattern for maximum current
Note3: Common mode voltage for LVDS driver
Note4: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CKB+/-
Note5: T_XSEL0, T_XSEL1
Note6: CS, SDATI, SCLK
Note7: SDATO

4.3.2 Backlight

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Backlight driving current	IF-R	0	-	385	mA	-
	IF-G	0	-	700	mA	-
	IF-B	0	-	700	mA	-
Forward voltage	VF-R	45	51.1	54	V	at IF-R= 350mA
	VF-G	61.7	67.9	75	V	at IF-G= 700mA
	VF-B	29.5	35.2	37.5	V	at IF-B= 700mA

4.3.3 Power supply voltage ripple

This product works, even if the ripple voltage levels are beyond the permissible values as following the table, but there might be noise on the display image.

Power supply voltage		Ripple voltage Note1 (Measure at input terminal of power supply)	Unit
VDD	12.0 V	≤ 100	mVp-p

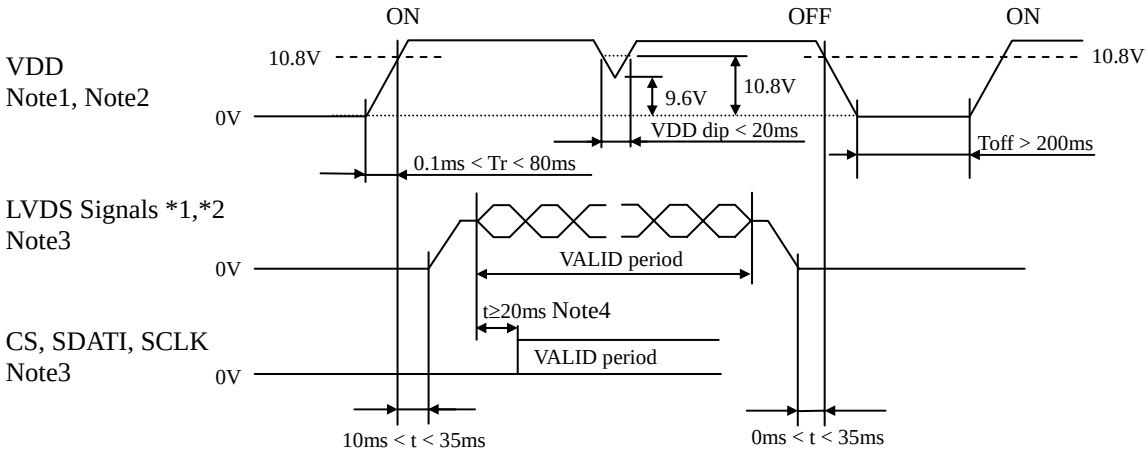
Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VDD	FCC16132AB	KAMAYA ELECTRIC Co., Ltd.	1.25A 32V	2.5A, 5s max.	Note1

Note1: The power supply capacity should be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

4.4 POWER SUPPLY VOLTAGE SEQUENCE



*1: DA0+/-, DA1+/-, DA2+/-, DA3+/-, CKA+/-, DB0+/-, DB1+/-, DB2+/-, DB3+/-, CKB+/-
*2: LVDS signals should be measured at the terminal of 100Ω resistance.

Note1: In terms of voltage variation (voltage drop) while VDD rising edge is below 10.8V, a protection circuit may work, and then this product may not work.
Note2: LVDS signals and CS, SDATI, SCLK must be Low or High-impedance, exclude the VALID period (See above sequence diagram), in order to avoid that internal circuits is damaged.
If some of signals are cut while this product is working, even if the signal input to it once again, it might not work normally. VDD should be cut when the display and function signals are stopped.
Note3: At the beginning of the serial communication mode, take 20ms or more after the LVDS signal input. When writing and reading the LUT data, see "**4.10 TEN-bit LOOK UP TABLE FOR GAMMA ADJUSTMENT**".
Note4: The inverter power supply voltage should be inputted within the valid period of LVDS signals, in order to avoid unstable data display.

4.5 INTERFACING AND PIN ASSIGNMENT OF CONNECTORS

4.5.1 LCD panel signal processing board

(1) CN1

Socket (LCD module side): DF19G-30P-1H (59/99) (Hirose Electric Co., Ltd. (HRS))
Adaptable plug: DF19-30S-1C (Hirose Electric Co., Ltd. (HRS))

Pin No.	Symbol	Signal	Remarks
1	DA0-	Pixel data A0	Odd pixel data Input (LVDS differential signal) Note1
2	DA0+		
3	DA1-	Pixel data A1	Odd pixel data Input (LVDS differential signal) Note1
4	DA1+		
5	DA2-	Pixel data A2	Odd pixel data Input (LVDS differential signal) Note1
6	DA2+		
7	GND	Ground	Signal ground Note2
8	CKA-	Pixel clock	Odd pixel clock Input (LVDS differential signal) Note1
9	CKA+		
10	DA3-	Pixel data A3	Odd pixel data Input (LVDS differential signal) Note1
11	DA3+		
12	DB0-	Pixel data B0	Even pixel data Input (LVDS differential signal) Note1
13	DB0+		
14	GND	Ground	Signal ground Note2
15	DB1-	Pixel data B1	Even pixel data Input (LVDS differential signal) Note1
16	DB1+		
17	GND	Ground	Signal ground Note2
18	DB2-	Pixel data B2	Even pixel data Input (LVDS differential signal) Note1
19	DB2+		
20	CKB-	Pixel clock	Even pixel clock Input (LVDS differential signal) Note1
21	CKB+		
22	DB3-	Pixel data B3	Even pixel data Input (LVDS differential signal) Note1
23	DB3+		
24	GND	Ground	Signal ground Note2
25	TxSEL0	Selection of LVDS data input map	Note3, Note4
26	TxSEL1		
27	GND	Ground	Signal ground Note2
28	VDD	Power supply	12V Note2
29	VDD		
30	VDD		

TxSEL1	TxSEL0	Mode
Open	Open	A
Open	Low	B
Low	Open	C
Low	Low	A

Note1: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note2: All GND and VDD terminals should be used without any non-connected lines.
Note3: This terminal is pulled-up in the product. (Pull-up resistance: 50kΩ)
Note4: See "**4.6 LVDS DATA INPUT MAP**".

(2) CN3

Socket (LCD module side): SM10B-SRSS-TB (J.S.T. Mfg Co., Ltd.)
Adaptable plug: SHR-10V-S, SHR-10V-S-B or 10SR-3S (J.S.T. Mfg Co., Ltd.)

Pin No.	Symbol	Signal	Remarks	
1	RSVD	Reserved	Keep open	
2	RSVD			
3	RSVD			
4	GND	Ground	Signal ground	Note1
5	CS	Chip selection	For LUT communication control	Note2
6	SDATO	Serial data output	For LUT output signal	
7	SDATI	Serial data input	For LUT communication control	Note3
8	SCLK	Serial clock	For LUT communication control	Note3
9	GND	Ground	Signal ground	Note1
10	RSVD	Reserved	Keep open	

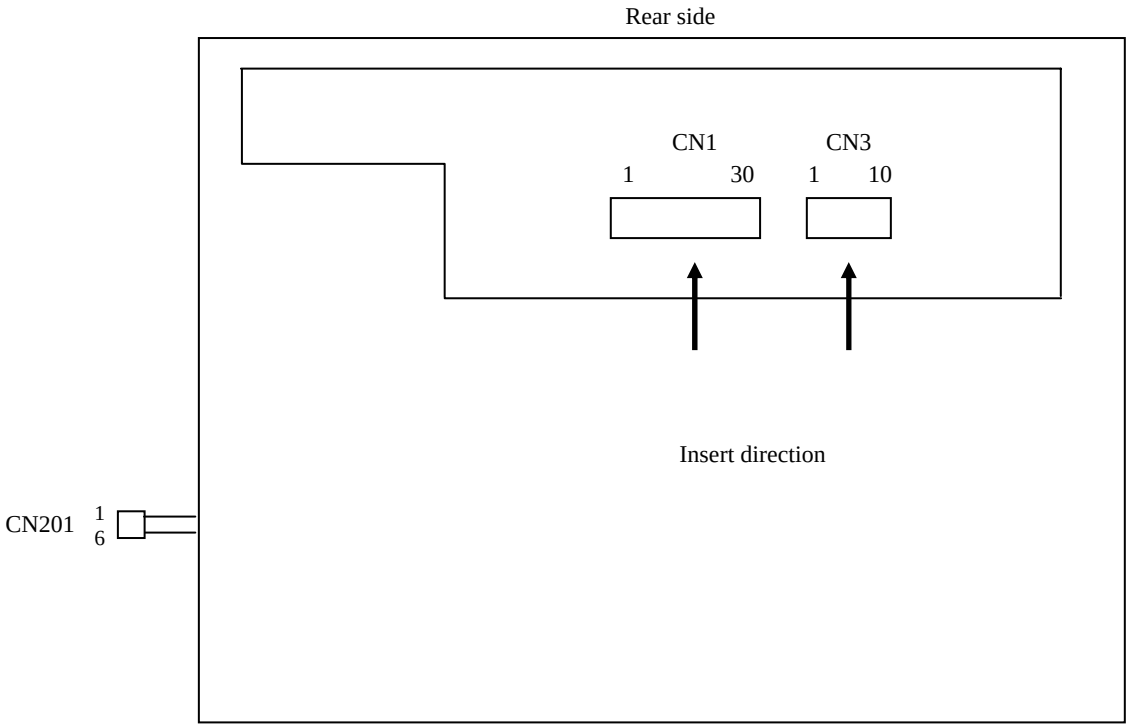
Note1: All GND terminals should be used without any non-connected lines.
Note2: This terminal is pulled-up in the product. (Pull-up resistance: 50kΩ)
Note3: These terminals are pulled-down in the product. (Pull-down resistance: 50kΩ)

4.5.2 Backlight

CN201plug (LCD module side): XHP-6 (J.S.T. Mfg Co., Ltd.)

Pin No.	Symbol	Signal	Remarks
1	R+	Red LED Anode	-
2	R-	Red LED Cathode	-
3	G+	Green LED Anode	-
4	G-	Green LED Cathode	-
5	B+	Blue LED Anode	-
6	B-	Blue LED Cathode	-

4.5.3 Positions of plug and socket



4.6 LVDS DATA INPUT MAP

4.6.1 Mode A

	Input data	Note1		Transmitter Pin	THC63LVDF83A		Transmitter Pin	THC63LVD823		CN1 Pin	CN1 Symbol
Odd pixel data and control signal		RA2	→	51	TA0		53	R12	Note2		
		RA3	→	52	TA1		54	R13	TA1- →	1	DA0-
		RA4	→	54	TA2		57	R14	TA1+ →	2	DA0+
		RA5	→	55	TA3		58	R15			
		RA6	→	56	TA4		59	R16	TB1- →	3	DA1-
		RA7	→	3	TA5		60	R17	TB1+ →	4	DA1+
		GA2	→	4	TA6		63	G12			
		GA3	→	6	TB0		64	G13	TC1- →	5	DA2-
		GA4	→	7	TB1		65	G14	TC1+ →	6	DA2+
		GA5	→	11	TB2		66	G15		7	GND
		GA6	→	12	TB3		67	G16	TCLK1- →	8	CKA-
		GA7	→	14	TB4		68	G17	TCLK1+ →	9	CKA+
		BA2	→	15	TB5		73	B12			
		BA3	→	19	TB6		74	B13	TD1- →	10	DA3-
		BA4	→	20	TC0	1st	75	B14	TD1+ →	11	DA3+
		BA5	→	22	TC1		76	B15			
		BA6	→	23	TC2		77	B16			
		BA7	→	24	TC3		78	B17			
	Note3	RSVD	→	27	TC4		7	RSVD			
	Note3	RSVD	→	28	TC5		8	RSVD			
		DE	→	30	TC6		9	DE			
		RA0	→	50	TD0		51	R10			
		RA1	→	2	TD1		52	R11			
		GA0	→	8	TD2		61	G10			
		GA1	→	10	TD3		62	G11			
		BA0	→	16	TD4		69	B10			
		BA1	→	18	TD5		70	B11			
	Note3	RSVD	→	25	TD6		-				
		CLK	→	31	CLKIN		10	CLK			
Even pixel data		RB2	→	51	TA0		81	R22			
		RB3	→	52	TA1		82	R23	TA2- →	12	DB0-
		RB4	→	54	TA2		83	R24	TA2+ →	13	DB0+
		RB5	→	55	TA3		84	R25		14	GND
		RB6	→	56	TA4		85	R26	TB2- →	15	DB1-
		RB7	→	3	TA5		86	R27	TB2+ →	16	DB1+
		GB2	→	4	TA6		91	G22		17	GND
		GB3	→	6	TB0		92	G23	TC2- →	18	DB2-
		GB4	→	7	TB1		93	G24	TC2+ →	19	DB2+
		GB5	→	11	TB2		94	G25			
		GB6	→	12	TB3		95	G26	TCLK2- →	20	CKB-
		GB7	→	14	TB4		96	G27	TCLK2+ →	21	CKB+
		BB2	→	15	TB5		99	B22			
		BB3	→	19	TB6		100	B23	TD2- →	22	DB3-
		BB4	→	20	TC0	2nd	1	B24	TD2+ →	23	DB3+
		BB5	→	22	TC1		2	B25		24	GND
		BB6	→	23	TC2		5	B26		25	TxSEL0
		BB7	→	24	TC3		6	B27		26	TxSEL1
	Note3	RSVD	→	27	TC4		-			27	GND
	Note3	RSVD	→	28	TC5		-			28	VDD
	Note3	RSVD	→	30	TC6		-			29	VDD
		RB0	→	50	TD0		79	R20		30	VDD
		RB1	→	2	TD1		80	R21			
		GB0	→	8	TD2		89	G20			
		GB1	→	10	TD3		90	G21			
		BB0	→	16	TD4		97	B20			
		BB1	→	18	TD5		98	B21			
	Note3	RSVD	→	25	TD6		-				
		CLK	→	31	CLKIN		-				

4.6.2 Mode B

Input data		Note1		Transmitter Pin	DS90CF383, C385			CN1 Pin	CN1 Symbol
Odd pixel data and control signal		RA7	→	51	TXIN0		Note2		
		RA6	→	52	TXIN1		TA1- →	1	DA0-
		RA5	→	54	TXIN2		TA1+ →	2	DA0+
		RA4	→	55	TXIN3				
		RA3	→	56	TXIN4		TB1- →	3	DA1-
		RA2	→	3	TXIN6		TB1+ →	4	DA1+
		GA7	→	4	TXIN7				
		GA6	→	6	TXIN8		TC1- →	5	DA2-
		GA5	→	7	TXIN9		TC1+ →	6	DA2+
		GA4	→	11	TXIN12			7	GND
		GA3	→	12	TXIN13		TCLK1- →	8	CKA-
		GA2	→	14	TXIN14		TCLK1+ →	9	CKA+
		BA7	→	15	TXIN15				
		BA6	→	19	TXIN18		TD1- →	10	DA3-
		BA5	→	20	TXIN19	1st	TD1+ →	11	DA3+
		BA4	→	22	TXIN20				
		BA3	→	23	TXIN21				
		BA2	→	24	TXIN22				
	Note3	RSVD	→	27	TXIN24				
	Note3	RSVD	→	28	TXIN25				
		DE	→	30	TXIN26				
		RA1	→	50	TXIN27				
		RA0	→	2	TXIN5				
		GA1	→	8	TXIN10				
		GA0	→	10	TXIN11				
		BA1	→	16	TXIN16				
		BA0	→	18	TXIN17				
	Note3	RSVD	→	25	TXIN23				
		CLK	→	31	CLKIN				
Even pixel data		RB7	→	51	TXIN0				
		RB6	→	52	TXIN1		TA2- →	12	DB0-
		RB5	→	54	TXIN2		TA2+ →	13	DB0+
		RB4	→	55	TXIN3			14	GND
		RB3	→	56	TXIN4		TB2- →	15	DB1-
		RB2	→	3	TXIN6		TB2+ →	16	DB1+
		GB7	→	4	TXIN7			17	GND
		GB6	→	6	TXIN8		TC2- →	18	DB2-
		GB5	→	7	TXIN9		TC2+ →	19	DB2+
		GB4	→	11	TXIN12				
		GB3	→	12	TXIN13		TCLK2- →	20	CKB-
		GB2	→	14	TXIN14		TCLK2+ →	21	CKB+
		BB7	→	15	TXIN15				
		BB6	→	19	TXIN18		TD2- →	22	DB3-
		BB5	→	20	TXIN19	2nd	TD2+ →	23	DB3+
		BB4	→	22	TXIN20			24	GND
		BB3	→	23	TXIN21			25	TxSEL0
		BB2	→	24	TXIN22			26	TxSEL1
	Note3	RSVD	→	27	TXIN24			27	GND
	Note3	RSVD	→	28	TXIN25			28	VDD
	Note3	RSVD	→	30	TXIN26			29	VDD
		RB1	→	50	TXIN27			30	VDD
		RB0	→	2	TXIN5				
		GB1	→	8	TXIN10				
		GB0	→	10	TXIN11				
		BB1	→	16	TXIN16				
		BB0	→	18	TXIN18				
	Note3	RSVD	→	25	TXIN23				
		CLK	→	31	CLKIN				

4.6.3 Mode C

	Input data	Note1		Transmitter Pin	DS90CF383, C385			CN1 Pin	CN1 Symbol
Odd pixel data and control signal		RA0	→	51	TXIN0		Note2		
		RA1	→	52	TXIN1		TA1- →	1	DA0-
		RA2	→	54	TXIN2		TA1+ →	2	DA0+
		RA3	→	55	TXIN3				
		RA4	→	56	TXIN4		TB1- →	3	DA1-
		RA5	→	3	TXIN6		TB1+ →	4	DA1+
		GA0	→	4	TXIN7				
		GA1	→	6	TXIN8		TC1- →	5	DA2-
		GA2	→	7	TXIN9		TC1+ →	6	DA2+
		GA3	→	11	TXIN12			7	GND
		GA4	→	12	TXIN13		TCLK1- →	8	CKA-
		GA5	→	14	TXIN14		TCLK1+ →	9	CKA+
		BA0	→	15	TXIN15				
		BA1	→	19	TXIN18		TD1- →	10	DA3-
		BA2	→	20	TXIN19	1st	TD1+ →	11	DA3+
		BA3	→	22	TXIN20				
		BA4	→	23	TXIN21				
		BA5	→	24	TXIN22				
	Note3	RSVD	→	27	TXIN24				
	Note3	RSVD	→	28	TXIN25				
		DE	→	30	TXIN26				
		RA6	→	50	TXIN27				
		RA7	→	2	TXIN5				
		GA6	→	8	TXIN10				
		GA7	→	10	TXIN11				
		BA6	→	16	TXIN16				
		BA7	→	18	TXIN17				
	Note3	RSVD	→	25	TXIN23				
		CLK	→	31	CLKIN				
Even pixel data		RB0	→	51	TXIN0				
		RB1	→	52	TXIN1		TA2- →	12	DB0-
		RB2	→	54	TXIN2		TA2+ →	13	DB0+
		RB3	→	55	TXIN3			14	GND
		RB4	→	56	TXIN4		TB2- →	15	DB1-
		RB5	→	3	TXIN6		TB2+ →	16	DB1+
		GB0	→	4	TXIN7			17	GND
		GB1	→	6	TXIN8		TC2- →	18	DB2-
		GB2	→	7	TXIN9		TC2+ →	19	DB2+
		GB3	→	11	TXIN12				
		GB4	→	12	TXIN13		TCLK2- →	20	CKB-
		GB5	→	14	TXIN14		TCLK2+ →	21	CKB+
		BB0	→	15	TXIN15				
		BB1	→	19	TXIN18		TD2- →	22	DB3-
		BB2	→	20	TXIN19	2nd	TD2+ →	23	DB3+
		BB3	→	22	TXIN20			24	GND
		BB4	→	23	TXIN21			25	TxSEL0
		BB5	→	24	TXIN22			26	TxSEL1
	Note3	RSVD	→	27	TXIN24			27	GND
	Note3	RSVD	→	28	TXIN25			28	VDD
	Note3	RSVD	→	30	TXIN26			29	VDD
		RB6	→	50	TXIN27			30	VDD
		RB7	→	2	TXIN5				
		GB6	→	8	TXIN10				
		GB7	→	10	TXIN11				
		BB6	→	16	TXIN16				
		BB7	→	18	TXIN18				
	Note3	RSVD	→	25	TXIN23				
		CLK	→	31	CLKIN				

Note1: LSB (Least Significant Bit) – RA0, GA0, BA0, RB0, GB0, BB0
MSB (Most Significant Bit) – RA7, GA7, BA7, RB7, GB7, BB7

Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note3: Input signal RSVD is not used inside the product, but do not keep this pin open to avoid noise problem.

4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 16,777,216 colors in 256 gray scales. Also the relation between display colors and input data signals is as the following table.

Display colors		Data signal (0: Low level, 1: High level)																											
		RA7	RA6	RA5	RA4	RA3	RA2	RA1	RA0	GA7	GA6	GA5	GA4	GA3	GA2	GA1	GA0	BA7	BA6	BA5	BA4	BA3	BA2	BA1	BA0
		RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0	GB7	GB6	GB5	GB4	GB3	GB2	GB1	GB0	BB7	BB6	BB5	BB4	BB3	BB2	BB1	BB0
Basic Colors	Black	0	0	0	0	0	0	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	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	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	1	1	1	1	0	0	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	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	0	0	0	0	0	0
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑					:								:								:			
	↓					:								:								:			
	bright	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	1	1	0	0	0	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	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑					:								:								:			
	↓					:								:								:			
	bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	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	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	dark	0	0	0	0	0	0	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	0	0	0	0	1	1	1	1	1	1	0	1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

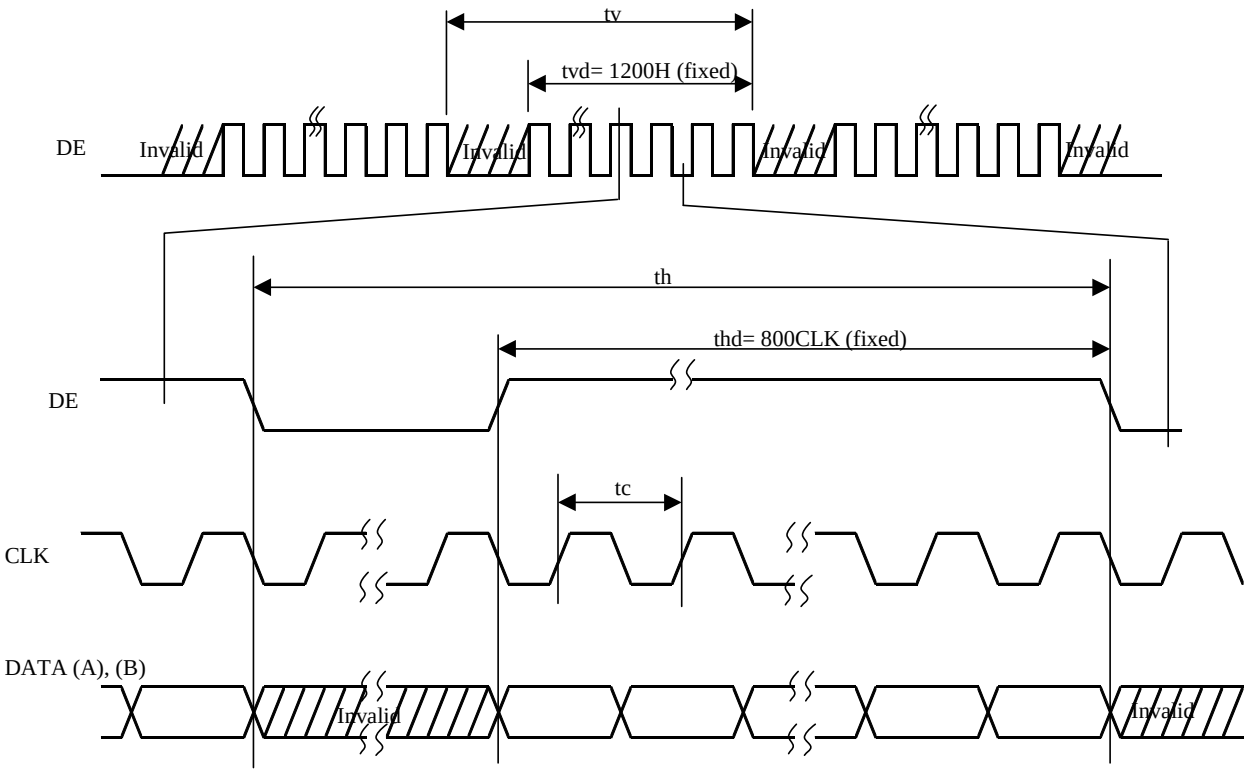
4.8 INPUT SIGNAL TIMINGS

4.8.1 Timing characteristics

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1/ tc	60.0	62.5	65.0	MHz	LVDS transmitter input
	Pulse width	tc	15.38	16.0	-	ns	
	Duty	-	See the data sheet of LVDS transmitter.			-	-
	Rise, fall	-				ns	
Horizontal	Cycle period	th	13.1	13.3	19.2	µs	Note1
			848	1,080	1,156	CLK	
	Display period	thd	800			CLK	-
Vertical	Cycle period	1/tv	59	60	61	Hz	-
		tv	1,206	1,250	-	H	
	Display period	tvd	1,200			H	-
DE, DATA	Setup time	-	See the data sheet of LVDS transmitter.			ns	-
	Hold time	-				ns	
	Rise, fall	-				ns	

Note1: During operation, fluctuation of horizontal cycle period must not exceed ±1 CLK. Otherwise, function errors will occur in the product.
e.g.: Acceptable fluctuation range is 1,079-1,081 CLK, when the horizontal cycle period is 1,080 CLK.

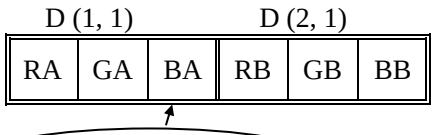
4.8.2 Input signal timing chart



4.9 DISPLAY POSITIONS

Odd pixel: RA= Red data GA= Green data BA= Blue data

Even pixel: RB= Red data GB= Green data BB= Blue data



D(1, 1)	D(2, 1)	• • •	D(X, 1)	• • •	D(1599, 1)	D(1600, 1)
D(1, 2)	D(2, 2)	• • •	D(X, 2)	• • •	D(1599, 2)	D(1600, 2)
• • •	• • •	• • • •	• • •	• • • •	• • •	• • • •
D(1, Y)	D(2, Y)	• • •	D(X, Y)	• • •	D(1599, Y)	D(1600, Y)
• • •	• • •	• • • •	• • •	• • • •	• • •	• • •
D(1, 1199)	D(2, 1199)	• • •	D(X, 1199)	• • •	D(1599, 1199)	D(1600, 1199)
D(1,1200)	D(2, 1200)	• • •	D(X, 1200)	• • •	D(1599, 1200)	D(1600, 1200)

4.10 TEN-bit LOOK UP TABLE FOR GAMMA ADJUSTMENT

Adjustment of gamma characteristics for each 8-bit RGB data is possible by using built-in 10-bit LUT (look up table) for Gamma characteristics.

The LUT is set with the serial data. The combination of the control command determines the R/W actions.: READ, Random/Sequential Address WRITE and Individual/Simultaneous LCR setting.

The serial data is composed as Table1.

Table1: Serial data Composition

DATA	DATA name	Function	Remarks
D31	CMD5	Control Command	See Table2 and 3.
D30	CMD4	Control Command	
D29	CMD3	Control Command	
D28	CMD2	Control Command	
D27	CMD1	Control Command	
D26	CMD0	Control Command	
D25	ADD9	LUT Address (MSB)	See Table4.
D24	ADD8	LUT Address	
D23	ADD7	LUT Address	
D22	ADD6	LUT Address	
D21	ADD5	LUT Address	
D20	ADD4	LUT Address	
D19	ADD3	LUT Address	
D18	ADD2	LUT Address	
D17	ADD1	LUT Address	
D16	ADD0	LUT Address (LSB)	
D15	Dummy	Dummy Data “0”	See Table5.
D14	Dummy	Dummy Data “0”	
D13	Dummy	Dummy Data “0”	
D12	Dummy	Dummy Data “0”	
D11	Dummy	Dummy Data “0”	
D10	Dummy	Dummy Data “0”	
D9	DATA9	LUT Data (MSB)	
D8	DATA8	LUT Data	
D7	DATA7	LUT Data	
D6	DATA6	LUT Data	
D5	DATA5	LUT Data	
D4	DATA4	LUT Data	
D3	DATA3	LUT Data	
D2	DATA2	LUT Data	
D1	DATA1	LUT Data	
D0	DATA0	LUT Data (LSB)	

Table2: Command table (CMD5 to CMD0: 6-bit)

DATA name	Parameter	Remarks
CMD5	Selection of WRITE/READ mode "1": WRITE mode "0": READ mode	In case of "0", must be set as follows. CMD4: "1", CMD3: "0", CMD2: "1" CMD1: "0", CMD0: "0"
CMD4	Must be set to "1".	-
CMD3	Selection of Random/Sequential Address WRITE "1": Random Address WRITE "0": Sequential Address WRITE	-
CMD2	Must be set to "1".	-
CMD1	Selection of Individual/Simultaneous RGB setting "1": Individual RGB setting "0": Simultaneous RGB setting	"1": Select the color by using ADD9 and ADD8. (See Table4.) "0": ADD9 and ADD8 are invalid.
CMD0	Must be set to "0".	-

Table3: Command Combination table (CMD5 to CMD0: 6-bit)

CMD5	CMD4	CMD3	CMD2	CMD1	CMD0	Mode
1	1	1	1	1	0	Random Address WRITE, Individual RGB setting
1	1	1	1	0	0	Random Address WRITE, Simultaneous RGB setting
1	1	0	1	1	0	Sequential Address WRITE, Individual RGB setting
1	1	0	1	0	0	Sequential Address WRITE, Simultaneous RGB setting
0	1	0	1	0	0	READ mode

*Other combinations are prohibited, and may cause function error.

Table4: Address table (ADD9 to ADD0: 10-bit)

DATA name	Parameter	Remarks
ADD9 ADD8	Color Selection ADD[9:8]= 0:0 Red 0:1 Green 1:0 Blue 1:1 ON/OFF selection of Gamma Correction	When "ADD[9:8]=1:1", ON/OFF of Gamma correction can select according to the GMA[2:0]. (See Table6 and Table7.)
ADD7 ADD6 ADD5 ADD4 ADD3 ADD2 ADD1 ADD0	LUT Address 256 address = 00h - FFh	When ADD[9:8] = 1:1, ADD[7:0] must be set to 00h.

Table5: Data table (DATA15 to DATA0: 16-bit)

DATA	DATA name	Parameter	Remarks
DATA15	Dummy	Dummy Data Must be set to "0".	-
DATA14	Dummy		
DATA13	Dummy		
DATA12	Dummy		
DATA11	Dummy		
DATA10	Dummy		
DATA9	DATA9	[MSB]	-
DATA8	DATA8		
DATA7	DATA7		
DATA6	DATA6		
DATA5	DATA5	10-bit LUT Data 000h - 3FFh	
DATA4	DATA4		
DATA3	DATA3		
DATA2	DATA2		
DATA1	DATA1		
DATA0	DATA0	[LSB]	

Table6: Gamma correction table (DATA15 to DATA0: 16bit)

DATA	DATA name	Parameter	Remarks
DATA15	Dummy	Dummy Data Must be set to "0".	-
DATA14	Dummy		
DATA13	Dummy		
DATA12	Dummy		
DATA11	Dummy		
DATA10	Dummy		
DATA9	Dummy		
DATA8	Dummy		
DATA7	Dummy		
DATA6	Dummy		
DATA5	Dummy		
DATA4	Dummy		
DATA3	Dummy		
DATA2	GMA2	[MSB]	See Table7.
DATA1	GMA1	GMA Data	
DATA0	GMA0	[LSB]	

Table7: Control code GMA[2:0]

GMA2	GMA1	GMA0	Function
0	0	0	No correction (Initial setting)
0	0	1	Correction according to the LUT Data. Note1

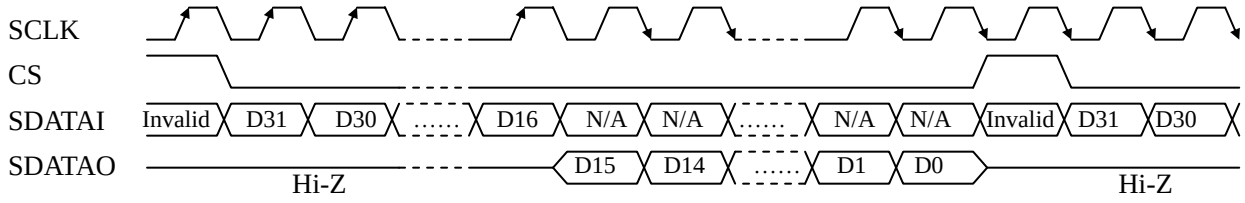
*Other combinations are prohibited, and may cause function error.

Note1: Initial setting of the LUT is undefined data. The LUT should be enabled by setting of the GMA after writing the LUT data in all the 256 addresses, in order to avoid undefined data display.
Note2: Transfer the data every power-on, because the LUT data isn't stored in the LCD module.
Note3: As writing and reading the LUT data, a noise may appear on the display image. In order to prevent the noise appearing on the display, following measures should be performed.
(1) The LUT data should be rewritten during invalid period of pixel data (See "**4.8 INPUT SIGNAL TIMINGS**".).
(2) The LUT data should be rewritten while the LUT data is invalid.

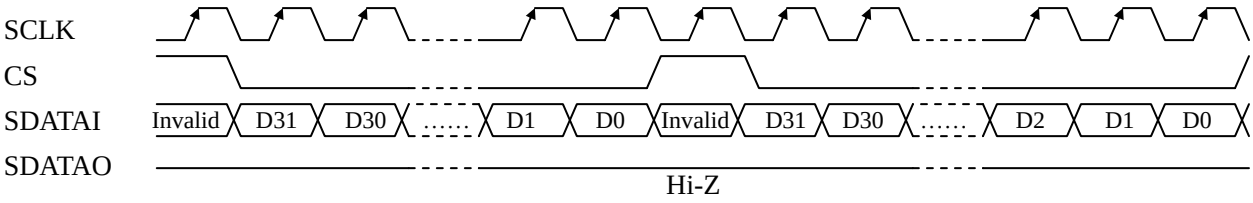
4.11 LUT SERIAL COMMUCATION TIMINGS

4.11.1 Timing Chart

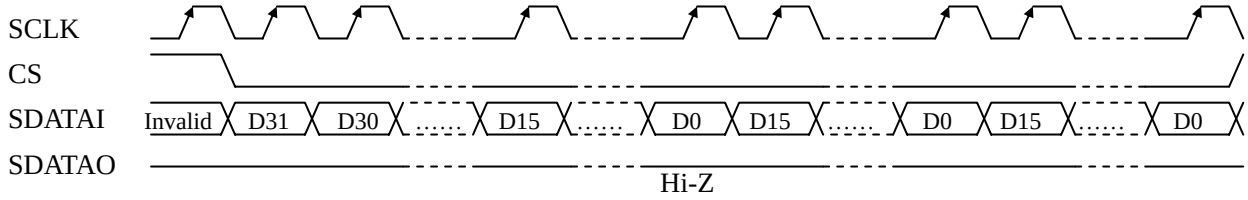
(1) READ Timing Chart



(2) Random Address WRITE Timing Chart



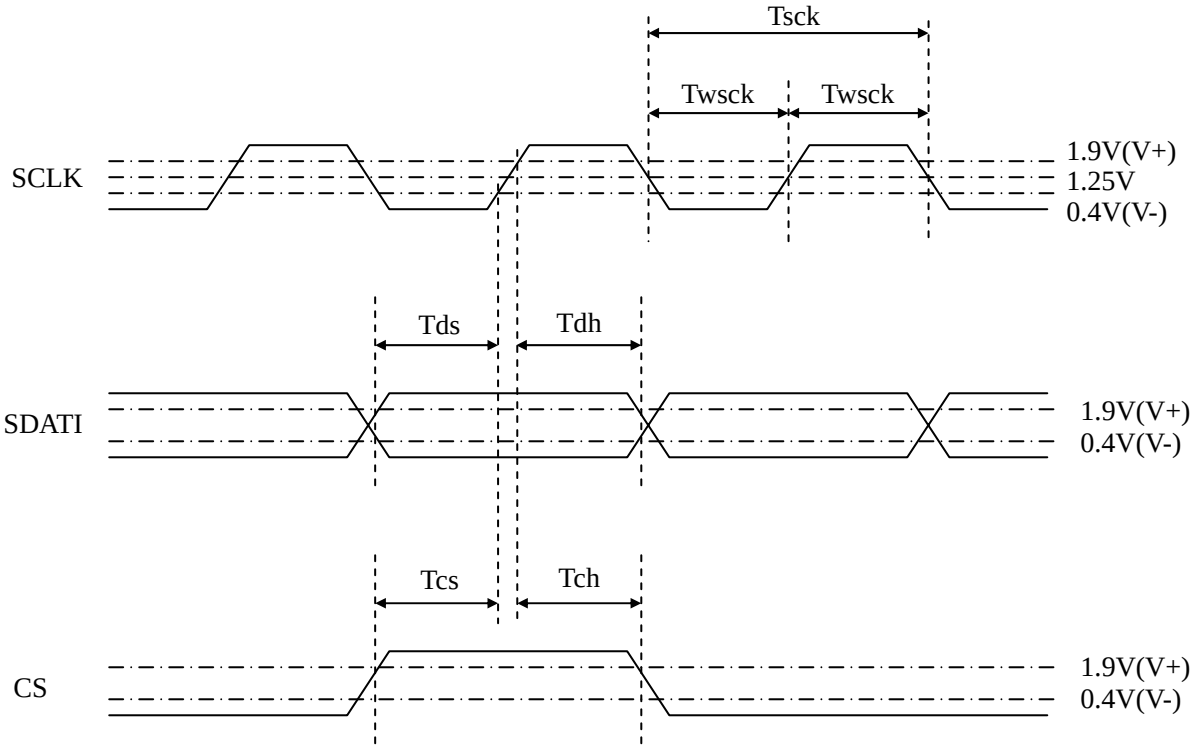
(3) Sequential Address WRITE Timing Chart



4.11.2 Timing specifications

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
SCLK Frequency	1/Tsck	-	-	5	MHz	-
SCLK Pulse Width (WRITE)	Twsck	50	-	-	ns	-
SCLK Pulse Width (READ)	Twsck	5	-	-	tc	Note1
SDATI-SCLK Setup Time	Tds	50	-	-	ns	-
SDATI-SCLK Hold Time	Tdh	50	-	-	ns	-
CS-SCLK Setup Time	Tcs	50	-	-	ns	-
CS-SCLK Hold Time	Tch	50	-	-	ns	-

Note1: At the READ of the serial communication mode, the SCLK Pulse Width (Twsck) must be greater than 5CLK (5 tc's). (See "**4.8.1 Timing characteristics**".)



Note2: During the serial communication mode, the display noise may appear because of rewriting the data. To avoid this, rewrite the data in the blanking timing. The external noise may cause the data change, refresh the data regularly according to need.

4.12 OPTICS

4.12.1 Optical characteristics

(Note1, Note2)

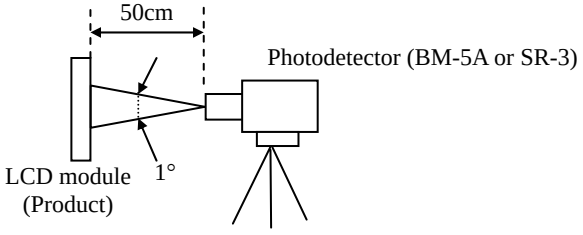
Parameter		Condition			Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°			L	TBD	250	-	cd/m^2	BM-5A or SR-3	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°			CR	TBD	430	-	-	BM-5A or SR-3	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°			LU	-	1.1	TBD	-	BM-5A	Note4
Chromaticity	Red	**x** coordinate			Rx	-	0.68	-	-	SR-3	Note5
		y coordinate			Ry	-	0.31	-	-		
	Green	**x** coordinate			Gx	-	0.21	-	-		
		y coordinate			Gy	-	0.71	-	-		
	Blue	**x** coordinate			Bx	-	0.15	-	-		
		y coordinate			By	-	0.07	-	-		
Color gamut		θR= 0°, θL= 0° θU= 0°, θD= 0° at center,	NTSC ratio		C1	TBD	103	-	%	SR-3	Note5 Note9
			Adobe (R) RGB ratio	Surface area	C2	-	109	-			
				Cover ratio	C3	-	98.3	-			
Response time		Black to White			Ton	-	9	TBD	ms	BM-5A	Note6 Note7
		White to Black			Toff	-	11	TBD	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10			θR	70	85	-	°	BM-5A	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10			θL	70	85	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10			θU	70	85	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10			θD	70	85	-	°		

Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta= 25°C, Temperature of Light Source Board= 55°C, VDD= 12.0V, IF-G= 600mAdc, White chromaticity: Wx= 0.314, Wy= 0.324, Display mode: UXGA, Horizontal cycle= 1/75.19kHz, Vertical cycle= 1/60.0Hz

Optical characteristics are measured after 20 minutes from working the product, in the dark room. Also measurement method for luminance is as follows.



Note3: See "**4.12.2 Definition of contrast ratio**".

Note4: See "**4.12.3 Definition of luminance uniformity**".

Note5: These coordinates are found on CIE 1931 chromaticity diagram.

Note6: Product surface temperature: TopF= TBD°C

Note7: See "**4.12.4 Definition of response times**".

Note8: See "**4.12.5 Definition of viewing angles**".

Note9: Adobe is trademark of Adobe Systems incorporated, and it is registered in the U.S. and other countries.

4.12.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

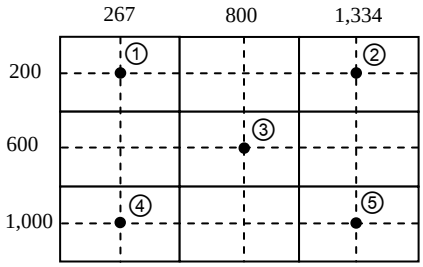
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.12.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

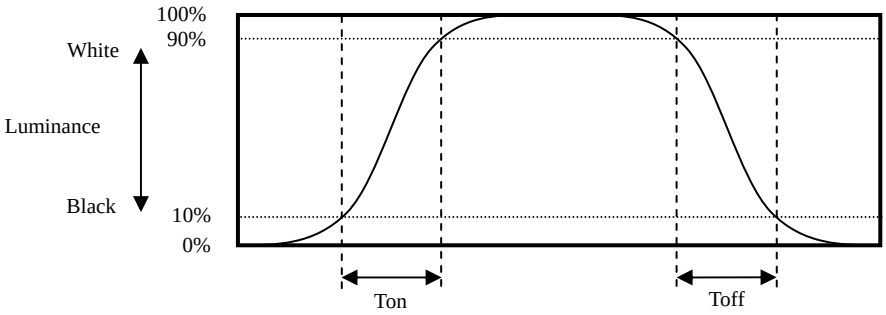
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}}$$

The luminance is measured at near the 5 points shown below.

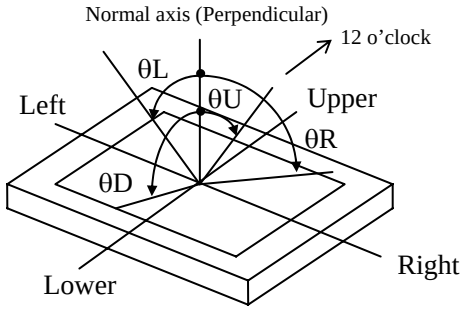


4.12.4 Definition of response times

Response time is measured, the luminance changes from "black" to "white", or "white" to "black" on the same screen point, by photo-detector. Ton is the time it takes the luminance change from 10% up to 90%. Also Toff is the time it takes the luminance change from 90% down to 10% (See the following diagram.).



4.12.5 Definition of viewing angles



5. PRECAUTIONS

5.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "5.2 CAUTIONS" and "5.3 ATTENTIONS", after understanding these contents!**

	This sign has the meaning that customer will be injured by himself or the product will sustain a damage, if customer has wrong operations.
	This sign has the meaning that customer will get an electrical shock, if customer has wrong operations.
	This sign has the meaning that customer will be injured by himself, if customer has wrong operations.

5.2 CAUTIONS

∗ Do not touch the working backlight. There is a danger of an electric shock.

∗ Do not touch the working backlight. There is a danger of burn injury.
∗ Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: To be not greater 294m/s^2 and to be not greater 11ms, Pressure: To be not greater 19.6N (ϕ16mm jig))

5.3 ATTENTIONS 

5.3.1 Handling of the product

① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
② Do not hook nor pull cables such as lamp cable, and so on, in order to avoid any damage.
③ When the product is put on the table temporarily, display surface must be placed downward.
④ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
⑤ The torque for product mounting screws must never exceed TBD N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be ≤ 5.0mm.
⑥ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area).
Bends or twist described above and undue stress to any portion except mounting hole portion may cause display mura.
⑦ Do not press or rub on the sensitive product surface. When cleaning the product surface, use of the cloth with ethanolic liquid such as screen cleaner for LCD is recommended.
⑧ Do not push nor pull the interface connectors while the product is working.
⑨ When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.

5.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
② In order to prevent dew condensation occurring by temperature difference, the product packing box should be opened after enough time being left under the environment of an unpacking room. Evaluate the leaving time sufficiently because a situation of dew condensation occurring is changed by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with packing state)
③ Do not operate in high magnetic field. Circuit boards may be broken down by it.
④ This product is not designed as radiation hardened.

5.3.3 Characteristics

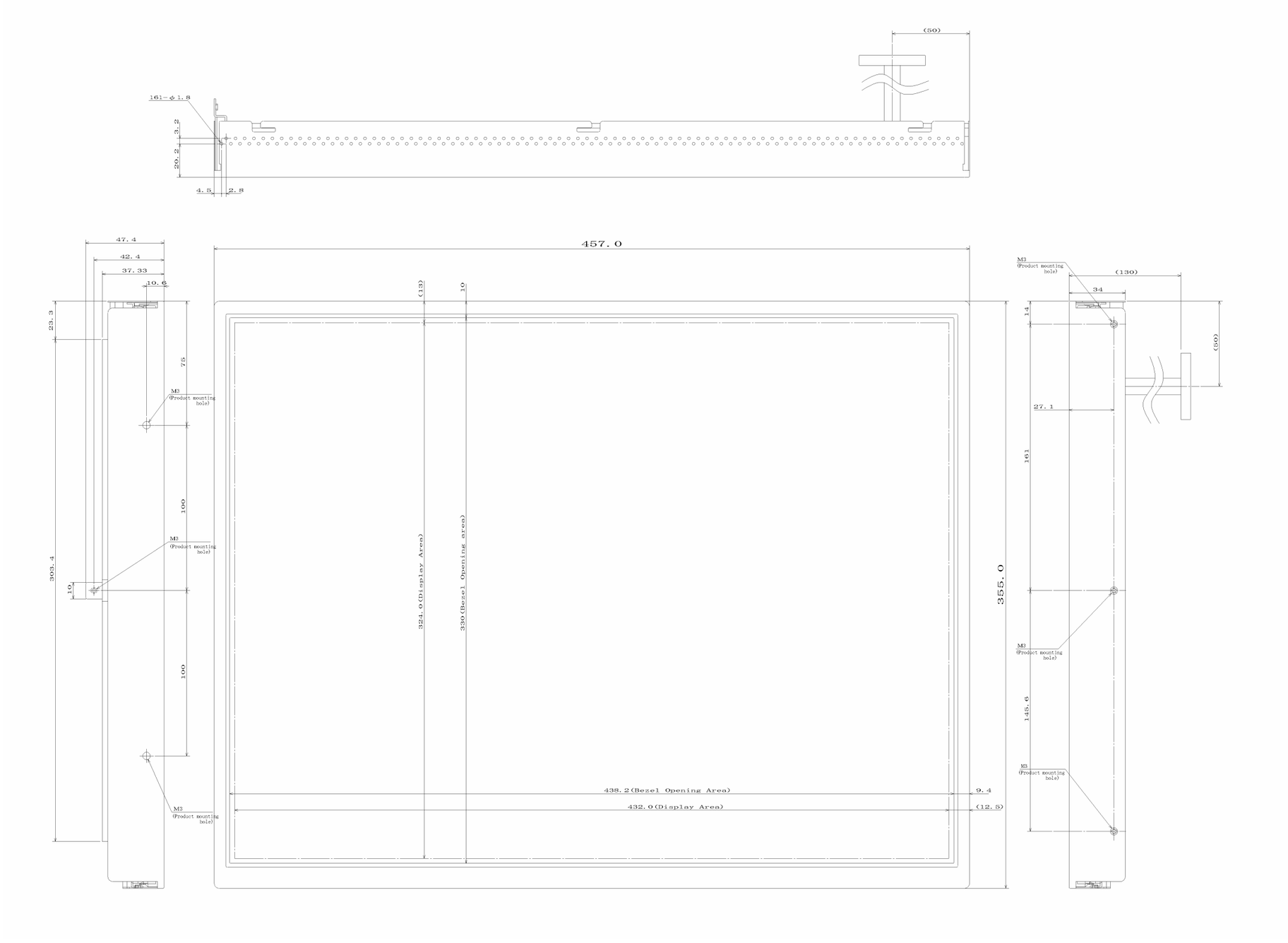
The following items are neither defects nor failures.

① Response time, luminance and color may be changed by ambient temperature.
② Display mura, flicker, vertical seam or small spot may be observed depending on display patterns.
③ Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating time, and especially low temperature, because the LCD has cold cathode fluorescent lamps.
④ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
⑤ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
⑥ Optical characteristics may be changed depending on input signal timings.
⑦ The interference noise between input signal frequency for this product's signal processing board and luminance control frequency of the inverter may appear on a display. Set up luminance control frequency of the inverter so that the interference noise does not appear.

5.3.4 Other

① All GND and VDD terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ Pack the product with original shipping package, in order to avoid any damages during transportation, when returning the product to NEC for repair and so on.
④ The LCD module by itself or integrated into end product should be packed and transported with display in the vertical position. Otherwise the display characteristics may be degraded.

6. OUTLINE DRAWINGS



Unit: mm

Note1: Not shown tolerances of the dimensions are TBD mm.
Note2: The values in parentheses are for reference.

REVISION HISTORY

The inside of latest specifications is revised to the clerical error and the major improvement of previous edition. Only a changed part such as functions, characteristic value and so on that may affect a design of customers, are described especially below.

Edition	Document number	Prepared date	Revision contents and signature
1st edition	DOD-PD-0938	Mar. 31, 2005	**Revision contents** New issue (abstract) **Writer** *Approved by* T. ITO *Checked by* ——— *Prepared by* R. KAWASHIMA
2nd edition	DOD-PD-1068	July 4, 2005	**Revision contents** New issue **Signature of writer** *Approved by* T. ITO *Checked by* ——— *Prepared by* R. KAWASHIMA