Laurel Electronics Co., Ltd.

LCD Module Specification

Model No.: LT035E-01A

3.5”, 320 (RGB) x 480 TFT LCM WITH MCU INTERFACE

Table of Contents

RECORD OF REVISION

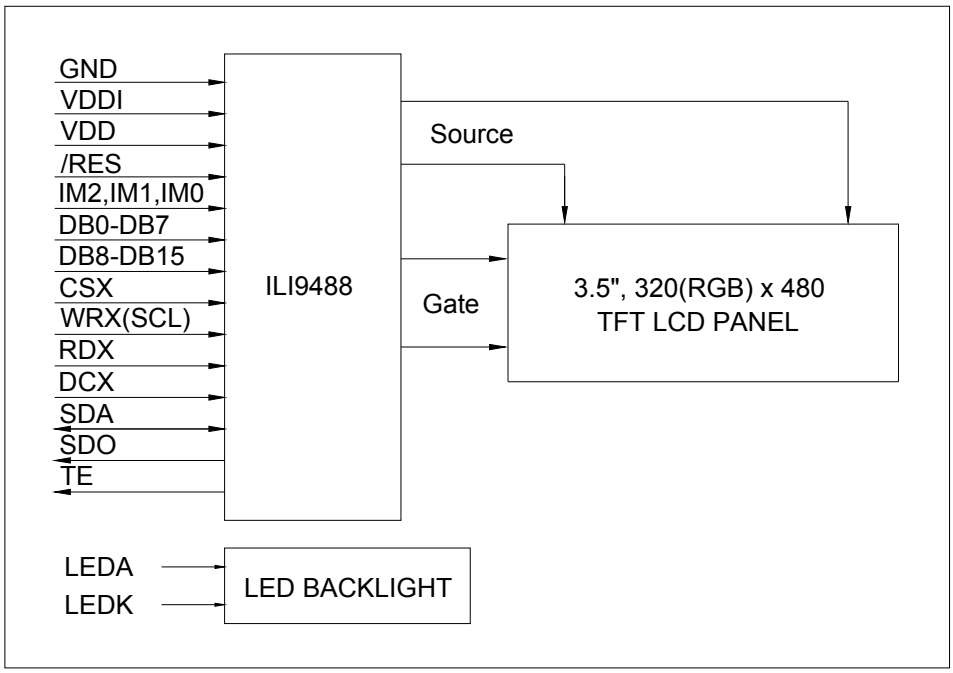
Rev.	Date	Page	Item	Description
0.1	2021/11/08	-	-	New release

1. BASIC SPECIFICATIONS

1.1 Features

Item	Specifications	Unit
Screen Size	3.5 (Diagonal)	inch
Resolution	320 (RGB) x 480	dot
Display Mode	Normally white, transmissive TFT	-
Color Configuration	RGB-Stripe	-
Color Depth	8(RGB=111), 65K(RGB=565) or 262K(RGB=666)	color
Viewing Direction	12:00 o'clock (Gray scale inversion direction)	-
Outline Dimension (WxHxT)	53.5 x 83.32 x 2.3 (FPC length not included)	mm
Viewing Area (WxH)	51.0 x 75.5	mm
Active Area (WxH)	48.96 x 73.44	mm
Dot Pitch (WxH)	0.051 x 0.153	mm
Display RAM (Frame Buffer)	320 x 480 x 18	bit
Touch Panel	None	-
Weight	20	g
LCD Controller	ILI9488	-
Interface Mode	8/9/16-bit 8080 parallel interface or 3/4-line SPI	-
Power Supply (VDDI)	1.65 to 3.3	V
Power Supply (VDD)	2.5 to 3.3	V

1.2 Block Diagram



1.3 Terminal Functions

Pin No.	Symbol	Level	Function
1 to 4	NC	-	No connection
5	GND	0V	Ground
6	VDDI (IOVCC)	1.65V to 3.3V	Power supply for digital and I/O system
7	VDD (VCI)	2.5V to 3.3V	Power supply for analog circuit.
8	TE	H/L	Tearing effect output pin to synchronies MCU to frame rate. Activated by S/W command. Keep this terminal open if not used.
9	CSX	L	Chip selection signal. Active “L”.
10	DCX	H/L	Data/command selection in 8080 parallel interface mode. DCX=“L”: Command; DCX=“H”: Display data or parameter
11	WRX(SCL)	-	Write signal for 8080 parallel interface mode. Bus data is latched at the rising edge of WRX. Serial clock SCL in serial interface.
12	RDX	L	Read signal for 8080 parallel interface mode. Read bus data when RDX is “L”. If not used, fix this pin to VDDI or GND.
13	SDA	-	Serial data input/output pin in serial interface mode. **Note 1** Data is latched at the rising edge of SCL. Fix this pin to GND if not used.
14	SDO	-	Serial data output pin in serial interface mode. **Note 1** Data is shifted out at the falling edge of SCL. Keep SDO open if not used.
15	/RES	L	Reset signal. Active “L”.
16	GND	0V	Ground
17	DB0	H/L	Data bus
18	DB1	H/L	Data bus
19	DB2	H/L	Data bus
20	DB3	H/L	Data bus
21	DB4	H/L	Data bus
22	DB5	H/L	Data bus
23	DB6	H/L	Data bus
24	DB7	H/L	Data bus
25	DB8	H/L	Data bus
26	DB9	H/L	Data bus
27	DB10	H/L	Data bus
28	DB11	H/L	Data bus
29	DB12	H/L	Data bus
30	DB13	H/L	Data bus
31	DB14	H/L	Data bus
32	DB15	H/L	Data bus
33	LEDA	-	LED backlight anode
34 to 36	LEDK	-	LED backlight cathode
37	GND	0V	Ground
38	IM0	H/L	MCU interface mode selection. Refer to section 1.4
39	IM1	H/L	
40	IM2	H/L	

Note 1: Refer to **Interface Mode Control (B0H)** command.
SDA_EN = 0: SDA is data input and SDO is data output for 3/4-line serial interface. **<Default>**
SDA_EN = 1: SDA is data input/output for 3/4-line serial interface and SDO is not used.

1.4 Set Interface Mode by IM2, IM1, IM0 Terminals

IM2	IM1	IM0	Interface Mode	Command Parameter	GRAM	Color Depth
0	0	1	8080 9-bit parallel	DB[7:0]	DB[8:0]: 9-bit data	262K(RGB=666)
0	1	0	8080 16-bit parallel	DB[7:0]	DB[15:0]: 16-bit data	65K(RGB=565) 262K(RGB=666)
0	1	1	8080 8-bit parallel	DB[7:0]	DB[7:0]: 8-bit data	65K(RGB=565) 262K(RGB=666)
1	0	1	3-line 9-bit SPI	SDA/SDO		8(RGB=111) 262K(RGB=666)
1	1	1	4-line 8-bit SPI	SDA/SDO		8(RGB=111) 262K(RGB=666)
Others			Not support			

Note: For 3/4-line SPI mode, only 3-bit/pixel (RGB=111) or 18-bit/pixel (RGB=666) data format is available. Users should set **Interface Pixel Format (3AH)** command to **0x11** for 8-bit/pixel (RGB=111) data format or **0x66** for 18-bit/pixel (RGB=666) data format.
For 16-bit/pixel (RGB=565) pixel data, users can switch them to 18-bit/pixel (RGB=666) data format by software before sending them to LCD.

2. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage (Logic, Analog)	V_{DDI}, V_{DD}	-0.3	3.3	V
LED Forward Current (Each LED)	I_F	-	25	mA
Input Voltage	V_{IN}	-0.3	V_{DDI} + 0.3	V
Operating Temperature	Topr	-20	+70	°C
Storage Temperature	Tstg	-30	+80	°C

Cautions: Stresses above those listed as 'absolute maximum ratings' may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

3. ELECTRICAL CHARACTERISTICS

3.1 DC Characteristics (Ta=25°C)

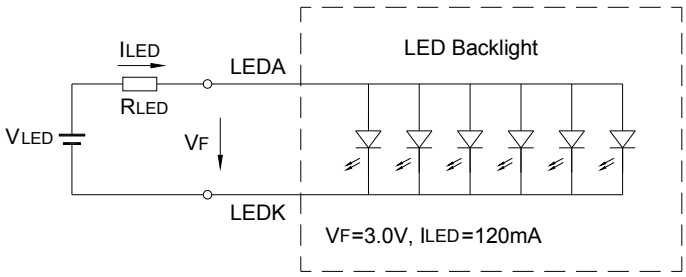
Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage (Analog)	V_{DD}		2.5	-	3.3	V
Supply Voltage (I/O)	V_{DDI}		1.65	-	3.3	V
Input High Voltage	V_{IH}		0.7V_{DDI}	-	V_{DDI}	V
Input Low Voltage	V_{IL}		0	-	0.3V_{DDI}	V
Output High Voltage	V_{OH}	I_{OH} = -1mA	0.8V_{DDI}	-	V_{DD}	V
Output Low Voltage	V_{OL}	I_{OL} = 1mA	0	-	0.2V_{DDI}	V
Supply Current	I_{DD}	V_{DD} = 3.3V V_{DDI} = 3.3V	-	8.0	12	mA

Note: Supply current I_{DD} includes V_{DD} current and V_{DDI} current.

3.2 LED Backlight Characteristics (Ta=25°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
LED Forward Voltage	V_F	Note 1	2.9	3.0	3.1	V
LED Forward Current	I_{LED}		-	120	132	mA
LED Life Time	-	Note 2	30,000	-	-	Hr

Note 1: The LED forward voltage is defined at Ta=25°C and I_F=20mA/each LED.
Note 2: The LED life time is defined as the module brightness decreases to 50% initial brightness at Ta=25°C and I_{LED}=120mA. The LED life time could be decreased if operating I_{LED} is larger than 120mA.



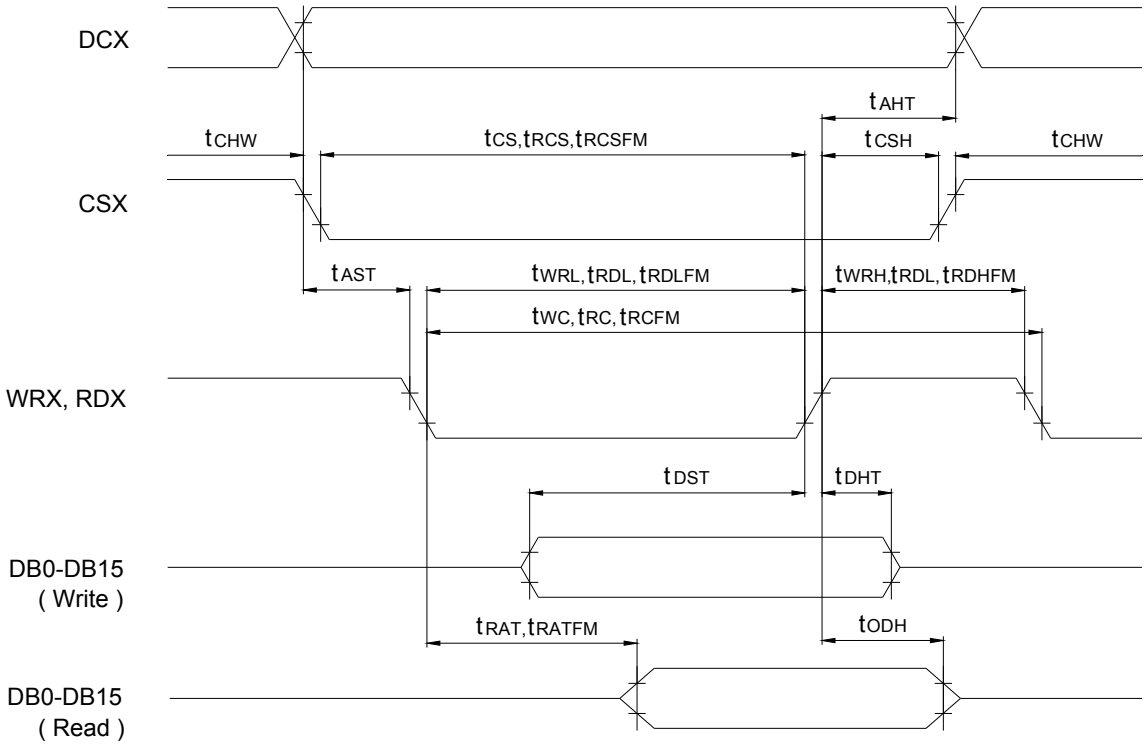
Recommended vaule for R_{LED}

V_{LED}	R_{LED}
5.0V	16.9Ω ±1%,1/2W
3.3V	2.55Ω ±1%,1/10W
3.0V	0.51Ω ±1%,1/10W

3.3 8080 8/9/16-bit Interface Read/Write Timing (V_{DDI}=2.5V to 3.3V, Ta=25°C)

Symbol	Signal	Parameter	Min.	Max.	Unit	Remark
DCX	t_{AST}	Address Setup Time	0	-	ns	
	t_{AHT}	Address Hold Time (Write/Read)	0	-	ns	
CSX	t_{CHW}	Chip Select “H” Pulse Width	0	-	ns	
	t_{CS}	Chip Select Setup Time (Write)	15	-	ns	
	t_{RCS}	Chip Select Setup Time (Read ID)	45	-	ns	
	t_{RCSFM}	Chip Select Setup Time (Read FM)	355	-	ns	
	t_{CSF}	Chip Select Wait Time (Write/Read)	10	-	ns	
	t_{CSH}	Chip Select Hold Time (Write/Read)	10	-	ns	
WRX	t_{WC}	Write Cycle	40	-	ns	
	t_{WRH}	Write Control Pulse “H” Duration	15	-	ns	
	t_{WRL}	Write Control Pulse “L” Duration	15	-	ns	
RDX(ID)	t_{RC}	Read Cycle (ID)	160	-	ns	When read ID data
	t_{RDH}	Read Control Pulse “H” Duration (ID)	90	-	ns	
	t_{RDL}	Read Control Pulse “L” Duration (ID)	45	-	ns	
RDX(FM)	t_{RCFM}	Read Cycle (FM)	450	-	ns	When read from frame memory
	t_{RDHFM}	Read Control Pulse “H” Duration (FM)	90	-	ns	
	t_{RDLFM}	Read Control Pulse “L” Duration (FM)	355	-	ns	
D[15:0]	t_{DST}	Data Setup Time	10	-	ns	For max. CL=30pF For min. CL=8pF
	t_{DHT}	Data Hold Time	10	-	ns	
	t_{RAT}	Read Access Time (ID)	-	40	ns	
	t_{RATFM}	Read Access Time (FM)	-	340	ns	
	t_{ODH}	Output DisableTime	20	80	ns	

Note: Rising time t_r and falling time t_f should not be larger than 15ns.

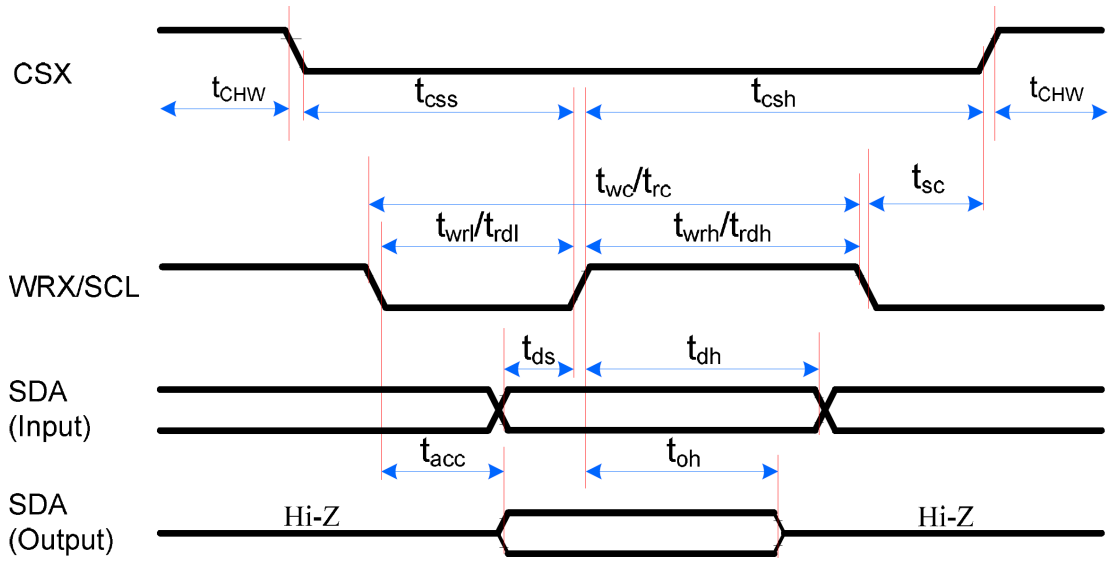


Bus Read/Write Timing

3.4 3-Line Serial Interface Timing (VDDI=2.5V to 3.3V, Ta=25°C)

Symbol	Signal	Parameter	Min.	Max.	Unit	Remark
CSX	t_{sc}	Chip Select Hold Time (Read)	15	-	ns	
	t_{CHW}	Chip Select "H" Pulse Width	40	-	ns	
	t_{css}	Chip Select Setup Time (Write)	60	-	ns	
	t_{csh}	Chip Select Hold Time (Write)	65	-	ns	
SCL	t_{wc}	Serial Clock Cycle (Write)	66	-	ns	
	t_{wrh}	SCL "H" Pulse Width (Write)	15	-	ns	
	t_{wrl}	SCL "L" Pulse Width (Write)	15	-	ns	
	t_{rc}	Serial Clock Cycle (Read)	150	-	ns	
	t_{rdh}	SCL "H" Pulse Width (Read)	60	-	ns	
	t_{rdl}	SCL "L" Pulse Width (Read)	60	-	ns	
SDA (Input)	t_{ds}	Data Setup Time (Write)	10	-	ns	
	t_{dh}	Data Hold Time (Write)	10	-	ns	
SDA/SDO (Output)	t_{acc}	Access Time (Read)	10	50	ns	For max. CL=30pF For min. CL=8pF
	t_{oh}	Output Disable Time (Read)	15	50	ns	

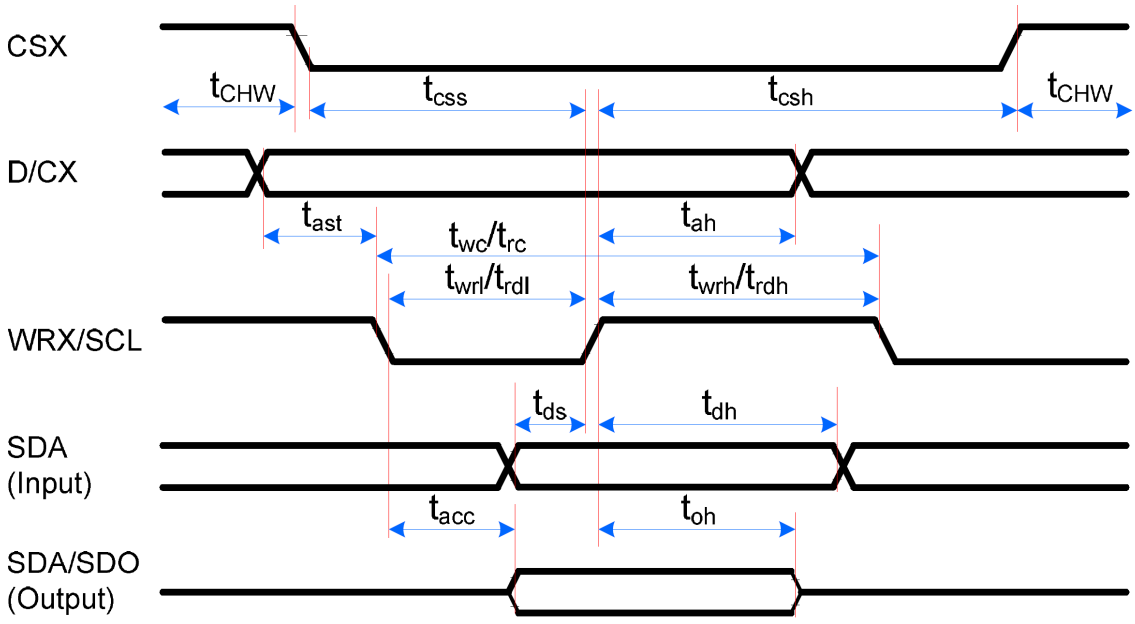
Note: Rising time tr and falling time tf should not be larger than 15ns.



3.5 4-Line Serial Interface Timing (V_{DDI}=2.5V to 3.3V, Ta=25°C)

Symbol	Signal	Parameter	Min.	Max.	Unit	Remark
CSX	t_{css}	Chip Select Setup Time (Write)	15	-	ns	
	t_{csh}	Chip Select Hold Time (Write)	15	-	ns	
	t_{CHW}	Chip Select "H" Pulse Width	40	-	ns	
SCL	t_{wc}	Serial Clock Cycle (Write)	50	-	ns	
	t_{wrh}	SCL "H" Pulse Width (Write)	10	-	ns	
	t_{wrl}	SCL "L" Pulse Width (Write)	10	-	ns	
	t_{rc}	Serial Clock Cycle (Read)	150	-	ns	
	t_{rdh}	SCL "H" Pulse Width (Read)	60	-	ns	
	t_{rdl}	SCL "L" Pulse Width (Read)	60	-	ns	
DCX	t_{ast}	DCX Setup Time (Write)	10	-	ns	
	t_{ah}	DCX Hold Time (Write/Read)	10	-	ns	
SDA (Input)	t_{ds}	Data Setup Time (Write)	10	-	ns	
	t_{dh}	Data Hold Time (Write)	10	-	ns	
SDA/SDO (Output)	t_{acc}	Access Time (Read)	10	50	ns	For max. CL=30pF For min. CL=8pF
	t_{oh}	Output Disable Time (Read)	15	50	ns	

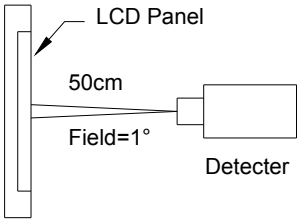
Note: Rising time tr and falling time tf should not be larger than 15ns.



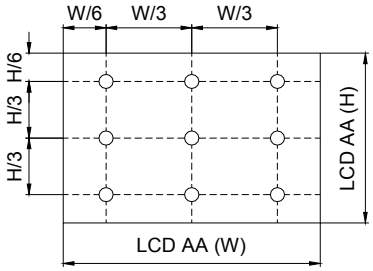
4. ELECTRO-OPTICAL CHARACTERISTICS (Ta=25°C)

Item	Symbol		Condition	Min.	Typ.	Max.	Unit	Note
Brightness of White	Bp		Θ=0° Φ=0° ILED=120mA	-	200	-	cd/m^2	1
Uniformity	△Bp			70%	-	-	-	2
Viewing Angle	Hor	ΘR	Cr ≥10	-	70	-	deg.	3
		ΘL		-	70	-		
	Ver	ΘU		-	60	-		
		ΘD		-	60	-		
Contrast Ratio	Cr			-	500	-	-	4
Response Time	Tr + Tf		Θ=0° Φ=0°	-	20	-	ms	5
Color Chromaticity	Wx			0.267	0.297	0.327	-	1, 6
	Wy			0.301	0.331	0.361	-	

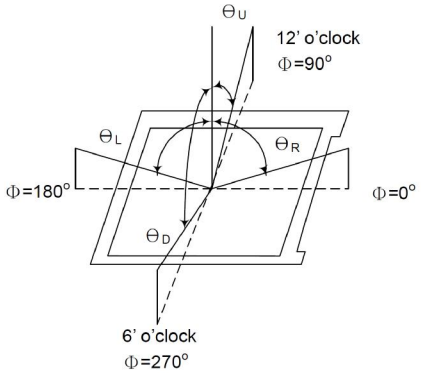
Note 1: The optical characteristics should be measured by BM-7 in dark room after 15 minutes operation. The optical properties are measured at the center point of the LCD.



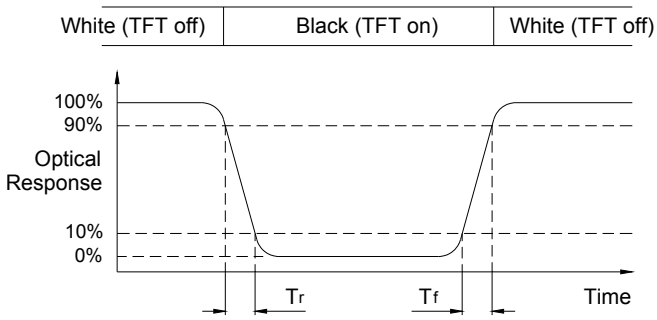
Note 2: △ Bp=Bp (Min.) / Bp (Max.) × 100 (%)
Bp(Max.)=Maximum brightness in 9
Bp(Min.)=Minimum brightness in 9



Note 3: Definition of Viewing Angle



Note 5: Definition of Response Time

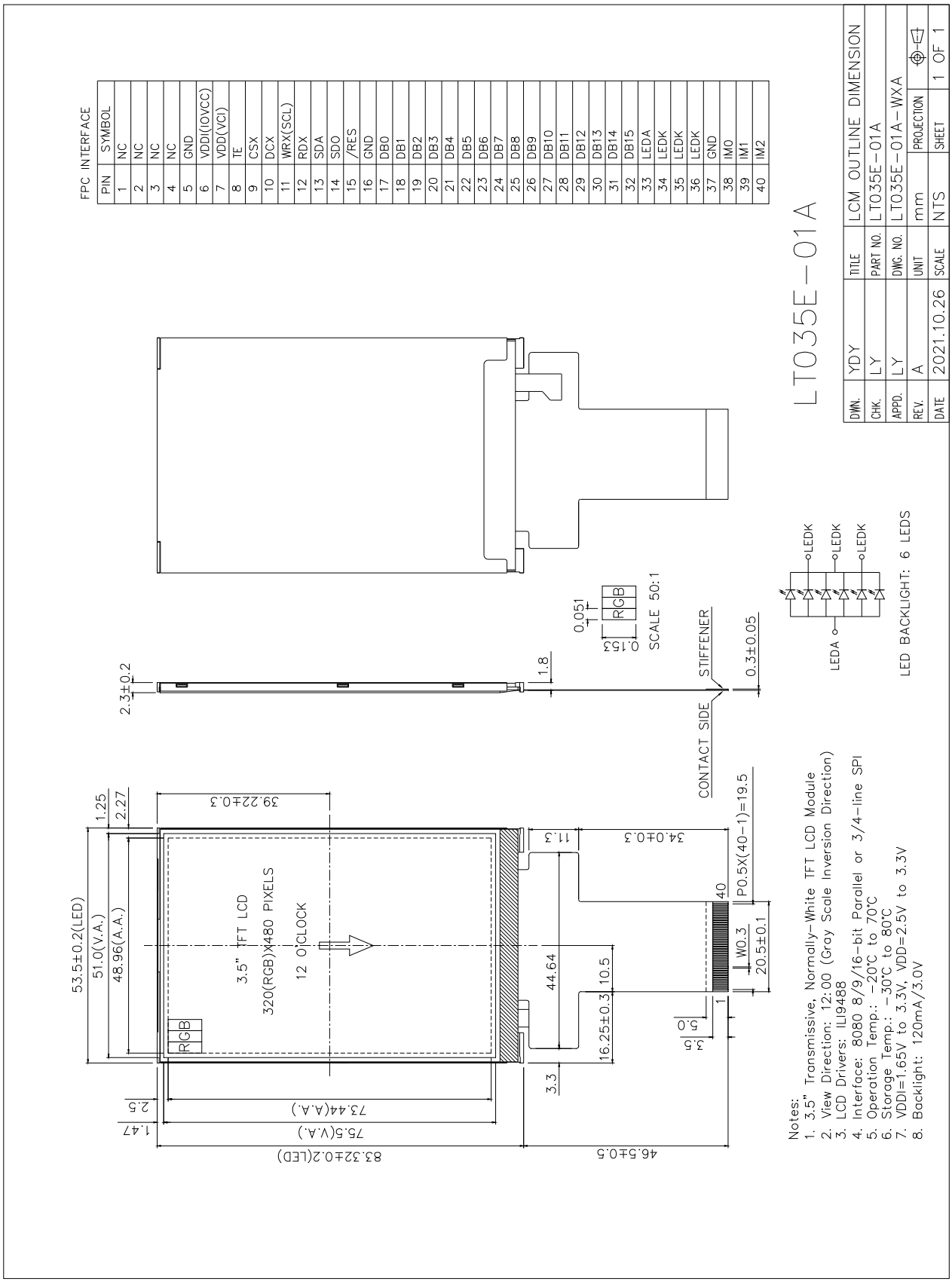


Note 4: Definition of Contrast Ratio

$$\text{Contrast Ratio (Cr)} = \frac{\text{Brightness measured when LCD on "White" State}}{\text{Brightness measured when LCD on "Black" state}}$$

Note 6: Definition of color chromaticity (CIE1931)
Color coordinates is measured at the center point of the LCD with ILED=75mA and the LCD displays white.

5. DIMENSIONAL OUTLINE



6. PRECAUTIONS FOR USE OF LCD MODULE

6.1 Handing Precautions

1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
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.
3) Do not apply excessive force on the surface of display or the adjoining areas of LCD module since this may cause the color tone to vary.
4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
5) If the display surface of LCD module becomes contaminated, blow on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, 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
6) When mounting the LCD module make sure that it is free of twisting, warping, and distortion. Distortion has great influence upon display quality. Also keep the stiffness enough regarding the outer case.
7) Be sure to avoid any solvent such as flux for soldering never stick to Heat-Seal. Such solvent on Heat-Seal may cause connection problem of heat-Seal and TAB.
8) Do not forcibly pull or bend the TAB I/O terminals.
9) Do not attempt to disassemble or process the LCD module.
10) NC terminal should be open. Do not connect anything.
11) If the logic circuit power is off, do not apply the input signals.
12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
    · Be sure to ground the body when handling the LCD module.
    · Tools required for assembly, such as soldering irons, must be properly grounded.
    · To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
    · The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

6.2 Storage Precautions

1) When storing the LCD module, avoid exposure to direct sunlight or to the light of fluorescent lamps and high temperature/high humidity. Whenever possible, the LCD module should be stored in the same conditions in which they were shipped from our company.
2) Exercise care to minimize corrosion of the electrodes. Corrosion of the electrodes is accelerated by water droplets or a current flow in a high humidity environment.

6.3 Design Precautions

1) The absolute maximum ratings represent the rated value beyond which LCD module can not exceed. When the LCD modules are used in excess of this rated value, their operating characteristics may be adversely affected.

2) To prevent the occurrence of erroneous operation caused by noise, attention must be paid to satisfy VIL, VIH specification values, including taking the precaution of using signal cables that are short.
3) The liquid crystal display exhibits temperature dependency characteristics. Since recognition of the display becomes difficult when the LCD is used outside its designated operating temperature range, be sure to use the LCD within this range. Also, keep in mind that the LCD driving voltage levels necessary for clear displays will vary according to temperature.
4) Sufficiently notice the mutual noise interference occurred by peripheral devices.
5) To cope with EMI, take measures basically on outputting side.
6) If DC is impressed on the liquid crystal display panel, display definition is rapidly deteriorated by the electrochemical reaction that occurs inside the liquid crystal display panel. To eliminate the opportunity of DC impressing, be sure to maintain the AC characteristics of the input signals sent to the LCD Module.

6.4 Others

1) Liquid crystals solidify under low temperatures (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the LCD module is subjected to a strong shock at a low temperature.
2) If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
3) To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity, etc., exercise care to avoid touching the following sections when handling the module:
   · Terminal electrode sections.
   · Part of pattern wiring on TAB, etc.