



ENH104V2-380/450/600 Color TFT-LCD Module Features GENERAL DESCRIPTION

WEDC provides optically enhanced solutions to the standard Optrex AA104VB05 color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module. The first enhancement is an index matching (IM) film lamination to the front surface of the display polarizer. The IM film is a contrast enhancement benefit and is available in two surface treatments - IM/Clear and IM/110 (a 10% diffusion). The second enhancement is the incorporation of reflective polarizer (RP) to improve brightness by up to 40%. The third enhancement is the incorporation of an enhanced light guide (ELG) to improve brightness by up to 35%. The resultant brightness level are shown in the Specifications below.

This module is composed of a color LCD panel, driver ICs, control circuit, and a backlight unit.

By applying 6 bit digital data 640 x 480, 260K-color images are displayed on the 10.4" diagonal screen.

Input power voltage is single 3.3V/5V for LCD driving. Both 3.3V-CMOS and 5.0V-CMOS level voltage are acceptable for logic input voltage.

Inverter for backlight is not included in this module. General specifications are summarized in the following table:

SPECIFICATIONS

ITEM	SPECIFICATION
Display Area (mm)	211.2 (H) x 158.4 (V) (10.39-inch diagonal)
Number of Dots	640 x 3 (H) x 480 (V)
Pixel Pitch (mm)	0.33 (H) x 0.33 (V)
Color Pixel Arrangement	RGB vertical stripe
Display Mode	normally white
Number of Color	260K
Wide Viewing Angle Technology	Optical compensation film
Optimum Viewing Angle (Contrast ratio)	12 o'clock
Brightness (cd/m ²)	
ENH104V2-380 (IM only)	380
ENH104V2-450 (IM, RP)	450
ENH104V2-600 (IM, RP, ELG)	600
Module Size (mm)	243.0 (W) x 181.6 (H) x 12.2 (D)
Module Mass (g)	530
Backlight Unit	CCFL, 2-tubes, replacements
Surface Treatment	IM/Clear (glossy) or IM/110 and hardcoat 3H

Characteristic value without any note is typical value.

The LCD product described in this specification is designed and manufactured for the standard use in office automation equipment, instrumentation, communication equipment, automation, point of sale, etc.

WEDC assumes no responsibility for any damage resulting from the use of the device which does not comply with the instructions and the precautions specified in these specifications sheets. WEDC does assume the responsibility for the warranty of the enhanced product.

ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN	MAX	Unit
Power Supply Voltage for LCD	V _{CC}	-0.3	6.5	V
Logic Input Voltage	V _I	0	6.5	V
Lamp Voltage	V _L	0	2000	V _{RMS}
Lamp Current	I _L	0	10.0	mA _{RMS}
Lamp Frequency	F _L	-	80	kHz
Operating temperature (1)	T _{OP}	0	50	°C
Storage Temperature (1)	T _{STG}	-20	60	°C

Notes:

1. t_{OP}, t_{STG} < 40°C: 90%RH max. without condensation
2. t_{OP}, t_{STG} < 40°C: Absolute humidity shall be less than the value of 90%RH at 40°C without condensation.



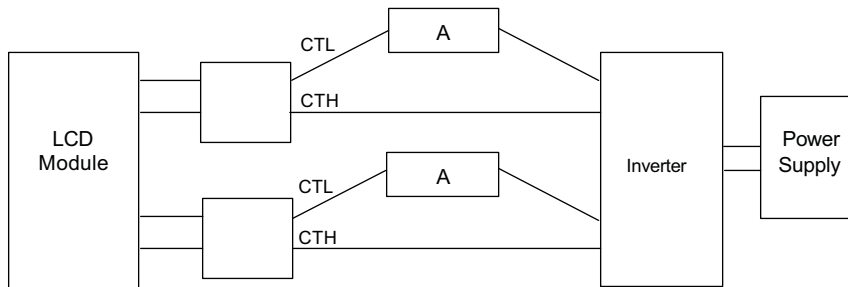
ELECTRICAL CHARACTERISTICS

TFT-LCD PANEL DRIVING, $t_A=25^\circ\text{C}$

ITEM		SYMBOL	MIN	TYP	MAX	UNIT	REMARK
Power Supply Voltage for LCD	3.3 V powered	V _{CC}	3.0	3.3	3.6	V	(A), (D)
	5.0 V powered	V _{CC}	4.75	5.0	5.25	V	(A), (D)
Power Supply Current for LCD	3.3 V powered	I _{CC}	-	220	380	mA	V _{CC} = 3.3V (B)
	5.0 V powered	I _{CC}	-	150	280	mA	V _{CC} = 5.0V (B)
Permissive Input Ripple Voltage		V _{RP}	-	-	100	mVp-p	V _{CC} = -3.3V/5.0V (B)
Logic Input Voltage	High	V _{IH}	2.0	-	5.25	V	
	Low	V _{IL}	0	-	0.8	V	

BACKLIGHT $t_A=25^\circ\text{C}$

ITEM	SYMBOL	MIN	TYP	MAX	UNIT	REMARK
Lamp Voltage	V_L	-	580	-	Vrms	$I_L=6.0\text{mA}$ rms
Lamp Current	I_L	3.0	6.0	7.0	mA rms	(1)
Lamp frequency	F_L	40	-	80	kHz	(2)
Starting Lamp Voltage	V_s	810	-	-	Vrms	
	$t_A=0^\circ\text{C}$	1000	-	-	Vrms	
Lamp Life Time	$I_L=3.0\text{mA}$ rms	L_T	50000	50000	hour	(3), (4)
	$I_L=6.0\text{mA}$ rms		40000	50000	hour	
	$I_L=7.0\text{mA}$ rms		30000	40000	hour	



Notes:

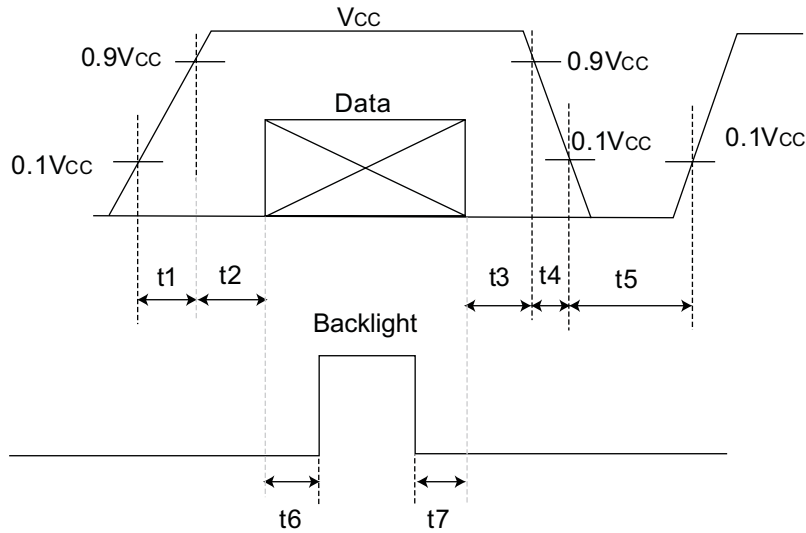
- Lamp current measurement method (The current meter is inserted in low voltage line.)
- Lamp frequency of inverter may produce interference with horizontal synchronous frequency, and this may cause horizontal beat on the display. Therefore, please adjust lamp frequency, and keep inverter as far from module as possible or use electronic shielding between inverter and module to avoid the interference.
- Lamp life time is defined as the time either when the brightness becomes 50% of the initial value, or when the starting lamp voltage does not meet the value specified in this table.
- The life time of the backlight depends on the ambient temperature. The life time will decrease under low/high temperature.



Notes:

1. Power and signals sequence:

$t1 \leq 10\text{ms}$	$400\text{ms} \leq t5$
$0 < t2 \leq 50\text{ms}$	$200\text{ms} \leq t6$
$0 < t3 \leq 50\text{ms}$	$0 \leq t7$
$0 < t4 \leq 50\text{ms}$	

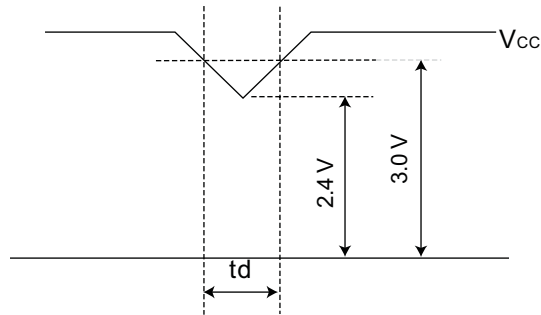


Data: RGB DATA, DCLK, HD, VD, DENA

V_{CC} -dip conditions

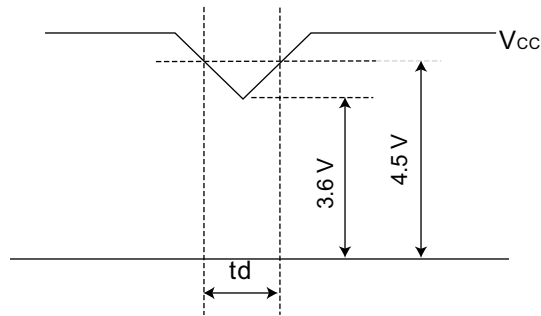
- A. 3.3V powered
 1. When $2.4\text{V} \leq V_{CC} < 3.0\text{V}$, $t_d \leq 10\text{ms}$
 2. When $V_{CC} \leq 2.4\text{V}$

V_{CC} -dip conditions should also follow the power and signals sequence.



- B. 5.0V powered
 1. When $3.6\text{V} \leq V_{CC} < 4.5\text{V}$, $t_d \leq 10\text{ms}$
 2. When $V_{CC} \leq 3.6\text{V}$

V_{CC} -dip conditions should also follow the power and signals sequence.



- B. Typical current conditions:
 - 64-gray-bar-pattern
 - 480 line mode
 - $V_{CC} = +3.3/5.0\text{V}$, $f_H = 31.6\text{kHz}$, $f_V = 60\text{Hz}$, $f_{CK} = 25\text{MHz}$



INTERPACE PIN CONNECTIONS

CN1 (Interface Signal)

Used Connector: DF9B-31P-1V (Hirose)/Corresponding connector: DF9B-31S-1V(Hirose)

Pin No.	Symbol	Function
1	GND	-
2	DCK	Clock signal for sampling each data signal
3	HD	Horizontal synchronous signal
4	VD	Vertical synchronous signal
5	GND	-
6	R0	RED data signal (LSB)
7	R1	RED data signal
8	R2	RED data signal
9	R3	RED data signal
10	R4	RED data signal
11	R5	RED data signal (MSB)
12	GND	-
13	G0	GREEN data signal (LSB)
14	G1	GREEN data signal
15	G2	GREEN data signal
16	G3	GREEN data signal
17	G4	GREEN data signal
18	G5	GREEN data signal (MSB)
19	GND	-
20	B0	BLUE data signal (LSB)
21	B1	BLUE data signal
22	B2	BLUE data signal
23	B3	BLUE data signal
24	B4	BLUE data signal
25	B5	BLUE data signal (MSB)
26	GND	-
27	DENA	Data enable signal(to settle the viewing area)
28	V _{cc}	+3.3/5.0V power supply
29	V _{cc}	+3.3/5.0V power supply
30	TEST	This pin should be open. Test signal output for only internal test use.
31	SC	Scan direction Control. (GND or Open: Normal, High: Reverse)

Note:

1. The shielding case is connected with GND.
2. See; Timing Chart (p. 7)

CN2, CN3 (Backlight)

Backlight-side connector: BHR-02(8.0)VS-1N(JST) Inverter-Side Connector: SM02(8.0)B-BHS(JST)

Pin No.	Symbol	Function
1	CTH	VBLH High Voltage
3	CTL	VBLL Low Voltage

Note:

VBLH-VBLL-VL



INTERFACE TIMING

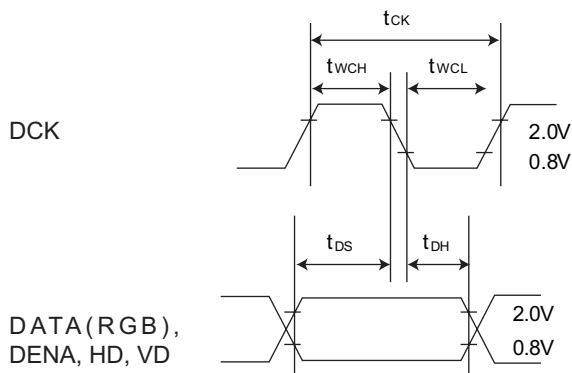
TIMING SPECIFICATIONS

	ITEM	SYMBOL	MIN	TYP	MAX	UNIT
DCK (1)(4)	Frequency	f_{CK}	-	25	29	MHz
	Period	t_{CK}	34.5	40	-	ns
	High Width	t_{WCL}	12	-	-	ns
	Low Width	t_{WCH}	12	-	-	ns
DATA (1) (R,G,B, DENA HD, VD)	Set up time	t_{DS}	5	-	-	ns
	Hold time	t_{DH}	5	-	-	ns
DENA (3)	Horizontal Active Time	t_{HA}	640	640	640	t_{CK}
	Horizontal Front Porch	t_{HFP}	10	16	-	t_{CK}
	Horizontal Back Porch	t_{HBP}	2	144	-	t_{CK}
	Vertical Active Time	t_{VA}	480	480	480	t_H
	Vertical Front Porch	t_{VFP}	1	12	-	t_H
	Vertical Back Porch	t_{VBP}	2	33	-	t_H
HD (2)(4)	Frequency	f_H	27	31.6	38	kHz
	Period	t_H	26.3	31.6	37.0	μs
	Low Width	t_{WHL}	5	96	-	t_{CK}
	Frequency	f_V	55	60	70	Hz
VD (2)	Period	t_V	14.3	16.7	18.2	ms
	Low Width	t_{WVL}	3	-	-	t_H

Notes:

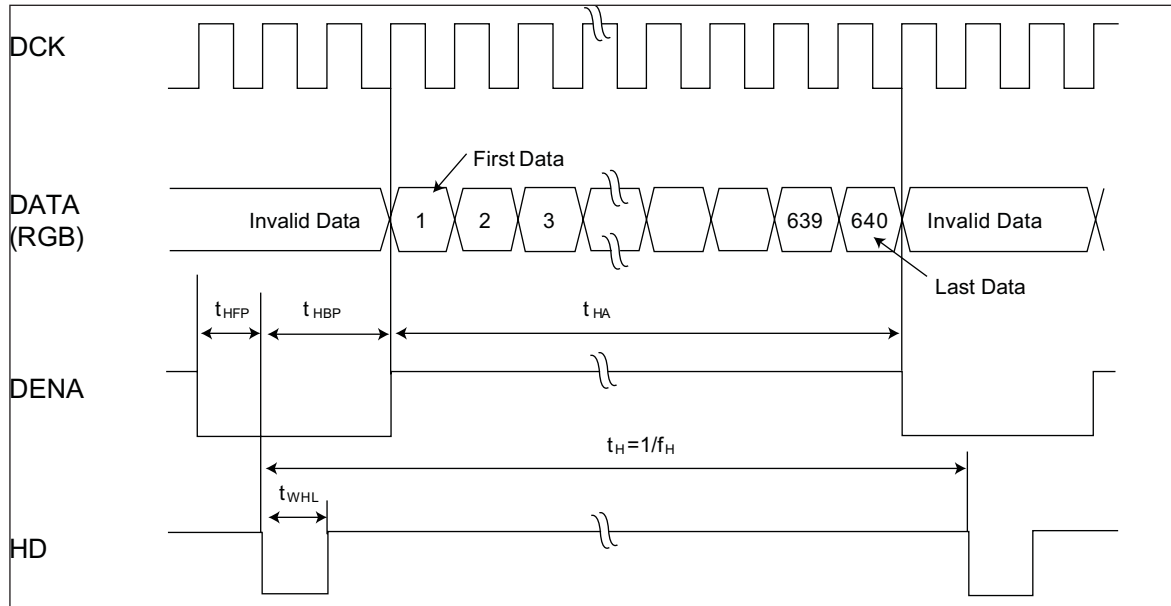
1. DATA is latched at fall edge of DCK in this specification.
2. Polarities of HD and VD are negative in the specification.
3. DENA (Data Enable) should always be positive polarity as shown in the timing specification.
4. DCK should appear during all invalid period, and HD should appear during invalid period of frame cycle.

PIXEL TIMING CHART

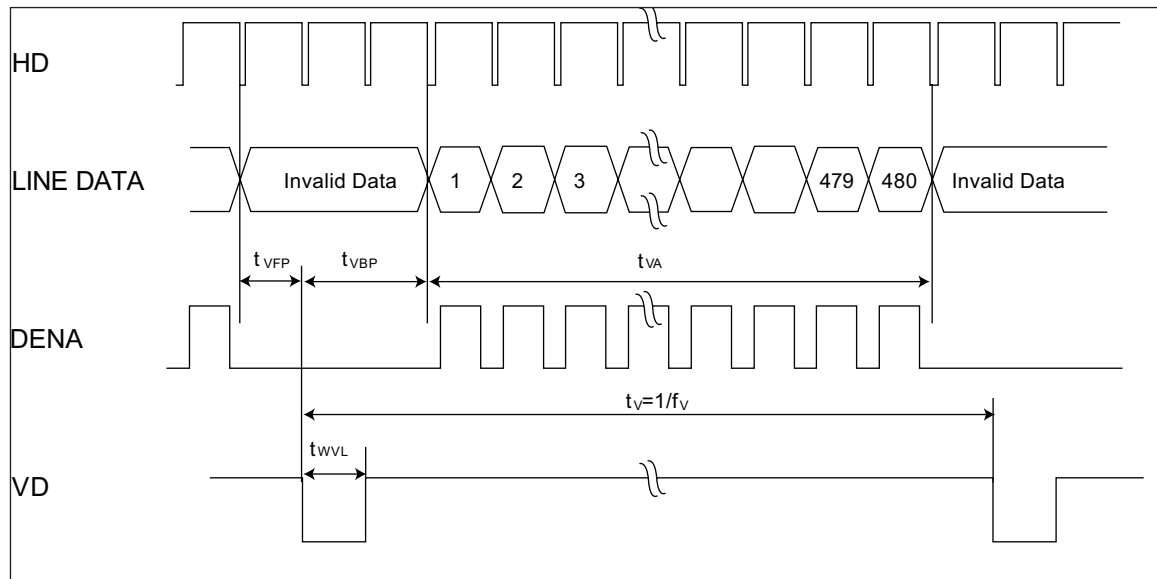




HORIZONTAL TIMING CHART



VERTICAL TIMING CHART





COLOR DATA ASSIGNMENT

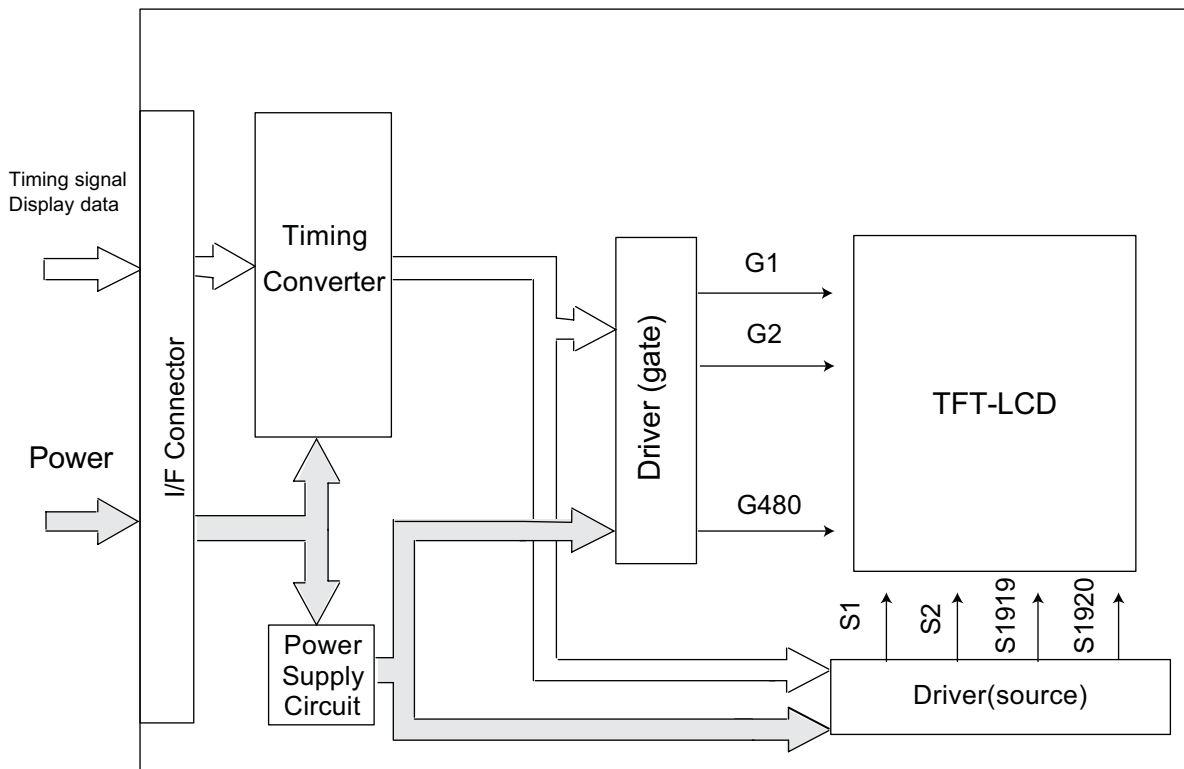
COLOR	INPUT DATA	R DATA						G DATA						B DATA					
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
		MSB					LSB	MSB					LSB	MSB					LSB
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	BLUE (63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	CYAN	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	MAGENTA	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN ()	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN ()	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN ()	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
	GREEN ()	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0
	GREEN ()	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
BLUE	BLUE ()	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	0	1
	BLUE ()	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	BLUE ()	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE ()	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1

Notes:

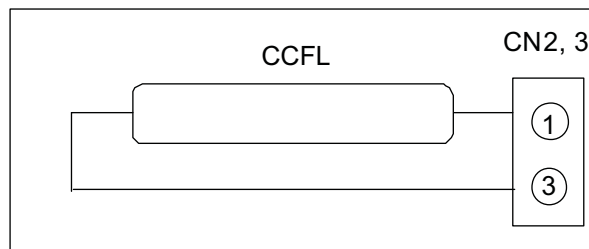
- Definition of gray scale
Color (n) ...n indicates gray scale level. Higher n means brighter level.
- Data 1:High, 0:Low



BLOCK DIAGRAM

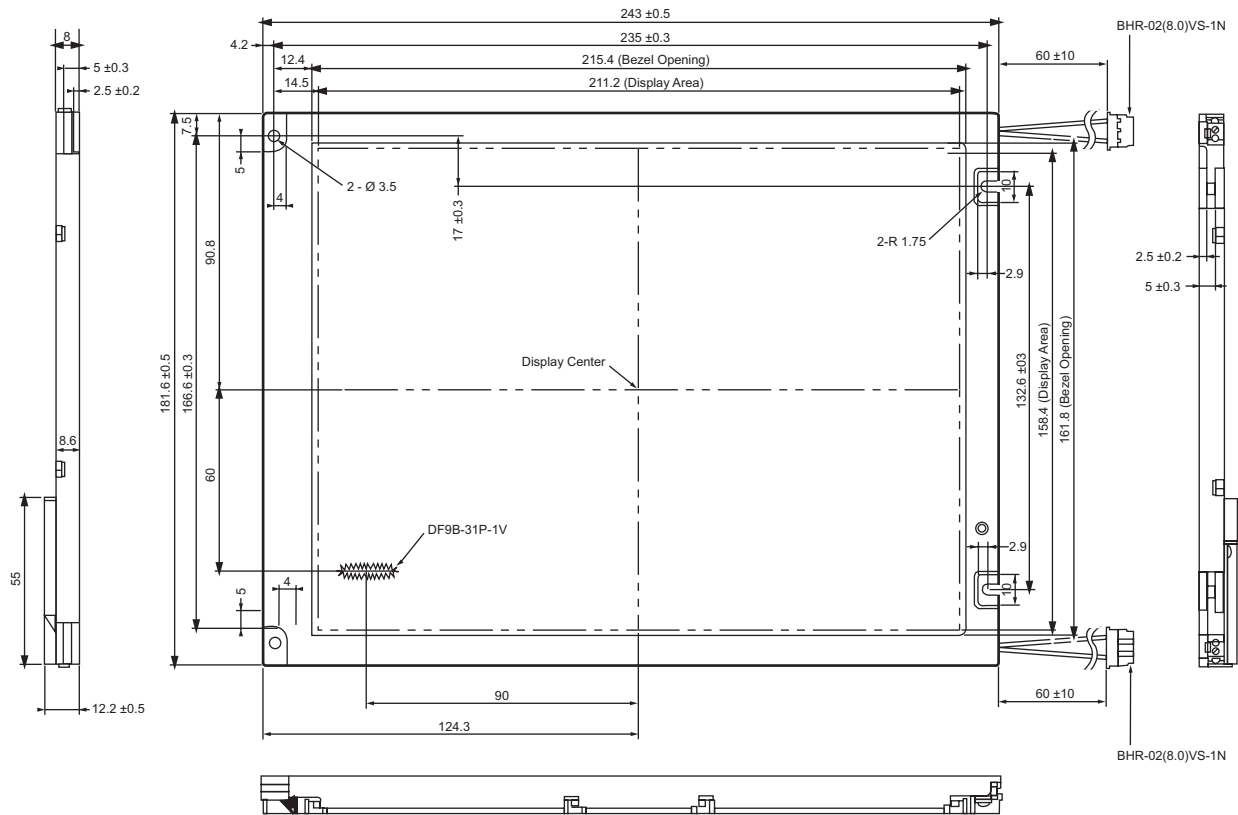


BACKLIGHT

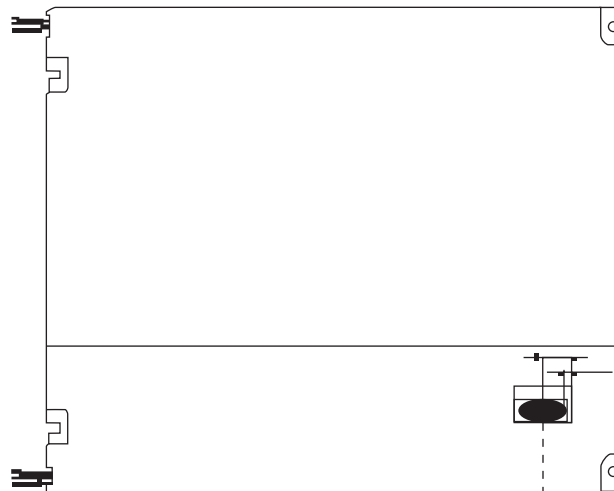




MECHANICAL SPECIFICATIONS



REAR VIEW



Note: Tolerance is $\pm 0.5\text{mm}$ unless noted.

White Electronic Designs Corp. reserves the right to change products or specifications without notice.

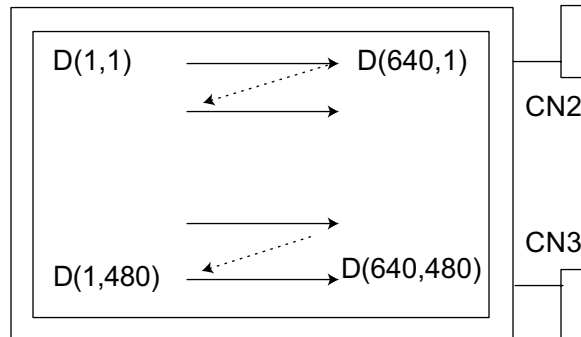
Original specifications created by Sharp.

August 2003
Rev. 0

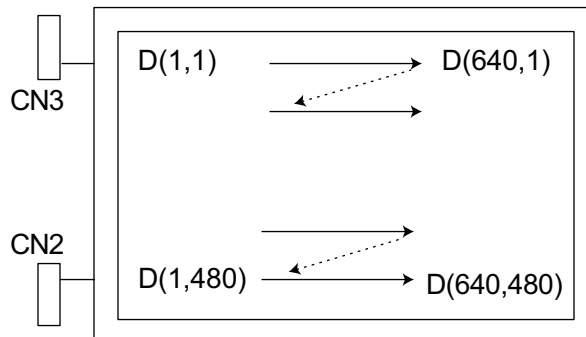


SCANNING DIRECTION

SC : High



SC : GND or Open





OPTICAL CHARACTERISTICS

$t_A=25^{\circ}\text{C}$, $V_{CC}=3.3/5.0\text{V}$, Input Signals: TYP Values Shown in Section 5

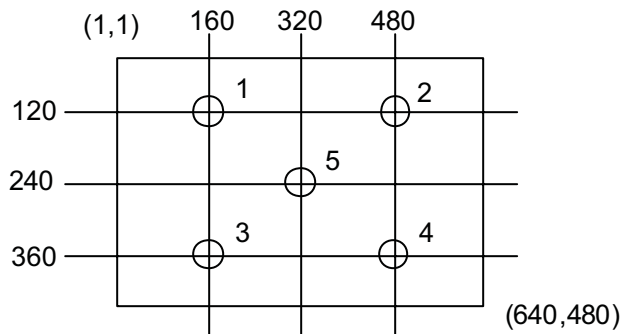
Parameter		Symbol	Condition	Min	Typ	Max	Unit	Remarks
Contrast Ratio		CR	$\theta = \phi = 0^{\circ}$	150	300	-	-	1, 3
Luminance ENH104V2-380 (IM only) ENH104V2-450 (IM, RP) ENH104V2-600 (IM, RP, ELG)		Lw	$\theta = \phi = 0^{\circ}$		380 450 600		cd/m ²	2, 3
Response Time		tr	$\theta = \phi = 0^{\circ}$	-	15	-	ms	3, 4
		tf	$\theta = \phi = 0^{\circ}$	-	35	-	ms	3, 4
Viewing Angle	Horizontal	ϕ	$CR \geq 10$	-	-60~60	-	$^{\circ}$	3
	Vertical	θ		-	-45~55	-	$^{\circ}$	3
Color Coordinates	Red	Rx	$\theta = \phi = 0^{\circ}$	0.54	0.57	0.60	-	3
		Ry		0.30	0.33	0.36		
	Green	Gx		0.30	0.33	0.36		
		Gy		0.49	0.52	0.55		
	Blue	Bx		0.14	0.17	0.20		
		By		0.15	0.18	0.21		
	White	Wx		0.29	0.32	0.35		
		Wy		0.31	0.34	0.37		

Notes:

These items are measured using BM-5A (TOPCON) or LCD-7000 (Otsuka Electronic) under the dark room condition (no ambient light).

Condition: IL=6.0mArms, FL-55kHz

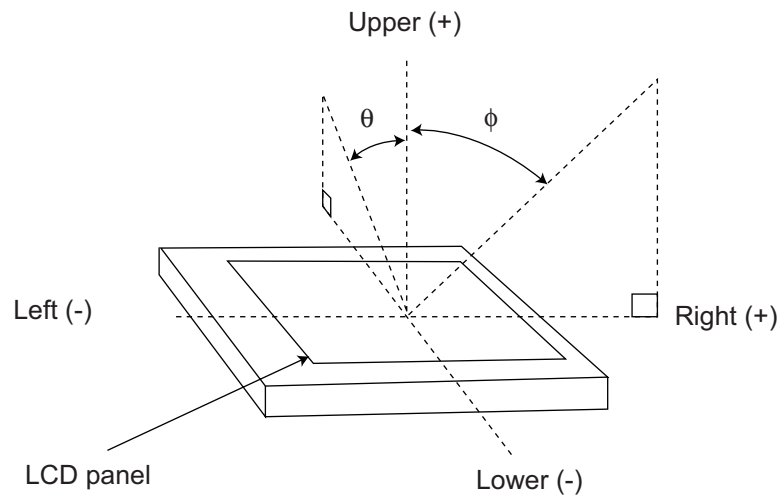
- Definition of Luminance
CR=ON (White) Luminance/OFF (Black) Luminance: average of 5 points.
- Definition of luminance
Lw=ON (White) Luminance: average of 5 points.



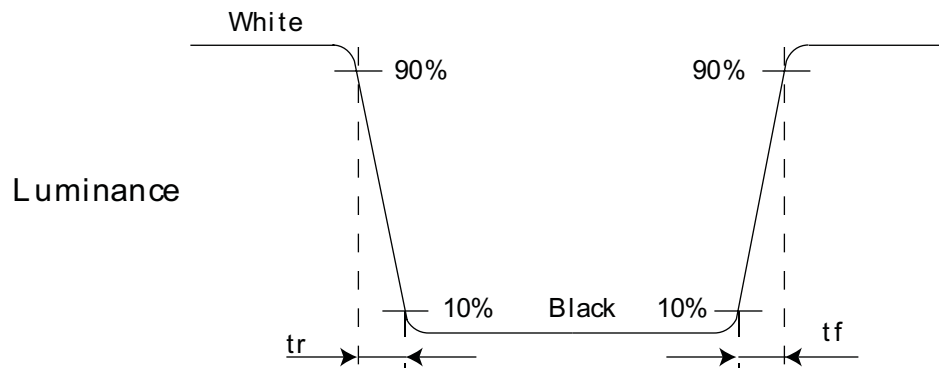
Measurement Point



3. Definition of Viewing Angle (θ , ϕ)



4. Definition of Response Time





RELIABILITY TEST CONDITIONS

TEMPERATURE & HUMIDITY

TEST ITEMS	CONDITIONS
High Temperature High Humidity Operation	40°C, 90%RH, 240 h
High Temperature Storage	60°C, 96 h
Low Temperature Storage	-20°C, 96 h
Thermal Shock (non-operation)	Between -20°C (1h) and 60°C (1h), 5 cycles

SHOCK & VIBRATION

ITEM	CONDITIONS
Shock (non-operation)	Shock level: 1470m/s ² (150G) Waveform: half sinusoidal wave, 2ms Number of shocks: one shock input in each direction of three mutually perpendicular axis for a total of six shock inputs
Vibration (non-operation)	Vibration level: 9.8m/s ² (1.0G) Waveform: sinusoidal Frequency range: 5 to 500Hz Frequency sweep rate: 0.5 octave /min Duration: one sweep from 5 to 500 to 5Hz in each of three mutually perpendicular axis (total 3 hours)

JUDGEMANT STANDARD

The judgement of the above test should be made as follow:

Pass: Normal display image with no obvious non-uniformity and no line defect.

Partial transformation of the module parts should be ignoreed.

Fail: No display image, obvious non-uniformity, or line defects.



HANDLING PRECAUTIONS FOR TFT-LCD MODULE

ASSEMBLY PRECAUTIONS

1. Please use the mounting hole on the module in installing and do not bending or wrenching LCD in assembling. And please do not drop, bend or twist LCD module in handling.
2. Please design display housing in accordance with the following guide lines.
 - (a) Housing case must be designed carefully so as not to put stresses on LCD all sides and not to wrench module. The stresses may cause non-uniformity even if there is no nonuniformity statically.
 - (b) Keep sufficient clearance between LCD module back surface and housing when the LCD module is mounted. Approximately 1.0mm of the clearance in the design is recommended taking into account the tolerance of LCD module thickness and mounting structure height on the housing.
 - (c) When some parts, such as, FPC cable and ferrite plate, are installed underneath the LCD module, still sufficient clearance is required, such as 0.5mm. This clearance is, especially, to be reconsidered when the additional parts are implemented for EMI countermeasure.
 - (d) Design the inverter location and connector position carefully so as not to give stress to lamp cable, or not to interface the LCD module by the lamp cable.
 - (e) Keep sufficient clearance between LCD module and the others parts, such as inverter and speaker so as not to interface the LCD module. Approximately 1.0mm of the clearance in the design is recommended.
3. Please do not push or scratch LCD panel surface with anything hard. And do not soil LCD panel surface by touching with bare hands. (Polarizer film, surface of LCD panel is easy to be flawed.)
4. Please do not press any parts on the rear side such as source TCP, gate TCP, control circuit board and FPCs during handling LCD module. If pressing rear part is unavoidable, handle the LCD module with care not to damage them.
5. Please wipe off LCD panel surface with absorbent cotton or soft cloth in case of it being soiled.

6. Please wipe off drops of adhesives like saliva and water on LCD panel surface immediately. They might damage to cause panel surface variation and color change.
7. Please do not take a LCD module to pieces and reconstruct it. Resolving and reconstructing modules may cause them not to work well.
8. Please do not touch metal frames with bare hands and soiled gloves. A color change of the metal frames can happen during a long preservation of soiled LCD modules.
9. Please pay attention to handling lead wire of backlight so that it is not tugged in connecting with inverter.
10. Please connect the metal frame of LCD module to GND in order to minimize the effect of external noise and EMI.
11. Please connect the metal frame of LCD module to GND in order to minimize the effect of external noise and EMI.

OPERATING PRECAUTIONS

1. Please be sure to turn off the power supply before connecting and disconnecting signal input cable.
2. Please do not change variable resistance settings in LCD module. They are adjusted to the most suitable value. If they are changed, it might happen LCD does not satisfy the characteristics specification.
3. LCD backlight takes longer time to become stable of radiation characteristics in low temperature than in room temperature.
4. A condensation might happen on the surface and inside of LCD module in case of sudden change of ambient temperature.
5. Please pay attention not to display the same pattern for very long time. Image might stick on LCD. Even if image sticking happens, it may disappear as the operation time proceeds.
6. Please obey the same safe instructions as ones being prepared for ordinary electronic products.



PRECAUTIONS WITH ELECTROSTATICS

1. This LCD module use CMOS-IC on circuit board and TFT-LCD panel, and so it is easy to be affected by electrostatics. Please be careful with electrostatics by the way of your body connecting to the ground and so on.
2. Please remove protection film very slowly from the surface of LCD module to prevent from electrostatics occurrence.

STORAGE PRECAUTIONS

1. Please do not leave the LCDs in the environment of high humidity and high temperature such as 60°C90%RH.
2. Please do not leave the LCDs in the environment of low temperature; below -20°C.

SAFETY PRECAUTIONS

1. When you waste damaged or unnecessary LCDs, it is recommended to crush LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.
2. If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.
3. Be sure to turn off the power supply when inserting or disconnecting the cable.
4. Inverter should be designed carefully so as not to keep working in case of detecting over current or open circuit on the lamp.

OTHERS

1. A strong incident light into LCD panel might cause display characteristics changing inferior because of polarizer film, color filter, and other materials becoming inferior. Please do not expose LCD module direct sunlight and strong UV rays.
2. Please pay attention to a panel side of LCD module not to contact with other materials in preserving it alone.
3. For the packaging box, please pay attention to the followings;
 - (a) Packaging box and inner case for LCD are designed to protect the LCDs from the damage or scratching during transportation. Please do not open except picking LCDs up from the box.
 - (b) Please do not pile them up more than 5 boxes. (They are not designed so.) And please do not turn over.
 - (c) Please handle packaging box with care not to give them sudden shock and vibrations. And also please do not throw them up.
 - (d) Packaging box and inner case for LCDs are made of cardboard. So please pay attention not to get them wet. (Such like keeping them in high humidity or wet place can occur getting them wet.)