



CrystalFontz America, Incorporated

CHARACTER LCD MODULE SPECIFICATIONS



Data Sheet Release 2012/08/22

for

[CFAH2002D-TMI-ET](#)

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Note on Hardware Revisions

For information about hardware revisions, see the Part Change Notifications (PCNs) under “News” in our website’s navigation bar.

Data Sheet Revision History

Current Data Sheet Release Date: 2012/08/22

Since last Data Sheet (2008/12/15):

- Added note About Variations on this page.
- Added definition for Duty and Bias. See [Driving Method \(Pg. 9\)](#).
- Corrected backlight specifications. See [LED Backlight Characteristics \(Pg. 17\)](#).
- Improved illustration. See [Module Outline Drawing \(Pg. 7\)](#).

2008/12/15	Data Sheet version: v1.0 Changes since last Data Sheet: <ul style="list-style-type: none">● Improved drawings, tables, and text.● Corrected error in Details of Interface Pin Functions. Arrows for description of R/W signal were reversed.● Added a photo with pins labeled. See Quick Reference for Pin Functions.● Added LCD CONTROLLER INTERFACE.● Added APPENDIX C: SITRONIX ST7066U CONTROLLER SPECIFICATION SHEET and removed redundant information in the Crystalfontz Data Sheet.
2006/12/15	New Data Sheet.

About Variations

We work continuously to improve our products. Because display technologies are quickly evolving, these products may have component or process changes. Slight variations (for example, contrast, color, or intensity) between lots are normal. If you need the highest consistency, whenever possible, order and arrange delivery for your production runs at one time so your displays will be from the same lot.



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MAIN FEATURES

- ❑ 20 characters by 2 lines LCD has a large display area in a compact 89.0 (W) x 21.5 (H) x 9.6 maximum (D) millimeter package (3.50" (W) x 0.94" (H) x 0.38" (D)).
- ❑ 4-bit or 8-bit parallel interface.
- ❑ Standard Hitachi HD44780 equivalent controller.
- ❑ White edge LED backlight with STN, negative, blue, transmissive mode LCD (displays light characters on a blue background).
- ❑ Wide temperature operation: -20°C to +70°C.
- ❑ RoHS compliant.

MODULE CLASSIFICATION INFORMATION



<u>C</u>	<u>F</u>	<u>A</u>	<u>H</u>	<u>2</u>	<u>0</u>	<u>2</u>	<u>D</u>	-	<u>T</u>	<u>M</u>	<u>I</u>	-	<u>E</u>	<u>T</u>	*
①	②	③	④	⑤		⑥	⑦	⑧		⑨	⑩	⑪			

①	Brand	CrystalFontz America, Inc.
②	Display Type	H – Character
③	Number of Characters (Width)	20 Characters
④	Number of Lines (Height)	2 Lines
⑤	Model Identifier	D
⑥	Backlight Type & Color	T – LED, white
⑦	Fluid Type, Image (Positive or Negative), & LCD Glass Color	M – STN, negative, blue
⑧	Polarizer Film Type, Wide (WT) Temperature Range, & Viewing Angle (O'clock)	I – Transmissive, WT, 6:00 ¹
⑨	Character Set (CGROM)	E – English and European fonts
⑩	Controller	T – Sitronix ST7066U
⑪	Special Codes	* – May have additional manufacturer's codes at this location.

¹For more information on Viewing Angle, see [Definition of 6 O'Clock and 12:00 O'Clock Viewing Angles \(Pg. 16\)](#).



ORDERING INFORMATION

PART NUMBER	FLUID	LCD GLASS COLOR	IMAGE	POLARIZER FILM	BACKLIGHT COLOR/TYPE	
CFAH2002D-TMI-ET	STN	blue	negative	transmissive	white LED	
<i>Additional variants (same form factor, different LCD mode or backlight):</i>						
CFAH2002D-YYH-ET	STN	yellow-green	positive	transflective	yellow-green LED	

MECHANICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS

ITEM	SIZE
Number of Characters and Lines	20 Characters x 2 Lines
Module Dimensions	89.0 (W) x 21.5 (H) x 9.6 Maximum (D) mm
Viewing Area	75.0 (W) x 15.0 (H) mm
Active Area	68.50 (W) x 10.70 (H) mm
Character Size	2.95 (W) x 5.15 (H) mm
Character Pitch	3.45 (W) x 5.55 (H) mm
Dot Size	0.55 (W) x 0.60 (H) mm
Dot Pitch	0.60 (W) x 0.65 (H) mm
Weight	18 grams (typical)



MODULE OUTLINE DRAWING

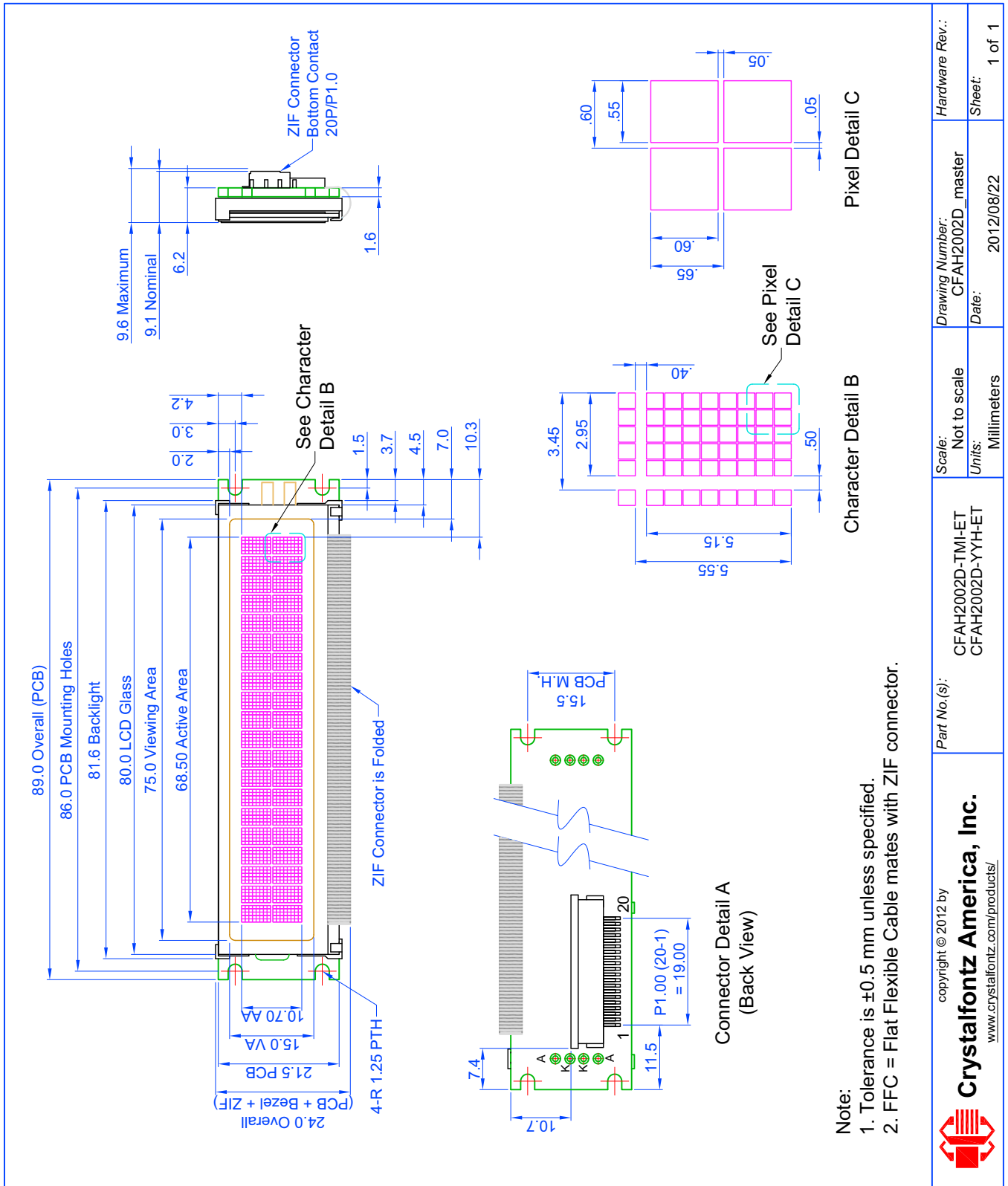


Figure 1. Module Outline Drawing



FLEX CABLE CONNECTIONS

The header on the CFAH2002D-TMI-ET is a 1.00 mm pitch Flat Flex Cable (FFC/FPC) 20 position connector.

Here is an example of a 3-inch long FFC for this connector:

<http://www.digikey.com/scripts/DkSearch/dksus.dll?PName?Name=HF20U-03-ND>

Here are a few examples of FFC/FPC mating connectors:

Vertical ZIF

Molex 71226-2025:

<http://www.digikey.com/scripts/DkSearch/dksus.dll?PName?Name=WM5308-ND>

Right angle, bottom contact ZIF

Molex 52043-2019:

http://www.molex.com/molex/products/datasheet.jsp?part=active/0520432019_FFC_FPC_CONNECTORS.xml&channel=Products&Lang=en-US

Right angle, top contact ZIF

Molex 52089-2019

http://www.molex.com/molex/products/datasheet.jsp?part=active/0520892019_FFC_FPC_CONNECTORS.xml&channel=Products&Lang=en-US

Other options include the Oupiin 2434 series of 1.00 mm FFC/FPC connectors (<http://www.oupiin.com/search-pro.asp>).

ELECTRICAL SPECIFICATIONS

SYSTEM BLOCK DIAGRAM

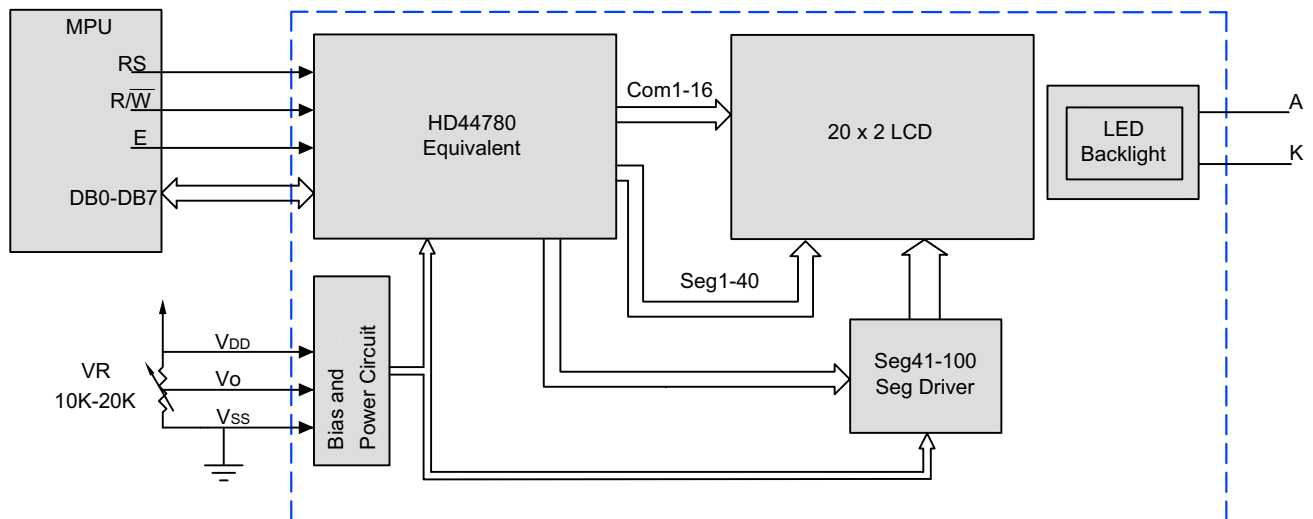


Figure 2. System Block Diagram



DRIVING METHOD

DRIVING METHOD	SPECIFICATION
Duty ¹	1/16
Bias ²	1/5

¹The duty cycle, also known as duty ratio or multiplex rate, is the fraction of total frame time that each row of the LCD is addressed.

²The drive bias, also known as voltage margin, is related to the number of voltage levels used when driving the LCD. Bias is defined as $1/(\text{number of voltage levels}-1)$. The more segments driven by each driver(1), the higher number of voltage levels are required. There is a direct relationship between the bias and the duty.



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
Input Voltage	V _I	V _{SS}	V _{DD}
Supply Voltage for Logic	V _{DD} - V _{SS}	-0.3v	+7v
Supply Voltage for LCD	V _{DD} - V _O	-0.3v	+13v

*Note: Prolonged exposure at temperatures outside of this range may cause permanent damage to the module.

DC CHARACTERISTICS (5V AND 3.3V OPERATION)

5V OPERATION							
PART	DC CHARACTERISTICS (4.5 to 5.5 volts)	TEST CONDITION	SYMBOL	MINIMUM	TYPICAL	MAXIMUM	NOTES
Controller and Board	Supply Voltage for Logic		V _{DD} - V _{SS}	+4.5v	+5.0v	+5.5v	
	Input High Voltage	V _{DD} = 5V	V _{IH}	+3.5v		V _{DD}	Pins: E, RS, R/W, DB0 - DB7
	Input Low Voltage		V _{IL}			+0.6v	
	Output High Voltage	V _{DD} = 5V	V _{OH}	+3.7v			I _{OH} = - 0.1 mA Pins: DB0 - DB7
	Output Low Voltage		V _{OL}			+0.4v	I _{OL} = 0.1 mA Pins: DB0 - DB7
	Supply Current	without backlight	I _{DD}		1.2 mA		
LCD Glass	Supply Voltage for Driving LCD	TA = -20°C				+4.2v	
		TA = +25°C	V _{DD} - V _O		+3.8v		
		TA = +70°C		+3.6v			

This is a summary of the module's major operating parameters. For detailed information, see [APPENDIX C: SITRONIX ST7066U CONTROLLER SPECIFICATION SHEET \(Pg. 29\)](#).



3.3V OPERATION							
PART	DC CHARACTERISTICS (2.7 to 4.5 volts)	TEST CONDITION	SYMBOL	MINIMUM	TYPICAL	MAXIMUM	NOTES
Controller and Board	Supply Voltage for Logic		$V_{DD} - V_{SS}$	+2.7v	+3.3v	+4.5v	
	Input High Voltage	$V_{DD} = 3.3V$	V_{IH}	+2.3v		V_{DD}	Pins: E, RS, R/W, DB0 - DB7
	Input Low Voltage		V_{IL}			+0.6v	
	Output High Voltage	$V_{DD} = 3.3V$	V_{OH}	+2.4v			$I_{OH} = -0.1 \text{ mA}$ Pins: DB0 - DB7
	Output Low Voltage		V_{OL}			+0.4v	$I_{OL} = 0.1 \text{ mA}$ Pins: DB0 - DB7
	Supply Current	without backlight	I_{DD}		1.2 mA		
LCD Glass	Supply Voltage for Driving LCD	TA = -20°C				+4.2v	
		TA = +25°C	$V_{DD} - V_O$		+3.8v		
		TA = +70°C		+3.6v			
<p>This is a summary of the module's major operating parameters. For detailed information see APPENDIX C: SITRONIX ST7066U CONTROLLER SPECIFICATION SHEET (Pg. 29).</p> <p>For more information about 3.3v operation, please see APPENDIX B: APPLICATION NOTE FOR 3.3V OPERATION (Pg. 27).</p>							



DETAILS OF INTERFACE PIN FUNCTIONS

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
1	NC			No Connection
2	NC			No Connection
3	VSS	0v		Ground
4	V _{DD}	+3~5.0v		Supply voltage for logic
5	V _O	variable		Supply voltage for driving LCD is V _O = +1v typical at V _{DD} = +5v which gives a V _{LCD} = (V _{DD} - V _O) = +4v
6	RS	H/L	I	Register selection input H: Data register (for read and write) L: Instruction code (for write)
7	R \bar{W}	H/L	I	H: Read (Host←Module) L: Write (Host→Module)
8	E	H,H→L	I	Read/write enable signal H: Read data is enabled by a high level H→L: Write data is latched on the falling edge
9	DB0	H/L	I/O	Data bit 0
10	DB1	H/L	I/O	Data bit 1
11	DB2	H/L	I/O	Data bit 2
12	DB3	H/L	I/O	Data bit 3
13	DB4	H/L	I/O	Data bit 4
14	DB5	H/L	I/O	Data bit 5
15	DB6	H/L	I/O	Data bit 6
16	DB7	H/L	I/O	Data bit 7
17	A (LED +)			Supply voltage for LED. "A" (anode) or "+" of LED backlight
18	K (LED -)			Supply voltage for LED. "K" (cathode or kathode for German and original Greek spelling) or "-" of LED backlight
19	NC			No Connection
20	NC			No Connection

For backlight connections, please refer to [LED Backlight Characteristics \(Pg. 17\)](#).



QUICK REFERENCE FOR PIN FUNCTIONS

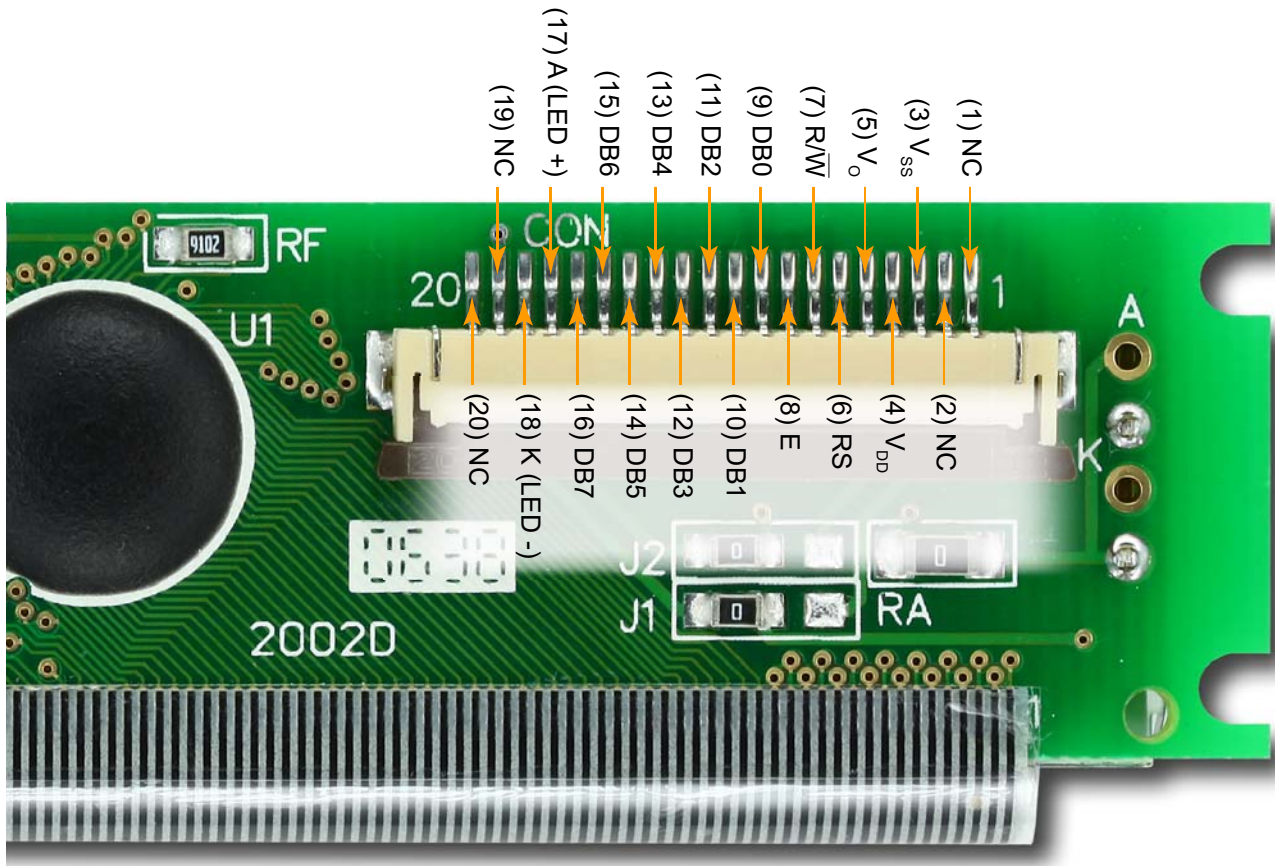


Figure 3. Back View of Pins (Labeled)

TYPICAL V_O CONNECTIONS FOR DISPLAY CONTRAST

Adjust V_O to +1v ($V_{LCD} = +4v$) as an initial setting. When the module is operational, readjust V_O for optimal display appearance.

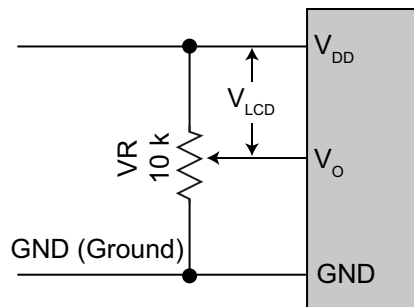


Figure 4. Typical V_O Connections

We recommend allowing field adjustment of V_O for all designs. The optimal value for V_O will change with temperature, variations in V_{DD} , and viewing angle. V_O will also vary module-to-module and batch-to-batch due to normal manufacturing variations.



Ideally, adjustments to V_O should be available to the end user so each user can adjust the display to the optimal contrast for their required viewing conditions. At a minimum, your design should allow V_O to be adjusted as part of your product's final test.

Although a potentiometer is shown as a typical connection, V_O can be driven by your microcontroller, either by using a DAC or a filtered PWM. Displays that require V_O to be negative may need a level-shifting circuit. Please do not hesitate to contact Crystalfontz application support for design assistance on your application.

ESD (ELECTRO-STATIC DISCHARGE) SPECIFICATIONS

This circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard antistatic precautions as you would for any other PCB such as expansion cards or motherboards. For more information, see [CARE AND HANDLING PRECAUTIONS \(Pg. 22\)](#).

OPTICAL SPECIFICATIONS

OPTICAL CHARACTERISTICS

ITEM	SYMBOL	CONDITION	MINIMUM	TYPICAL	MAXIMUM
Viewing Angle (6 o'clock) (Vertical, Horizontal)	(V) θ	CR \geq 2	20°		40°
	(H) ϕ	CR \geq 2	-30°		30°
Contrast Ratio	CR			3	
LCD Response Time*	T rise	Ta = 25°C		150 ms	200 ms
	T fall	Ta = 25°C		150 ms	200 ms
*Response Time: The amount of time it takes a liquid crystal cell to go from active to inactive or back again.					

OPTICAL DEFINITIONS

- Operating Voltage (V_{LCD}): V_{OP}
- Viewing Angle
 - Vertical (V) θ : 0°
 - Horizontal (H) ϕ : 0°
- Frame Frequency: 64 Hz
- Driving Waveform: 1/16 Duty, 1/5 Bias
- Ambient Temperature (Ta): 25°C



Definition of Operation Voltage (Vop)

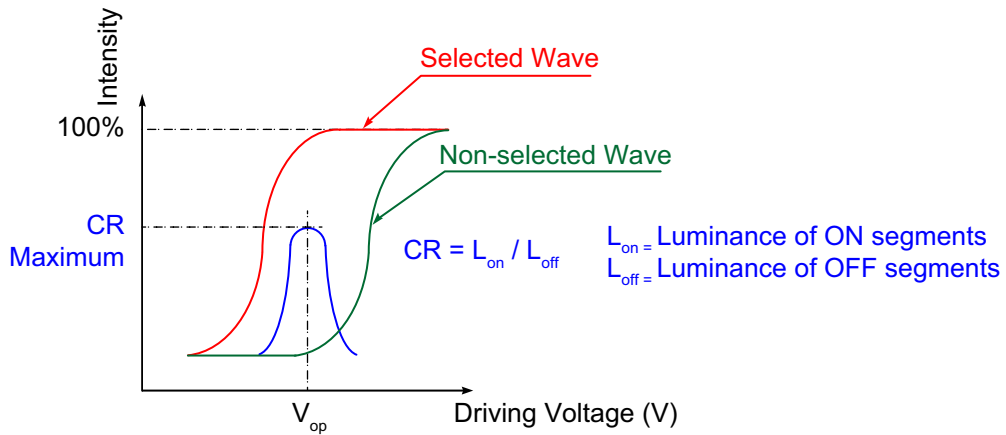


Figure 5. Definition of Operation Voltage (V_{OP}) (Negative)

Definition of Response Time (T_r , T_f)

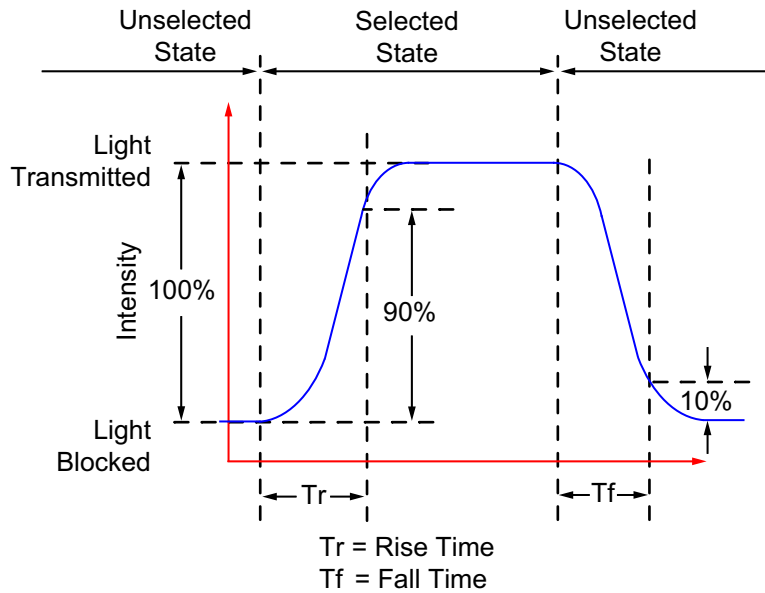


Figure 6. Definition of Response Time (T_r , T_f) (Negative)



Definition of Vertical and Horizontal Viewing Angles ($CR \geq 2$)

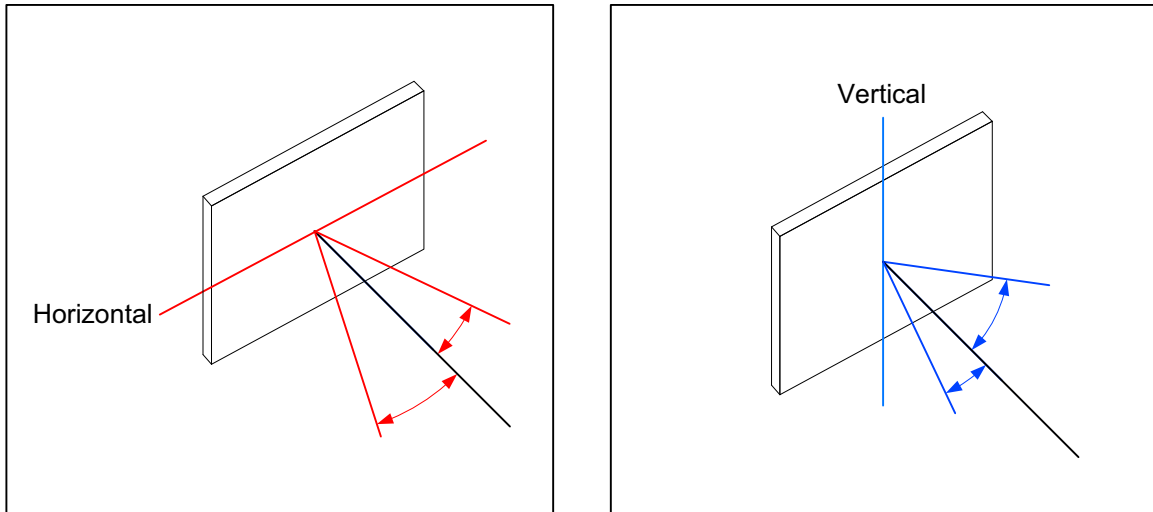


Figure 7. Definition of Horizontal and Vertical Viewing Angles ($CR > 2$)

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

This module has a 6:00 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.

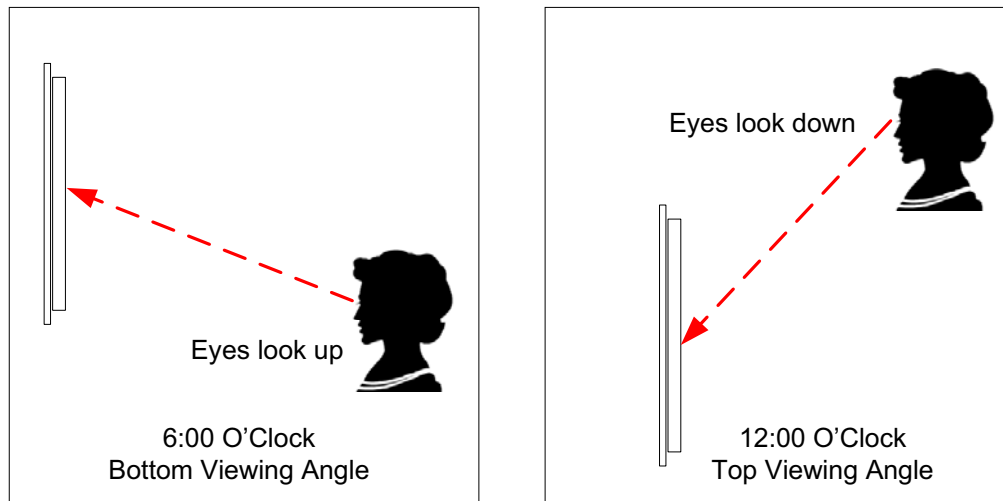


Figure 8. Definition of 6:00 O'Clock and 12:00 O'Clock Viewing Angles



LED BACKLIGHT CHARACTERISTICS

The CFAH2002D-TMI-ET uses an LED backlight. LED backlights are easy to use, but they are also easily damaged by abuse.

NOTE

Do not connect +5v directly to the backlight terminals. This will ruin the backlight.

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.

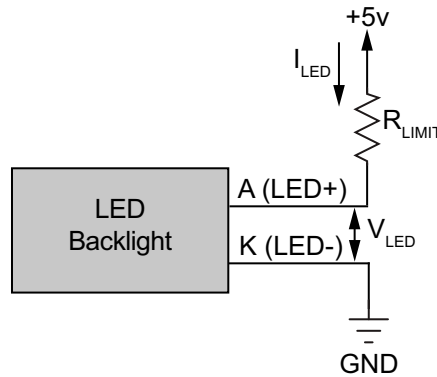


Figure 9. Typical LED Backlight Connections for “Always On”

The equation to calculate R_{LIMIT} is:

$$R_{LIMIT} \text{ (minimum)} = \frac{V_{DD} \text{ (Supply Voltage)} - V_{LED} \text{ (Typical LED Forward Voltage)}}{I_{LED} \text{ (Typical LED Forward Current)}}$$

The specific R_{LIMIT} calculation for the CFAH2002D-TMI-ET at $V_{DD} = +5v$ is:

$$R_{LIMIT} = \frac{5v - 3.5v}{0.03 \text{ A}} = 50\Omega \text{ (minimum)}$$



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

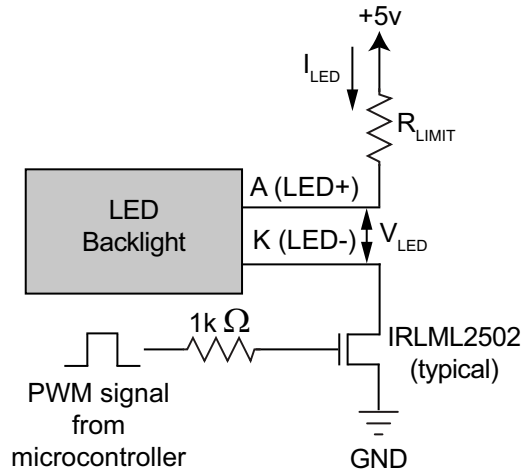



Figure 10. Example of LED Backlight Connections for PWM Dimming

LED Backlight Characteristics			
			
Light dots on blue background. <i>White edge-lit with two LEDs on each side.</i>			
PARAMETER	MINIMUM	TYPICAL	MAXIMUM
Forward Current (I_{LED}) $V = 3.5v$	7.2 mA per LED 7.2 mA x 4 = 28.8 mA	8 mA per LED 8 mA x 4 = 32 mA	12.5 mA per LED 12.5 mA x 4 = 50 mA
Forward Voltage (V_{LED})	+3.4v	+3.5v	+3.6v
Reverse Voltage (V_R)			+5v
Luminous Intensity* (I_V) $I_{LED} = 32 mA$	130 cd/m ²	150 cd/m ²	
*Direct measurement of backlight—the backlight is not measured through the LCD.			



LCD CONTROLLER INTERFACE

This module uses a Sitronix ST7066U controller. The Sitronix ST7066U is compatible with the industry standard Hitachi HD44780 controller. Software written for modules that use the HD44780 should work without modification.

For your reference, we added [APPENDIX C: SITRONIX ST7066U CONTROLLER SPECIFICATION SHEET \(Pg. 29\)](#) to this Data Sheet.

DISPLAY POSITION DDRAM ADDRESS

The following table shows the relationship between the controller's addresses and the corresponding character location on the module.

		COLUMN																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ROW	0	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07	0x08	0x09	0xA	0xB	0xC	0xD	0xE	0xF	0x10	0x11	0x12	0x13
	1	0x40	0x41	0x42	0x43	0x44	0x45	0x46	0x47	0x48	0x49	0x4A	0x4B	0x4C	0x4D	0x4E	0x4F	0x50	0x51	0x52	0x53



CHARACTER GENERATOR ROM (CGROM)

To find the code for a given character, add the two numbers that are shown in bold for its row and column. For example, the lowercase “h” is in the column labeled “96₁₀” and in the row labeled “8₁₀”. So you would add 96 + 8 to get 104. When you send a byte with the value of 104 to the display, then a lowercase “h” will be shown. (See [APPENDIX C: SITRONIX ST7066U CONTROLLER SPECIFICATION SHEET \(Pg. 29\)](#)).

upper 4 bits lower 4 bits	0 ₁₀ 0000 ₂	16 ₁₀ 0001 ₂	32 ₁₀ 0010 ₂	48 ₁₀ 0011 ₂	64 ₁₀ 0100 ₂	80 ₁₀ 0101 ₂	96 ₁₀ 0110 ₂	112 ₁₀ 0111 ₂	128 ₁₀ 1000 ₂	144 ₁₀ 1001 ₂	160 ₁₀ 1010 ₂	176 ₁₀ 1011 ₂	192 ₁₀ 1100 ₂	208 ₁₀ 1101 ₂	224 ₁₀ 1110 ₂	240 ₁₀ 1111 ₂
0 ₁₀ 0000 ₂	CGRAM [0]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
1 ₁₀ 0001 ₂	CGRAM [1]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2 ₁₀ 0010 ₂	CGRAM [2]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3 ₁₀ 0011 ₂	CGRAM [3]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4 ₁₀ 0100 ₂	CGRAM [4]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5 ₁₀ 0101 ₂	CGRAM [5]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6 ₁₀ 0110 ₂	CGRAM [6]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7 ₁₀ 0111 ₂	CGRAM [7]	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8 ₁₀ 1000 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
9 ₁₀ 1001 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10 ₁₀ 1010 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11 ₁₀ 1011 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
12 ₁₀ 1100 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
13 ₁₀ 1101 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
14 ₁₀ 1110 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
15 ₁₀ 1111 ₂		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 11. Character Generator ROM (CGROM)



MODULE RELIABILITY AND LONGEVITY

MODULE RELIABILITY

ITEM	SPECIFICATION	
LCD excluding backlight	50,000 to 100,000 hours (typical)	
White LED Backlight ($I_{LED} < 40 \text{ mA}$)* <i>*We recommend that the backlight of the white LED backlit modules be dimmed or turned off during periods of inactivity to conserve the white LED backlight lifetime.</i>	Power-On Hours	% of Initial Brightness (New Module)
	<10,000	>90%
	<50,000	>50%

We list the lifetime of this white LED at 10,000 hours to emphasize that white LEDs do not have the extremely long lifetime typical of red or green LEDs. 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)

Crystalfontz is committed to making all of our LCD 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 it replaces. 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:

- *LCD fluid, polarizers, or the LCD manufacturing process.* These items may change the appearance of the display, requiring an adjustment to V_O (See [Typical VO Connections for Display Contrast \(Pg. 13\)](#)).
- *Backlight LEDs.* Brightness may be affected (perhaps the new LEDs have better efficiency) or the current they draw may change (new LEDs may have a different VF).
- *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 PCB such as expansion cards or motherboards. Ground your body, work surfaces, and equipment.

DESIGN AND MOUNTING

- The exposed surface of the LCD “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.
- Solder only to the I/O terminals. Use care when removing solder—it is possible to damage the PCB.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the module.

AVOID SHOCK, IMPACT, TORQUE, AND TENSION

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

IF LCD PANEL BREAKS

- If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or eyes.
- If the liquid crystal fluid touches your skin, clothes, or work surface, wash it off immediately using soap and plenty of water.
- Do not eat the LCD panel.

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 (for example, Scotch® brand “Crystal Clear 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 them to a PC's parallel port is often difficult, frustrating, and can result in a "dead" display due to mishandling. For more information, see our forum thread at <http://www.crystalfontz.com/forum/showthread.php?s=&threadid=3257>.
- 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.
 - At lower temperatures of this range, response time is delayed.
 - At higher temperatures of this range, display becomes dark. (You may need to adjust the contrast.)
- Operate away from dust, moisture, and direct sunlight.

STORAGE AND RECYCLING

- Store in an ESD-approved container away from dust, moisture, and direct sunlight.
- 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.
- Do not allow weight to be placed on the modules while they are in storage.
- Please recycle your outdated CrystalFontz LCD modules at an approved facility.



APPENDIX A: QUALITY ASSURANCE STANDARDS

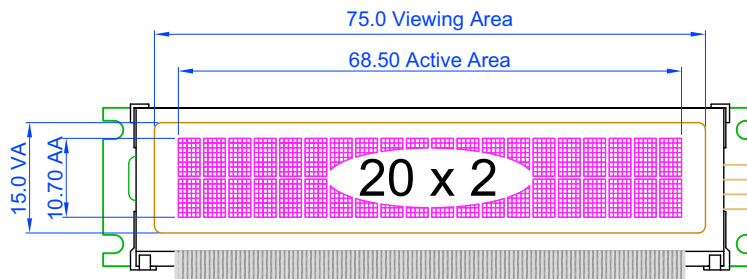
INSPECTION CONDITIONS

- 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 LCD modules as accurately as possible. For the photos, we adjust the backlight (if any) and contrast 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

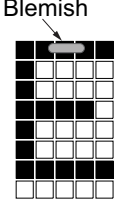
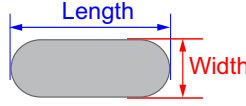
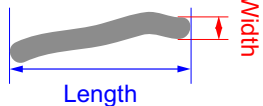
DEFECTS CLASSIFICATION

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	Contrast adjustment defect	Contrast adjustment fails or malfunctions.			Major	
4	Blemishes or foreign matter on display segments		<i>Defect Size</i>	<i>Acceptable Qty</i>	Minor	
			≤0.30 mm	3		
			≤2 defects within 10 mm of each other			
5	Blemishes or foreign matter outside of display segments	Defect Size = (Width + Length)/2 	<i>Defect Size</i>	<i>Acceptable Qty</i>	Minor	
			≤0.15 mm	Ignore		
			0.15 to 0.20 mm	3		
			0.20 to 0.25 mm	2		
			> 0.30 mm	1		
6	Dark lines or scratches in display area		<i>Defect Width</i>	<i>Defect Length</i>	<i>Acceptable Qty</i>	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	
7	Bubbles between polarizer film and glass		<i>Defect Size</i>	<i>Acceptable Qty</i>	Minor	
			≤0.20 mm	Ignore		
			0.20 to 0.40 mm	3		
			0.40 to 0.60 mm	2		
			≥0.60 mm	0		



#	DEFECT TYPE	CRITERIA	MAJOR / MINOR								
8	Display pattern defect		Minor								
		<table border="1"> <thead> <tr> <th>Dot Size</th> <th>Acceptable Qty</th> </tr> </thead> <tbody> <tr> <td>$((A+B)/2) \leq 0.20 \text{ mm}$</td> <td rowspan="5"> ≤ 3 total defects ≤ 2 pinholes per digit </td> </tr> <tr> <td>$C > 0 \text{ mm}$</td> </tr> <tr> <td>$((D+E)/2) \leq 0.25 \text{ mm}$</td> </tr> <tr> <td>$((F+G)/2) \leq 0.25 \text{ mm}$</td> </tr> <tr> <td></td> </tr> </tbody> </table>		Dot Size	Acceptable Qty	$((A+B)/2) \leq 0.20 \text{ mm}$	≤ 3 total defects ≤ 2 pinholes per digit	$C > 0 \text{ mm}$	$((D+E)/2) \leq 0.25 \text{ mm}$	$((F+G)/2) \leq 0.25 \text{ mm}$	
		Dot Size		Acceptable Qty							
		$((A+B)/2) \leq 0.20 \text{ mm}$		≤ 3 total defects ≤ 2 pinholes per digit							
		$C > 0 \text{ mm}$									
$((D+E)/2) \leq 0.25 \text{ mm}$											
$((F+G)/2) \leq 0.25 \text{ mm}$											
9	Backlight defects	<ol style="list-style-type: none"> 1. Light fails or flickers. (Major) 2. Color and luminance do not correspond to specifications. (Major) 3. Exceeds standards for display's blemishes, foreign matter, dark lines or scratches. (Minor) 	See list ←								
10	PCB defects	<ol style="list-style-type: none"> 1. Oxidation or contamination on connectors.* 2. Wrong parts, missing parts, or parts not in specification.* 3. Jumpers set incorrectly. (Minor) 4. Solder (if any) on bezel, LED pad, zebra pad, or screw hole pad is not smooth. (Minor) <p>*Minor if display functions correctly. Major if the display fails.</p>	See list ←								
11	Soldering defects	<ol style="list-style-type: none"> 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. <p>*Minor if display functions correctly. Major if the display fails.</p>	Minor								



APPENDIX B: APPLICATION NOTE FOR 3.3V OPERATION

This module can be used with a 3.3v power supply. In order to meet the requirements of V_{LCD} , you must provide a negative voltage source for V_O (pin 3, see [Details of Interface Pin Functions \(Pg. 12\)](#)). You need to drive V_O to below ground (typically -1v or -2v) until the V_{LCD} is met, making display contrast acceptable.

You can supply the negative voltage by one of the following methods:

1. Use an available source for the negative voltage.

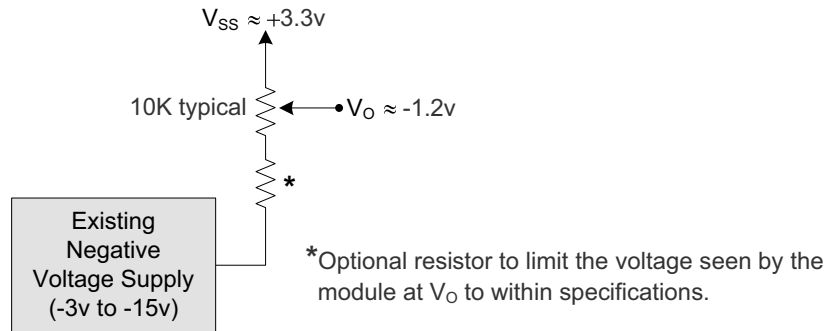


Figure 1. Use Existing Negative Voltage Supply

2. Use a “7660” CMOS switched-capacitor voltage converter or one of the many other available solutions for creating a negative voltage from a positive supply.

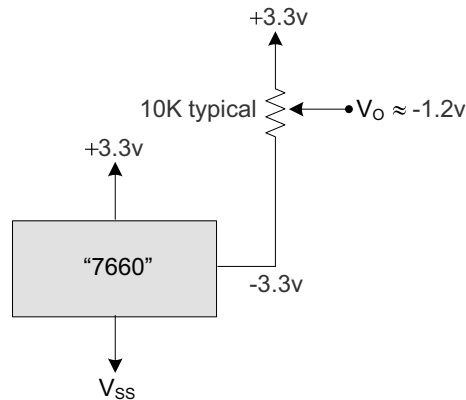


Figure 2. “7660” Switched-Capacitor Voltage Converter



3. Use the circuit in the figure below to create the voltage for V_O by using a PWM (Pulse Width Modulation) output of your microcontroller. This circuit allows the contrast to be adjusted under software control.

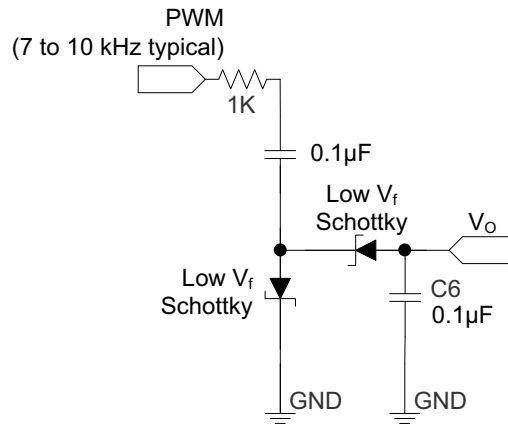


Figure 3. V_O Driving Circuit

Since V_O is pulled up internally by the LCD controller, this circuit will produce positive ($\approx +1v$) V_{LCD} ($V_{LCD} = \text{small}$, contrast is light) for low ($\approx 10\%$) or high (90%) duty cycles. For duty cycles near 50% , this circuit will produce negative ($\approx -2v$) levels of V_O ($V_{LCD} = \text{big}$, contrast is dark).

4. Replace this module with the module in this series that has an on-board negative voltage generator. (The part number has a "V" at the end of it.)

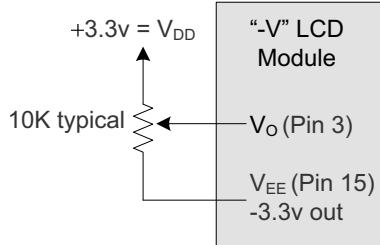


Figure 4. On-Board Negative Voltage Generator



APPENDIX C: SITRONIX ST7066U CONTROLLER SPECIFICATION SHEET

The complete *Sitronix ST7066U Dot Matrix LCD Controller/Driver* specifications (42 pages) follows.