ER-TFT035-1

LCD Module User Manual

EastRising Technology Co., Ltd

REV	Descriptions	Release Date
1.0	Preliminary Release	Apr-09-2011
2.0	Correct the size of visual area	Apr-29-2011

FEATURES

- Full-color (16.7M) 320 x RGB x 240 TFT consists of a TFT panel, a driver IC, an FFC (Flat Flexible Cable), and an LED backlight.
- Module Dimensions
  - Active Area is 3.5" diagonal, 70.07 (W) x 52.55 (H) mm (2.76" (W) x 2.07" (H)).
  - Module dimensions *excluding* module's FFC is 77.60 (W) x 64.40 (H) x 3.30 maximum (D) mm (3.06" (W) x 2.54" (H) x 0.13" (D)).
  - Module overall dimensions *including* module's FFC is 88.15 (W) x 106.80 (H) x 3.30 maximum (D) mm (3.47" (W) x 4.20" (H) x 0.13" (D)).
- 8-bit, 9-bit, 16-bit, and 18-bit parallel (8080 or 6800), RGB, or SPI interface.
- Transmissive display with LED backlight. White edge-lit with two parallel rows of LEDs, three LEDs in each row, six LEDs total. Display light pixels on a dark colored area (any color combination) or invert for dark colored pixels (any color combination) on a light area.
- Built-in for DC-DC converter for panel voltage.
- 12:00 o'clock polarizer viewing direction.
- Wide temperature for operation is -20°C to +70°C.
- RoHS compliant.

PHYSICAL CHARACTERISTICS

Number of Pixels		
320 x 240 pixels = 76,800 pixels		
Pixel Detail	**Horizontal**	**Vertical**
Pixel Size	0.063	0.209
RGB Pixel Pitch	0.219	0.219

Module Depth		
	Maximum	**Nominal**
Millimeters	3.30	3.10
Inches	0.13"	0.12"

Viewing Area		
	Width	**Height**
Millimeters	70.07	52.55
Inches	2.76"	2.07"

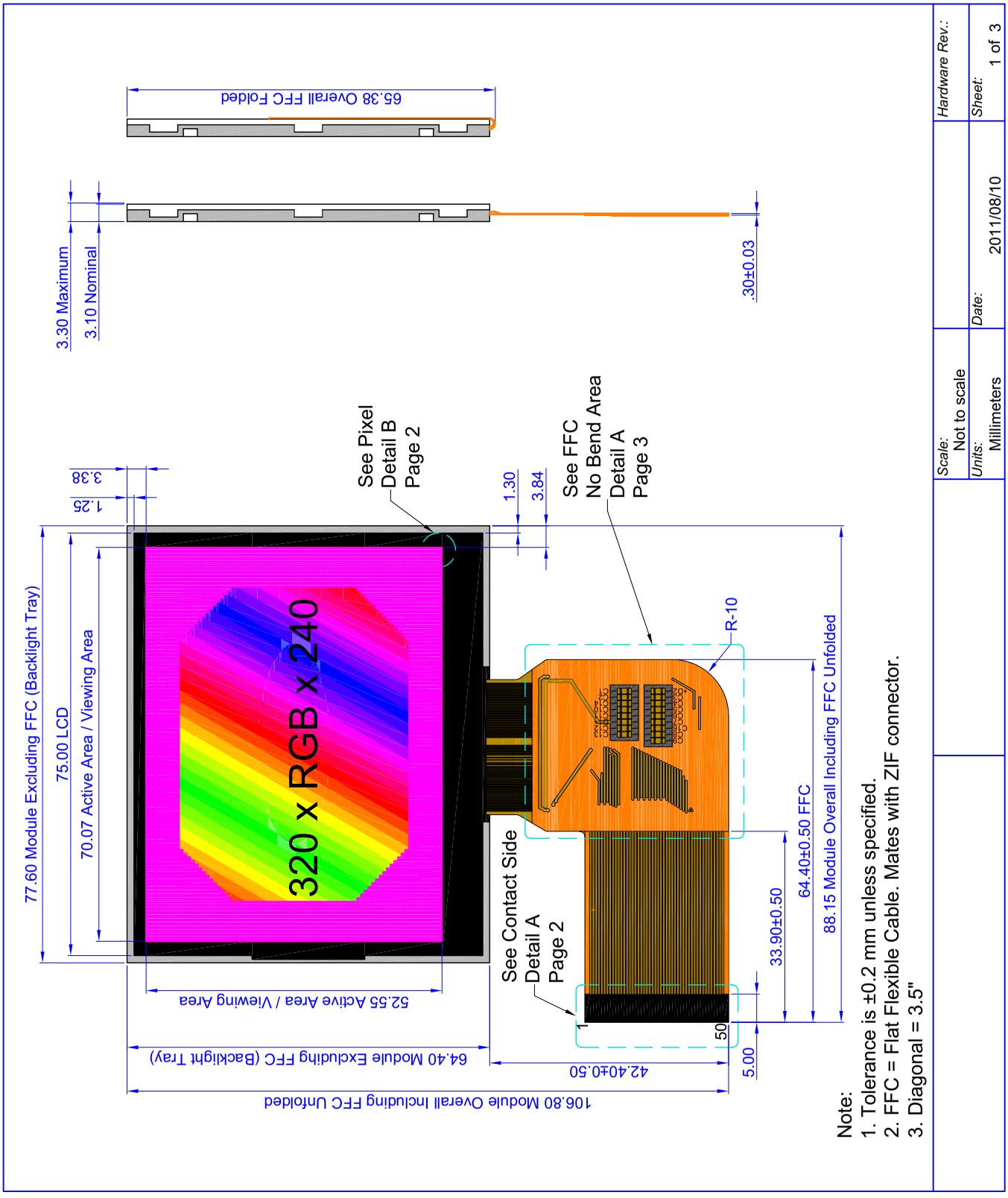
Active Area		
Diagonal	Inches: 3.5"	
	Width	**Height**
Millimeters	70.07	52.55
Inches	2.76"	2.07"

Module Excluding FFC		
	Width	**Height**
Millimeters	77.60	64.40
Inches	3.06"	2.54"

Module Overall Including FFC Unfolded		
	Width	**Height**
Millimeters	88.15	106.80
Inches	3.47"	4.20"

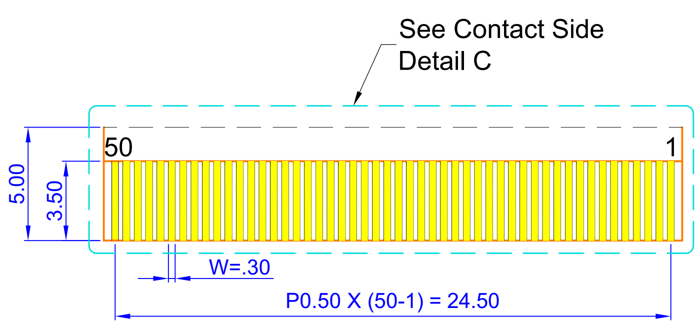
MODULE OUTLINE DRAWINGS

Figure 1. Module Outline Drawings (3 pages)

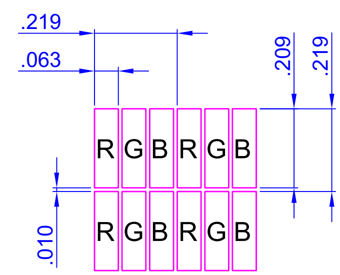


Pin	Symbol
1	GND
2	NC
3	NC
4	GND
5	GND
6	GND
7	$\overline{RD}_{8080}(E_{6800})$
8	SDO
9	$\overline{RST}$
10	$\overline{CS}$
11	SCL
12	SDI
13	$D/\overline{C}$
14	$\overline{WR}_{8080}(R/\overline{W}_{6800})$
15	PS3
16	PS2
17	PS1
18	PS0
19	DB17
20	DB16
21	DB15
22	DB14
23	DB13
24	DB12
25	DB11
26	DB10
27	DB9
28	DB8
29	DB7
30	DB6
31	DB5
32	DB4
33	DB3
34	DB2
35	DB1
36	DB0
37	DEN
38	HSYNC
39	VSYNC
40	DCLK
41	NC
42	GND
43	GND
*44	V_{LOGIC}
*45	V_{LOGIC}
46	NC
47	$K_2(LED_2-)$
48	$A_2(LED_2+)$
49	$A_1(LED_1+)$
50	$K_1(LED_1-)$

Contact Side Detail C



Contact Side Detail A



Pixel Detail B

Note:
1. Tolerance is ±0.2 mm unless specified.
2. FFC = Flat Flex Cable. Mates with ZIF connector.
3. Diagonal = 3.5"
4. * Both V_{LOGIC} pins (44,45) need to be connected.

No Bend Area Detail A

Note:
1. Tolerance is ±0.2 mm unless specified.
2. FFC = Flat Flexible Cable. Mates with ZIF connector.
3. Diagonal = 3.5"

SYSTEM BLOCK DIAGRAM

Note: Selected interface will affect which pins are actually used.

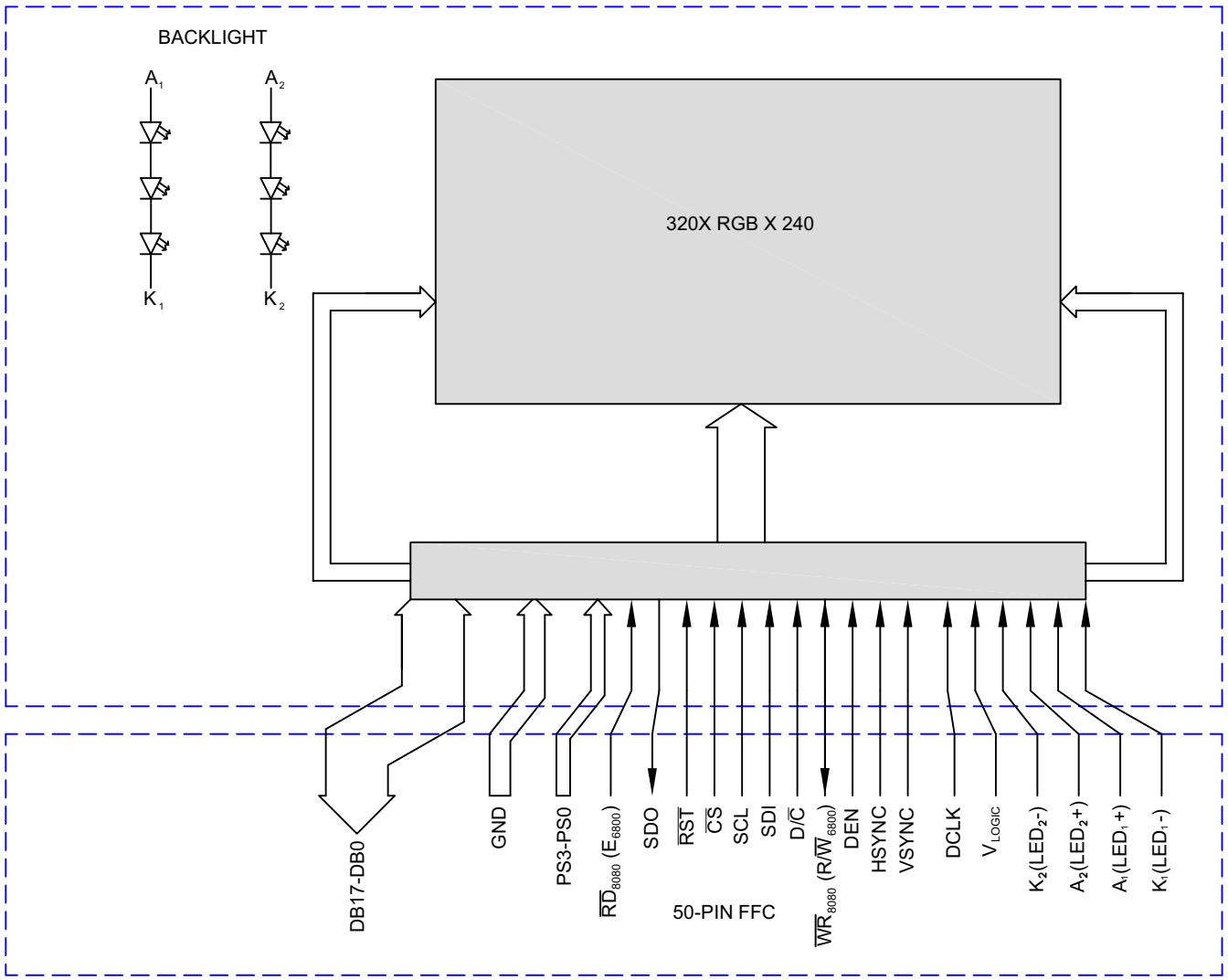


Figure 2. System Block Diagram

ABSOLUTE MAXIMUM RATINGS

ABSOLUTE MAXIMUM RATINGS	SYMBOL	MINIMUM	MAXIMUM
Operating Temperature*	T_{OP}	-20°C	+70°C
Storage Temperature*	T_{ST}	-30°C	+80°C
Humidity	RH	0%	90%
Supply Voltage	$V_{LOGICIO}$	-0.3v	+4.0v
Logic Supply Voltage	V_{LOGIC}	-0.3v	+4.0v
Power Supply Current for TFT	I_{DD}	TBD mA	TBD mA
*Prolonged exposure at temperatures outside of this range may cause permanent damage to the module.			

DC CHARACTERISTICS

This is a summary of the module's major operating parameters.

DC CHARACTERISTICS	TEST CONDITION	SYMBOL	MINIMUM	TYPICAL	MAXIMUM
Logic Supply Voltage*	T_{OP} = -20°C to +70°C	V_{LOGIC}	+2.5	+3.0v	+3.6v
Supply Voltage for I/O signals	T_{OP} = -20°C to +70°C	$V_{LOGIC\ I/O}$	+1.4v	+3.0v	+3.6v
Input High Voltage		V_{IH}	+0.8v x V_{Logic} For V_{Logic} = +3.0v V_{OH}= +0.8v x +3.0v = +2.4v		V_{Logic}
Input Low Voltage		V_{IL}	0v (GND)		+0.2v x V_{Logic} For V_{Logic} = +3.0v V_{IL} = +0.2v x +3.0v = +0.6v
Output High Voltage	I_{OUT} = 100µA 3.3MHz	V_{OH}	+0.9v x V_{Logic} For V_{Logic} = +3.0v V_{OH}= +0.9v x +3.0v = +2.7v		V_{Logic}
Output Low Voltage	I_{OUT} = 100µA 3.3MHz	V_{OL}	0v (GND)		+0.1v x V_{Logic} For V_{Logic} = +3.0v V_{OL}= +0.1v x +3.0v = +0.3v
Current for Normal Operation		I_{OP}	0.05mA		
Current for Standby Mode		I_{ST}	0.03mA		0.2mA

*If you use a +3.3v supply, you will need to step up the power supply for the LED backlight because it requires +9.9v.

DETAILS OF INTERFACE PIN FUNCTION

Pins depends on choice of 8-bit, 9-bit, 16-bit, and 18-bit parallel (8080 or 6800), RGB, or SPI interface.

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
1	GND	L		Power supply and signal ground. Must be connected to an external ground.
2-3	NC			No Connection
4-6	GND	L		Ground. Must be connected to an external ground.
7	$\overline{RD}_{8080}$ (E_{6800})	H/L	I	Host interface input. *8080 Host:* Active low. Signal on the databus is latched at the rising edge of $\overline{RD}$. *6800 Host:* Enable control signal input active high. E = *High:* Read or Write operation is active E = *Low:* No operation
8	SDO	H/L	O	Data output pin in serial interface. (Serial Data Out/MISO)
9	$\overline{RST}$	H/L	I	Reset signal. *Low:* Display controller is reset. The $\overline{RST}$ pin should be pulsed low shortly after power is applied. *High:* The $\overline{RST}$ pin should be brought high for normal operation.
10	$\overline{CS}$	H/L	I	Chip select input. *Low:* Controller chip is selected. Communications with host is possible. *High:* Controller chip is not selected. Host interface signals are ignored by the controller.
11	SCL	H/L	I	Serial clock input.
12	SDI	H/L	I	Data input pin in serial interface. (Serial Data In/MOSI)
13	D/$\overline{C}$	H/L	I	Data/Command control. Determines whether data bits are data or command. *1 – High:* Addresses the data register. *0 – Low:* Addresses the command register.

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION (Continued)
14	$\overline{WR}_{8080}$ (R/$\overline{W}_{6800}$)	H/L	IO	Host interface input. *8080 Host:* Active low. Signal on the databus is latched at the rising edge of $\overline{WR}$ signal. *6800 Host:* Read/Write control signal output. *R/$\overline{W}$* = High: Read (Host←Module) *R/$\overline{W}$* = Low: Write (Host→Module)
15-18	PS3-PS0	H/L		Notice the descending order. See .
19-36	DB17-DB0	H/L	IO	Parallel databus. Notice the descending order.
37	DEN	H/L	I	Display enable pin from controller. (RGB interface only.)
38	HSYNC	H/L	I	Line synchronization input. (RGB interface only.)
39	VSYNC	H/L	I	Frame/RAM write synchronization input. (RGB interface only.)
40	DCLK	H/L	I	Dot-clock signal and oscillator source. A non-stop external clock must be provided to that pin even at front or back porch non-display period.
41	NC			No Connection.
42-43	GND	L		Ground. Must be connected to an external ground.
44-45	V_{LOGIC}	H	I	Power supply input. Must be connected to an external source. **Note: Both pins must be connected.**
46	NC			No Connection.
47	K_2 (LED_2 -)	L		Supply pin for LED. “K” (cathode or kathode for German and original Greek spelling) or “-” of LED backlight.
48	A_2 (LED_2 +)	H		Supply pin for LED. “A” (anode) or “+” of LED backlight.
49	A_1 (LED_1 +)	H		Supply pin for LED. “A” (anode) or “+” of LED backlight.
50	K_1 (LED_1 -)	L		Supply pin for LED. “K” (cathode or kathode for German and original Greek spelling) or “-” of LED backlight.
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PHOTO REFERENCE FOR PIN FUNCTIONS

Note: Both V_{LOGIC} pins (44 and 45) must be connected.

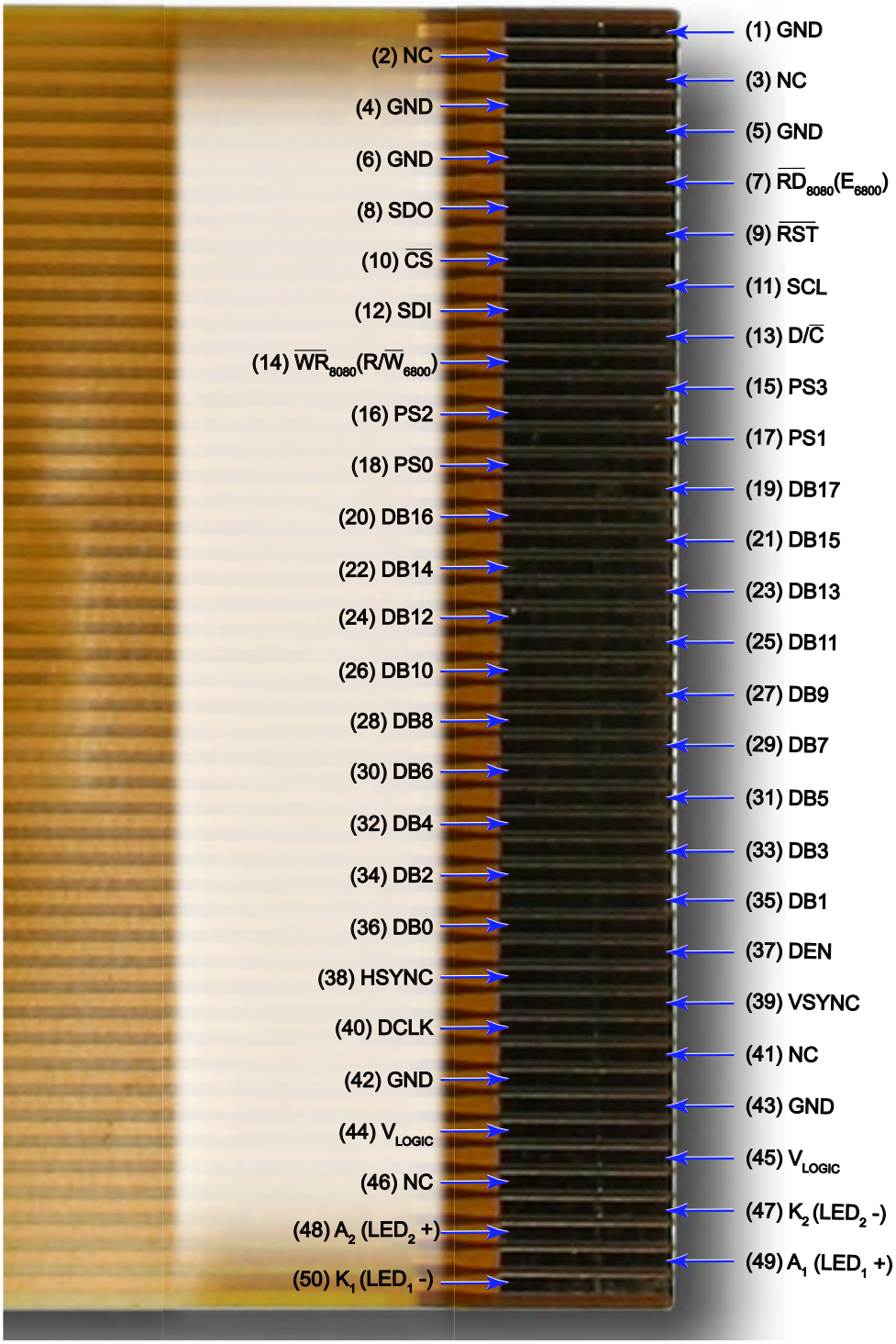


Figure 3. Back View of FFC (Pins Labeled)

INTERFACE PIN USAGE TABLE

Label	Pin	6800 – 8 Bit	6800 – 9 Bit	6800 – 16 Bit	6800 – 18 bit	8080 – 8 Bit	8080 – 9 Bit	8080 -16 Bit	8080 – 18 bit	SPI – 4 Wire	SPI – 3 Wire	RGB - 262K	RGB – 64K
Vss	1	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
NC	2	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
NC	3	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
Vss	4	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vss	5	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vss	6	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
RD	7	Enable	Enable	Enable	Enable	Read Strobe	Read Strobe	Read Strobe	Read Strobe	+3v	+3v	Ground	Ground
SDO	8	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	Data Output	Data Output	Ground	Ground
Reset	9	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset
CS	10	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Serial Chip Select	Serial Chip Select	No Connect	No Connect
SCL	11	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	Serial Clock Input	Serial Clock Input	Ground	Ground
SDA	12	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	Data Input	Data Input	Ground	Ground
RS	13	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Serial Data / Command	No Connect	Ground	Ground
RW	14	Read / Write	Read / Write	Read / Write	Read / Write	Write / Read	Write / Read	Write / Read	Write / Read	No Connect	No Connect	Ground	Ground
PS3	15	0	1	0	1	0	1	0	1	1	1	0	0
PS2	16	0	0	0	0	0	0	0	0	1	1	1	1
PS1	17	0	0	0	0	1	1	1	1	1	1	1	0
PS0	18	1	1	0	0	1	1	1	0	1	1	0	1
DB17	19	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR5	RR4
DB16	20	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR4	RR3
DB15	21	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR3	RR2
DB14	22	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR2	RR1
DB13	23	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR1	RR0
DB12	24	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR0	GG5
DB11	25	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	GG5	GG4
DB10	26	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	GG4	GG3
DB9	27	NC or Gnd	x	NC or Gnd	x	NC or Gnd	x	NC or Gnd	x	NC or Gnd	NC or Gnd	GG3	NC or Gnd
DB8	28	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	GG2	GG2
DB7	29	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	GG1	GG1
DB6	30	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	GG0	GG0
DB5	31	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB5	BB4
DB4	32	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB4	BB3
DB3	33	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB3	BB2
DB2	34	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB2	BB1
DB1	35	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB1	BB0
DB0	36	NC or Gnd	NC or Gnd	NC or Gnd	x	NC or Gnd	NC or Gnd	NC or Gnd	x	NC or Gnd	NC or Gnd	BB0	NC or Gnd
DEN	37	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Data Enable	Data Enable
HSYNC	38	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Line Sync	Line Sync
VSYNC	39	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Frame / RAM Sync	Frame / RAM Sync
DCLK	40	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Dot Clock	Dot Clock
NC	41	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
Vss	42	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vss	43	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vcc	44	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v
Vcc	45	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v
NC	46	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
K2	47	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -
A2	48	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +
A1	49	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +
K1	50	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -
Label	Pin	6800 – 8 Bit	6800 – 9 Bit	6800 – 16 Bit	6800 – 18 bit	8080 – 8 Bit	8080 – 9 Bit	8080 -16 Bit	8080 – 18 bit	SPI – 4 Wire	SPI – 3 Wire	RGB – 262K	RGB – 64K

ADDITIONAL INFORMATION ON INTERFACE TYPES

- I want to display video. Which interface is faster, SPI or parallel?

  The SPI interface is a clocked interface. Each command or data bit is clocked. With the 18-bit parallel interface, you are able to pass 18 bits of command or data at a time. Using the same controller at the same clock speed, the parallel interface will always be faster.

- What if I need RS-232 serial interface?

  Three-wire or four-wire SPI interface is not RS-232 but does not require the control lines that the 8-, 9-, of 16-bit interfaces do.

- Using the 8-bit 8080 interface, what should be done with pins DB9-DB0 (pins 27-36)? Tie them to ground, pull them up, or let them float?

  Leave unused pins floating.

ESD (ELECTRO-STATIC DISCHARGE)

The circuitry is industry standard CMOS logic and susceptible to ESD damage. Please use industry standard antistatic precautions as you would for any other static sensitive devices such as expansion cards, motherboards, or integrated circuits. Ground your body, work surfaces, and equipment.

OPTICAL CHARACTERISTICS

Ambient Temperature (Ta) = 25°C, Maximum 75% Relative Humidity					
ITEM	**SYMBOL**	**ADDITIONAL TEST CONDITIONS**	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Color Depth				16.7M[1]	
Transmittance	T	with polarizer	5.7%	6.76%	
Contrast Ratio (CR)[2]		θ = φ - 0°	320	400	
TFT Response Time[3]	Tr			8 ms	12 ms
	Tf			17 ms	23 ms
Red Chromaticity	x		0.627 ms	0.647 ms	0.667 ms
	y		0.316 ms	0.336 ms	0.356 ms
Green Chromaticity	x		0.116 ms	0.136 ms	0.156 ms
	y		0.556 ms	0.576 ms	0.596 ms
Blue Chromaticity	x		0.116 ms	0.136 ms	0.156 ms
	y		0.109 ms	0.129 ms	0.149 ms
White Chromaticity	x		0.285 ms	0.305 ms	0.325 ms
	y		0.314 ms	0.334 ms	0.354 ms
Viewing Direction (O'Clock)				>12:00	

[1]Any one of the pixels can show any of the 16.7 million colors.

[2]Contrast Ratio = (brightness with pixels light)/(brightness with pixels dark).

[3]Response Time is the amount of time it takes a pixel to change from active to inactive or back again. Tr = T rise, Tf = T fall.

DEFINITION OF RESPONSE TIME (TR, TF)

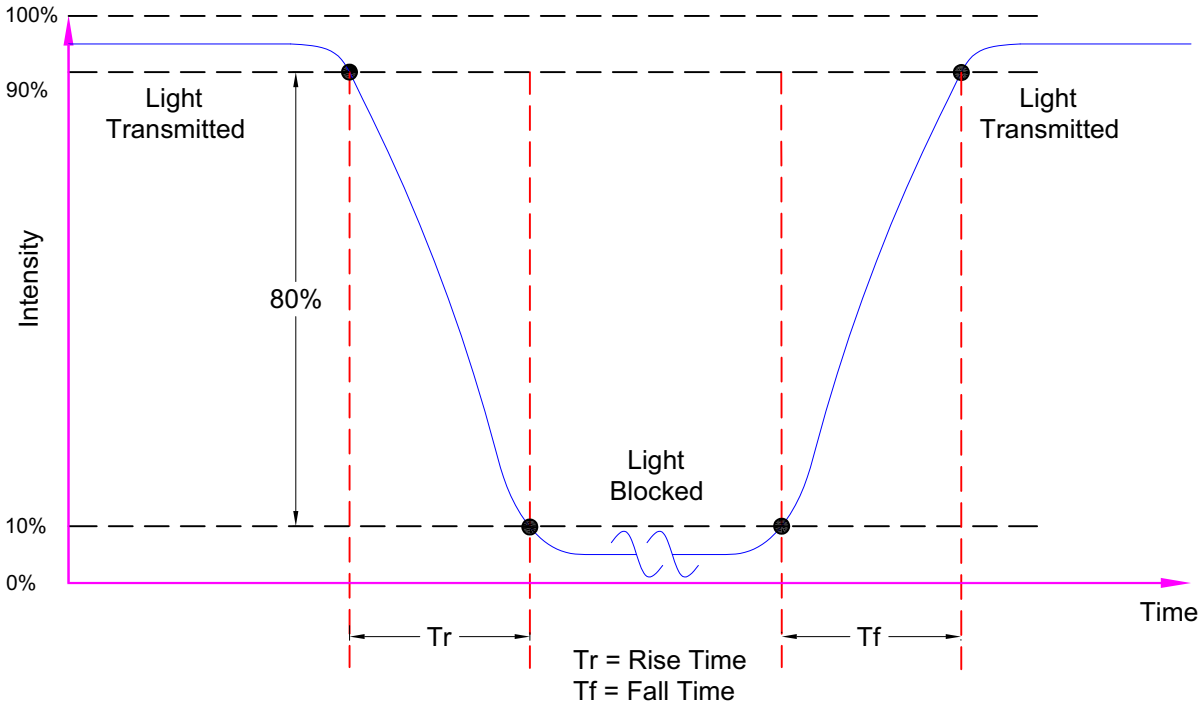


Figure 4. Definition of Response Time (Tr, Tf)

Definition of Vertical and Horizontal Viewing Angles (CR≥2)

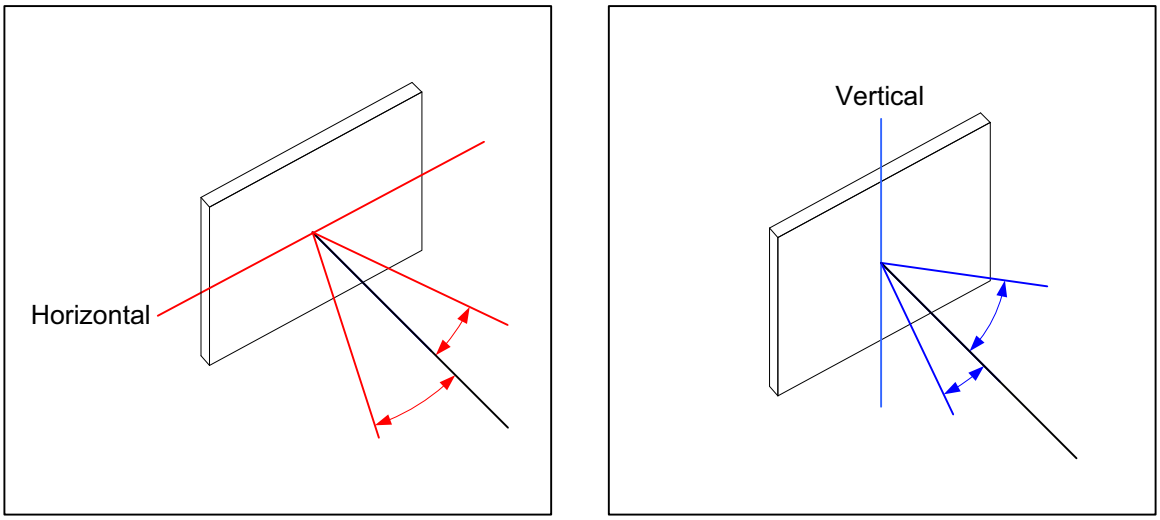


Figure 5. Definition of Horizontal and Vertical Viewing Angles (CR>2)

Definition of 6 O'Clock and 12:00 O'Clock Viewing Angles

This module has a 12:00 o'clock viewing angle. A 6:00 o'clock viewing angle is a bottom viewing angle like what you would see when you look at a cell phone or calculator. A 12:00 o'clock viewing angle is a top viewing angle like what you would see when you look at the gauges in a golf cart or airplane.

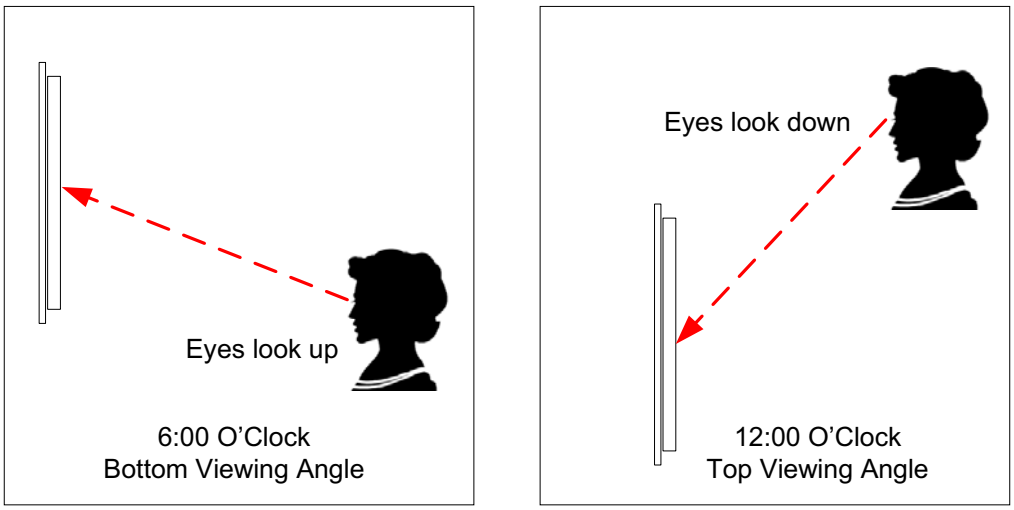


Figure 6. Definition of 6:00 O'Clock and 12:00 O'Clock Viewing Angles

LED BACKLIGHT CHARACTERISTICS

The ER-TFT035-1 uses an LED backlight. LED backlights are easy to use, but they are also easily damaged by abuse.

NOTE

We recommend that the LED backlight be dimmed or turned off during periods of inactivity to conserve its lifetime.

LEDs are "current" devices. The important aspect of driving an LED is the current flowing through it, not the voltage across it. Ideally, a current source would be used to drive the LEDs. In practice, a simple current limiting resistor in line from a voltage source will work well in most applications and is much less complex than a current source.

You need to know what the forward voltage of the LEDs is so you can calculate the current limiting resistor (R_{LIMIT}). The forward voltage will vary slightly from display to display.

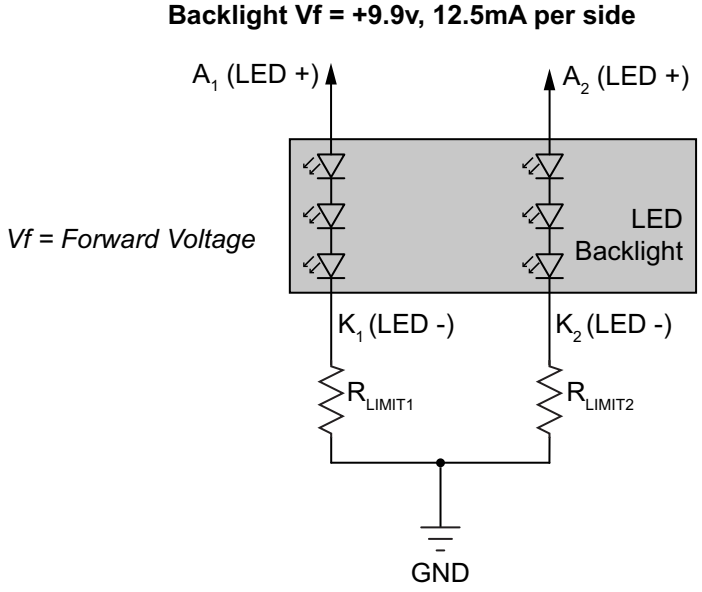


Figure 7. Typical LED Backlight Connections for “Always On”

PWM Dimming

The backlight may be dimmed by PWM (Pulse Width Modulation). The typical range for the PWM frequency is from 100 to 300 Hz.

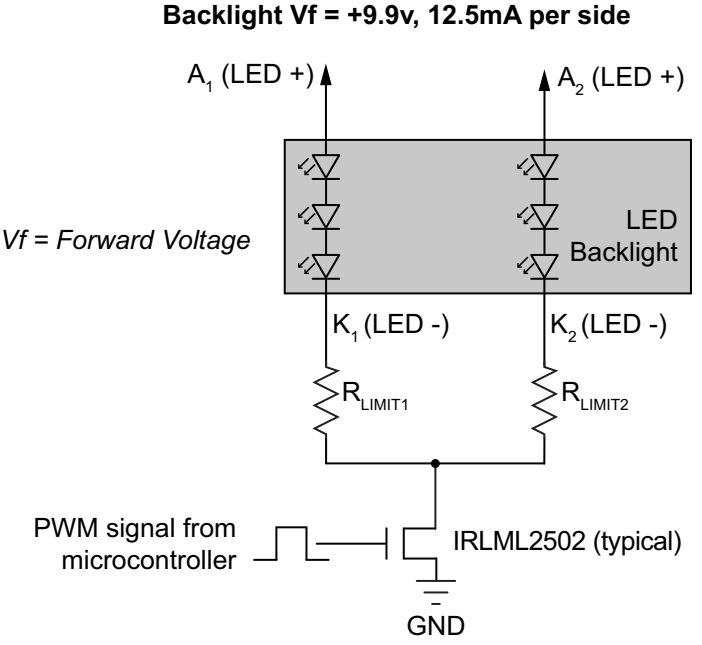


Figure 8. Example of LED Backlight Connections for PWM Dimming

Ambient temperature: T_A = 25°C

Backlight Characteristics

White edge-lit with two parallel rows of LEDs, three LEDs in each row, six total LEDs.

White LED backlight displays light pixels on a dark colored area (any color combination) or invert for dark colored pixels (any color combination) on a light area.

PARAMETER	MINIMUM	TYPICAL	MAXIMUM
Forward Current (I_{LED})	10mA per row 10mA x 2 rows = 20mA	12.5mA per row 12.5mA x 2 rows = 25mA	20mA per row 20mA x 2 rows = 40mA
Driving the backlight above 25mA will shorten its lifetime.			
Forward Voltage (V_{LED})	+8.4v	+9.6v	+10.2v
Luminous Intensity* (I_V) I_{LED} = 25mA	175 cd/m^2	200 cd/m^2	225 cd/m^2
The backlight is measured through the TFT. Direct backlight measurement is significantly brighter.			
Reverse Voltage (VR)			15v
Wavelength (I λ) I_{LED} = 25mA	x=0.25 y=0.25		x=0.29 y=0.29
Uniformity (minimum/maximum x 100%)	80%		

HOW TO USE CURRENT FEEDBACK LED DRIVER

The backlight has a total of six LEDs with two rows of three LEDs in series. The forward voltage for each LED is +3.3v. You need about +9.9v on each of the two anode lines for +19.8v total. Your I_{LED} (current) is about 12.5mA. You can, of course, adjust these values as needed for your application.

The maximum forward voltage is +3.5v. For lifetime reliability, we do not recommend pushing more than the 12.5mA through the LEDs.

MODULE RELIABILITY

ITEM	SPECIFICATION*
ER-TFT035-1	50,000 hours >50% of Initial Brightness (New Module)
*Under operating and storage temperature specification limitations, humidity RH 45+20%, and no exposure to direct sunlight.	

The white LEDs dim over time, especially if driven with high currents. The dimming may not be noticeable when a single display is installed. However, if a new display is installed next to a display that has been on continuously for a very long time, you will see the difference. To preserve the lifetime of white LEDs, we recommend that white LED backlights are dimmed or turned off when not needed. *Also, please do not use more current than you need to achieve your brightness requirements.*

MODULE LONGEVITY (EOL/REPLACEMENT POLICY)

EastRisingz is committed to making all of our modules available for as long as possible. For each module we introduce, we intend to offer it indefinitely. We do not preplan a module's obsolescence. The majority of modules we have introduced are still available.

We recognize that discontinuing a module may cause problems for some customers. However, rapidly changing technologies, component availability, or low customer order levels may force us to discontinue ("End of Life", EOL) a module. For example, we must occasionally discontinue a module when a supplier discontinues a component or a manufacturing process becomes obsolete. When we discontinue a module, we will do our best to find an acceptable replacement module with the same fit, form, and function.

In most situations, you will not notice a difference when comparing a "fit, form, and function" replacement module to the discontinued module. However, sometimes a change in component or process for the replacement module results in a slight variation, perhaps an improvement, over the previous design.

Although the replacement module is still within the stated Data Sheet specifications and tolerances of the discontinued module, changes may require modification to your circuit and/or firmware. Possible changes include:

- *Controller.* A new controller may require minor changes in your code.
- *Component tolerances.* Module components have manufacturing tolerances. In extreme cases, the tolerance stack can change the visual or operating characteristics.

Please understand that we avoid changing a module whenever possible; we only discontinue a module if we have no other option. We will post Part Change Notices on the product's webpage as soon as possible. If interested, you can subscribe to future part change notifications.

CARE AND HANDLING PRECAUTIONS

For optimum operation of the module and to prolong its life, please follow the precautions below.

ESD (ELECTRO-STATIC DISCHARGE)

The circuitry is industry standard CMOS logic and susceptible to ESD damage. Please use industry standard antistatic precautions as you would for any other static sensitive devices such as expansion cards, motherboards, or integrated circuits. Ground your body, work surfaces, and equipment.

DESIGN AND MOUNTING

- The exposed surface of the “glass” is actually a polarizer laminated on top of the glass. To protect the soft plastic polarizer from damage, the module ships with a protective film over the polarizer. Please peel off the protective film slowly. Peeling off the protective film abruptly may generate static electricity.
- The polarizer is made out of soft plastic and is easily scratched or damaged. When handling the module, avoid touching the polarizer. Finger oils are difficult to remove.
- To protect the soft plastic polarizer from damage, place a transparent plate (for example, acrylic, polycarbonate, or glass) in front of the module, leaving a small gap between the plate and the display surface. We use GE HP-92 Lexan, which is readily available and works well.
- Do not disassemble or modify the module.
- Do not modify the tab of the metal holder or make connections to it.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the module.
- Use care to keep the exposed terminals clean. Contamination, including fingerprints, may make soldering difficult and the reliability of the soldered connection poor.
- Sharp bends can damage the module FFC (Flat Flex Cable). Limit bend radius to at least R5.00 mm.

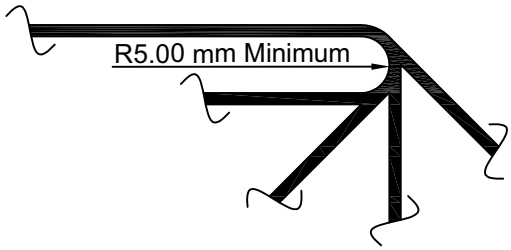


Figure 10. Limit Bend Radius of FFC

- Sharp bends can damage the module’s FFC. Do not crease FFC. Do not bend FFC tightly against the edge of the TFT panel.
- Do not repeatedly bend the FFC beyond its elastic region.

AVOID SHOCK, IMPACT, TORQUE, OR TENSION

- Do not expose the module to strong mechanical shock, impact, torque, or tension.
- Do not drop, toss, bend, or twist the module.
- Do not place weight or pressure on the module.

CLEANING

- The polarizer (laminated to the glass) is soft plastic. The soft plastic is easily scratched or damaged. Be very careful when you clean the polarizer.
- Do not clean the polarizer with liquids. Do not wipe the polarizer with any type of cloth or swab (for example, Q-tips).
- Use the removable protective film to remove smudges (for example, fingerprints) and any foreign matter. If you no longer have the protective film, use standard transparent office tape.
  If the polarizer is dusty, you may carefully blow it off with clean, dry, oil-free compressed air.

OPERATION

- We do not recommend connecting this module to a PC's parallel port as an "end product." This module is not "user friendly" and connecting it to a PC's parallel port is often difficult, frustrating, and can result in a "dead" display due to mishandling. .
- Your circuit should be designed to protect the module from ESD and power supply transients.
- Observe the operating temperature limitations: from -20°C minimum to +70°C maximum with minimal fluctuations. Operation outside of these limits may shorten the life and/or harm the display.
- Operate away from dust, moisture, and direct sunlight.

STORAGE AND RECYCLING

- Store in an ESD-approved container away from dust, moisture, and direct sunlight, fluorescent lamps, or any ultraviolet ray.
- Observe the storage temperature limitations: from -30°C minimum to +80°C maximum with minimal fluctuations. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Maximum storage life is 10 years within storage temperature limitations and normal humidity.
- Do not allow weight to be placed on the modules while they are in storage.
- Please recycle your outdated EastRising modules at an approved facility.

APPENDIX A: QUALITY ASSURANCE STANDARDS

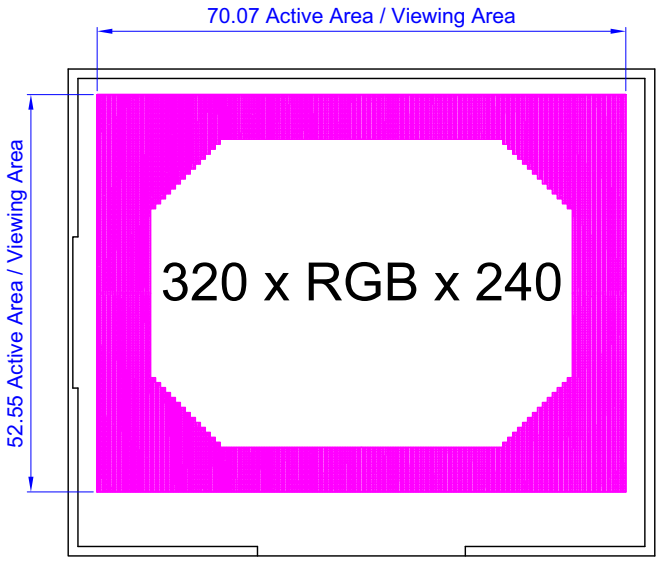
INSPECTION CONDITIONS

- Environment
  - Temperature: 25±5°C
  - Humidity: 30~85% RH (noncondensing)
- For visual inspection of active display area
  - Source lighting: two 20-Watt or one 40-Watt fluorescent light
  - Display adjusted for best contrast
  - Viewing distance: 30±5 cm (about 12 inches)
  - Viewing angle: inspect at 45° angle of vertical line right and left, top and bottom

COLOR DEFINITIONS

We try to describe the appearance of our modules as accurately as possible. For the photos, we adjust for optimal appearance. Actual display appearance may vary due to (1) different operating conditions, (2) small variations of component tolerances, (3) inaccuracies of our camera, (4) color interpretation of the photos on your monitor, and/or (5) personal differences in the perception of color.

DEFINITION OF ACTIVE AREA AND VIEWING AREA



ACCEPTANCE SAMPLING

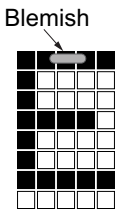
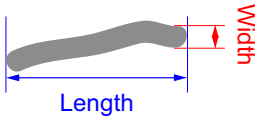
DEFECT TYPE	AQL*
Major	≤.65%
Minor	<1.0%
* Acceptable Quality Level: maximum allowable error rate or variation from standard	

DEFECTS CLASSIFICATION

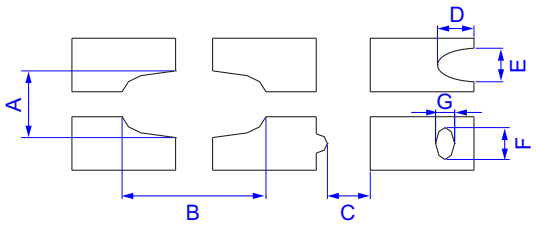
Defects are defined as:

- Major Defect: results in failure or substantially reduces usability of unit for its intended purpose.
- Minor Defect: deviates from standards but is not likely to reduce usability for its intended purpose.

ACCEPTANCE STANDARDS

#	DEFECT TYPE	CRITERIA			MAJOR / MINOR
1	Electrical defects	1. No display, display malfunctions, or shorted segments. 2. Current consumption exceeds specifications.			Major
2	Viewing area defect	Viewing area does not meet specifications.			Major
3	Blemishes or foreign matter on display segments		*Defect Size*	*Acceptable Qty*	Minor
			≤0.30 mm	3	
			≤2 defects within 10 mm of each other		
4	Dark lines or scratches in display area 	*Defect Width*	*Defect Length*	*Acceptable Qty*	Minor
		≤0.03 mm	≤3.0 mm	3	
		0.03 to 0.05	≤2.0 mm	2	
		0.05 to 0.08	≤2.0 mm	1	
		0.08 to 0.10	≤3.0 mm	0	
		≥0.10	>3.0 mm	0	

ACCEPTANCE STANDARDS, CONTINUED

<table>
<tr><th>#</th><th>DEFECT TYPE</th><th colspan="3">CRITERIA</th><th>MAJOR / MINOR</th></tr>
<tr><td rowspan="5">5</td><td rowspan="5">Bubbles between polarizer film and glass</td><td colspan="2">Defect Size</td><td>Acceptable Qty</td><td rowspan="5">Minor</td></tr>
<tr><td colspan="2">≤0.20 mm</td><td>Ignore</td></tr>
<tr><td colspan="2">0.20 to 0.40 mm</td><td>3</td></tr>
<tr><td colspan="2">0.40 to 0.60 mm</td><td>2</td></tr>
<tr><td colspan="2">≥0.60 mm</td><td>0</td></tr>
<tr><td rowspan="6">6</td><td rowspan="6">Display pattern defect</td><td colspan="3"> 
</td><td rowspan="6">Minor</td></tr>
<tr><td>Pixel Size</td><td colspan="2">Acceptable Qty</td></tr>
<tr><td>((A+B)/2)≤0.20 mm</td><td colspan="2" rowspan="4">≤3 total defects
≤2 pinholes per digit</td></tr>
<tr><td>C>0 mm</td></tr>
<tr><td>((D+E)/2)≤0.25 mm</td></tr>
<tr><td>((F+G)/2)≤0.25 mm</td></tr>
<tr><td>7</td><td>PCB defects</td><td colspan="3">1. Oxidation or contamination on connectors.*
2. Wrong parts, missing parts, or parts not in specification.*
3. Jumpers set incorrectly.
4. Solder (if any) on bezel, LED pad, zebra pad, or screw hole pad is not smooth.
*Minor if display functions correctly. Major if the display fails.</td><td>Minor</td></tr>
<tr><td>8</td><td>Soldering defects</td><td colspan="3">1. Unmelted solder paste.
2. Cold solder joints, missing solder connections, or oxidation.*
3. Solder bridges causing short circuits.*
4. Residue or solder balls.
5. Solder flux is black or brown.
*Minor if display functions correctly. Major if the display fails.</td><td>Minor</td></tr>
</table>

APPENDIX B: TFT MODULE TERMS AND SYMBOLS

Symbol	Description
A (LED +)	Supply pin for LED. "A" (anode) or "+" of LED backlight. If more than one, may be labeled as A_1, A_2, ...
cd/m^2 lumen	Candela per square meter. A unit of measurement used to measure Luminous Intensity. cd/m^2 = 1 lumen
$\overline{CS}$ CS#	Chip select input. *Low:* Controller chip is selected. Communications with host are possible. *High:* Controller chip is not selected. Host interface signals are ignored by the controller.
COF	Chip On Flex. Controller is on the FPC. Similar in appearance to "TAB." The flex circuit on COF is typically much thinner than the flex of a "flex tail."
COG	Chip On Glass. Controller is on the glass panel.
DB0 ~ DB*n* D0 ~ D*n*	Parallel databus.
D/$\overline{C}$ RS A0 CD D/C#	Data/Command control. Determines whether data bits are data or command. *1 – High:* Addresses the data register. *0 – Low:* Addresses the command register.
DCLK	Dot-clock signal and oscillator source. A non-stop external clock must be provided to that pin even at front or back porch non-display period. RGB interface only.
DEN	Display enable pin from controller. RGB interface only.
ESD	Electro-Static Discharge. Sudden and brief electrical current that flows between two objects. ESD between a human and a TFT module can cause permanent damage.
FFC	Flat Flexible Cable. Also called "flex tail" or "pigtail". Typically thinner than the "flex" film of COG (Chip On Glass).
FPC	Flexible Printed Circuit. Also called "flex tail" or "pigtail". Typically much thicker than the "flex" film of COF (Chip On Flex).
GND V_{SS}	Power supply and signal ground. Must be connected to an external ground.
HSYNC	Line synchronization input. RGB interface only.
I_{DD}	Typical power supply current for LCD. Total electrical current (I) in the Drains of a CMOS circuit.
I_{LED}	Current used by LED backlight.
IM*n*	Interface mode select pin. (Where *n* is the corresponding number.)

<table>
<tr><th>Symbol</th><th>Description (Continued)</th></tr>
<tr><td>I_{OP}</td><td>Current for normal Operation, typically measured in milliamperes (mA).
1 mA = 0.001A (Ampere)</td></tr>
<tr><td>I_{ST}</td><td>Current for STandby mode, typically measured in microampere (μA).
1 μA = 0.000,001A (Ampere)</td></tr>
<tr><td>I/O
IO</td><td>Input/Output</td></tr>
<tr><td>K (LED -)</td><td>Supply pin for LED. “K” (cathode or kathode for German and original Greek spelling) or “-” of LED backlight. If more than one, may be labeled as K_1, K_2, ...</td></tr>
<tr><td>mm</td><td>Millimeter or millimetre. Unit of length equal to one thousandth of a meter.
1 millimeter = 0.0394 inches</td></tr>
<tr><td>mW</td><td>Milliwatt is equal to one thousandth of a Watt.
Watts = Volts x Amps</td></tr>
<tr><td>NC
nc</td><td>Make no connection.</td></tr>
<tr><td>PSn-PS0</td><td>
<table>
<tr><th>PS3</th><th>PS2</th><th>PS1</th><th>PS0</th><th>Interface Mode</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>16-bit 6800 parallel interface. (if available)</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>8-bit 6800 parallel interface. (if available)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>16-bit 8080 parallel interface.</td></tr>
<tr><td colspan="5">. . . . . .</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>8-bit 8080 parallel interface. (if available)</td></tr>
</table>
</td></tr>
<tr><td>PWM</td><td>Pulse Width Modulation is a way to simulate intermediate levels by switching a level between full on and full off. PWM is typically used to control the brightness of LED backlights, relying on the natural averaging by the human eye.</td></tr>
<tr><td>$\overline{RD}_{8080}$ (E_{6800})
$\overline{RD}$ (E)
E ($\overline{RD}$)
E</td><td>Host interface input.

8080 Host: Active low. Signal on the databus is latched at the rising edge of $\overline{RD}$.

6800 Host (if available): Enable control signal input active high.
E = High: Read or Write operation is active
E = Low: No operation</td></tr>
<tr><td>RGB</td><td>Typically used to indicate that Red, Green, and Blue are combined to produce a broad array of colors.</td></tr>
<tr><td>RoHS</td><td>Restriction of Hazardous Substances Directive, an environmental standard.</td></tr>
</table>

Symbol	Description (Continued)
$\overline{RST}$ $\overline{RES}$ RST# RES RESET#	Reset signal. *Low:* Display controller is reset. The $\overline{RST}$ pin should be pulsed low shortly after power is applied. *High:* The $\overline{RST}$ pin should be brought high for normal operation.
SCL	Serial clock input.
SDO MISO	Data output pin in serial interface. (Serial Data Out)
SI SDI MOSI	Data input pin in serial interface. (Serial Data In)
Ta TA	"Ambient temperature" is the temperature of the air that surrounds a component.
Tf	Unit of measurement for LCD response time. f = falling edge.
TFT	Thin-Film Transistor fabricated directly on the display substrate.
T_{OP}	Operating temperature.
Tr	Unit of measurement for LCD response time. r = rising edge.
T_{ST} T_{STG}	Storage temperature.
V_{IH} V_{ICH}	High level input voltage.
V_{IL} V_{LCH}	Low level input voltage.
V_{LED}	Forward voltage for LED backlight.
V_{LOGIC} V_{CC} V_{DD} V_{CI}	Power supply input. Must be connected to an external source.
$V_{LOGIC\ I/O}$ V_{CCIO}	Supply voltage for I/O signals.
V_{OH} V_{OHC}	High level output voltage.

Symbol	Description (Continued)
V_{OL} V_{OLC}	Low level output voltage.
VSYNC	Frame/RAM write synchronization input. RGB Interface only.
$\overline{WR}_{8080}$ ($R/\overline{W}_{6800}$) $R/\overline{W}$ ($\overline{WR}$) $\overline{WR}$ ($R/\overline{W}$) R/W#	Host interface input. *8080 Host:* Active low. Signal on the databus is latched at the rising edge of $\overline{WR}$ signal. *6800 Host (if available):* Read/Write control signal output. *R/$\overline{W}$* = High: Read (Host←Module) *R/$\overline{W}$* = Low: Write (Host→Module)