CHARACTER DISPLAY MODULE DATA SHEET

Data Sheet Release 2015-05-20
for CFAH4002A Series:
CFAH4002A-TFH-JT
CFAH4002A-TMI-JT
CFAH4002A-YYH-JT

Crystalfontz America, Incorporated

12412 East Saltese Avenue
Spokane Valley, WA 99216-0357

Phone: 888-206-9720
Fax: 509-892-1203
Email: support@crystalfontz.com
URL: www.crystalfontz.com

CONTENTS

LIST OF FIGURES

Data Sheet Revision History

Data Sheet Release: 2015-5-20
The CFAH4002A series of character LCD modules has three variants (color choices): *CFAH4002A-TFH-JT*, *CFAH4002A-TMI-JT*, and *CFAH4002A-YYH-JT*. Previously, each variant had a separate data sheet. This data sheet combines the information for all variants.

- In Physical Characteristics (Pg. 7), display module weight changed due to a more accurate scale:
  - *CFAH4002A-TFH-JT* and *CFAH4002A-TMI-JT:* from 91 grams to 98 grams.
  - *CFAH4002A-YYH-JT:* 85 grams to 92 grams.
- in LED Backlight Characteristics (Pg. 22),
  - Improvement in the white LED backlight resulted in specifications change for *CFAH4002A-TFH-JT* and *CFAH4002A-TMI-JT*. Luminous intensity measurements were taken through the LCD.
  - Measurement of the luminous intensity for *CFAH4002A-YYH-JT* was taken through the LCD, replacing the specification for direct measurement of the backlight in the previous data sheet.
- Formatting and content are updated to match current data sheet standards, including:
  - Added new section Display Module Reliability Test Conditions (Pg. 27).
  - Expanded CARE AND HANDLING PRECAUTIONS (Pg. 28).

Data Sheet Release: 2008-08-15
New products. New Data Sheet version v1.0

Hardware Updates

To check for update notices for this display module, see the Part Change Notifications (PCNs) under “News” in our website’s navigation bar or look at the Product Notices tab on this product’s web page. Product pages without a Product Notices tab do not have product notices.

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.

About Volatility

These display modules have volatile memory.

The Fine Print

Certain applications using Crystalfontz America, Inc. products may involve potential risks of death, personal injury, or severe property or environmental damage (“Critical Applications”). CRYSTALFONTZ AMERICA, INC. PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. Inclusion of Crystalfontz America, Inc. products in such applications is understood to be fully at the risk of the customer. In order to minimize risks associated with customer applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazard. Please contact us if you have any questions concerning potential risk applications.

Crystalfontz America, Inc. assumes no liability for applications assistance, customer product design, software performance, or infringements of patents or services described herein. Nor does Crystalfontz America, Inc. warrant or represent that any license, either express or implied, is granted under any patent right, copyright, or other intellectual property right of Crystalfontz America, Inc. covering or relating to any combination, machine, or process in which our products or services might be or are used.

All specifications in Data Sheets and on our website are, to the best of our knowledge, accurate but not guaranteed. Corrections to specifications are made as any inaccuracies are discovered.

Company and product names mentioned in this publication are trademarks or registered trademarks of their respective owners.

MAIN FEATURES

- This 40 characters by 2 lines LCD character display module series has three variants:
  - *CFAH4002A-TFH-JT*: White edge LED backlight with FSTN, positive, light gray, transflective mode LCD. Displays dark (near-black) characters on light (near-white) background. The display can be read in normal office lighting, in dark areas, and in bright sunlight.
  - *CFAH4002A-TMI-JT*: White edge LED backlight with STN, negative, blue, transmissive mode LCD. Displays light (near-white) characters on blue background. The display can be read in normal office lighting and in dark areas. May be difficult to read in direct sunlight.
  - *CFAH4002A-YYH-JT*: Yellow-green array LED backlight with STN, positive, yellow-green, transflective mode LCD. Displays dark (near-black) characters on yellow-green background. The display can be read in normal office lighting, in dark areas, and in bright sunlight.
- Display module dimensions are:
  - Active Area is 147.50 (W) x 11.50 (H) millimeters.
    Inches = 5.80" (W) x 0.45" (H).
  - Overall display module is 182.00 (W) x 33.50 (H) x 13.60 (D) millimeters.
    Inches = 7.17" (W) x 1.32" (H)
- Host interface choices are 4-bit or 8-bit parallel interface.
- These display modules have an integrated Sitronix ST7066U or equivalent controller. See the controller data sheet here on our website. The controller is an Hitachi HD44780 equivalent controller.
- 6:00 o'clock viewing angle (polarizer viewing direction).
- Temperature range for operation: -20°C to +70°C
- RoHS compliant.
- Crystalfontz America, Incorporated is ISO certified.

DISPLAY MODULE CLASSIFICATION INFORMATION

CFA ❶ H ❷ 40 ❸ 02 ❹ A ❺ - * ❻ * ❼ * ❽ - J ❾ T ❿

❶	**Brand**	Crystalfontz America, Inc.
❷	**Display Type**	H – Character
❸	**Number of Characters (Width)**	40 Characters
❹	**Number of Lines (Height)**	2 Lines
❺	**Model Identifier**	A
❻	**Backlight Type & Color**	T – LED, white Y – LED, yellow-green
❼	**Fluid Type, Image (Positive or Negative), & LCD Glass Color**	F – FSTN, positive, light gray M – STN, negative, blue Y – STN, positive, yellow-green
❽	**Polarizer Film Type & Viewing Angle (O'clock)**	H – Transflective, 6:00[1] I – Transmissive, 6:00[1]
❾	**Character Set (CGROM)**	J – English and Japanese fonts
❿	**Controller**	Sitronix ST7066U

[1]*Note: For more information on Viewing Angle, see Definition of 6 O'Clock and 12:00 O'Clock Viewing Angles (Pg. 21).*

ORDERING INFORMATION

PART NUMBER	FLUID	LCD GLASS COLOR	IMAGE	POLARIZER FILM	BACKLIGHT COLOR/TYPE	
CFAH4002A-TFH-JT	FSTN	light gray	positive	transflective	white LED	
CFAH4002A-TMI-JT	STN	blue	negative	transmissive	white LED	
CFAH4002A-YYH-JT	STN	yellow-green	positive	transflective	yellow-green LED	

MECHANICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS

ITEM	SIZE
Number of Characters and Lines	40 Characters x 2 Line
Display Module Dimensions	Millimeters: 182.00 (W) x 33.50 (H) x 13.60 (D) mm Inches: 7.17" (W) x 1.32" (H) x 0.53" (D)
Viewing Area	Millimeters: 154.40 (W) x 16.50 (H) mm Inches: 6.07" (W) x 16.50" (H)
Active Area	Millimeters: 147.50 (W) x 11.50 (H) mm Inches: 5.81" (W) x 0.45" (H)
Character Size	Millimeters: 3.20 (W) x 5.55 (H) mm Inches: 0.126" (W) x 0.219" (H)
Character Pitch	Millimeters: 3.70 (W) x 5.95 (H) mm Inches: 0.146" (W) x 0.234" (H)
Pixel Size	Millimeters: 0.600 (W) x 0.650 (H) mm
Pixel Pitch	Millimeters: 0.650 (W) x 0.700(H) mm
Weight	*CFAH4002A-TFH-JT:* 98 grams (typical) *CFAH4002A-TMI-JT:* 98 grams (typical) *CFAH4002A-YYH-JT:* 92 grams (typical)

DISPLAY MODULE OUTLINE DRAWINGS

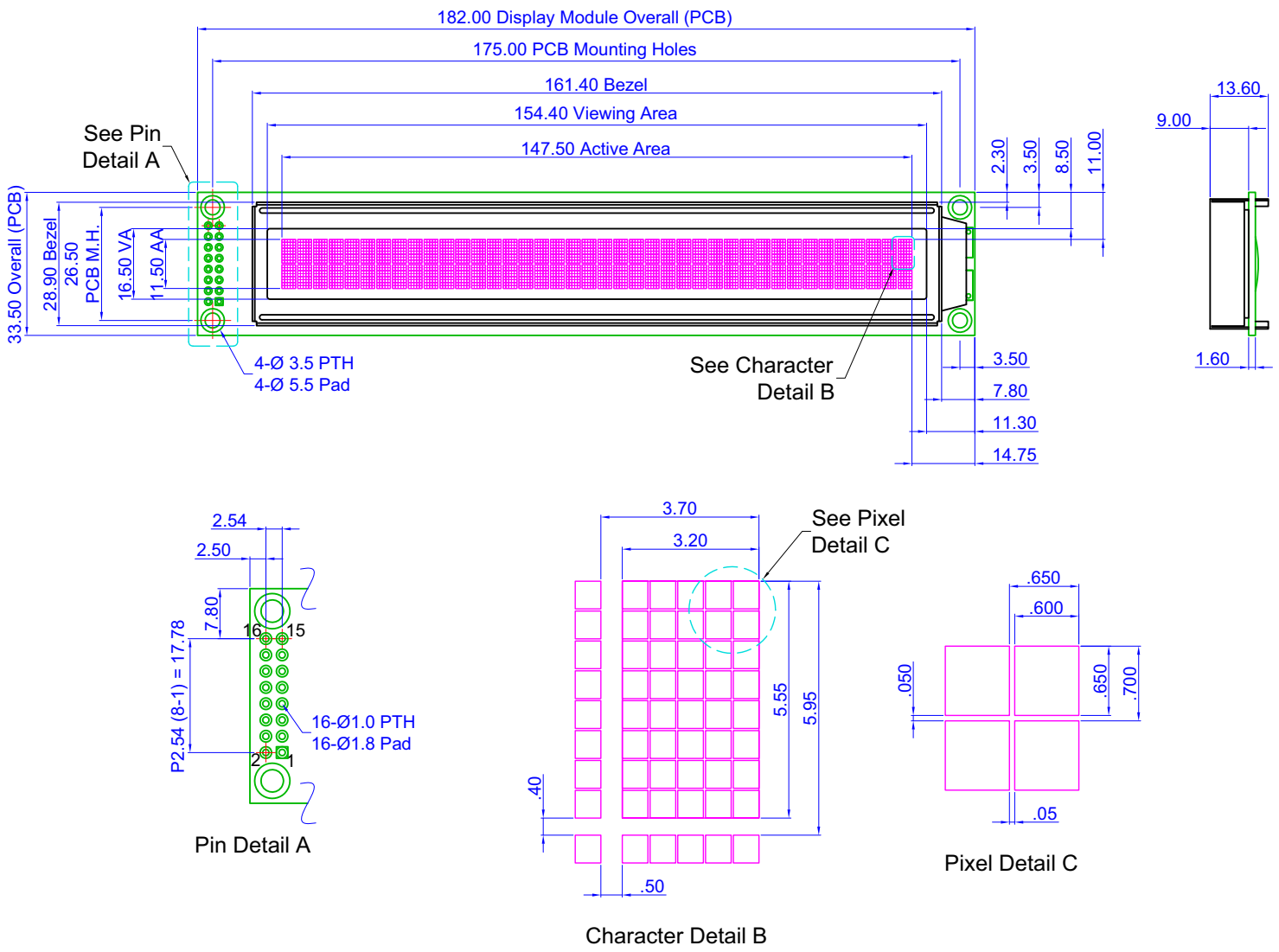
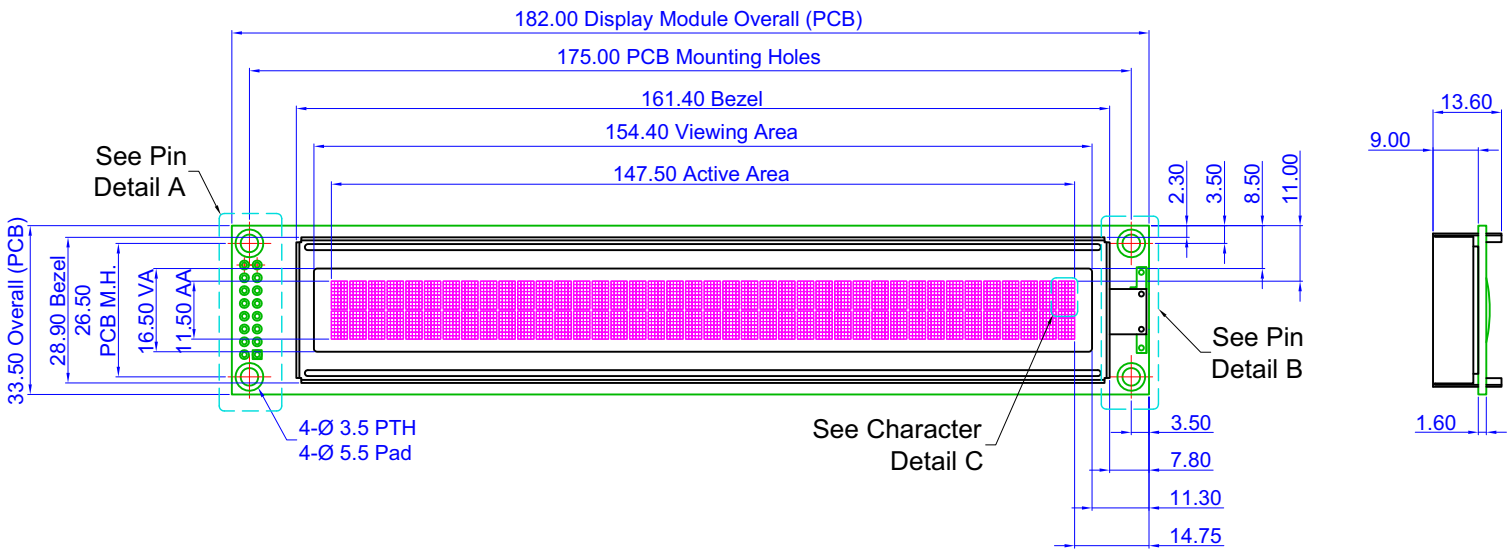


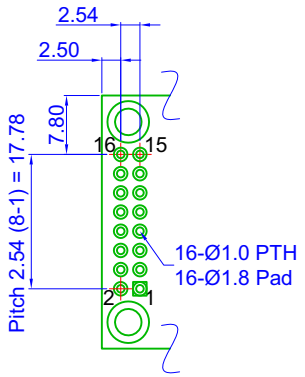
Figure 1. Display Module Outline Drawings (Two)

Note: Illustration deemed accurate but not guaranteed.

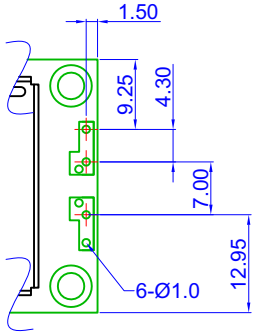
Crystalfontz America, Inc.
www.crystalfontz.com/products/

Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAH4002A-TFH-JT CFAH4002A-TMI-JT	Not to scale	CFAH4002A Series	
	Units: Millimeters	Date: 2015-05-18	Sheet: 1 of 1

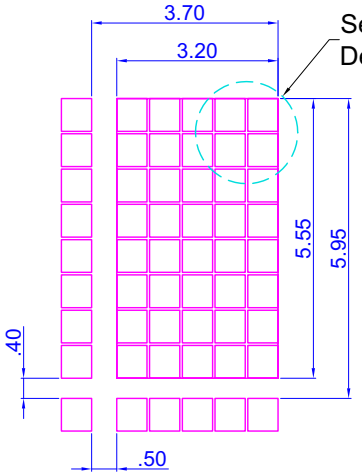




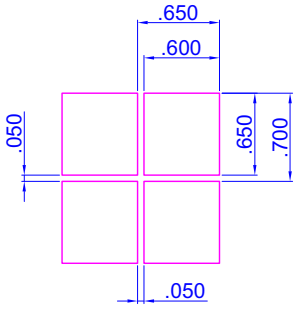
Pin Detail A



Pin Detail B



Character Detail C



Pixel Detail D

Note: Illustration deemed accurate but not guaranteed.

Crystalfontz America, Inc.

www.crystalfontz.com/products/

Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAH4002A-YYH-JT	Not to scale	CFAH4002A Series	
	Units: Millimeters	Date: 2015-05-18	Sheet: 1 of 1

ELECTRICAL SPECIFICATIONS

SYSTEM BLOCK DIAGRAM

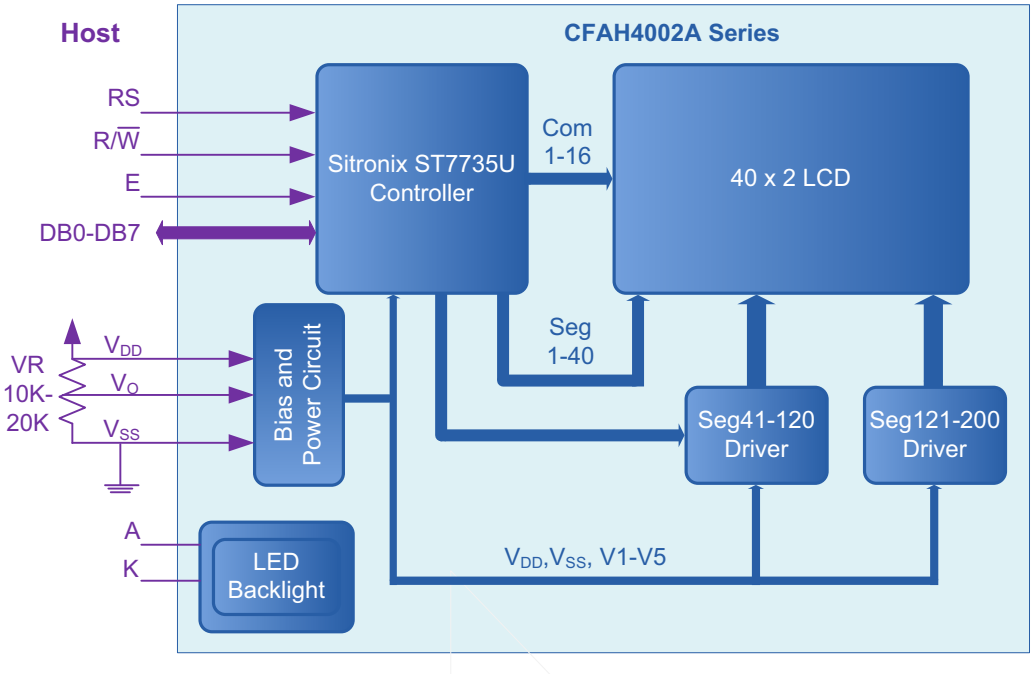


Figure 2. System Block Diagram

DRIVING METHOD

DRIVING METHOD	SPECIFICATION
Duty[1]	1/16
Bias[2]	1/15

[1]The 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.

[2]The 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/(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

Notes:
Prolonged exposure at temperatures outside of the operating range may cause permanent damage to the display module.

Background color changes slightly depending on ambient temperature. This phenomena is reversible.

RECOMMENDED DC CHARACTERISTICS

5V OPERATION						
PART	**DC CHARACTERISTICS (4.5 to 5.5 volts)**	**TEST CONDITION**	**SYMBOL**	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Controller and Board	Supply Voltage for Logic		V_{DD} - V_{SS}	+4.5v	+5.0v	+5.5v
	Input High Voltage Pins: E, RS, R/W, DB0 - DB7		V_{IH}	+0.7v * V_{DD} for V_{DD}= +5.0v V_{IH} = +0.7v * +5.0v = **+3.5v**		V_{DD}
	Input Low Voltage		V_{IL}	0v (GND)		+0.6v
	Output High Voltage I_{OH} **= - 0.1 mA** **Pins: DB0 - DB7**	V_{DD} = 5V	V_{OH}	+3.9v		V_{DD}
	Output Low Voltage I_{OL} = 0.1 mA Pins: DB0 - DB7		V_{OL}	0v (GND)		+0.4v
	Supply Current	(without backlight)	I_{DD}	1.0 mA	1.2 mA	1.5 mA
LCD Glass	Supply Voltage for Driving LCD	TA = -20ºC				+5.3v
		TA = +25ºC	V_{DD} - V_O	+4.4v	+4.5v	+4.6v
		TA = +70ºC		+3.8v		

This is a summary of the display module's major operating parameters. For detailed information, see the Sitronix ST7066U controller data sheet on our website.

3.3V OPERATION						
PART	**DC CHARACTERISTICS (2.7 to 4.5 volts)**	**TEST CONDITION**	**SYMBOL**	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Controller and Board	Supply Voltage for Logic		V_{DD} - V_{SS}	+2.7v	+3.3v	+4.5v
	Input High Voltage Pins: E, RS, R/$\overline{W}$, DB0 - DB7	V_{DD} = 3.3V	V_{IH}	+2.3v		V_{DD}
	Input Low Voltage		V_{IL}			+0.6v
	Output High Voltage I_{OH} = - 0.1 mA Pins: DB0 - DB7	V_{DD} = 3.3V	V_{OH}	+2.4v		
	Output Low Voltage I_{OL} = 0.1 mA Pins: DB0 - DB7		V_{OL}			+0.4v
	Supply Current	without backlight	I_{DD}		1.2 mA	
LCD Glass	Supply Voltage for Driving LCD	TA = -20ºC				+4.2v
		TA = +25ºC	V_{DD} - V_O		+3.8v	
		TA = +70ºC		+3.6v		

This is a summary of the display module's major operating parameters. For detailed information, see the Sitronix ST7066U controller data sheet on our website.

For more information about 3.3v operation, please see APPENDIX B: APPLICATION NOTE FOR 3.3V OPERATION (Pg. 34).

DETAILS OF INTERFACE PIN FUNCTIONS

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
1	V_{SS}	0v		Ground
2	V_{DD}	+5.0v		Supply voltage for logic
3	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
4	RS	H/L	I	Register selection input. H: Data register (for read and write) L: Instruction code (for write)
5	R/$\overline{W}$	H/L	I	H: Read (Host←Display Module) L: Write (Host→Display Module)
6	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.
7	DB0	H/L	I/O	Data bit 0
8	DB1	H/L	I/O	Data bit 1
9	DB2	H/L	I/O	Data bit 2
10	DB3	H/L	I/O	Data bit 3
11	DB4	H/L	I/O	Data bit 4
12	DB5	H/L	I/O	Data bit 5
13	DB6	H/L	I/O	Data bit 6
14	DB7	H/L	I/O	Data bit 7
15	A (LED +)			Supply voltage for LED. “A” (anode) or “+” of LED backlight
16	K (LED -)			Supply voltage for LED. “K” (cathode or kathode for German and original Greek spelling) or “-” of LED backlight
For backlight connections, please refer to LED Backlight Characteristics (Pg. 22).				

QUICK REFERENCE FOR PIN FUNCTIONS (FRONT & BACK PHOTOS)

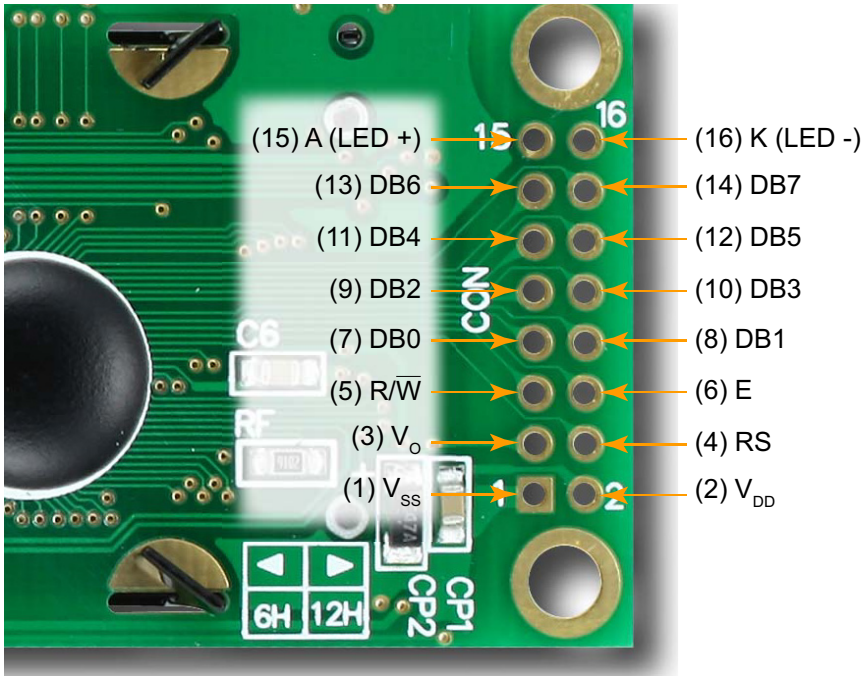


Figure 3. Back View of Pins (Labeled)

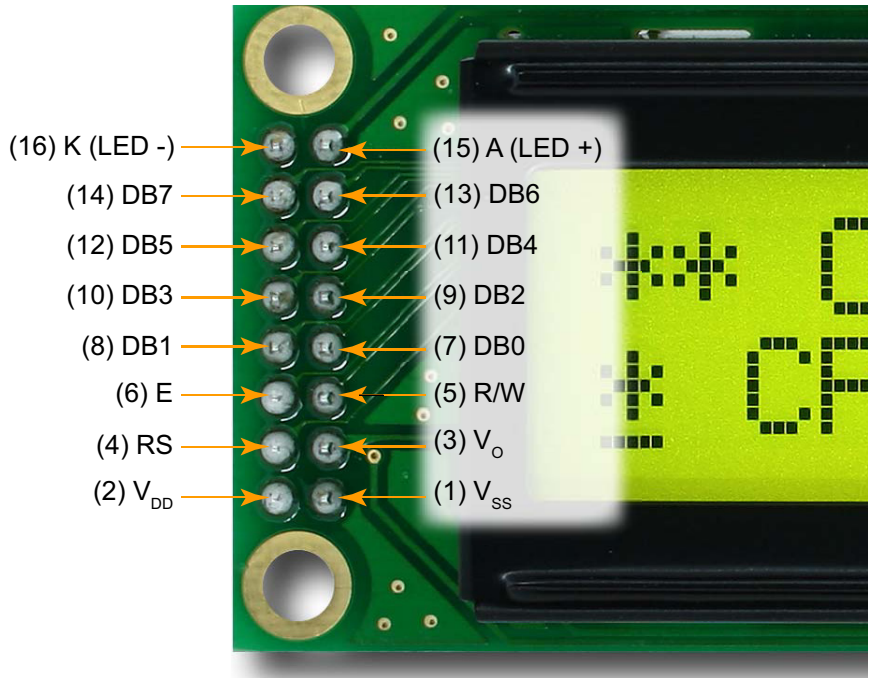


Figure 4. Front View of Pins (Labeled)

TYPICAL VO CONNECTIONS FOR DISPLAY CONTRAST

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

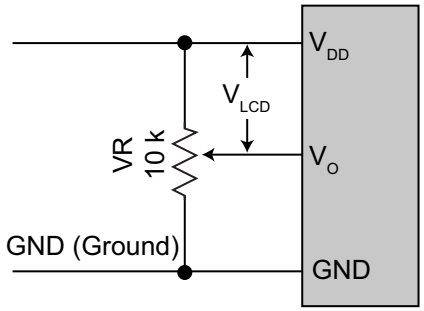


Figure 5. Typical V_O Connections

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 controller, 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

The circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard anti-static 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 SPECIFICATIONS

OPTICAL CHARACTERISTICS

CFAH4002A-TFH-JT

ITEM	SYMBOL	CONDITION	MINIMUM	TYPICAL	MAXIMUM
Viewing Angle (6 o'clock) (Vertical, Horizontal CR≥2	(V)θ	ψ = 180° (Top)	0°		30°
		ψ = 0° (Bottom)	0°		60°
	(H)φ	ψ = 90° (Right	0°		45°
		ψ = 270° (Left)	0°		45°
Contrast Ratio	CR			5	
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.*					

CFAH4002A-TMI-JT

ITEM	SYMBOL	CONDITION	MINIMUM	TYPICAL	MAXIMUM
Viewing Angle (6 o'clock) (Vertical, Horizontal CR≥2	(V)θ	ψ = 180° (Top)	0°		20°
		ψ = 0° (Bottom)	0°		40°
	(H)φ	ψ = 90° (Right	0°		30°
		ψ = 270° (Left)	0°		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.*					

CFAH4002A-YYH-JT

ITEM	SYMBOL	CONDITION	MINIMUM	TYPICAL	MAXIMUM
Viewing Angle (6 o'clock) (Vertical, Horizontal CR≥2	(V)θ	ψ = 180° (Top)	20°		40°
		ψ = 0° (Bottom)	-30°		30°
	(H)φ	ψ = 90° (Right	0°		45°
		ψ = 270° (Left)	0°		45°
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)

CFAH4002A-TFH-JT And CFAH4002A-YYH-JT

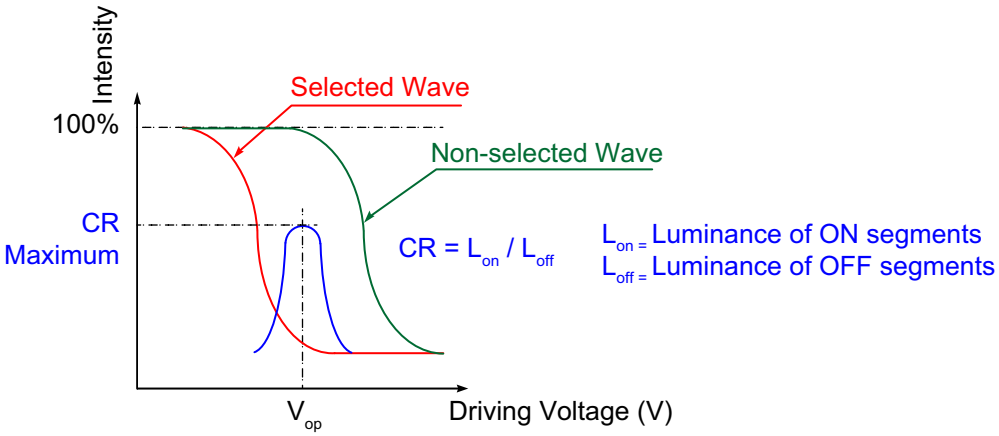


Figure 6. Definition of Operation Voltage (V_{OP}) (Positive)

CFAH4002A-TMI-JT

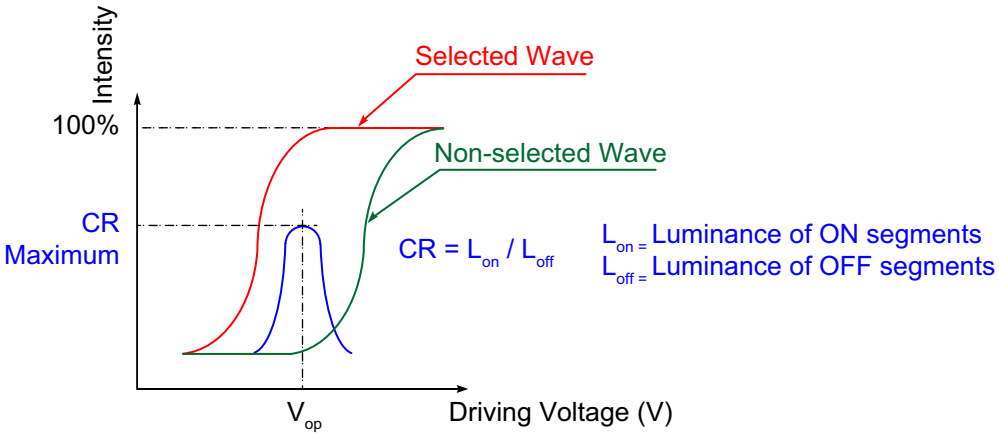


Figure 7. Definition of Operation Voltage (V_{OP}) (Negative)

Definition of Response Time (Tr, Tf)

CFAH4002A-TFH-JT And CFAH4002A-YYH-JT

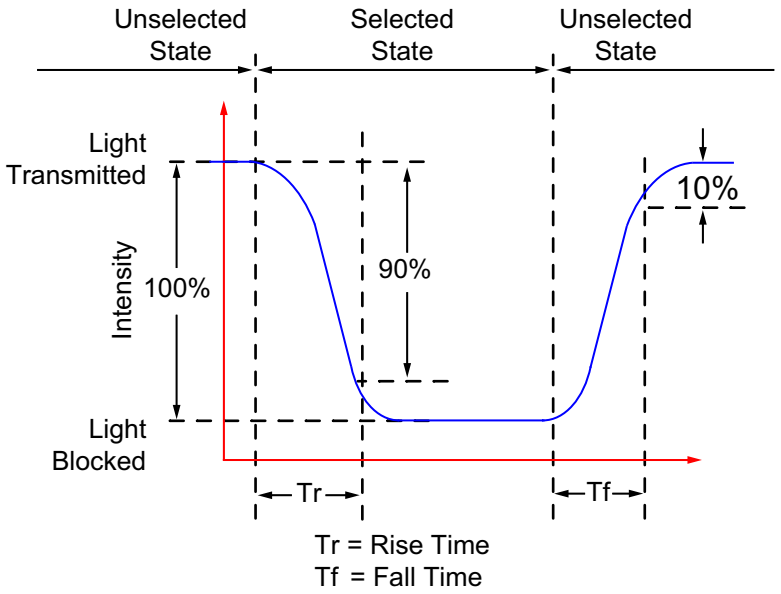


Figure 8. Definition of Response Time (Tr, Tf) (Positive)

CFAH4002A-TMI-JT

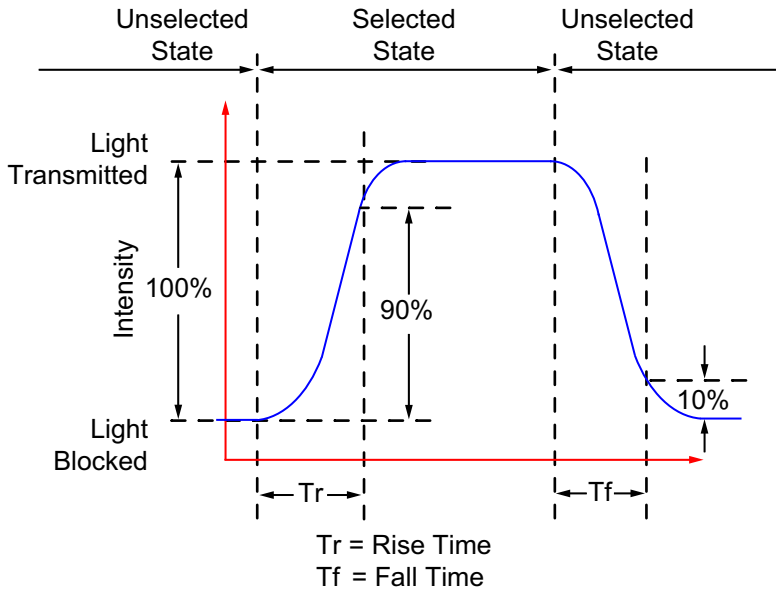


Figure 9. Definition of Response Time (Tr, Tf) (Negative)

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

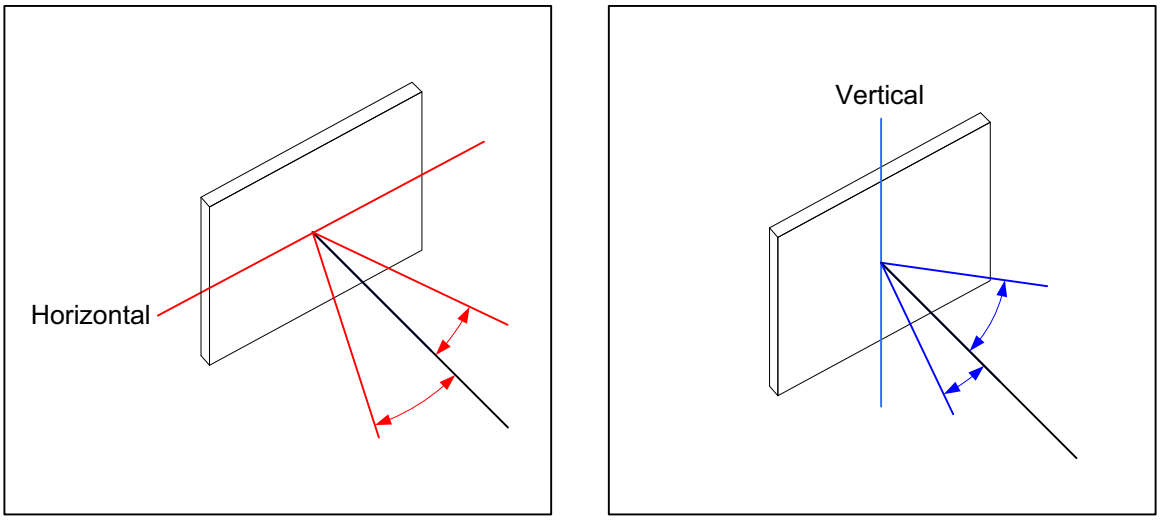


Figure 10. Definition of Horizontal and Vertical Viewing Angles (CR>2)

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

This display module has a 6:00 o'clock viewing angle.

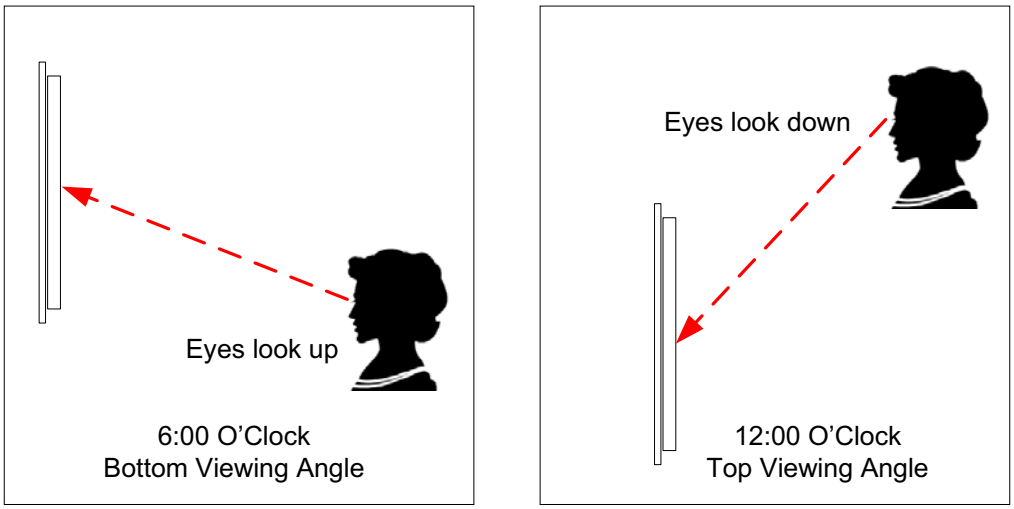


Figure 11. Definition of 6:00 O'Clock and 12:00 O'Clock Viewing Angles

LED BACKLIGHT CHARACTERISTICS

Luminous Intensity measurements are taken through the LCD.

Backlight Specifications CFAH4002A-TFH-JT Dark (Near-Black) Pixels On Light (Near-White) Background			
PARAMETER	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Forward Current (I_{LED}) $V_{LED} \approx 3.5v$	43.2 mA	48 mA*	75 mA
**Driving the backlight above 48 mA may shorten its lifetime.*			
Forward Voltage (V_{LED})	+3.4v	+3.5v	+3.6v
Reverse Voltage (V_R)			+5v
Luminous Intensity* (I_V) I_{LED} = 48 mA		68 cd/m^2	

Backlight Specifications CFAH4002A-TMI-JT Light (Near-White) Pixels On Blue Background			
PARAMETER	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Forward Current (I_{LED}) $V_{LED} \approx 3.5v$	43.2 mA	48 mA*	75 mA
**Driving the backlight above 48 mA may shorten its lifetime.*			
Forward Voltage (V_{LED})	+3.4v	+3.5v	+3.6v
Reverse Voltage (V_R)			+5v
Luminous Intensity* (I_V) I_{LED} = 48 mA		75 cd/m^2	

Backlight Specifications CFAH4002A-YYH-JT Dark (Near-Black) Pixels On Yellow-Green Background			
PARAMETER	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Forward Current (I_{LED}) $V_{LED} \approx 3.5$	190 mA	230 mA*	340mA
**Driving the backlight above 230 mA may shorten its lifetime.*			
Forward Voltage (V_{LED})	+4.0v	+4.2v	+4.4v
Reverse Voltage (V_R)			+8v
Luminous Intensity* (I_V) I_{LED} = 230 mA		30 cd/m^2	
Wavelength* ($I \lambda$) I_{LED} = 230 mA	560 nm	570 nm	580 nm

The CFAH4002A series display modules use an LED backlight. LED backlights are easy to use, but they are also easily damaged by abuse.

Caution

Ensure that you have proper current and voltage control for your backlight before connecting the backlight circuit.

Note For CFAH4002A-TFH-JT And CFAH4002A-TMI-JT

We recommend that the white 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.

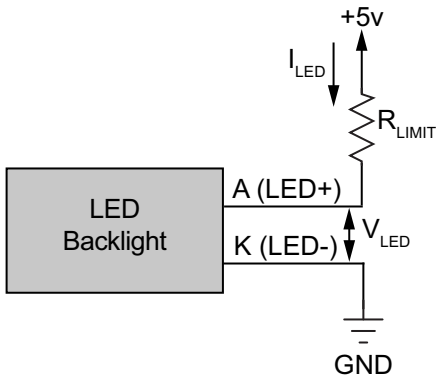


Figure 12. Typical LED Backlight Connections for “Always On”

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 *CFAH4002A-TFH-JT* and *CFAH4002A-TMI-JT* at V_{DD} = +5v is:

$$R_{LIMIT} = \frac{5v - 3.5v}{0.048\ A} = 25.0\Omega\text{ (minimum)}$$

The specific R_{LIMIT} calculation for the *CFAH4002A-YYH-JT* at V_{DD} = +5v is:

$$R_{LIMIT} = \frac{5v - 4.2v}{0.23\ A} = 3.48\Omega\text{ (minimum)}$$

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

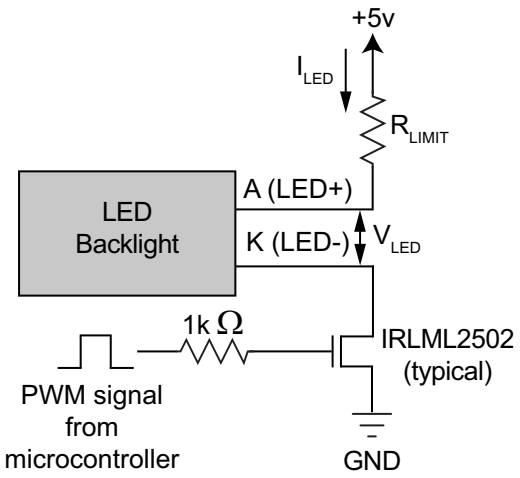


Figure 13. Example of LED Backlight Connections for PWM Dimming

DISPLAY MODULE CONTROLLER INTERFACE

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

This is a summary of the display module's major operating parameters. For detailed information, see the Sitronix ST7066U controller data sheet on our website.

DISPLAY POSITION DDRAM ADDRESS

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

		COLUMN																
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**....**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**49**
ROW	**0**	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x0B	....	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
	1	0x40	0x41	0x42	0x43	0x44	0x45	0x46	0x4B	**....**	0x60	0x61	0x62	0x63	0x64	0x65	0x66	0x67

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 “96_{10}” and in the row labeled “8_{10}”. 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

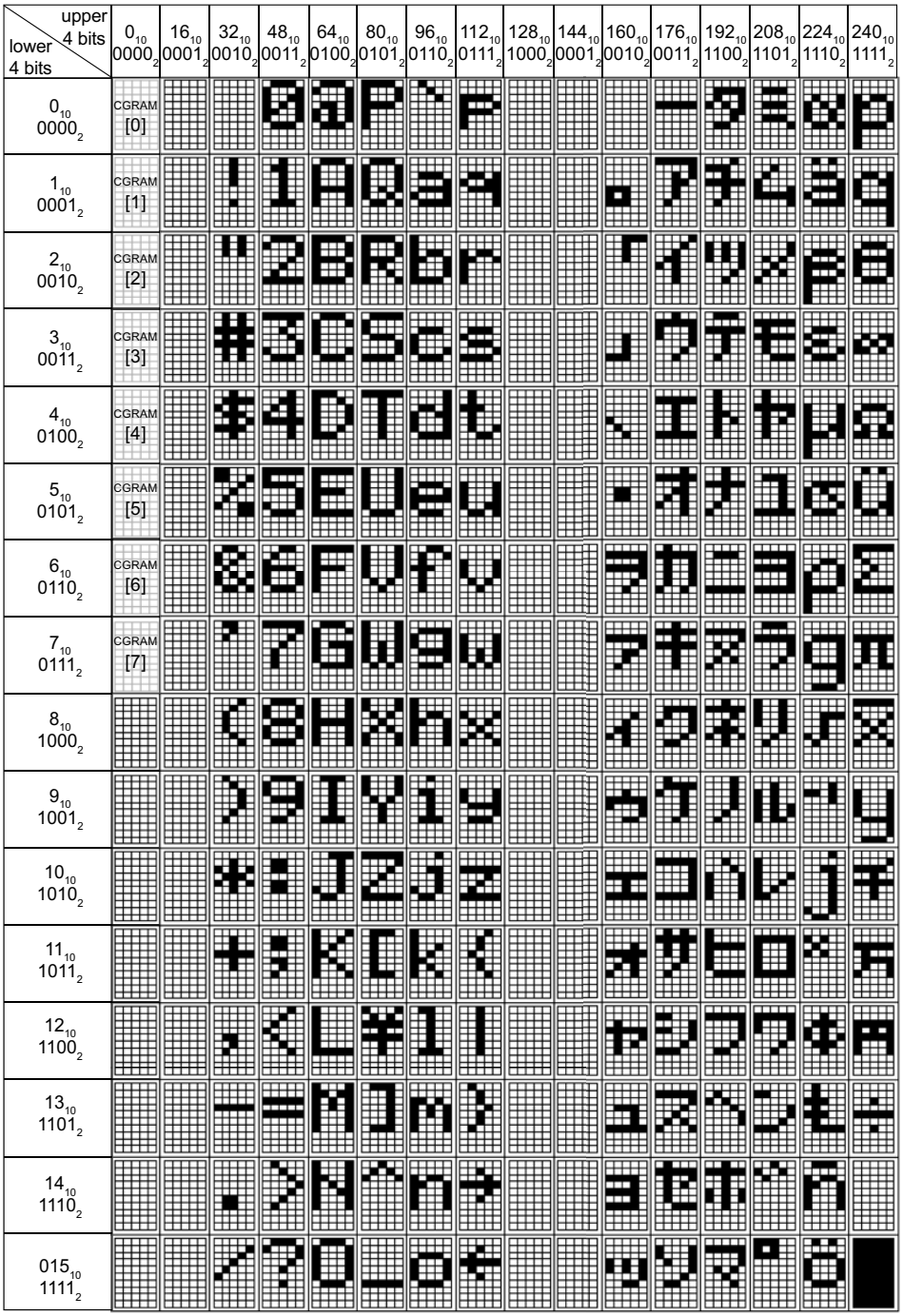


Figure 14. Character Generator ROM (CGROM)

DISPLAY MODULE RELIABILITY AND LONGEVITY

DISPLAY MODULE RELIABILITY TEST CONDITIONS

RELIABILITY TEST CONDITIONS	
TEST	**CONDITION**
High Temperature Operation	70°C, 200 Hours
Low Temperature Operation	-20°C, 200 Hours
High Temperature Storage	80°C, 200 Hours
Low Temperature Storage	-30°C, 200 Hours
High Temperature Humidity Storage	60°C, 90% RH, 96 Hours
Temperature Cycle On/Off	-20°C, 70°C, On/Off, 20 Cycles On cycle: >10 seconds Off cycle: <10 seconds
ESD	VS=800V, RS=1.5kΩ, CS=100pF, 1 time
Thermal Shock Resistance	See test description.

One test cycle for thermal shock resistance is:

1. Test Low for 30 minutes.
2. Normal temperature for 5 minutes.
3. Test High for 30 minutes.
4. Normal temperature for 5 minutes.
5. Take out and dry at Normal temperature and allow to stand for 24 hours.

Repeat these steps for a total of 10 cycles.

DISPLAY MODULE RELIABILITY

CFAH4002A-TFH-JT And CFAH4002A-TMI-JT	SPECIFICATION	
Display module excluding backlight	50,000 to 100,000 hours (typical)	
White LED Backlight (I_{LED} < 48 mA)	**Power-On Hours**	***% of Initial Brightness (New Display Module)***
	<10,000	>70%
	<50,000	>50%

Note on display modules with white LEDs: We list the lifetime of white LEDs at 10,000 hours to emphasize that white LEDs do not have the extremely long lifetime typical of red, yellow-green, or blue 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.

CFAH4002A-YYH-JTI	SPECIFICATION
Display module including yellow-green LED backlight	50,000 to 100,000 hours (typical)

DISPLAY MODULE LONGEVITY (EOL / REPLACEMENT POLICY)

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

We recognize that discontinuing a display 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 display module. For example, we must occasionally discontinue a display module when a supplier discontinues a component or a manufacturing process becomes obsolete. When we discontinue a display module, we will do our best to find an acceptable replacement display 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 display module to the discontinued display module it replaces. However, sometimes a change in component or process for the replacement display module results in a slight variation, perhaps an improvement, over the previous design.

Although the replacement display module is still within the stated Data Sheet specifications and tolerances of the discontinued display 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. 16)).
- *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. Display 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 display module whenever possible; we only discontinue a display module if we have no other option. We will post Part Change Notices on the product's web page as soon as possible. If interested, you can subscribe to future part change notifications.

CARE AND HANDLING PRECAUTIONS

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

Excessive voltage will shorten the life of the display module. You must drive the display module within the specified voltage limit.See Absolute Maximum Ratings (Pg. 11).

HANDLING CAUTION FOR DISPLAY MODULES SHIPPED IN TRAYS

If you receive display modules packed in trays, handle trays carefully by supporting the entire tray. Trays were made to immobilize the display modules inside their packing carton. Trays are not designed to be rigid. Do not carry trays by their edges; trays and display modules may be damaged.

ESD (ELECTRO-STATIC DISCHARGE)

The circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard anti-static 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 controller maintains its internal operating modes until something happens to change it. Excessive external noise can change these internal modes. In your packaging and system design, suppress or prevent the noise from influencing the controller. Also, refresh the operating modes periodically to prevent the effects of unanticipated noise.
- 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 display 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 display 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 display 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 display module.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the display module.
- Use care to keep the exposed terminals clean. Contamination, including fingerprints may make soldering difficult, and the reliability of the soldered connection poor.

AVOID SHOCK, IMPACT, TORQUE, OR TENSION

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

IF LCD PANEL BREAKS

All electronics may contain harmful substances. Avoid contamination by using care to avoid damage during handling. If any residues, gases, powders, liquids, or broken fragments come in contact with your skin, eyes, mouth, or lungs, immediately contact your local poison control or emergency medical center.

HOW TO CLEAN

1. Turn display module off.
2. 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”).
3. If the polarizer is dusty, you may carefully blow it off with clean, dry, oil-free compressed air.
4. If you must clean with a liquid, never use glass cleaners, as they may contain ammonia or alcohol that will damage the polarizer over time. Never apply liquids directly on the polarizer. Long contact with moisture may permanently spot or stain the polarizer. Use filtered water to slightly moisten a clean lint-free microfiber cloth designed for cleaning optics. (For example, use a cloth sold for cleaning plastic eyeglasses.)
5. The plastic is easily scratched or damaged. Use a light touch as you clean the polarizer. Wipe gently.
6. Use a dry microfiber cloth to remove any trace of moisture before turning on the TFT.

7. Gently wash the microfiber cloths in warm, soapy water and air dry before reuse.

OPERATION

- We do not recommend connecting this display module to a PC's parallel port as an end product. This display 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 module 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 display module from ESD and power supply transients.
- Observe the operating temperature limitations: a minimum of-20°C to a maximum of +70°C non-condensing with minimal fluctuation. Operation outside of these limits may shorten life and/or harm the display module. Changes in temperature can result in changes in contrast.
  - 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, fluorescent lamps, or any strong ultraviolet radiation.
- 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 display modules while they are in storage.
- Please recycle your outdated Crystalfontz display modules at an approved facility.

APPENDIX A: QUALITY ASSURANCE STANDARDS

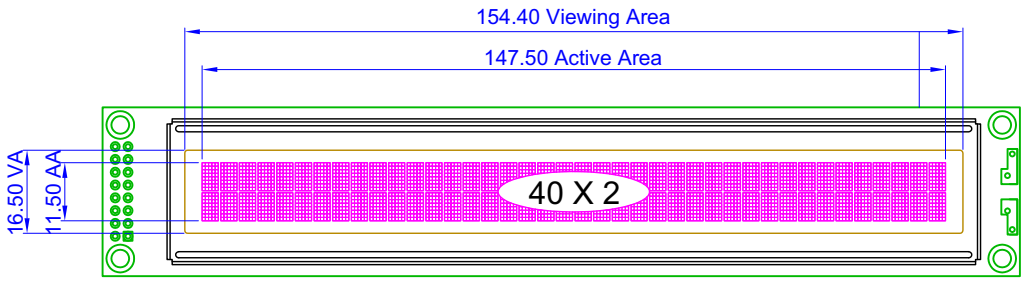
INSPECTION CONDITIONS

- Environment
  - Temperature: 25±5°C
  - Humidity: 30~85% RH (non-condensing)
- 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 VIEWING AREA AND ACTIVE AREA

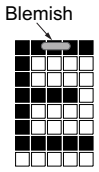
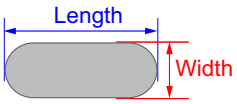
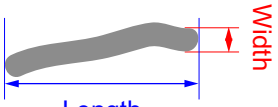


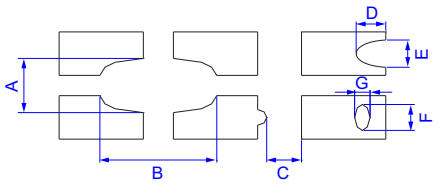
DEFECTS CLASSIFICATION

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	ACCEPTANCE STANDARDS 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		*Defect Size (mm)*	*Acceptable Qty*	Minor
			≤0.3	3	
			≤2 defects within 10 mm of each other		
5	Other blemishes or foreign matter outside of display segments	Defect size = (A + B)/2 	*Defect Size (mm)*	*Acceptable Qty*	Minor
			≤0.15	Ignore	
			0.15 to 0.20	3	
			0.20 to 0.25	2	
			0.25 to 0.30	1	
6	Dark lines or scratches in display area 	*Defect Width (mm)*	*Defect Length (mm)*	*Acceptable Qty*	Minor
		≤0.03	≤3.0	3	
		0.03 to 0.05	≤2.0	2	
		0.05 to 0.08	≤2.0	1	
		0.08 to 0.10	≤3.0	0	
		≥0.10	>3.0	0	
7	Bubbles between polarizer film and glass		*Defect Size (mm)*	*Acceptable Qty*	Minor
			≤0.20	Ignore	
			0.20 to 0.40	3	
			0.40 to 0.60	2	
			≥0.60	0	

<table>
<tr><th>#</th><th>DEFECT TYPE</th><th>ACCEPTANCE STANDARDS CRITERIA (Continued)</th><th>MAJOR / MINOR</th></tr>
<tr><td>8</td><td>Display pattern defect</td><td> 

<table>
<tr><th>Dot Size (mm)</th><th>Acceptable Qty</th></tr>
<tr><td>((A+B)/2)≤0.2</td><td rowspan="4">≤3 total defects

≤2 pinholes per digit</td></tr>
<tr><td>C>0</td></tr>
<tr><td>((D+E)/2)≤0.25</td></tr>
<tr><td>((F+G)/2)≤0.25</td></tr>
</table></td><td>Minor</td></tr>
<tr><td>9</td><td>Backlight defects</td><td>1. Light fails or flickers.*
2. Color and luminance do not correspond to specifications.*
3. Exceeds standards for display’s blemishes or foreign matter (see test 5, Pg. 32), and dark lines or scratches (see test 6, Pg. 32).
*Minor if display functions correctly. Major if the display fails.</td><td>Minor</td></tr>
<tr><td>10</td><td>COB defects</td><td>1. Pinholes >0.2 mm.
2. Seal surface has pinholes through to the IC.
3. More than 3 locations of sealant beyond 2 mm of the sealed areas.</td><td>Minor</td></tr>
<tr><td>11</td><td>PCB defects</td><td>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>12</td><td>Soldering defects</td><td>1. Unmelted solder paste.
2. Cold solder joints, missing solder connections, or oxidation.*
3. Solder bridges causing short circuits.*
4. Solder balls.
*Minor if display functions correctly. Major if the display fails.</td><td>Minor</td></tr>
</table>

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. 14)). 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.

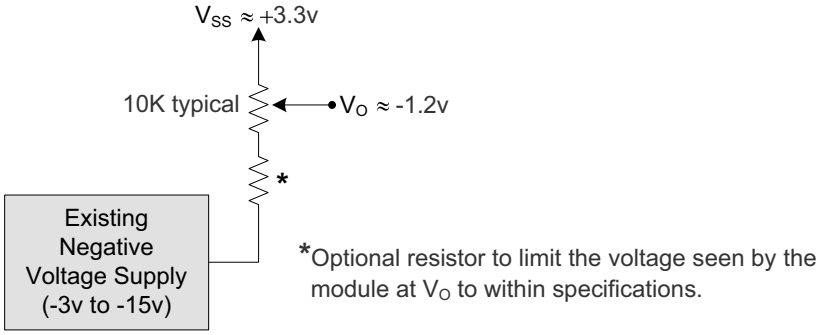


Figure 1. Use Existing Negative Voltage Supply

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.

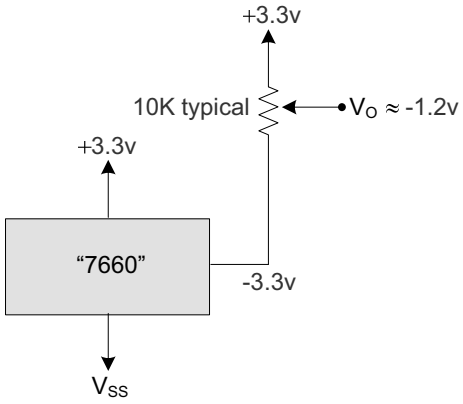


Figure 2. “7660” Switched-Capacitor Voltage Converter

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.

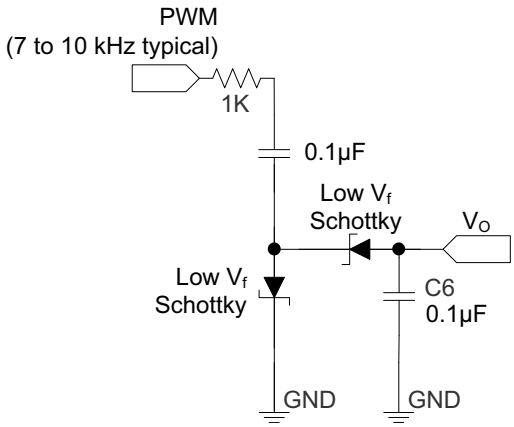


Figure 3. V_O Driving Circuit

Since VO is pulled up internally by the LCD controller, this circuit will produce positive (»+1v) VLCD (VLCD = small, contrast is light) for low (»10%) or high (90%) duty cycles. For duty cycles near 50%, this circuit will produce negative (»-2v) levels of VO (VLCD = 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.)

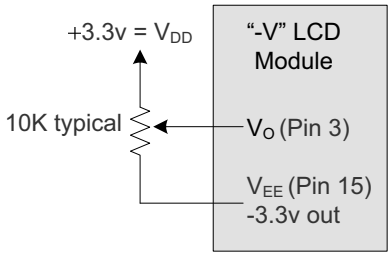


Figure 4. On-Board Negative Voltage Generator