SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014

Specifications for

TFT-LCD Monitor (TENTATIVE)

MODEL   COM20T2N52XSB

Customer's Approval

Signature:

Name:

Section:

Title:

Date:

ORTUSTECH

ORTUS TECHNOLOGY CO., LTD.

Approved by

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Approved by

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Checked by

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Prepared by

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ORTUS TECHNOLOGY CO.,LTD.

| SPECIFICATIONS № **TLM*** | Issue Nov. 19, 2014 |

Version History

Date	Page	Description
Nov. 19, 2014	-	-- Tentative issue

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Contents

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1. Application

This Specification is applicable to 5.12cm (2.0 inch) TFT-LCD monitor for non-military use.

◎ ORTUS TECHNOLOGY makes no warranty or assume no liability that use of this Product and/or any information
   including drawings in this Specification by Purchaser is not infringing any patent or other intellectual
   property rights owned by third parties, and ORTUS TECHNOLOGY shall not grant to Purchaser any right to use
   any patent or other intellectual property rights owned by third parties. Since this Specification contains
   ORTUS TECHNOLOGY's confidential information and copy right, Purchaser shall use them with high degree of
   care to prevent any unauthorized use, disclosure, duplication, publication or dissemination of
   ORTUS TECHNOLOGY'S confidential information and copy right.

◎ If Purchaser intends to use this Products for an application which requires higher level of reliability
   and/or safety in functionality and/or accuracy such as transport equipment
   (aircraft, train, automobile, etc.), disaster-prevention/security equipment or various safety
   equipment, Purchaser shall consult ORTUS TECHNOLOGY on such use in advance.

◎ This Product shall not be used for application which requires extremely higher level of
   reliability and/or safety such as aerospace equipment, telecommunication equipment for trunk lines,
   control equipment for nuclear facilities or life-support medical equipment.

◎ It must be noted as an mechaniacl design manner, especial attention in housing design to prevent
   arcuation/flexureor caused by stress to the LCD module shall be considered.

◎ ORTUS TECHNOLOGY assumes no liability for any damage resulting from misuse, abuse, and/or
   miss-operation of the Product deviating from the operating conditions and precautions
   described in the Specification.

◎ ORTUS TECHNOLOGY is not responsible for any nonconformities and defects
   that are not specified in this specifications.

◎ If any issue arises as to information provided in this Specification or any other information,
    ORTUS TECHNOLOGY and Purchaser shall discuss them in good faith and seek solution.

◎ ORTUS TECHNOLOGY assumes no liability for defects such as electrostatic discharge failure occurred
   during peeling off the protective film or Purchaser's assembly process.

◎ This Product is compatible for RoHS directive.

Object substance	Maximum content [ppm]
Cadmium and its compound	100
Hexavalent Chromium Compound	1000
Lead & Lead compound	1000
Mercury & Mercury compound	1000
Polybrominated biphenyl series（PBB series）	1000
Polybrominated biphenyl ether series（PBDE series）	1000

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SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014

2. Outline Specifications

2.1 Features of the Product

- 2.0 inch diagonal display, 2,880 [H] x 540 [V] dots.
- RGB 8-bit 16,777,216 colors display capability.
- Built in Timing generator (TG), Built-in power supply circuit, Counter-electrode driving circuit.
- Long life & high brightness LED back-light
- With transparent heater for response speed improvement at low temperature

2.2 Display Method

Items	Specifications	Remarks
Display type	TN type 16,777,216 colors. Transmissive type, Normally white	
Driving method	a-Si TFT Active matrix Line-scanning, Non-interlace	
Dot arrangement	RGB stripe arrangement	Refer to "Dot arrangement"
Signal input method	8-bit RGB, parallel input.	
Backlight type	Long life & High bright white LED.	
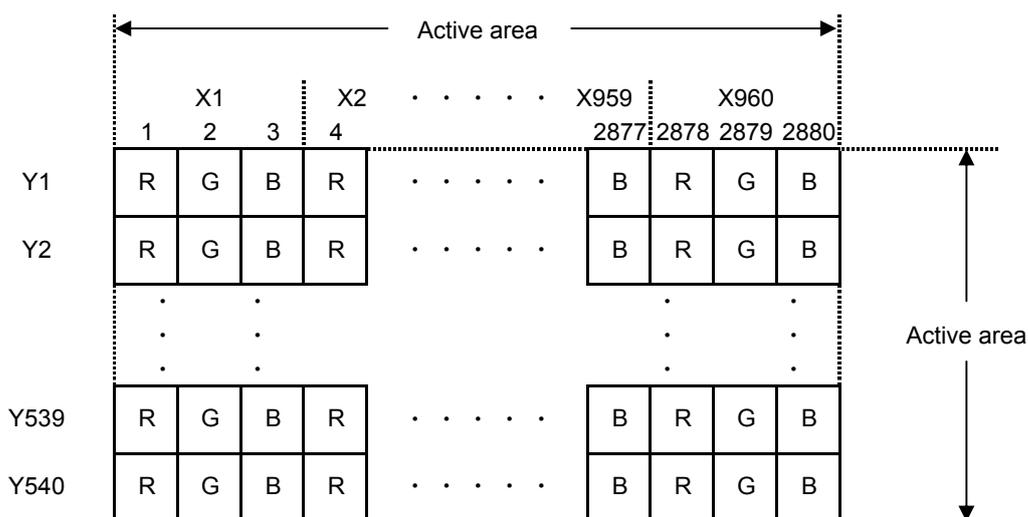
Dot arrangement
(When "S LABEL" on the front case is placed at the lower right)

3. Dimensions and Shape

3.1 Dimensions

Items	Specifications	Unit	Remarks
Outline dimensions	55.04[H] × 39.07[V] × 9.78[D]	mm	
Active area	44.64[H] × 25.11[V]	mm	5.12cm diagonal
Number of dots	2,880[H] × 540[V]	dot	
Dot pitch	15.5[H] × 46.5[V]	μm	
Surface hardness of the polarizer	3	H	Load:2.0 N Angle:45 degrees Criteria:JIS-K5600
Weight	24.5	g	

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3.2 Outward Form

(0.14 Max)
(Dashing out of POLARIZER)

8.28 ±0.50
(S CASE A-PCB surface)

1.50 Max
(The maximum height of electronic parts)

55.04 ±0.15 (FRAME)

29.62 ±0.30

6.00   47.44   (S CASE A Opening)

15.31 ±1.00

Polarizer area
(Active area-Polarizer)

All around   0.50 min

49.20 ±0.50

5.68

2.0

Active area center

14.74 ±0.50

25.11 (Active area)

27.91

19.53 ±0.3

39.07 ±0.15 (FRAME)

19.53 ±0.3 (S CASE A Opening)

19.54 ±1.00

Note1

44.64 (Active area)

0.30 ±0.3

3.50

(23.54)

A

1.00 Max

① ② ③ ⑪ ④

⑧ ⑨ ⑥ ⑤ ⑦

5.00 ±0.50
(Reinforcing board)

3.30 ±0.75

2-R0.20

2.00 ±0.03

2.00 ±0.05

4.00 ±0.05

2p (5,6,7)

1p (1,2,3)

Detail of A
(S=5/1)

1.00 ±0.10

2-1.40 ±0.03

PART NAME	ITEM	MATERIAL GRADE	REMARK
S LABEL	11		10×1.85×0.075t
HEATER TERMINAL	10		
CONNECTOR	9	04 6281 245 202 846+ (KYOCERA ELCO)	pitch0.3x45pin(Lower contact)
PCB	8		1.0t
LED-FPC	7		
FPC B	6		
FPC A	5		
Frame	4		
Polarizer	3		with protection sheet
S CASE A	2	SUS (t=0.15)	
TFT-LCD	1	Glass substrate thickness=0.5t	

Note 1. Angular deviation of LCD cell from the TFT-LCD monitor's reference axis shall be less than [±40'].
Note 2. S LABEL is affixed on the area shown in the drawing.
Note 3. Protective film is affixed on front surface of the screen.
Location tolerance of the protective film shall be ±1.5 mm to the polarizing film.
Note 4. Recommended HEATER TERMINAL connector
For HEATER TERMINAL : JST, part number: 07FLZ-SM2-TB(Upper contact)
Note 5. Refer to "11.CRITERIA OF JUDGMENT" about the appearance specification of a polarizer.

APPROVED 橋爪	GENERAL TOLERANCE ±0.3	SCALE 2/1, (5/1)	UNIT mm	**ORTUSTECH**
CHECKED 平信	ISSUE (Y:M:D) 10:07:29	MODEL COM20T2N52X**		ORTUS TECHNOLOGY CO.,LTD.
CHECKED	NAME			DO NOT DUPLICATE, CONFIDENTIAL AND PROPRIETARY
DESIGN 大橋貴文				DRAWING No. / REV. / SHEET / DIV.
DRAW 大橋貴文	OUTLINE-D2N52			RJD520658D301 / / / PART

SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014

3.3 SERIAL LABEL (S-LABEL)

1) Display Items

S-label indicates the least significant digit of manufacture year (1digit), manufacture month with below alphabet (1letter), model code (5characters), serial number (6digits).

* Contents of Display

```
*     *     *****     ******
─     ─     ─────     ──────
a     b       c         d
```

	Contents of display			
a	The least significant digit of manufacture year			
b	Manufacture month	Jan-A	May-E	Sep-I
		Feb-B	Jun-F	Oct-J
		Mar-C	Jul-G	Nov-K
		Apr-D	Aug-H	Dec-L
c	Model code	20FXB (Made in Japan)		
		20FYB (Made in Malaysia)		
d	Serial number			

* Example of indication of Serial label (S-label)

・Made in Japan

    5G20FXB000125

means "manufactured in July 2015, 2.0" FX type, B specifications, serial number 000125"

・Made in Malaysia

    5G20FYB000125

means "manufactured in July 2015, 2.0" FY type, B specifications, serial number 000125"

2) Location of Serial Label (S-label)

Refer to 3.2 "Outward Form".

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SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014

4. Pin Assignment

4.1 Display Module / Backlight

| No.	Symbol	Function	Signal voltage
1	VLEDA	Backlight power supply input.(anode side)	
2	VLEDA	Backlight power supply input.(anode side)	
3	VLEDK	Backlight power supply input.(cathode side)	
4	VLEDK	Backlight power supply input.(cathode side)	
5	VSS	GND.	
6	DR7	Display data(R).	VDDIO
7	DR6	00h: Black	
8	DR5	DR0：LSB　　　DR7：MSB	
9	DR4		
10	DR3		
11	DR2		
12	DR1		
13	DR0		
14	VSS	GND.	
15	DG7	Display data(G).	VDDIO
16	DG6	00h: Black	
17	DG5	DG0：LSB　　　DG7：MSB	
18	DG4		
19	DG3		
20	DG2		
21	DG1		
22	DG0		
23	VSS	GND.	
24	DB7	Display data(B).	VDDIO
25	DB6	00h: Black	
26	DB5	DB0：LSB　　　DB7：MSB	
27	DB4		
28	DB3		
29	DB2		
30	DB1		
31	DB0		
32	VSS	GND.	
33	CLK	Clock signal.	VDDIO
34	VSS	GND.	
35	HSYNC	Horizontal sync signal.	VDDIO
36	VSYNC	Vertical sync signal.	VDDIO
37	RESETB	Reset signal.(Low : reset　Hi : normal)	VDD
38	SCK	Clock input for serial communication. Latching data at the rising edge.	VDD
39	SDI	Data input for serial communication.	VDD
40	CSB	Chip select input for serial communication. (Low active)	VDD
41	VSS	GND.	
42	VDDIO	Power supply for IO input.	VDDIO
43	VDD	Power supply input.	VDD
44	VDD	Power supply input.	VDD
45	VDD	Power supply input.	VDD

- Used connector: KYOCERA Connector Products CO., LTD.　6281 series [04 6281 245 202 846+]
- Please refer to the section "3.2 Outward Form" for pin terminal order.
- The terminals of the connector (04 6281 245 202 846+) are plated with Au.
  So, the terminals of the FPC are desirably plated with Au.

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4.2 Transparent heater

No.	Symbol	Function
1	Vheat_1	Positive Voltage Input for Transparent Heater.
2	Vheat_1	Positive Voltage Input for Transparent Heater.
3	Vheat_1	Positive Voltage Input for Transparent Heater.
4	NC	NC.
5	Vheat_2	Negative Voltage Input for Transparent Heater.
6	Vheat_2	Negative Voltage Input for Transparent Heater.
7	Vheat_2	Negative Voltage Input for Transparent Heater.

- Used connector: J.S.T. CO., LTD. 07FLZ series 07FLZ-SM2-TB
- Please refer to the section "3.2 Outward Form" for pin terminal order.
- The terminals of the connector (07FLZ-SM2-TB) are plated with Au.
  So, the terminals of the FPC are desirably plated with Au.

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5. Circuit

5.1 Block Diagram

Each arrow shows signal flow.

5.2 LED Circuit

VLEDA ○

VLEDK ○

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SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014
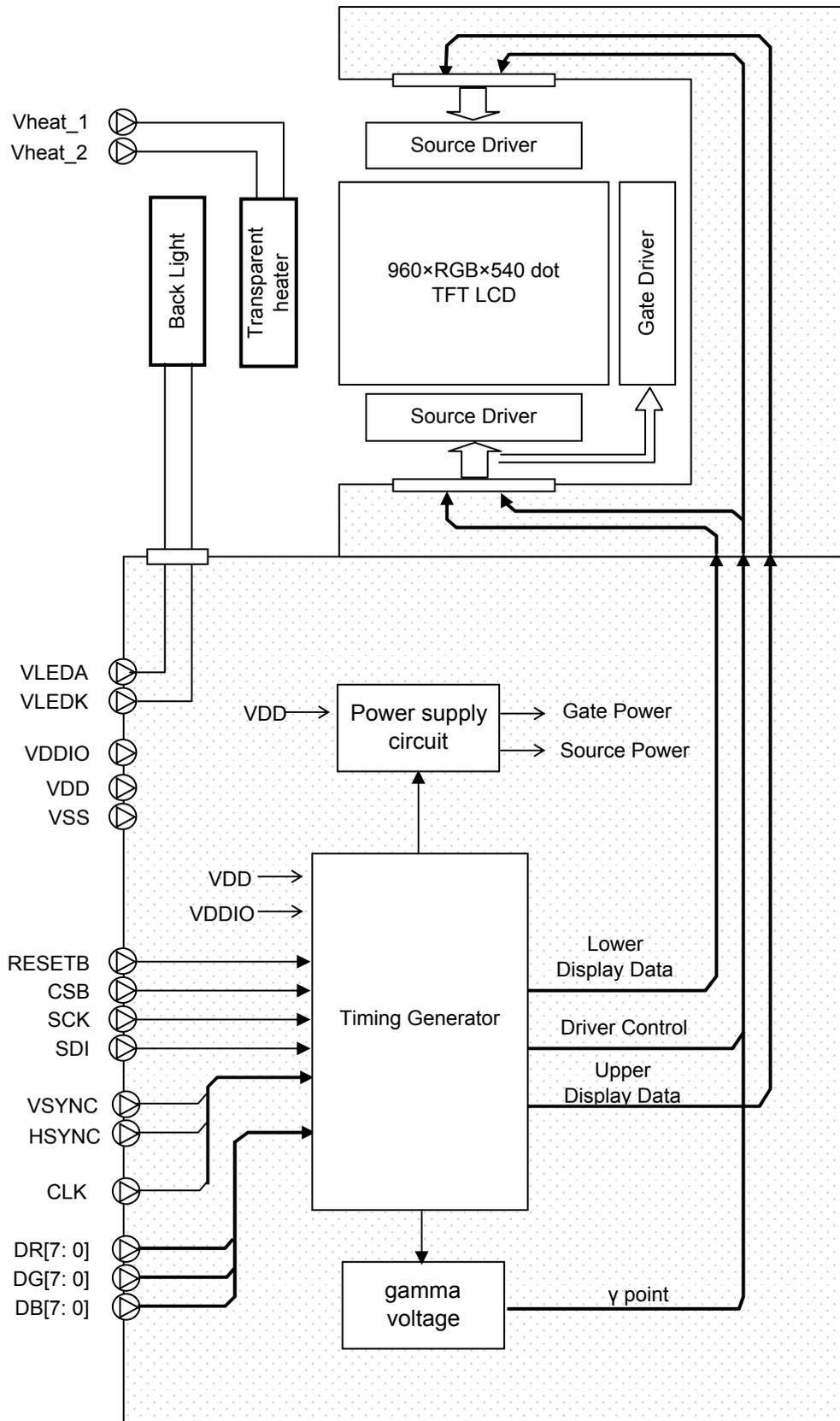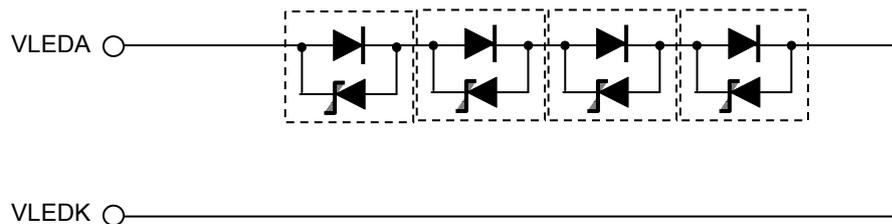
6. Absolute Maximum Rating

VSS=0V

Item	Symbol	Condition	Rating		Unit	Applicable terminal
			MIN	MAX		
Supply voltage 1	VDD		-0.3	3.7	V	VDD
Supply voltage 2	VDDIO		-0.3	3.7	V	VDDIO
Input voltage for logic 1	VI1		-0.3	VDD+0.3	V	RESETB,CSB,SCK, SDI
Input voltage for logic 2	VI2		-0.3	VDDIO+0.3	V	VSYNC,HSYNC,CLK, DR[7:0],DG[7:0],DB[7:0]
LED forward current	IL		—	40	mA	VLEDA-VLEDK
Heater Power Rating	PR heat		—	1.8	W	Vheat 1-Vheat 2
Storage temperature range	Tstg		-30	80	°C	

7. Recommended Operating Conditions

7.1 Display Module / Backlight

VSS=0V

Item	Symbol	Condition	Rating			Unit	Applicable terminal
			MIN	TYP	MAX		
Supply voltage 1	VDD		3.0	3.3	3.4	V	VDD
Supply voltage 2	VDDIO		1.7	1.8	3.4	V	VDDIO
Input voltage for logic 1	VI1		0	—	VDD	V	RESETB,CSB,SCK, SDI
Input voltage for logic 2	VI2		0	—	VDDIO	V	VSYNC,HSYNC,CLK, DR[7:0],DG[7:0],DB[7:0]
Operating temperature range	Top		-20	25	70	°C	Panel surface temperature

7.2 Transparent heater

Item	Symbol	Condition	Rating			Unit	Applicable terminal
			MIN	TYP	MAX		
Resistance between terminals	R heat		18.2	22.5	26.8	Ohm	Vheat_1-Vheat_2
Input voltage for heater	VIL				6	V	
Operational temperature	Top		-20	25	70	°C	Panel surface temperature

Note : Please use COM20T2N52XSB on the condition of that panel surface temperature is 70 °C or less.
(Don't use COM20T2N52XSB on the condition of that panel surface temperature is over 70 °C.)

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SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014

8. Characteristics

8.1 DC Characteristics

8.1.1 Display Module

(Unless otherwise noted, Ta=25 °C,VDD=3.3V,VDDIO=1.8V,VSS=0V)

Item	Symbol	Condition	Rating			Unit	Applicable terminal
			MIN	TYP	MAX		
Input voltage for logic 1	VIH 1		0.8VDD	—	VDD	V	RESETB,CSB,SCK,SDI
	VIL 1		0	—	0.2VDD	V	
Input voltage for logic 2	VIH 2		0.8VDDIO	—	VDDIO	V	VSYNC,HSYNC,CLK, DR[7:0],DG[7:0],DB[7:0]
	VIL 2		0	—	0.2VDDIO	V	
Operating Current	IDD	fCLK=37.1MHz Color bar display	—	270	540	mA	VDD
	IDDIO		—	7	14	mA	VDDIO
Standby Current	IDDs	Input signal : const R02h PSAVE=0	—	50	100	mA	VDD
	IDDIOs		—	6	12	mA	VDDIO

8.1.2 Backlight

Item	Symbol	Condition	Rating			Unit	Applicable terminal
			MIN	TYP	MAX		
LED forward current	IL		—	25	40	mA	VLEDA-VLEDK
LED forward voltage	VL	Ta=25 °C, IL=25mA	—	11.0	12.6	V	
Estimated Lifetime of LED	LL	Ta=25 °C, IL=25mA Note	—	15000	—	hrs	

Note : - The lifetime of the LED is defined as a period till the brightness of the LED
decreases to the half of its initial value.
- This figure is given as a reference purpose only, and not as a guarantee.
- This figure is estimated for an LED operating alone.
As the performance of an LED may differ when assembled as a monitor
together with a TFT panel due to different environmental temperature.
- Estimated lifetime could vary on a different temperature and usually
higher temperature could reduce the lifetime significantly.

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| SPECIFICATIONS № **TLM*** | Issue Nov. 19, 2014 |

8.1.3 Transparent heater

Measurement Condition

|	
State of monitor	The influence of convection is not received in the temperature chamber.
Measuring instruments:	KEYENCE FT-H10 / FT-50
Backlight:	IL=25mA
Measured temperature:	Ta=25 °C

Item	Symbol	Condition	Rating			Unit	
			MIN	TYP	MAX		
Rising temperature	RT	view center, after 10minutes		17.5		C/W	Reference value Refer to Figure below
Rising Time	Trt	at 1.8W to 0.9 x (Saturated temperature)		11		minutes	Reference value Refer to Figure below
Temperature uniformity	U t	at 1.8W after 30 minutes 9 point in view area		80		%	Reference value
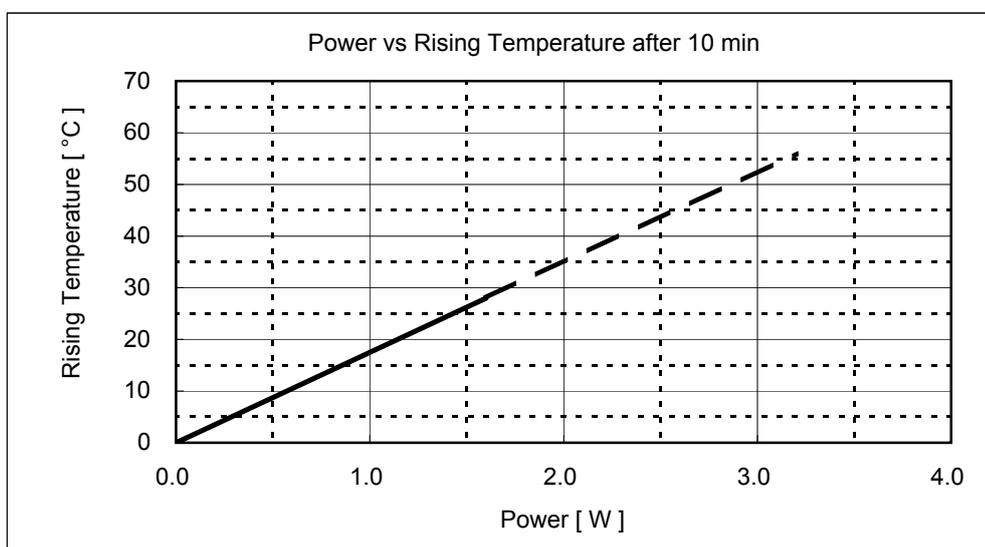
Power vs Rising Temperature after 10 min

Note : Please use COM20T2N52XSB on the condition of that panel surface temperature is 70 °C or less.
     (Don't use COM20T2N52XSB on the condition of that panel surface temperature is over 70 °C.)

Temperature Rising Characteristic

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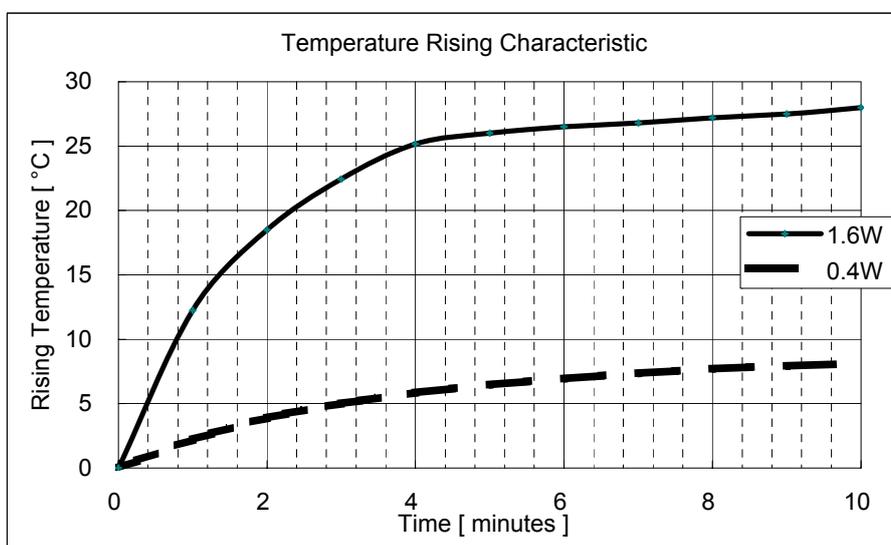
8.2 AC Characteristics

8.2.1 RGB Interface Block

(Unless otherwise noted, Ta=25 °C,VDD=3.3V,VDDIO=1.8V,VSS=0V)

Item	Symbol	Condition	Rating			Unit	Applicable terminal
			MIN	TYP	MAX		
CLK frequency	fCLK		—	37.1	45	MHz	CLK
CLK Low period	tw1L		3	—	—	ns	CLK
CLK High period	tw1H		3	—	—	ns	CLK
Setup time	tsp		7	—	—	ns	CLK, DR[7:0],DG[7:0],DB[7:0],
Hold time	thd		7	—	—	ns	HSYNC,VSYNC

*INVALID

Note : HPOL,VPOL=1   CKEG=0

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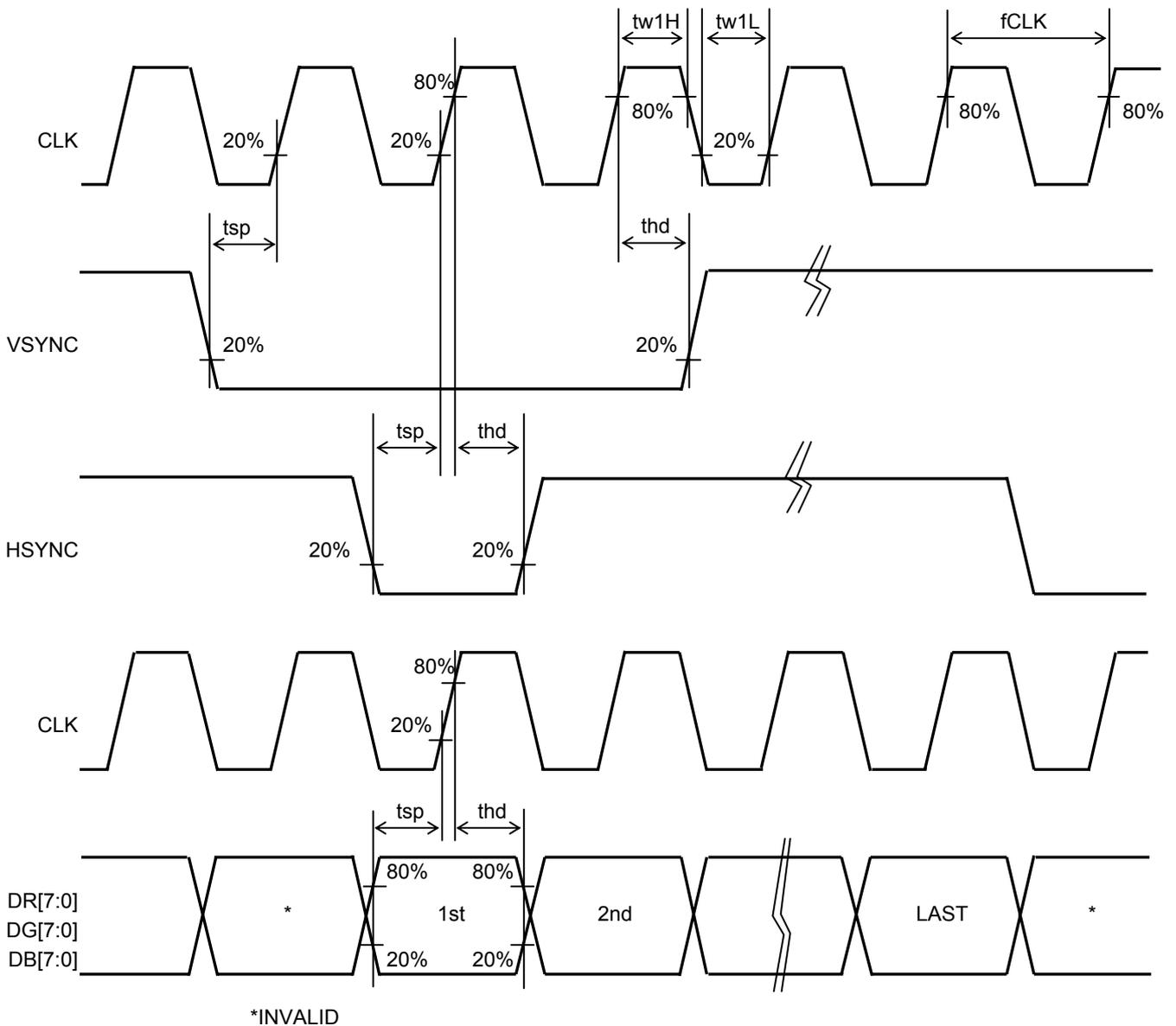
8.2.2 Serial Communication Block

(Unless otherwise noted, Ta=25 °C,VDD=3.3V,VDDIO=1.8V,VSS=0V)

Item	Symbol	Condition	Rating			Unit	Applicable terminal
			MIN	TYP	MAX		
SCK pulse frequency	fSCK		1	5	10	MHz	SCK
SCK pulse Low period	tw0L		20	—	—	ns	SCK
SCK pulse High period	tw0H		20	—	—	ns	SCK
CSB pulse High period	tw1H		20	—	—	ns	CSB
CSB setup time	tsp1		20	—	—	ns	CSB,SCK
CSB hold time	thd1		20	—	—	ns	CSB,SCK
SDI setup time	tsp2		20	—	—	ns	SDI,SCK
SDI hold time	thd2		20	—	—	ns	SDI,SCK
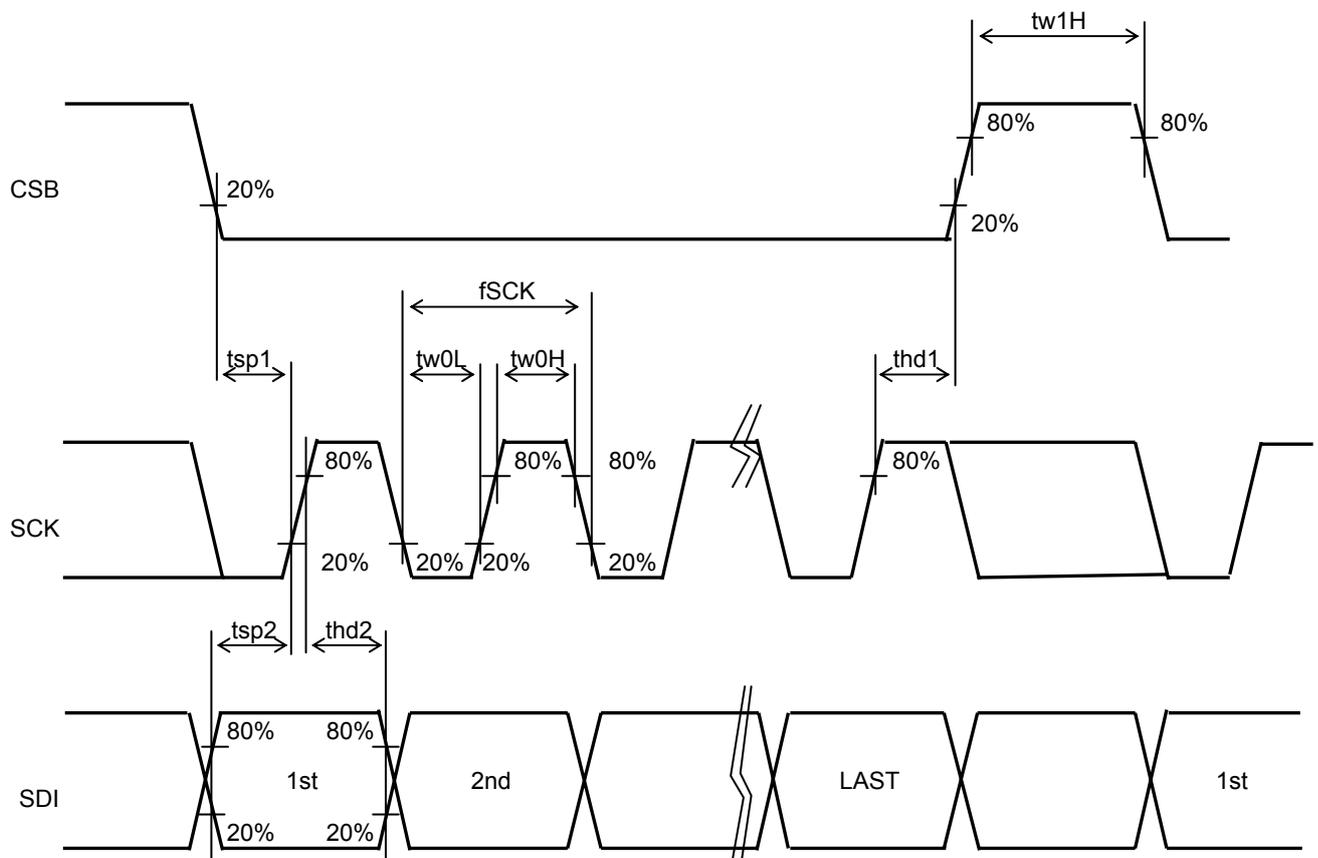
8.3 Input Timing Characteristics

Item	Symbol	Rating			Unit	Applicable terminal
		MIN	TYP	MAX		
CLK frequency	fCLK		37.1	45	MHz	CLK
VSYNC Frequency Note	fVSYNC	48	59.9		Hz	VSYNC
Number of Frame Line	tv	559	563		H	VSYNC,HSYNC
VSYNC Pulse Width	tw2H	2	3		H	
Vertical Back Porch	tvb	17	18		H	VSYNC,HSYNC,
Vertical front Porch	tvf	2	5		H	DR[7:0],DG[7:0],DB[7:0]
Vertical Display Period	tvdp	—	540	—	H	
HSYNC frequency	fHSYNC	—	33.8	35.0	KHz	HSYNC
HSYNC Cycle	th	1044	1100		CLK	HSYNC,CLK
HSYNC Pulse Width	tw3H	5	20		CLK	
Horizontal Back Porch	thb	56	106		CLK	HSYNC,CLK,
Horizontal front Porch	thf	28	34		CLK	DR[7:0],DG[7:0],DB[7:0]
Horizontal Display Period	thdp	—	960	—	CLK	

Note : Above input timing characteristics is standard.
   Please check carefully display quality,
       if COM20T2N52XSB is operated on out of standard condition.

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8.4 Driving Timing Chart

-Vertical Timing

-Horizontal Timing

Note : HPOL,VPOL=1   CKEG=0

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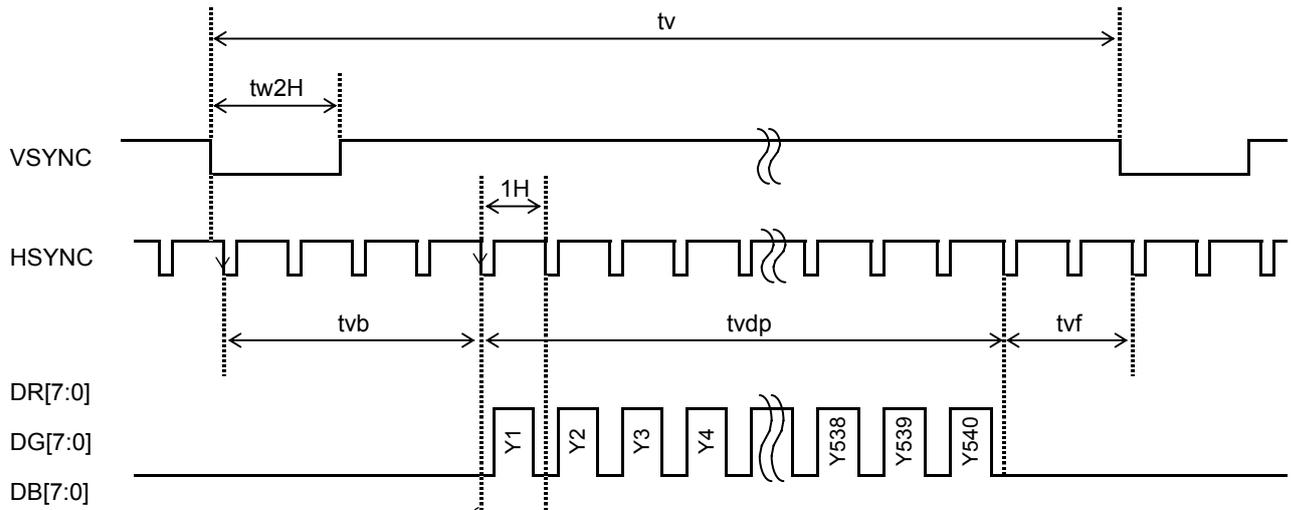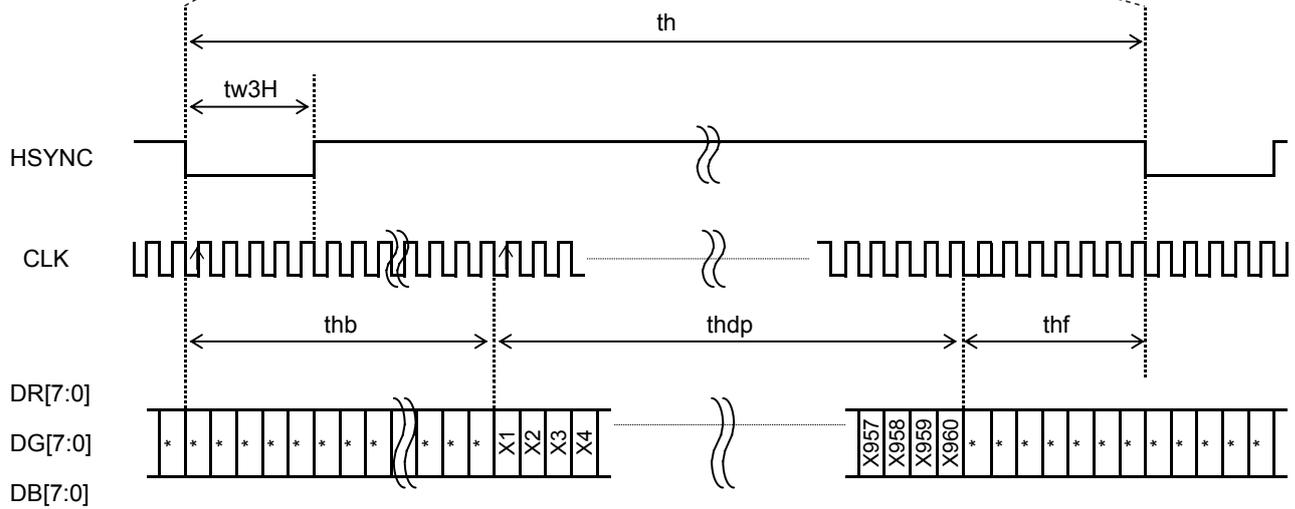
8.5 Example of Driving Timing Chart

-Vertical Timing

In case of that the period from VSYNC falling edge to data input start is 18H, set VBP=18(dec)=12(hex) please.


-Horizontal Timing

Note : HPOL,VPOL=1 CKEG=0

SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014
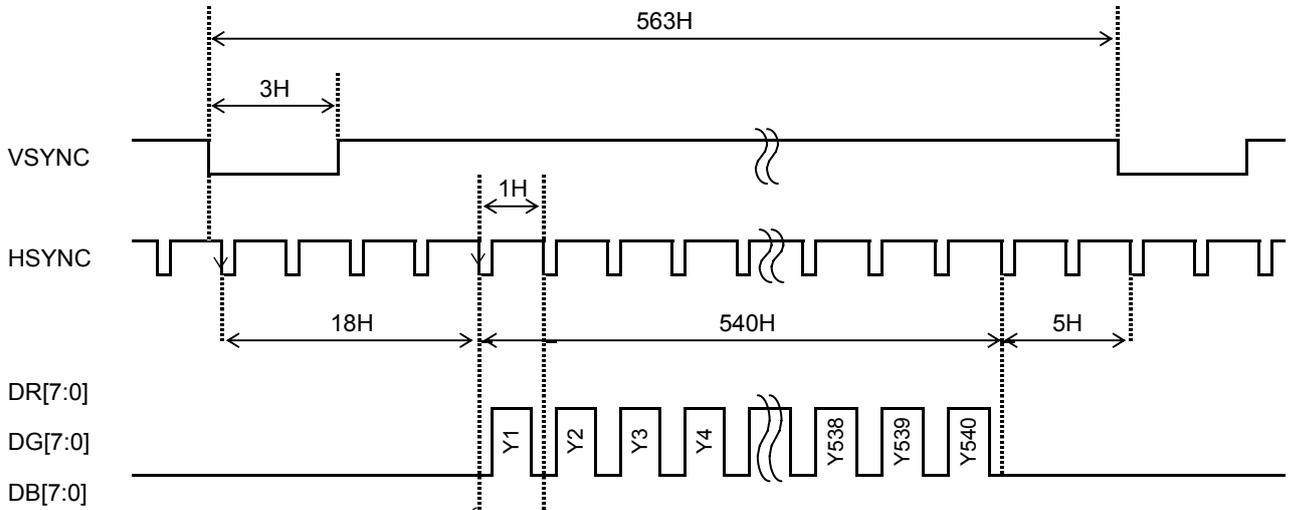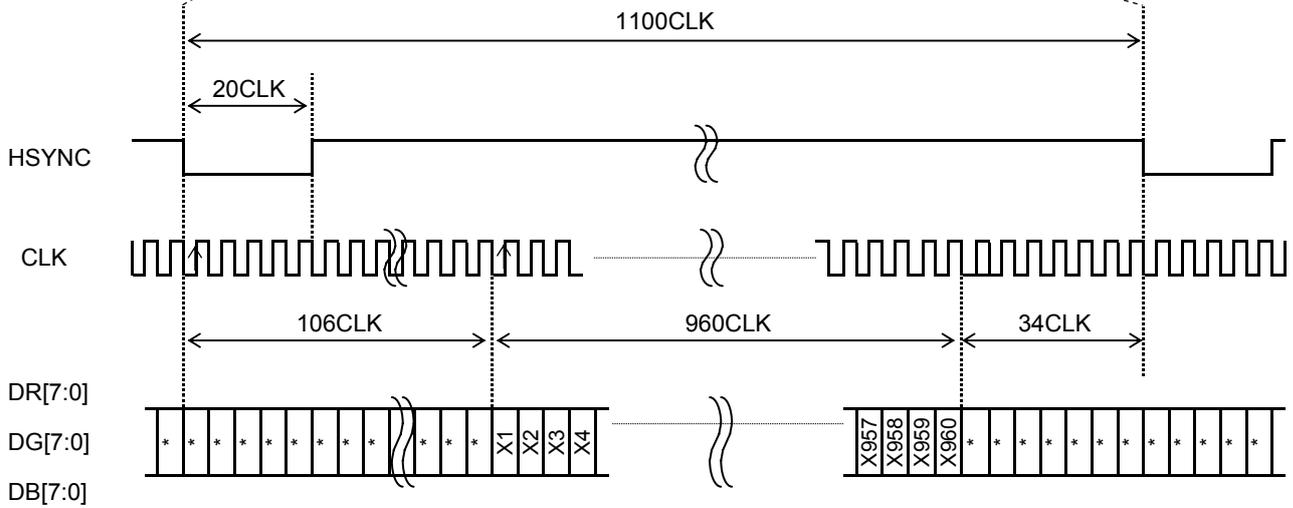
9. Description of Operation

9.1 Serial Communication Timing

After input signal of CSB drops from Hi to Lo, the Shift Resister loads 16 bits of serial data from SDI
at the rising edge of the input signal of SCK.
When loaded SDI data during the low period of CSB is less than 16 bits, all loaded data are discarded .
When loaded SDI data during the low period of CSB is 16 bits or more, the last read of 16 bits is used .
Serial Communication Control Block is configurable at any time normal operation mode and standby mode
as it is completely independent from other circuit run by CLK in the monitor.
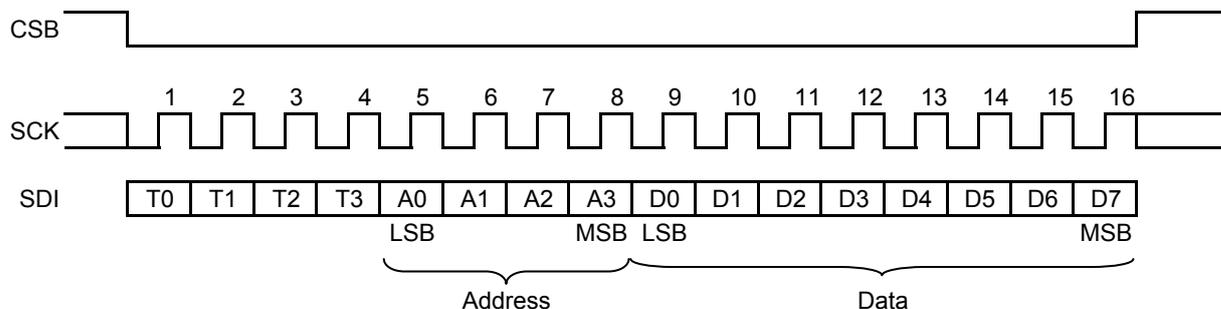
9.2 Serial Communication Data

	T0-T3	A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
R00h		0	0	0	0	VBP0	VBP1	VBP2	VBP3	VBP4	VBP5	VBP6	VBP7
			initial			0	1	1	1	1	0	0	0
R01h		1	0	0	0	HBP0	HBP1	HBP2	HBP3	HBP4	HBP5	HBP6	HBP7
			initial			0	1	1	1	1	0	0	0
R02h		0	1	0	0	UDB	LRB	-	PSAVE	HPOL	VPOL	CKEG	TEST
			initial			0	0	0	0	1	1	0	0
R03h		1	1	0	0	HCKNMB0	HCKNMB1	HCKNMB2	HCKNMB3	HCKNMB4	HCKNMB5	HCKNMB6	HCKNMB7
			initial			1	1	0	0	1	0	0	0
R04h		0	0	1	0								
			initial										
R05h		1	0	1	0								
			initial										
R06h		0	1	1	0								
			initial										
R07h		1	1	1	0								
			initial										
R08h	0000	0	0	0	1								
			initial										
R09h		1	0	0	1								
			initial										
R0Ah		0	1	0	1								
			initial										
R0Bh		1	1	0	1	TDR0	TDR1	TDR2	TDR3	TDR4	TDR5	TDR6	TDR7
			initial			0	0	0	0	0	0	0	0
R0Ch		0	0	1	1	TDG0	TDG1	TDG2	TDG3	TDG4	TDG5	TDG6	TDG7
			initial			0	0	0	0	0	0	0	0
R0Dh		1	0	1	1	TDB0	TDB1	TDB2	TDB3	TDB4	TDB5	TDB6	TDB7
			initial			0	0	0	0	0	0	0	0
R0Eh		0	1	1	1	TLINE	TPIX	TNINE	TCENT	TWAK	TRON	TGON	TBON
			initial			0	0	0	0	0	0	0	0
R0Fh		1	1	1	1								
			initial										

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SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014

(1) R00h : Vertical Back Porch Period

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
0	0	0	0	VBP0	VBP1	VBP2	VBP3	VBP4	VBP5	VBP6	VBP7
				0	1	1	1	1	0	0	0

VBP[7:0]   Setting numbers of HSYNC from the falling edge of VSYNC to valid RGB data (When VPOL=1).
When VPOL=0 , it becomes a count from the rising edge of VSYNC.
This command is executed by VSYNC immediately after the rising the edge of CSB.

(2) R01h : Horizontal Back Porch Period

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
1	0	0	0	HBP0	HBP1	HBP2	HBP3	HBP4	HBP5	HBP6	HBP7
				0	1	1	1	1	0	0	0

HBP[7:0]   Setting numbers of CLK from the falling edge of HSYNC to valid RGB data (When HPOL=1).
When HPOL=0 , it becomes a count from the rising edge of HSYNC.
This command is executed by VSYNC immediately after the rising the edge of CSB.

(3) R02h : Interface Mode

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
0	1	0	0	UDB	LRB	-	PSAVE	HPOL	VPOL	CKEG	TEST
				0	0	0	0	1	1	0	0

UDB   Setting for vertical flip display. The selected display mode is carried out by VSYNC.
  0 : Normal Display
  1 : Vertical Flip Display (Up/Down)
LRB   Setting for horizontal flip display. The selected display mode is carried out by VSYNC.
  0 : Normal Display
  1 : Horizontal Flip Display (Right/Left)
PSAVE   Setting into Standby mode. It is carried out by the rising edge of CSB.
  0 : Standby mode
    Power consumption is significantly reduced in standby mode .
    Serial data can be received by serial communication block even in standby mode.
  1 : Normal operation
HPOL   Setting the polarity of HSYNC. It is carried out by the rising edge of CSB.
  0 : HSYNC is High active (Normally Low)
  1 : HSYNC is Low active (Normally High)
VPOL   Setting the polarity of VSYNC. It is carried out by the rising edge of CSB.
  0 : VSYNC is High active (Normally Low)
  1 : VSYNC is Low active (Normally High)
CKEG   Setting the timing of data read. It is carried out by the rising edge of CSB.
  0 : The data is read on the rising edge of CLK
  1 : The data is read on the falling edge of CLK
TEST   The TEST pattern is inserted in the display image. It is carried out by VSYNC.
  0 : Normal Display
  1 : The TEST pattern is inserted
    The inserted TEST pattern is specified by register R0Bh-R0Eh.

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(4) R03h : Setting 1H period

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
1	1	0	0	HCKNMB0	HCKNMB1	HCKNMB2	HCKNMB3	HCKNMB4	HCKNMB5	HCKNMB6	HCKNMB7
				1	1	0	0	1	0	0	0

HCKNMB[7:0]   Setting number of CLKs per 1H period
The setting figure is calculated by the following expressions.
The expressions omit the figure after the decimal fractions.

$$HCKNMB = (\text{number of CLK per 1H period} - 1024) \div 4$$

Example1. In case of Number of 1H period = 1100
$$HCKNMB[7:0] = (1100 - 1024) \div 4 = 19(dec) = 0001\_0011(bin)$$

Example2. In case of Number of 1H period = 1430
$$HCKNMB[7:0] = (1430 - 1024) \div 4 = 101.5 \rightarrow 101(dec) = 0110\_0101(bin)$$

(5) R0Bh : R Data of TEST pattern (valid when R02h[D7:TEST] =1)

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
1	1	0	1	TDR0	TDR1	TDR2	TDR3	TDR4	TDR5	TDR6	TDR7
				0	0	0	0	0	0	0	0

TDR[7:0]   Setting for Red data of TEST pattern when R02h[D7:TEST]=1. It is carried out by VSYNC.

(6) R0Ch : G Data of TEST pattern (valid when R02h[D7:TEST] =1)

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
0	0	1	1	TDG0	TDG1	TDG2	TDG3	TDG4	TDG5	TDG6	TDG7
				0	0	0	0	0	0	0	0

TDG[7:0]   Setting for Green data of TEST pattern when R02h[D7:TEST]=1. It is carried out by VSYNC.

(7) R0Dh : B Data of TEST pattern (valid when R02h[D7:TEST] =1)

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
1	0	1	1	TDB0	TDB1	TDB2	TDB3	TDB4	TDB5	TDB6	TDB7
				0	0	0	0	0	0	0	0

TDB[7:0]   Setting for Blue data of TEST pattern when R02h[D7:TEST]=1. It is carried out by VSYNC.

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(8) R0Eh : TEST patterns (valid when R02h[D7:TEST]=1)

A0	A1	A2	A3	D0	D1	D2	D3	D4	D5	D6	D7
0	1	1	1	TLINE	TPIX	TNINE	TCENT	TWAK	TRON	TGON	TBON
				0	0	0	0	0	0	0	0

TLINE　　Control to insert the TEST pattern at intervals of one line . It is carried out by VSYNC.
　　　　　　0 : Normal Display
　　　　　　1 : At intervals of one line , the TEST pattern is inserted.

TPIX　　Control to insert the TEST pattern at intervals of one pixel . It is carried out by VSYNC.
　　　　　　0 : Normal Display
　　　　　　1 : At intervals of one pixel , the TEST pattern is inserted.
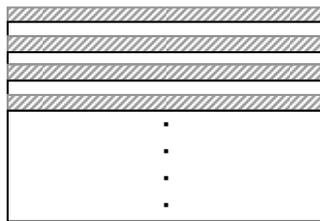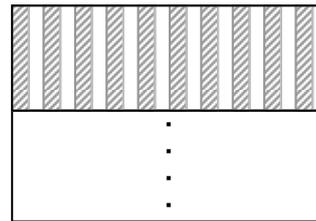
: TEST pattern

: Normal image

　　　　　　<TLINE=1>　　　　　　　　　　<TPIX=1>

TNINE　　Control the line which divides the screen into nine . It is carried out by VSYNC .
　　　　　　0 : Normal Display
　　　　　　1 : The line which divides the screen into nine is inserted.

TCENT　　Control the cross line which shows the center of the screen . It is carried out by VSYNC .
　　　　　　0 : Normal Display
　　　　　　1 : The cross line which shows the center of the screen is inserted.

TWAK　　Control the line which shows the frame of the screen . It is carried out by VSYNC .
　　　　　　0 : Normal Display
　　　　　　1 : The line which shows the frame of the screen is inserted.

　　　　<TNINE=1>　　　　　　　　<TCENT=1>　　　　　　　　<TWAK=1>
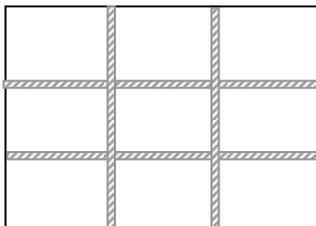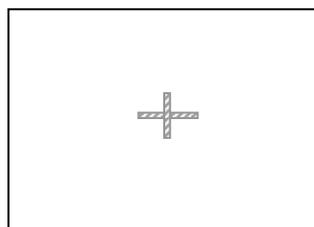
TRON　　ON/OFF of a RED pixel of the TEST pattern . It is carried out by VSYNC .
　　　　　　0 : R OFF (DR[7:0]=00h)
　　　　　　1 : R ON (DR[7:0]=FFh)

TGON　　ON/OFF of a GREEN pixel of the TEST pattern . It is carried out by VSYNC .
　　　　　　0 : G OFF (DG[7:0]=00h)
　　　　　　1 : G ON (DG[7:0]=FFh)

TBON　　ON/OFF of a BLUE pixel of the TEST pattern . It is carried out by VSYNC .
　　　　　　0 : B OFF (DB[7:0]=00h)
　　　　　　1 : B ON (DB[7:0]=FFh)

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- The logic of each test signal is as follows.

```
Terminal DR[7:0] ⎫ TEST=0
Terminal DG[7:0] ⎬
Terminal DB[7:0] ⎭

                          Select ─────────────────────→ ┌────────┐
                                                         │        │
TDR[7:0] ⎫ TEST=1                                        │ Insert │──→ Display Data
TDG[7:0] ⎬                                               │        │
TDB[7:0] ⎭                          Inserted Data ──────→│        │
                                                         └────────┘
              ↑
    ┌──────────────────┐      ┌──────────────────┐
    │  R02h  TEST      │      │ TRON,TGON,TBON   │
    └──────────────────┘      └──────────────────┘
                                       ↑ Inserted Timing
              └────────────→ ┌──────────────────┐
                             │  R0Eh  D[4:0]    │
                             └──────────────────┘
```

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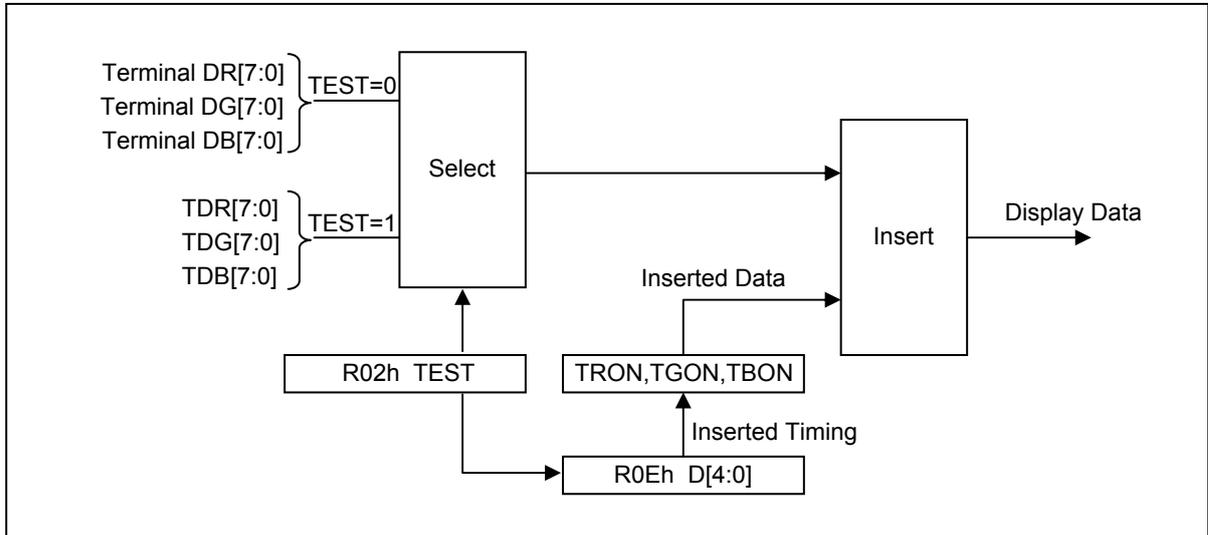
9.3 Power ON/OFF sequence
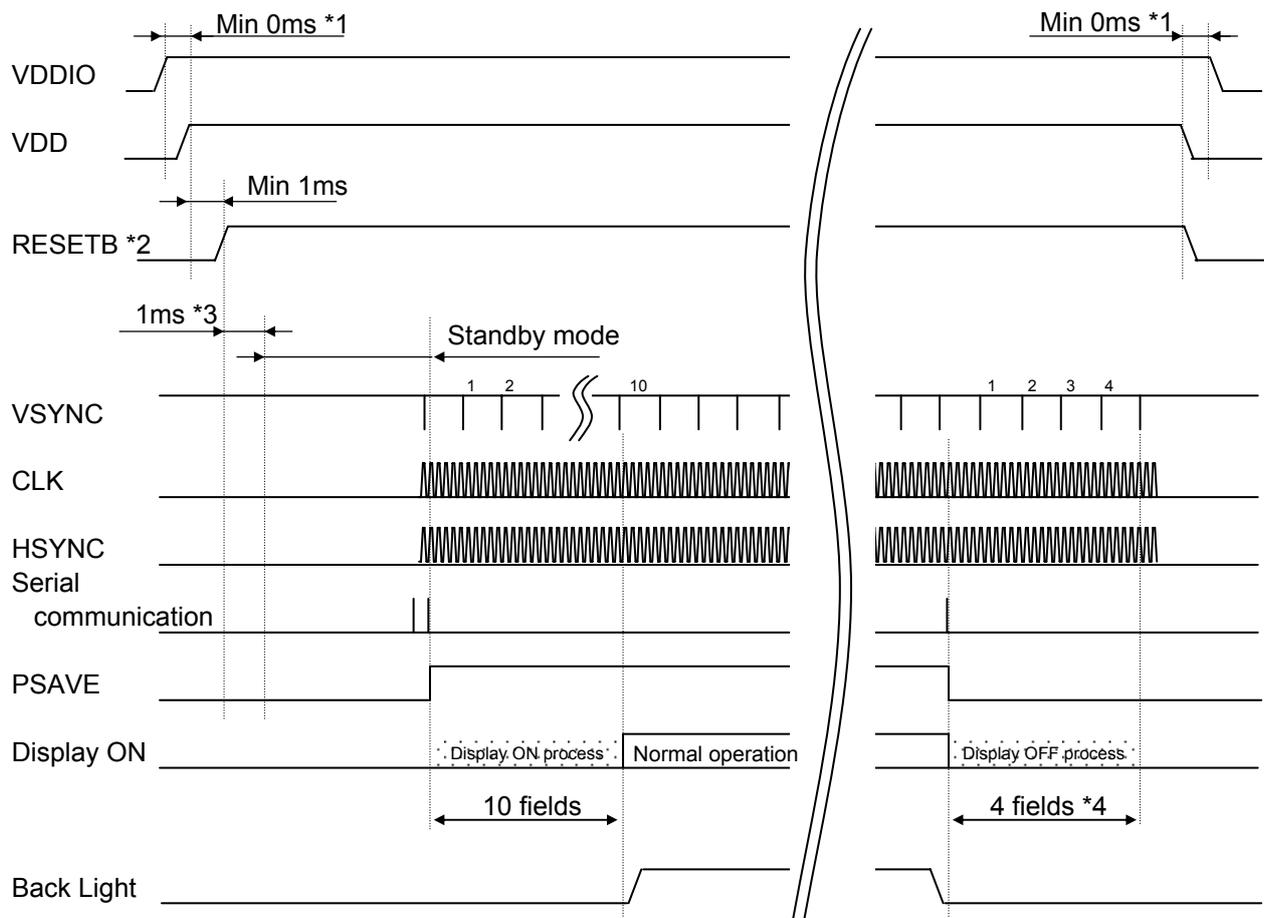
*1 Please set Power ON order VDDIO -> VDD or VDDIO = VDD.
     Please set Power OFF order VDD -> VDDIO or VDD = VDDIO.

*2 Please set RESETB=Hi, 1ms or more later after VDD turns to ON.

*3 Please input NO signal for 1ms after RESETB=Hi.
     Please fix all signals (except RESETB) to Hi or Lo for 1ms after RESETB=Hi.
     Please input signals more than 1ms later after RESETB=Hi.

*4 Display OFF process is 4 fields.
     Please keep to input HSYNC, VSYNC and clk for display OFF process.

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10. Optics

10.1 Optical Characteristics

< Measurement Condition >

Measuring instruments: CS1000（KONICA MINOLTA）, LCD7200(OTSUKA ELECTRONICS）,
EZcontrast160D（ELDIM）

Driving condition: Typical Rating of "7. Recommended Operating Conditions".
Optimized VCOMDC

Backlight: IL=25mA

Measured temperature: Ta=25°C

Item		Symbol	Condition	MIN	TYP	MAX	Unit	Note No.	Remark
Response time	Rise time	TON	[Data]= (FF)h→(00)h	—	(5)	—	ms	1	※
	Fall time	TOFF	[Data]= (00)h→(FF)h	—	(12)	—	ms		
Contrast ratio		CR	[Data]= (FF)h/(00)h	(120)	(200)	—		2	
Viewing angle	Left	θL	[Data]= (FF)h/(00)h CR≧(10)	(45)	—	—	deg	3	※
	Right	θR		(45)	—	—	deg		
	Up	φU		(45)	—	—	deg		
	Down	φD		(45)	—	—	deg		
White Chromaticity	x		[Data]=(FF)h	White chromaticity range				4	
	y								
Burn-in				No noticeable burn-in image should be observed after 2 hours of window pattern display.				5	
Center brightness			[Data]=(FF)h	(175)	(250)	—	cd/m^2	6	
Brightness distribution			[Data]=(FF)h	(70)	—	—	%	7	

* Note number 1 to 7: Refer to the APPENDIX of "Reference Method for Measuring Optical Characteristics".
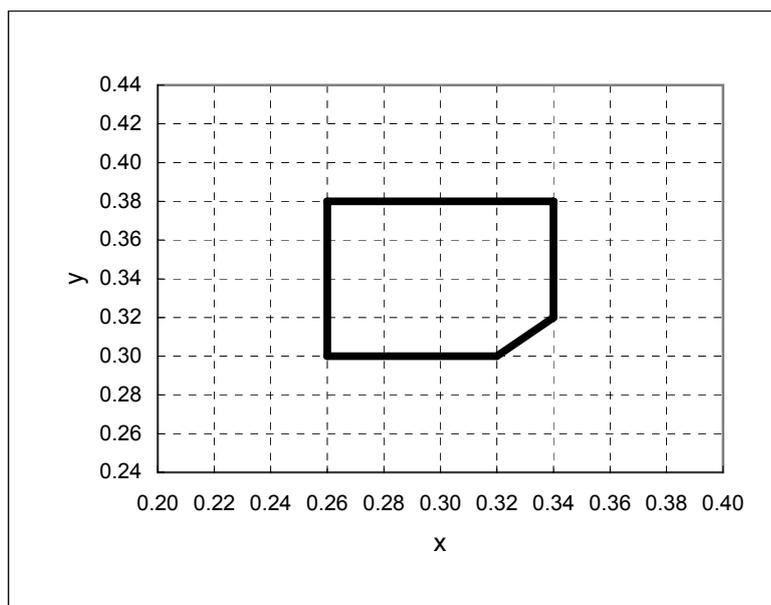
※ Measured in the form of LCD module.

【White Chromaticity Range】

x	y
(0.34)	(0.32)
(0.34)	(0.38)
(0.26)	(0.38)
(0.26)	(0.30)
(0.32)	(0.30)

White Chromaticity Range

10.2 Temperature Characteristics

< Measurement Condition >

Measuring instruments: CS1000（KONICA MINOLTA）, LCD7200(OTSUKA ELECTRONICS）

Driving condition: Typical Rating of "6. Recommended Operating Conditions".
Optimized VCOMDC
IL=25mA

Backlight:

Item			Specification		Remark
			Ta＝－10°C	Ta＝70°C	
Contrast ratio		CR	40 or more	40 or more	
Response time	Rise time	TON	200 msec or less	30 msec or less	※
	Fall time	TOFF	300 msec or less	50 msec or less	※
Display Quality			No noticeable display defect or ununiformity should be observed.		Use the criteria for judgment specified in the section 11.

※ Measured in the form of LCD module.

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11. Criteria of Judgment

11.1 Defective Display and Screen Quality

Test Condition: Observed TFT-LCD monitor from front during operation with the following conditions
Driving Signal Raster Pattern (RGB in monochrome, white, black)
Signal condition [Data]: (FF)h, (97)h, (00)h (3 steps)
Observation distance 30 cm
Illuminance 200 to 350 lx
Backlight IL=25mA

Defect item		Defect content		Criteria
Display Quality	Line defect	Black, White or color line, 5 or more neighboring defective dots.		Not exists
	Dot defect	Uneven brightness due to defective TFT or CF, or dust is counted as dot defect (brighter dot, darker dot) High bright dot: Visible through 2% ND filter at [Data]=(00)h Low bright dot: Visible through 5% ND filter at [Data]=(00)h Dark dot: Appear dark through white display at [Data]=(97)h		Refer to table 1
		Invisible through 5% ND filter at [Data]=(00)h		ignored
Screen Quality	Dirt	Point-like uneven brightness (white stain, black stain etc)		Invisible through 1% ND filter
	Foreign particle	Point-like	0.25mm< φ	N=0
			0.20mm< φ ≦0.25mm	N≦2
			φ ≦0.20mm	Ignored
		Liner	3.0mm<length and 0.08mm<width	N=0
			length≦3.0mm or width≦0.08mm	Ignored
	Others			Use boundary sample for judgment when necessary

φ(mm): Average diameter = (major axis + minor axis)/2
Permissible number: N

Table 1

Area	High bright dot	Low bright dot	Dark dot	Total	Criteria
A	0	2	2	2	4 or less neighboring defective dots are counted as one. Permissible distance between same color bright dots : 3 mm or more
B	1	2	2	3	
Total	1	2	2	3	

<Landscape model>
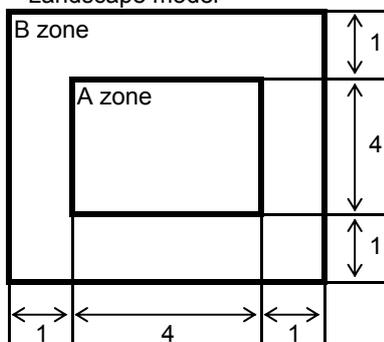
Division of A and B areas
 B area: Active area
 Dimensional ratio between A and B areas: 1: 4: 1 (Refer to the left figure)

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11.2 Screen and Other Appearance

Testing conditions

Observation distance	30cm
Illuminance	1200～2000 lx

Item		Criteria	Remark
Polarizer	Flaw Stain Bubble Dust Dent	Ignore invisible defect when the backlight is on.	Applicable area: Active area only (Refer to the section 3.2 "Outward form")
S-case		No functional defect occurs	
FPC cable		No functional defect occurs	
Connector		No functional defect occurs	

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12. Reliability Test

Test item		Test condition	number of failures /number of examinations
Durability test	High temperature storage	Ta=80°C 240hrs	TBD
	Low temperature storage	Ta=(-30°C) 240hrs	TBD
	High temperature & high humidity storage	Ta=60°C, RH=90% 240hrs non condensing ※	TBD
	High temperature operation	Tp=70°C 240hrs	TBD
	Low temperature operation	Tp=(-20°C) 240hrs	TBD
	High temp & humid operation	Tp=40°C, RH=90% 240hrs non condensing ※	TBD
	Thermal shock storage	(-30)←→80°C(30min/30min) 100 cycles	TBD
Mechanical environmental test	Surface discharge test (Non operation)	C=250pF, R=100Ω, V=±(12)kV Each 5 times of discharge in both polarities on the center of screen with the case grounded.	TBD
	Vibration test	Total amplitude 1.5mm, f=10～55Hz, X,Y,Z directions for each 2 hours	TBD
	Impact test	Use ORTUS TECHNOLOGY original jig (see next page)and make an impact with peak acceleration of 1000m/s2 for 6 msec with half sine-curve at 3 times to each X, Y, Z directions in conformance with JIS 60068-2-27-2011.	TBD
Packing test	Packing vibration-proof test	Acceleration of 19.6m/s^2 with frequency of 10→55→10Hz, X,Y, Zdirection for each 30 minutes	TBD
	Packing drop test	Drop from 75cm high. 1 time to each 6 surfaces, 3 edges, 1 corner	TBD

Note:Ta=ambient temperature   Tp=Panel temperature

※ The profile of high temperature/humidity storage and High Temperature/humidity operation
(Pure water of over 10MΩ·cm shall be used.）
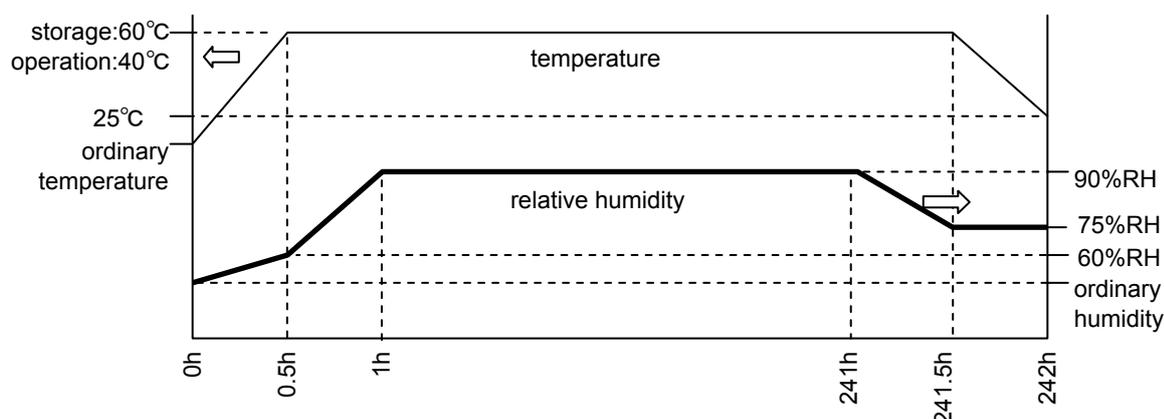
Table2.Reliability Criteria

Measure the parameters after leaving the monitor at the ordinary temperature
for 24 hours or more after the test completion.

item	Standard	Remarks
Display quality	No visible abnormality shall be seen.	As criteria of "11 Criteria of Judgment".
Contrast ratio	40 or more	

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ORTUS TECHNOLOGY Original Jig

LCD
Monitor

LCD Monitor

Original jig

Screw

1mm

1mm
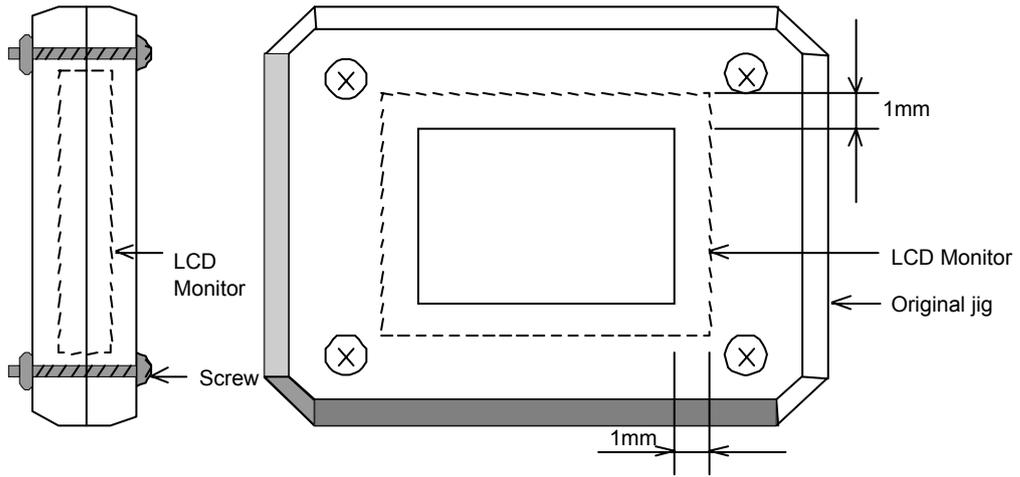
13. Packing Specifications

TBD

14. Handling Instruction
　14.1 Cautions for Handling LCD panels

<div align="center">

⚠ **Caution**

</div>

(1)　Do not make an impact on the LCD panel glass because it may break and you may get injured from it.

(2)　If the glass breaks, do not touch it with bare hands.
　　　（Fragment of broken glass may stick you or you cut yourself on it.

(3)　If you get injured, receive adequate first aid and consult a medial doctor.

(4)　Do not let liquid crystal get into your mouth.
　　　（If the LCD panel glass breaks, try not let liquid crystal get into your mouth even toxic property
　　　of liquid crystal has not been confirmed.

(5)　If liquid crystal adheres, rinse it out thoroughly.
　　　（If liquid crystal adheres to your cloth or skin, wipe it off with rubbing alcohol or wash
　　　it thoroughly with soap. If liquid crystal gets into eyes, rinse it with clean water
　　　for at least 15 minutes and consult an eye doctor.

(6)　If you scrap this products, follow a disposal standard of industrial waste
　　　that is legally valid in the community, country or territory where you reside.

(7)　Do not connect or disconnect this product while its application products is powered on.

(8)　Do not attempt to disassemble or modify this product as it is precision component.

(9)　For protection your circuit, we recommend you to add excess current protection circuit to power supply.

⚠ **Caution**　**This mark is used to indicate a precaution or an
instruction which, if not correctly observed, may
result in bodily injury, or material damages alone.**

<div align="center">

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</div>

14.2 Precautions for Handling

1) Wear finger tips at incoming inspection and for handling the TFT monitors to keep display quality and keep the working area clean.
Do not touch the surface of the monitor as it is easily scratched.

2) Wear grounded wrist-straps and use electrostatic neutralization blowers to prevent static charge and discharge when handling the TFT monitors as the LED in this TFT monitors is damageable to electrostatic discharge.
Designate an appropriate operating area, and set equipment, tools, and machines properly when handling this product.

3) Avoid strong mechanical shock including knocking, hitting or dropping to the TFT monitors for protecting their glass parts. Do not use the TFT monitors that have been experienced dropping or strong mechanical shock.

4) Do not use or storage the TFT monitors at high temperature and high humidity environment.
Particularly, never use or storage the TFT monitors at a location where condensation builds up.

5) Avoid using and storing TFT monitors at a location where they are exposed to direct sunlight or ultraviolet rays to prevent the LCD panels from deterioration by ultraviolet rays.

6) Do not stain or damage the contacts of the connector .
FPC cable needs to be inserted until it can reach to the end of connector slot.
During insertion, make sure to keep the cable in a horizontal position to avoid an oblique insertion.
Otherwise, it may cause poor contact or deteriorate reliability of the connector.

7) Peel off the protective film on the TFT monitors during mounting process.
Refer to the section 14.5 on how to peel off the protective film.
We are not responsible for electrostatic discharge failures or other defects occur when peeling off the protective film.

14.3 Precautions for Operation

1) Since this TFT monitors are not equipped with light shielding for the driver IC, do not expose the driver IC to strong lights during operation as it may cause functional failures.

2) When turning off the power, turn off the input signal before or at the same timing of switching off the power.

3) Do not plug in or out the connector while power supply is switch on.
Plug the connector in and out while power supply is switched off.

4) Do not operate the TFT monitors in the strong magnetic field. It may break the TFT monitors.

5) Do not display a fixed image on the screen for a long time.
Use a screen-saver or other measures to avoid a fixed image displayed on the screen for a long time.
Otherwise, it may cause burn-in image on the screen due the characteristics of liquid crystal.

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14.4 Storage Condition for Shipping Cartons

Storage environment
- ・ Temperature   0 to 40°C
- ・ Humidity   60%RH or less
  No-condensing occurs under low temperature with high humidity condition.
- ・ Atmosphere   No poisonous gas that can erode electronic components and/or wiring materials should be detected.
- ・ Time period   3 months
- ・ Unpacking   To prevent damages caused by static electricity, anti-static precautionary measures (e.g. earthing, anti-static mat) should be implemented.

- ・ Maximum piling up   (7) cartons

14.5 Precautions for Peeling off the Protective film

The followings work environment and work method are recommended to prevent the TFT monitors from static damage or adhesion of dust when peeling off the protective films.

A) Work Environment
- a) Humidity: 50 to 70 %RH, Temperature15 to 27°C
- b) Operators should wear conductive shoes, conductive clothes, conductive finger tips and grounded wrist-straps. Anti-static treatment should be implemented to work area's floor.
- c) Use a room shielded against outside dust with sticky floor mat laid at the entrance to eliminate dirt.

B) Work Method

TBD

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APPENDIX

Reference Method for Measuring Optical Characteristics and Performance

1. Measurement Condition

|	
Measuring instruments:	CS1000（KONICA MINOLTA）, LCD7200(OTSUKA ELECTRONICS) ,EZcontrast160D（ELDIM)
Driving condition:	Refer to typical rating of the section "Recommended Operating Conditions".
Measured temperature:	25°C unless specified
Measurement system:	See the chart below. The luminance meter is placed on the normal line of measurement system.
Measurement point:	At the center of the screen unless otherwise specified

Dark box at constant temperature

TFT monitor   Luminance meter

LCD7200: 220mm
CS1000: 362mm
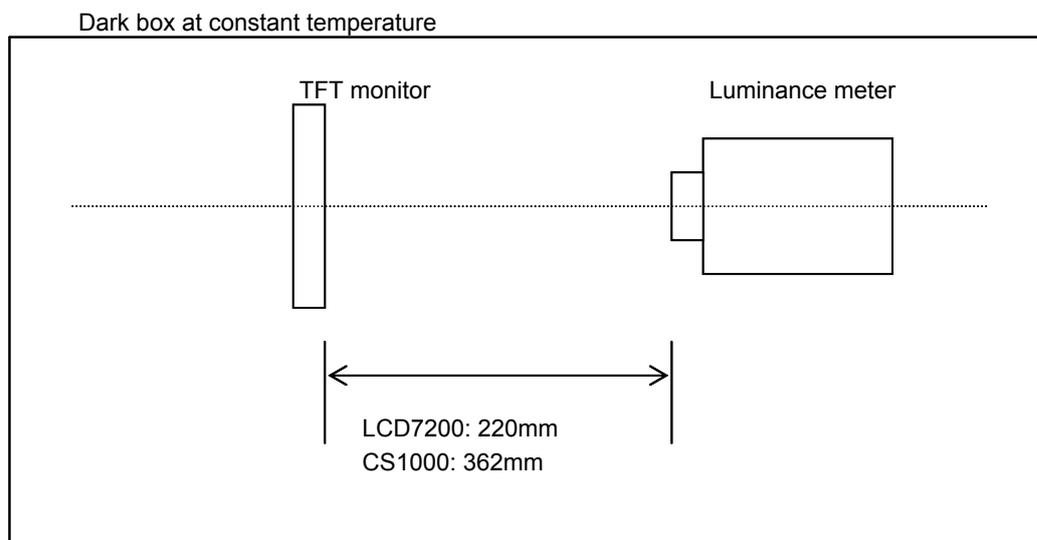
Measurement is made after 30 minutes of lighting of the backlight.

Measurement point: At the center point of the screen
                           Brightness distribution: 9 points shown in the following drawing.

<Landscape model>

1
2
2
1

1   2   2   1
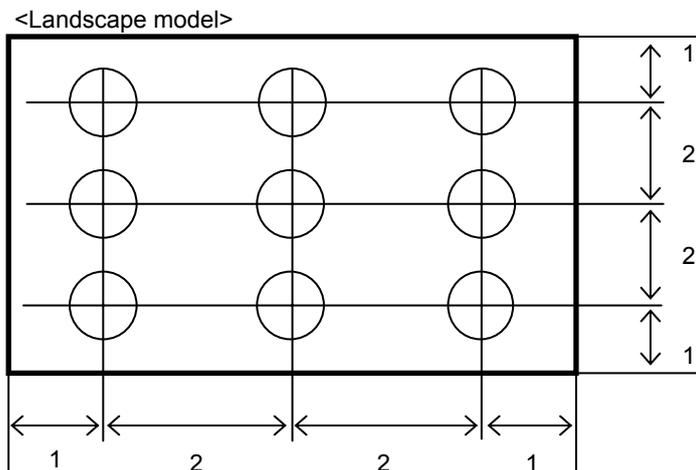
Dimensional ratio of active area

Backlight   IL=25mA

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SPECIFICATIONS № **TLM***	Issue Nov. 19, 2014

2. Test Method

Notice	Item	Test method	Measuring instrument	Remark
1	Response time	Measure output signal waveform by the luminance meter when raster of window pattern is changed from white to black and from black to white. White Black White White 100% 90% 10% 0% Black TON TOFF	LCD7200	Black display [Data]=(00)h White display [Data]=(FF)h TON Rise time TOFF Fall time
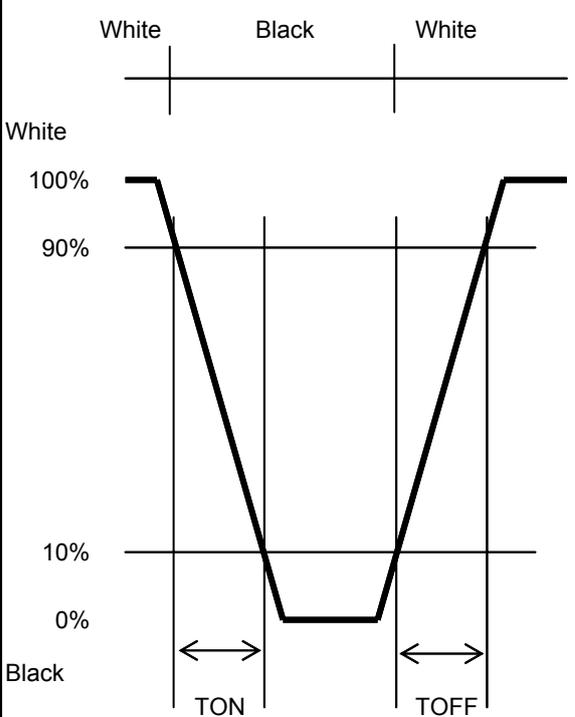
2	Contrast ratio	Measure maximum luminance Y1([Data]=(FF)h) and minimum luminance Y2([Data]=(00)h) at the center of the screen by displaying raster or window pattern. Then calculate the ratio between these two values.
		    Contrast ratio = Y1/Y2
		    Diameter of measuring point: 8mmφ
			CS1000	

3	Viewing angle Horizontalθ Verticalφ	Move the luminance meter from right to left and up and down and determine the angles where contrast ratio is (10).	EZcontrast160D	
4	White chromaticity	Measure chromaticity coordinates x and y of CIE1931 colorimetric system at [Data] = (FF)h Color matching faction: 2°view	CS1000	
5	Burn-in	Visually check burn-in image on the screen after 2 hours of "window display" ([Data]=(FF)h/(00)h).		At optimized VCOMDC
6	Center brightness	Measure the brightness at the center of the screen.	CS1000	
7	Brightness distribution	(Brightness distribution) = 100 x B/A % A : max. brightness of the 9 points B : min. brightness of the 9 points	CS1000	

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