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Datasheet

Distec

DD-070WV8-SL02

DD-01-008

FORTEC ELEKTRONIK AG

DD-070WV8-SL02

PRODUCT SPECIFICATIONS

For Customer:_____

☐ : APPROVAL FOR SPECIFICATION

Customer Model No. _____

☐ : APPROVAL FOR SAMPLE

Module No.: *DD-070WV8-SL02*

Date : 2022-09-15

Table of Contents

For Customer's Acceptance:

Approved By	Comment

PREPARED	CHECKED	VERIFIED BY QA DEPT	VERIFIED BY R&D DEPT
NIKOLA			

2. Revision Record

Date	Rev.No.	Page	Revision Items	Prepared
2022-02-21	**V0**		**The first release**	**NIKOLA**
2022-02-24	**V1**		**Updated the drawing in Item#4.0**	**CJ**
2022-04-25	**V2**		**Updated Item#3**	**CJ**
2022-09-15	**V3**		**Added Item#6.4.4 and 6.6**	**NIKOLA**

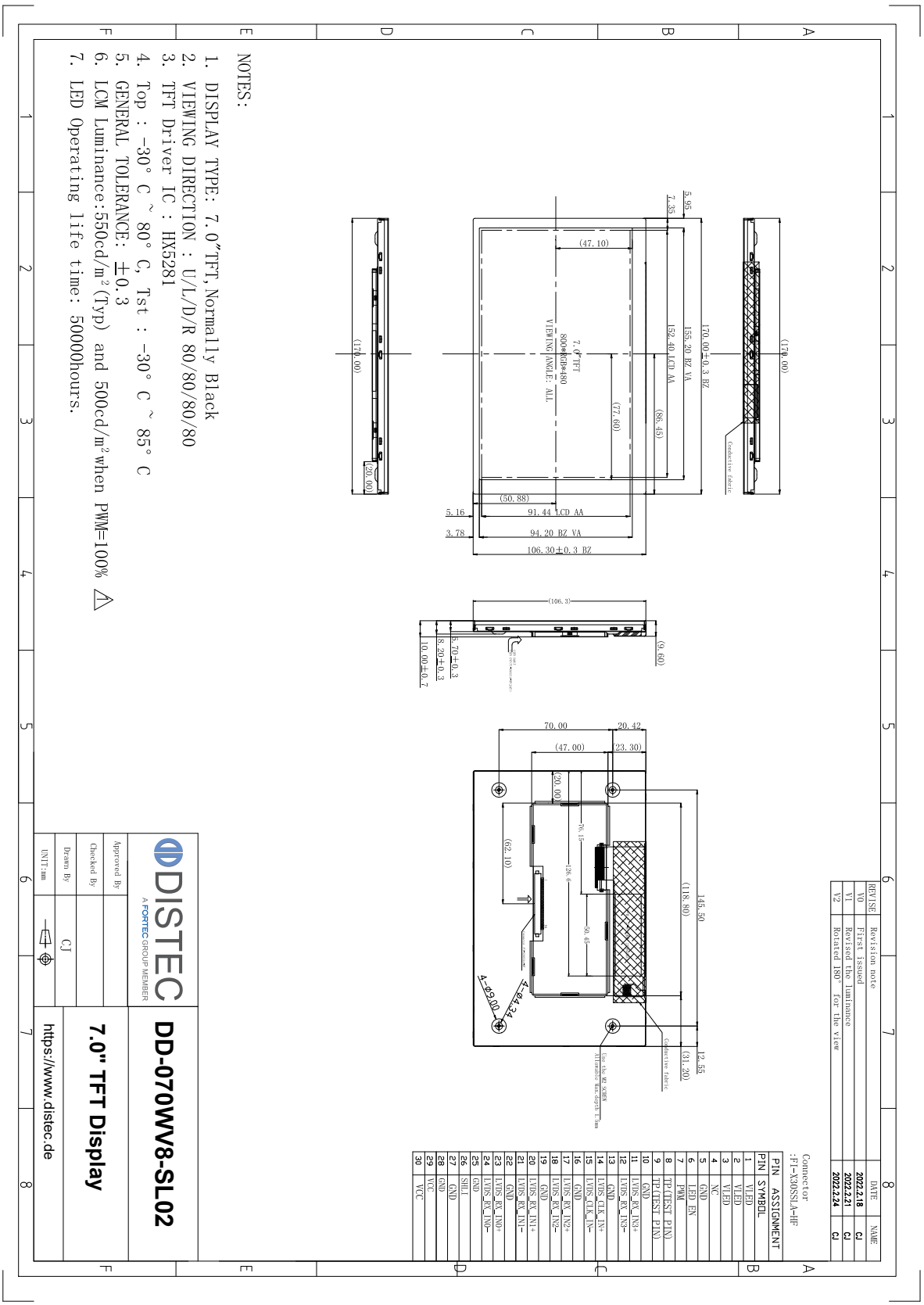
3. General Specifications

DD-070WV8-SL02 is a TFT-LCD module. It is composed of a TFT-LCD panel, driver IC, FPC,TP,a back light unit. The 7.0 ″display area contains 800 x 480 pixels and can display up to 16.7M colors. This product accords with RoHS environmental criterion.

Item	Contents	Unit	Note
LCD Type	TFT	-	
Display color	16.7M		1
Viewing Direction	ALL	O'Clock	
Display Mode	Normally Black	-	
Operating temperature	-30~+80	℃	
Storage temperature	-30~+85	℃	
Active Area(W×H)	152.4X91.44	mm	
Number of Dots	800x480	dots	
Power Supply Voltage	3.3	V	
Outline Dimensions	Refer to outline drawing	-	
Backlight	White LEDs	-	
TFT Driver IC	HX5281		
Weight	180（TYP）	g	
Interface	LVDS Interface	-	
Surface Treatment	Anti-glare treatment of the front polarizer		

Note 1: Color tune is slightly changed by temperature and driving voltage.

4.Outline Drawing



PIN	SYMBOL
1	VLED
2	VLED
3	VLED
4	NC
5	GND
6	LED_EN
7	PWM
8	TP(TEST_PIN)
9	TP(TEST_PIN)
10	GND
11	LVDS_RX_IN3+
12	LVDS_RX_IN3-
13	GND
14	LVDS_CLK_IN+
15	LVDS_CLK_IN-
16	GND
17	LVDS_RX_IN2+
18	LVDS_RX_IN2-
19	GND
20	LVDS_RX_IN1+
21	LVDS_RX_IN1-
22	GND
23	LVDS_RX_IN0+
24	LVDS_RX_IN0-
25	GND
26	SHLI
27	GND
28	GND
29	VCC
30	VCC

REVISE	Revision note	DATE	NAME
V0	First issued	2022.2.18	CJ
V1	Revised the luminance	2022.2.21	CJ
V2	Rotated 180° for the view	2022.2.24	CJ

5. Absolute Maximum Ratings(Ta=25℃)

5.1 Electrical Absolute Maximum Ratings.(Vss=0V ,Ta=25℃)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{CC}	-0.3	4.6	V	1，2

Notes:

1. If the module is above these absolute maximum ratings. It may become permanently damaged. Using the module within the following electrical characteristic conditions are also exceeded, the module will malfunction and cause poor reliability.

2. V_{CC} >V_{SS} must be maintained.

3. Please be sure users are grounded when handing LCD Module.

5.2 Environmental Absolute Maximum Ratings.

Item	Storage		Operating		Note
	MIN.	MAX.	MIN.	MAX.	
Ambient Temperature	-30℃	85℃	-30℃	80℃	1,2
Humidity	-	-	-	-	3

1. The response time will become lower when operated at low temperature.

2. Background color changes slightly depending on ambient temperature.

The phenomenon is reversible.

3. Ta<=40℃:85%RH MAX.

Ta>=40℃:Absolute humidity must be lower than the humidity of 85%RH at 40℃.

6. Electrical Specifications and Instruction Code

6.1 Electrical characteristics(Vss=0V ,Ta=25℃)

Parameter		Symbol	Condition	Min	Typ	Max	Unit	Note
Power supply		VCC	Ta=25℃	2.6	3.3	3.6	V	
Input voltage	'H'	V_{IH}	VCC=3.3V	0.7VCC	-	VCC+0.3	V	
	'L'	V_{IL}	VCC=3.3V	-0.3	-	0.3VCC	V	
Current Consumption		I_{CC}	VCC=3.3V	-	100	-	mA	1

Note 1: Tested in white display pattern.

6.2 LED backlight specification(VSS=0V ,Ta=25℃)

Item		Symbol	Min	Typ	Max	Unit	Note
Supply voltage		VLED	9	12.0	13.2	V	
Supply Current		I_{LED}	-	300	-	mA	(VLED=12V) PWM=100%
Power Consumption		PL	-	3.6	-	W	(VLED=12V) PWM=100%
PWM Control Frequency		F_{PDIM}	100	-	30K	Hz	
Backlight ON-OFF	High	BLEN	1.6	-	VLED	V	
	Low		0	-	0.8	V	
PWM Control Level	High	V_{PDIM}	1.6	-	VLED	V	
	Low		0	-	0.8	V	
Uniformity		∆Bp	75	80	-	%	
Life Time		time	-	50K	-	hours	1

Note1： The life time is determined as the time at which brightness of LED is 50% compare to that of initial value at the typical LED current.

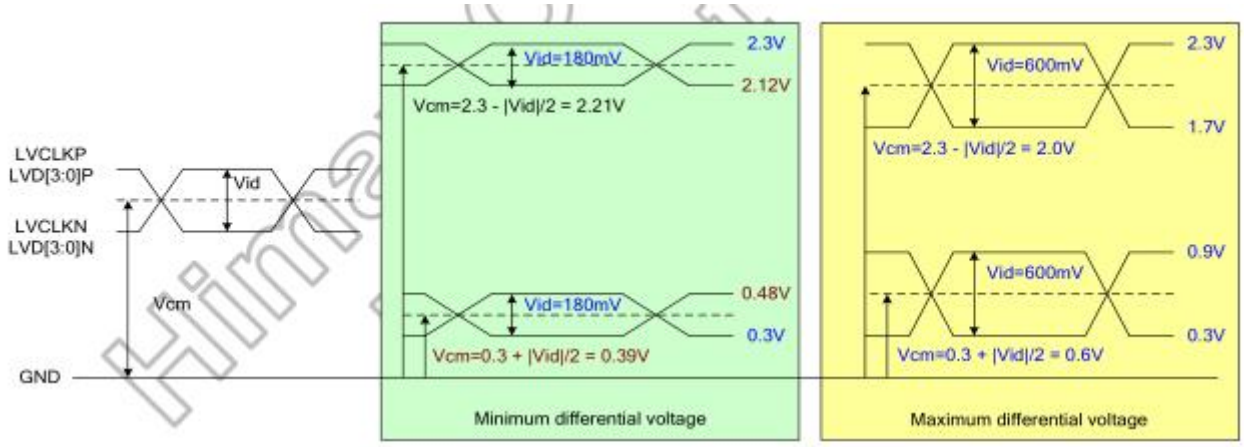
6.3 Interface signals

Pin No.	Symbol	I/O	Function
1~3	VLED	P	LED back light power supply.
4	NC	-	No connection.
5	GND	P	Ground.
6	LED_EN	I	High(3.3V): Backlight On, Low(0V): Backlight Off
7	PWM	I	PWM input for dimming control
8~9	TP(TEST PIN)	-	Test Pin. It should be floating
10	GND	P	Ground.
11	LVDS_RX_IN3+	I	LVDS Positive polarity of voltage differential data signal(Data lane 3).
12	LVDS_RX_IN3-	I	LVDS Negative polarity of voltage differential data signal(Data lane 3).
13	GND	P	Ground.
14	LVDS_CLK_IN+	I	LVDS Positive differential clock signal input.
15	LVDS_CLK_IN-	I	LVDS Negative differential clock signal input.
16	GND	P	Ground.
17	LVDS_RX_IN2+	I	LVDS Positive polarity of voltage differential data signal(Data lane 2).
18	LVDS_RX_IN2-	I	LVDS Negative polarity of voltage differential data signal(Data lane 2).
19	GND	P	Ground.
20	LVDS_RX_IN1+	I	LVDS Positive polarity of voltage differential data signal(Data lane 1).
21	LVDS_RX_IN1-	I	LVDS Negative polarity of voltage differential data signal(Data lane 1).
22	GND	P	Ground.
23	LVDS_RX_IN0+	I	LVDS Positive polarity of voltage differential data signal(Data lane 0).
24	LVDS_RX_IN1-	I	LVDS Negative polarity of voltage differential data signal(Data lane 0).
25	GND	P	Ground.
26	SHLI	I	Reverse scan L/R/U/D (L： Left -> Right and Up -> Down),(H:Reverse)
27~28	GND	P	Ground.
29~30	VCC	P	Power Supply for module 3.3V Typical.

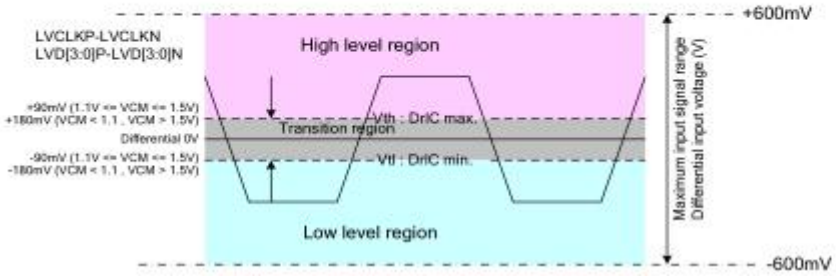
6.4 LVDS SIGNAL CHARACTERISTICS

6.4.1 DC characteristics of LVDS

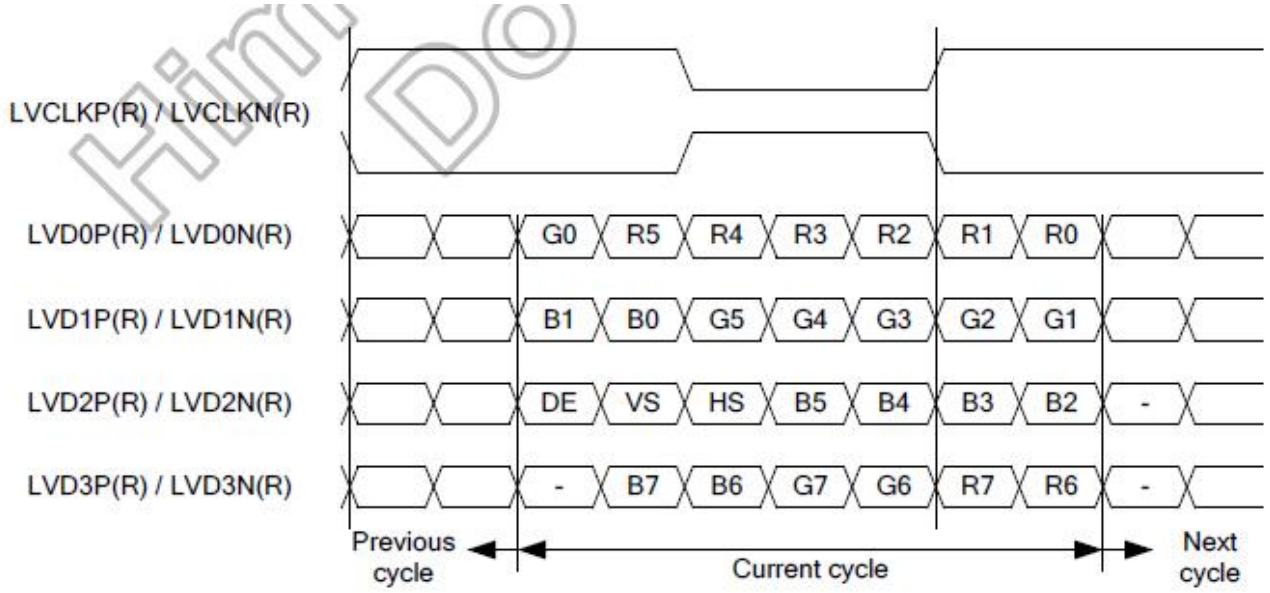
Parameter	Symbol	Condition	Spec. Min.	Spec. Typ.	Spec. Max.	Unit
LVDS input threshold high level voltage	Vth	Vcm<1.0V	-	-	180	mV
		1.0V≦Vcm<1.1V (>75MHz)	-	-	180	
		1.0V≦Vcm<1.1V (≦75MHz)			90	
		1.1V≦Vcm≦1.5V	-	-	90	
		Vcm>1.5V	-	-	180	
LVDS input threshold low level voltage	Vtl	Vcm<1.0V	-180	-	-	mV
		1.0V≦Vcm<1.1V (>75MHz)	-180	-	-	
		1.0V≦Vcm<1.1V (≦75MHz)	-90			
		1.1V≦Vcm≦1.5V	-90	-	-	
		Vcm>1.5V	-180	-	-	
Input differential voltage	Vid	Vcm<1.0V	180	350	600	mV
		1.0V≦Vcm<1.1V (>75MHz)	180	350	600	
		1.0V≦Vcm<1.1V (≦75MHz)	90			
		1.1V≦Vcm≦1.5V	90	350	600	
		Vcm>1.5V	180	350	600	
Common mode voltage of LVDS	Vcm	VDD2=2.6 to 3.6V T_A=-40 to 95°C	0.3 + |Vid|/2		2.3-|Vid|/2	V
Termination resistor	Zid	VDD2=2.6 to 3.6V T_A=-40 to 95°C	90	100	110	Ω



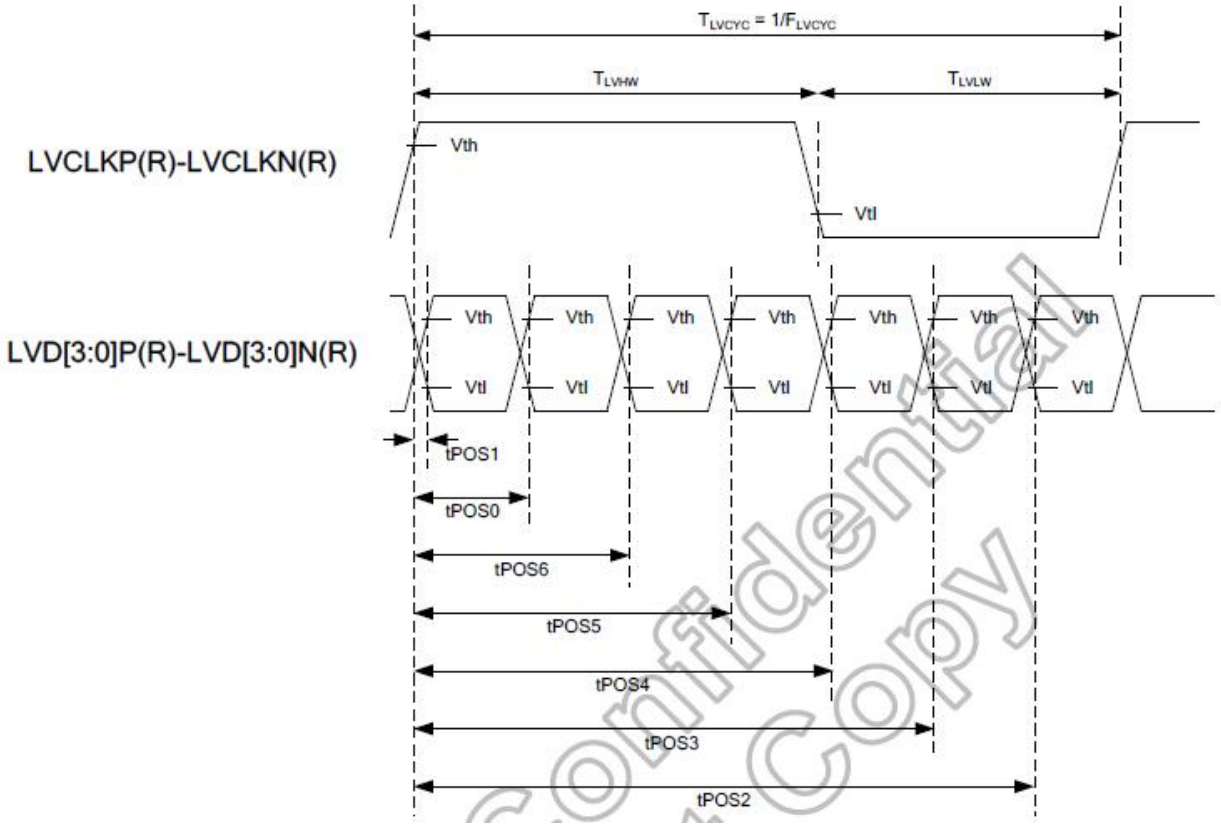
LVDS receiver input signal range



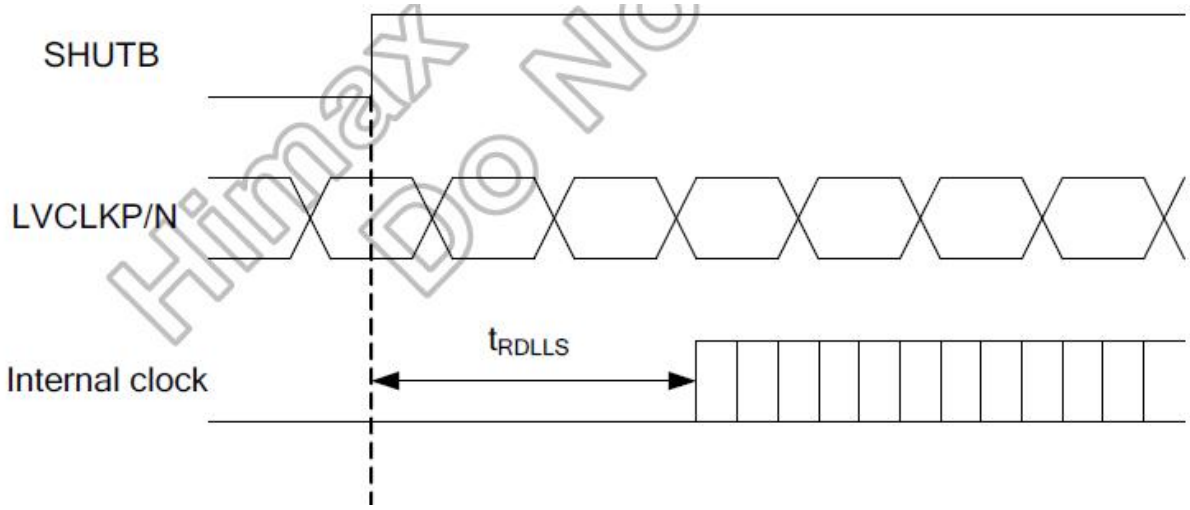
DC characteristics of LVDS



6.4.3 LVDS AC electrical characteristics

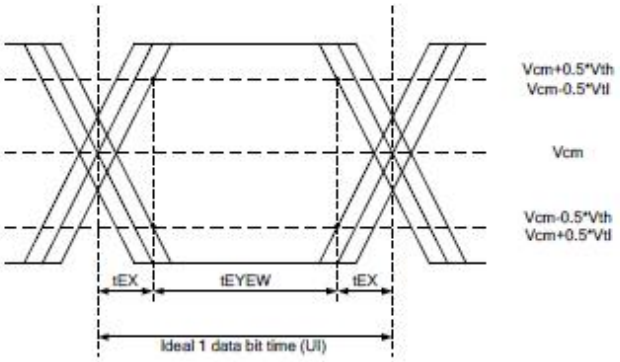


LVDS input timing

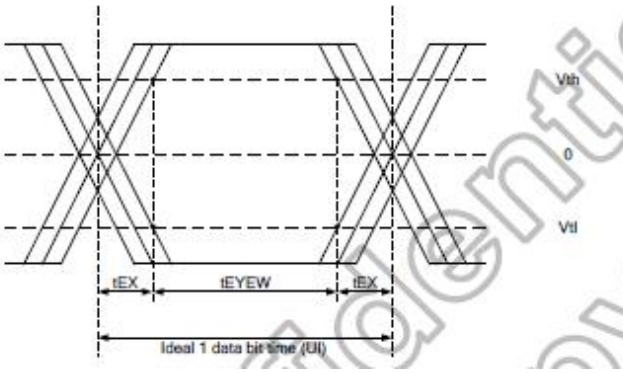


LVDS wake up time

Single-ended:
LVCLKP,
LVCLKN,
LVD[3:0]P,
LVD[3:0]N



Differential:
LVCLKP-LVCLKN
LVD[3:0]P-LVD[3:0]N



LVDS input eye diagram

Input clock/data parameters in LVDS interface

(VDDIO=1.65V to 3.6V, VDD1=2.6V to 3.6V, VDD2=2.6V to 3.6V, GND=0V, T_A=-40 to +95°C)

Parameter	Symbol	Spec.			Unit
		Min.	Typ.	Max.	
LVDS wake up time	tRDLLS	-	-	150	μs
LVDS clock cycle time	tLVCYC	11.8	-	100	ns
LVDS clock high width	tLVHW	0.35 * tLVCYC	-	-	ns
LVDS clock low width	tLVLW	0.35 * tLVCYC	-	-	ns
tPOS1 position	tPOS1	- tSKM	0	+tSKM	ns
tPOS0 position	tPOS0	(1/7) x tLVCYC - tSKM	(1/7) x tLVCYC	(1/7) x tLVCYC+tSKM	ns
tPOS6 position	tPOS6	(2/7) x tLVCYC - tSKM	(2/7) x tLVCYC	(2/7) x tLVCYC+tSKM	ns
tPOS5 position	tPOS5	(3/7) x tLVCYC - tSKM	(3/7) x tLVCYC	(3/7) x tLVCYC+tSKM	ns
tPOS4 position	tPOS4	(4/7) x tLVCYC - tSKM	(4/7) x tLVCYC	(4/7) x tLVCYC+tSKM	ns
tPOS3 position	tPOS3	(5/7) x tLVCYC - tSKM	(5/7) x tLVCYC	(5/7) x tLVCYC+tSKM	ns
tPOS2 position	tPOS2	(6/7) x tLVCYC - tSKM	(6/7) x tLVCYC	(6/7) x tLVCYC+tSKM	ns
Skew margin	tSKM	-	-	400(1)	ps
		-	-	550(2)	ps
		-	-	650(3)	ps
Eye border	tEX	-	-	0.2	UI
Eye width	tEYEW	0.6	-	-	UI

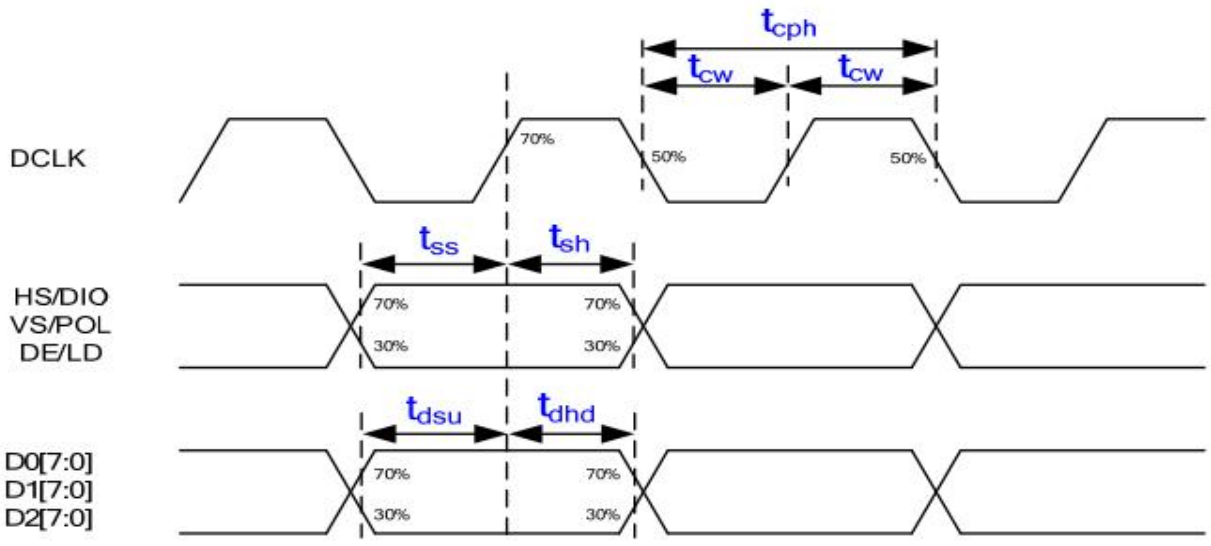
Note: (1) 85MHz.
(2) 60MHz.
(3) 40MHz.

Input clock/data parameters in LVDS interface

6.4.4 TIMING CHARACTERISTICS

Parameter	Symbol	Min	Typ	Max	Unit	Remark
DCLK frequency	Fck	23.7	25	35.4	MHz	
Horizontal back porch	thbp	8	14	255	Tcph	
Horizontal display area	thd	-	800	-	Tcph	
Horizontal front porch	thfp	8	26	260	Tcph	
Horizontal period	th	817	852	-	Tcph	
Horizontal pulse width	thpw	1	12	Thbp-1	Tcph	
Vertical back porch	tvbp	2	4	255	th	
Vertical display area	tvd	-	480	-	th	

Vertical front porch	tvfp	5	8	260	th	
Vertical period	tv	488	495	-	th	
Vertical pulse width	tvpw	1	3	Tvbp-1	th	
Frame Rate	F	-	60	-	Hz	



Parameter	Symbol	Spec.			Unit
		Min.	Typ.	Max.	
DCLK period	T_{cph}	16.67	-	-	ns
DCLK duty ratio	T_{CW}	40	50	60	%
Data setup time	T_{dsu}	5	-	-	ns
Data hold time	T_{dhd}	5	-	-	ns
VS/POL setup time	T_{ss}	5	-	-	ns
VS/POL hold time	T_{sh}	5	-	-	ns
HS/DIO setup time	T_{ss}	5	-	-	ns
HS/DIO hold time	T_{sh}	5	-	-	ns
DE/LD setup time	T_{ss}	5	-	-	ns
DE/LD hold time	T_{sh}	5	-	-	ns

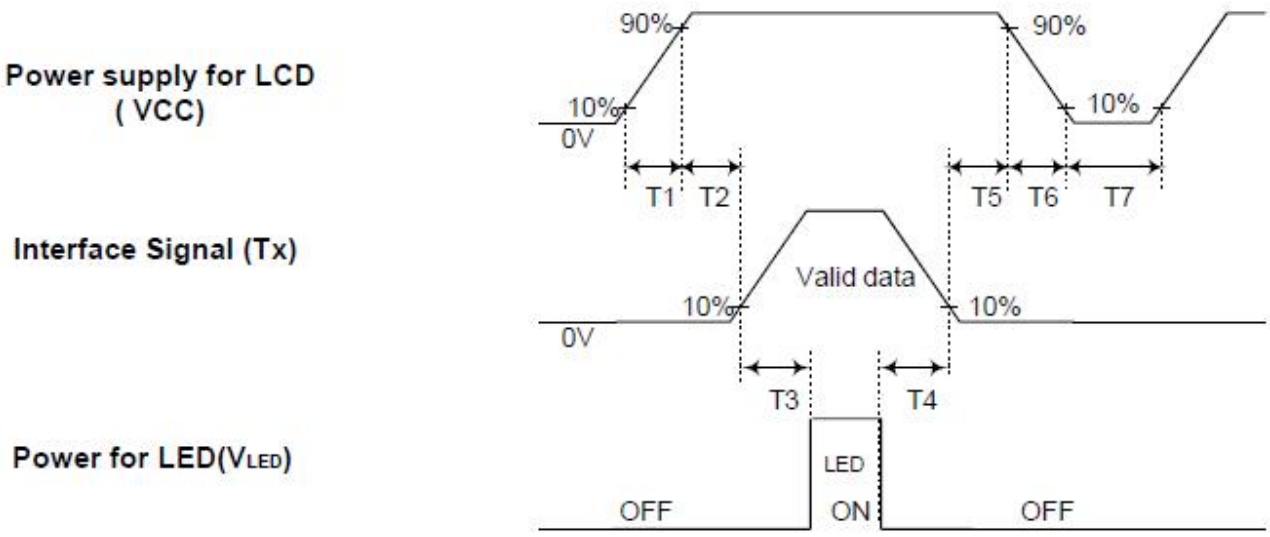
6.5 Color Data Reference

Relationship Between Displayed Color and Input

	Display	MSB R7	R6	R5	R4	R3	R2	R1	LSB R0	MSB G7	G6	G5	G4	G3	G2	G1	LSB G0	MSB B7	B6	B5	B4	B3	B2	B1	LSB B0	Gray scale Level
Basic color	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-
	Blue	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	-
	Green	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	-
	Light Blue	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	-
	Red	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	-
	Purple	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	-
	Yellow	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	-
	White	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	-
Gray scale of Red	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L1
	↑	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L2
	↑	:								:								:								L3…L251
	↓	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L252
	Light	H	H	H	H	H	H	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L253
		H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L254
	Red	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	Red L255
Gray scale of Green	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L1
	↑	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L2
	↑	:								:								:								L3…L251
	↓	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L252
	Light	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	H	L	L	L	L	L	L	L	L	L253
		L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L254
	Green	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	Green L255
Gray scale of Blue	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L1
	↑	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L2
	↑	:								:								:								L3…L251
	↓	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	L	L252
	Light	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	H	L253
		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	L	L254
	Blue	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	Blue L255
Gray scale of White & Black	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L0
	Dark	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L1
	↑	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	H	L	L2
	↑	:								:								:								L3…L251
	↓	H	H	H	H	H	H	L	L	H	H	H	H	H	H	L	L	H	H	H	H	H	H	L	L	L252
	Light	H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	H	L253
		H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	L	L254
	White	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	White L255

6.6 Power on / off sequence

For LCD's normal operation, it is recommended to keep below power supply sequence.



Parameter	Value			Units
	Min.	Typ.	Max.	
T_1	-	-	10	(ms)
T_2	50	-	-	(ms)
T_3	200	-	-	(ms)
T_4	200	-	-	(ms)
T_5	0	-	50	(ms)
T_6	-	-	10	(ms)
T_7	500	-	-	(ms)

Note)
1. Please avoid floating state of interface signal at invalid period.
2. When the interface signal is invalid, be sure to pull down the power supply for LCD VCC to 0V.
3. Lamp power must be turn on after power supply for LCD and interface signal are valid.

7. Optical Characteristics

Item	Symbol		Condition	Min.	Typ.	Max.	Unit	Note
Brightness	Bp		θ=0° Φ=0°	500	550	-	Cd/m^2	1
Uniformity	⊿Bp			75	80	-	%	1,2
Viewing Angle	3:00		Cr≥10	-	80	-	Deg	6
	6:00			-	80	-		
	9:00			-	80	-		
	12:00			-	80	-		
Contrast Ratio	Cr		θ=0° Φ=0°	800	-	-	-	4
Response Time	$T_{r+}T_f$			-	-	30	ms ms	5
Color of CIE Coordinate	W	x	θ=0° Φ=0°	TYP-0.05	0.308	TYP+0.05	-	7
		y			0.325		-	
	R	x			0.649		-	
		y			0.332		-	
	G	x			0.317		-	
		y			0.611		-	
	B	x			0.151		-	
		y			0.063		-	
NTSC Ratio	S			-	70	-	%	

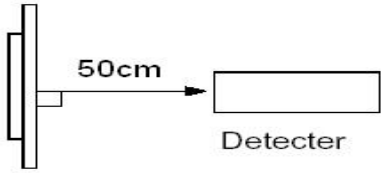
Note：The parameter is slightly changed by temperature, driving voltage and materiel

Note 1: The data are measured after LEDs are turned on for 5 minutes. LCM displays full white. The brightness is the average value of 9 measured spots. Measurement equipment PR-705 (Φ8mm)

Measuring condition:

- *Measuring surroundings: Dark room.*
- *Measuring temperature: Ta=25 ℃.*
- *Adjust operating voltage to get optimum contrast at the center of the display.*

Measured value at the center point of LCD panel after more than 5 minutes while backlight turning on.

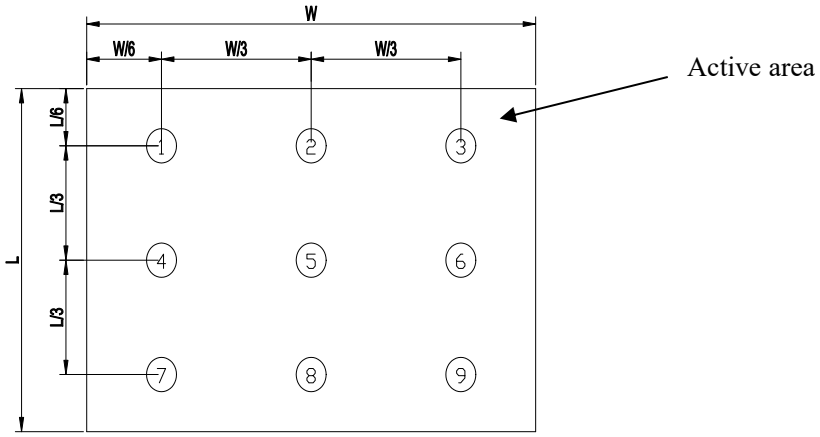


Note 2: The luminance uniformity is calculated by using following formula.

⊿Bp = Bp (Min.) / Bp (Max.)×100 (%)

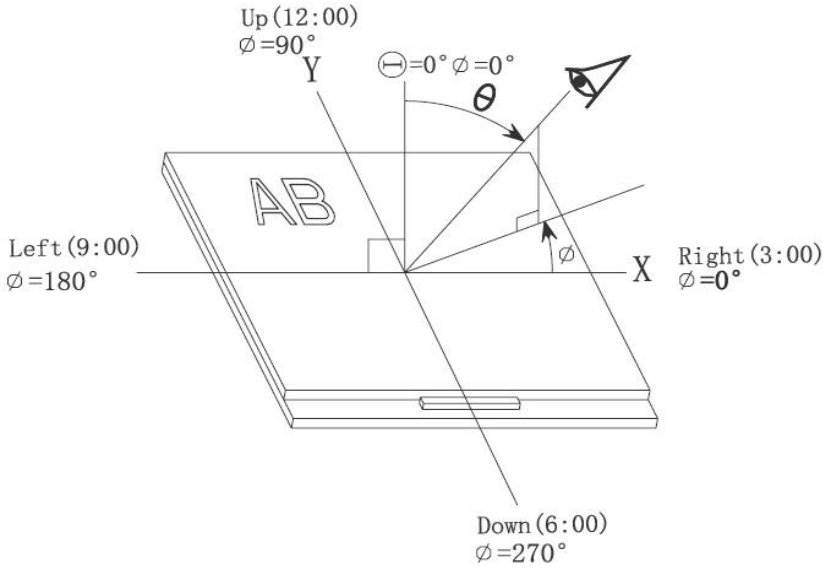
Bp (Max.) = Maximum brightness in 9 measured spots

Bp (Min.) = Minimum brightness in 9 measured spots.

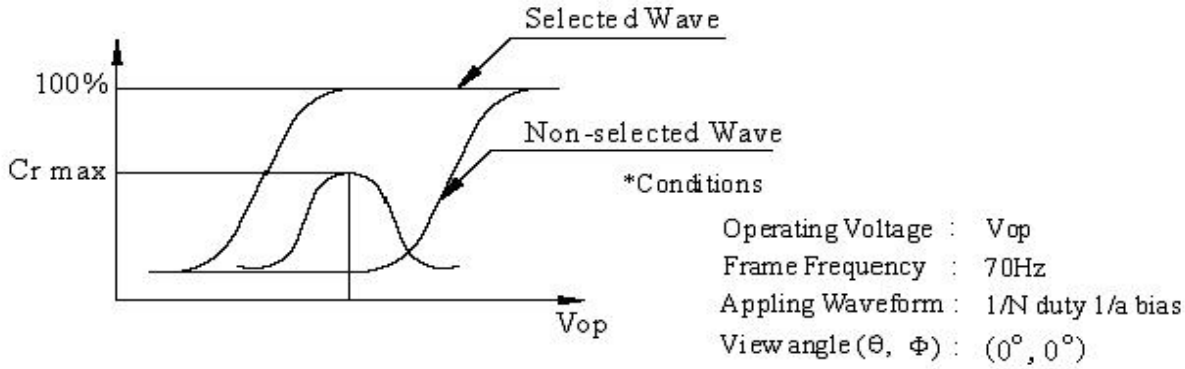


Note 3: The definition of viewing angle:

Refer to the graph below marked by ϑ and Φ



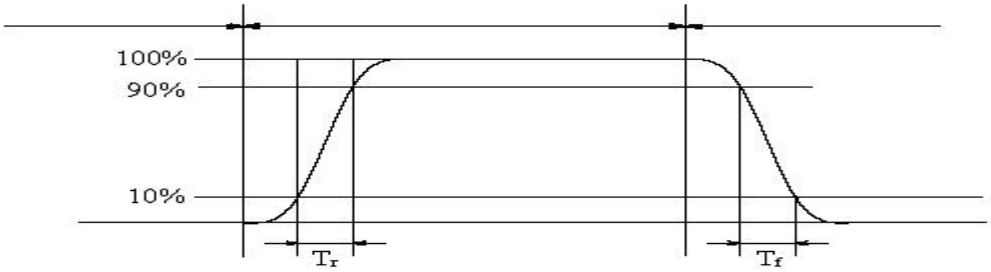
Note 4: Definition of contrast ratio.(Test LCD using DMS501)



$$Contrast\ ratio(Cr) = \frac{Brightness\ of\ selected\ dots}{Brightness\ of\ non-selected\ dots}$$

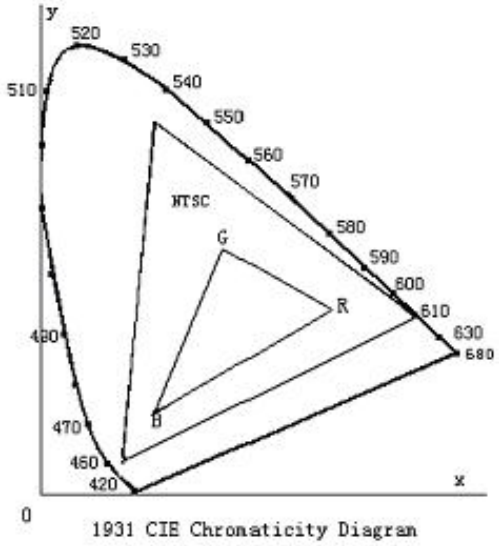
Note 5: Definition of Response time. (Test LCD using DMS501):

The output signals of photo detector are measured when the input signals are changed from "black" to "white"(falling time) and from "white" to "black"(rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes.Refer to figure as below.



The definition of response time

Note 6: Definition of Color of CIE Coordinate and NTSC Ratio.

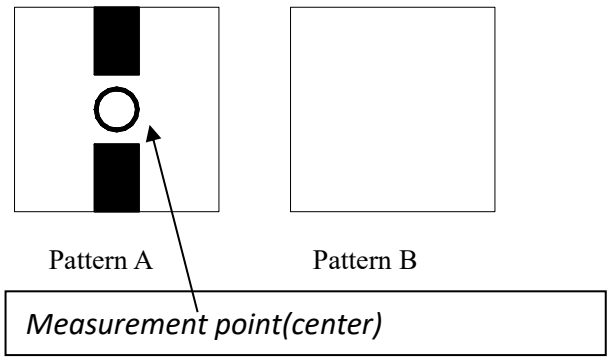


Color gamut:

$$\mathbf{S = \frac{area\ of\ RGB\ triangle}{area\ of\ NTSC\ triangle} \times 100\%}$$

Note 7: Definition of cross talk.

*Cross talk ratio(%)=|pattern A Brightness-pattern B Brightness|/pattern A Brightness*100*



Electric volume value=3F+/-3Hex

8. Reliability Test Items and Criteria

No	Test Item	Test condition	Criterion
1	High Temperature Storage	85℃ 240H Restore 2H at 25℃ Power off``	1. After testing, cosmetic and electrical defects should not happen. 2. Total current consumption should not be more than twice of initial value.
2	Low Temperature Storage	-30℃ 240H Restore 2H at 25℃ Power off	
3	High Temperature Operation	80℃ 240H Restore 2H at 25℃ Power on	
4	Low Temperature Operation	-30℃ 240H Restore 4H at 25℃ Power on	
5	High Temperature/Humidity Operation	60℃±2℃ 90%RH 240H Power on	
6	Temperature Cycle	--30℃←----------→85℃ 30min 5min 30min after 5 cycle, Restore 2H at 25℃ Power off	
7	Vibration Test	10Hz~150Hz, 100m/s2, 120min	Not allowed cosmetic and electrical defects.
8	Shock Test	Half- sine wave,300m/s2,11ms	

9. *Precautions for Use of LCD Modules*

9.1 Handling Precautions

9.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

9.1.2 If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.

9.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

9.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

9.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:

— Isopropyl alcohol — Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

— Water — Ketone — Aromatic solvents

9.1.6 Do not attempt to disassemble the LCD Module.

9.1.7 If the logic circuit power is off, do not apply the input signals.

9.1.8 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

a. Be sure to ground the body when handling the LCD Modules.

b. Tools required for assembly, such as soldering irons, must be properly ground.

c. To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.

d. The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

9.2 Storage precautions

9.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

9.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

Temperature : 0℃ ～ 40℃

Relatively humidity: ≤80%

9.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

9.3 ***The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.***

END

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