Crystalfontz America, Incorporated

GRAPHIC OLED MODULE SPECIFICATIONS

Crystalfontz Model Number	**CFAL12864L-Y-B6**
Hardware Version	**Revision A, February 2009**
Data Sheet Version	**Revision 1.0, December 2009**
Product Pages	www.crystalfontz.com/product/CFAL12864LYB6.html

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REVISION HISTORY

HARDWARE	
2009/02/19	Current hardware version: **vA**

DATA SHEET	
2009/12/28	Current Data Sheet version: **v1.0** Since last revision (Preliminary, no version number): ● Moved specifications into standard Graphic OLED template. ● In Physical Characteristics (Pg. 8) table (formerly "3. General Specification": - Corrected module viewing area width from "60.85" to "63.41" mm and viewing area height from "13.7" to "32.69" mm. Viewing Area was correct in Contour Drawing. Module has not changed. - Corrected module depth maximum from "6.0" mm to "2.50" mm. Depth was correct in Contour Drawing. Module has not changed. - Added specifications for nominal depth ("2.20" mm), Module Connector, and Weight. ● In Absolute Maximum Ratings (Pg. 14), - For Logic Supply Voltage (V_{LOGIC}), Increased minimum from "+2.4v" to "-0.3v" and increased maximum from "+3.5v" "+4.0v". - Added specifications for Humidity and Driver Supply Voltage. ● Added new sections MAIN FEATURES (Pg. 6), Circuit Example – VPANEL Externally Supplied for Display (Pg. 13), and Power Up and Power Down Sequencing (Pg. 13). ● Clarified, expanded, and used CF standard terms for Absolute Maximum Ratings (Pg. 14), "Electrical Characteristics" (see DC Characteristics (Pg. 15), and "Interface Pin Functions" (see Details of Interface Pin Function (Pg. 16)). ● Added photo with FFC pins labeled. See Photo Reference for Pin Functions (Pg. 18). ● Replaced brief "2.Precautions in use of OLED Modules" section with expanded CARE AND HANDLING PRECAUTIONS (Pg. 22). Be sure to read important information on hot bar machine soldering and hand soldering.
Continued on next page.	

DATA SHEET	
Continued from previous page.	
2009/12/28	● Also added important information on ESD (Electro-Static Discharge) (Pg. 19), Module Longevity (EOL/Replacement Policy) (Pg. 21), APPENDIX A: QUALITY ASSURANCE STANDARDS (Pg. 24), APPENDIX B: SAMPLE CODE (Pg. 27), APPENDIX C: OLED MODULE TERMS AND SYMBOLS (Pg. 31), and APPENDIX D: SOLOMON SYSTECH SSD1305 CONTROLLER SPECIFICATION SHEET (Pg. 36). ● Improved illustrations throughout, including System Block Diagram (Pg. 12). ● Deleted information that is repeated in the appended controller specifications. ● This module can be ordered as part of a CFA10009 demonstration board kit. The *CFA10009 User Guide* was added at the end of this Data Sheet.
2009/02/19	New Data Sheet. Preliminary, no version number.

The Fine Print

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CONTENTS

LIST OF FIGURES

MAIN FEATURES

DEMONSTRATION AND EVALUATION PLATFORM

This module is available installed on a Crystalfontz CFA-10009 Demonstration PCB. The DMO-L12864LYB6 kit has everything you need to easily demonstrate and experiment with the module.The kit can also be used as a reference for your designs. The *CFA10009 User Guide* can be found at the end of this Data Sheet.

COMPARISON TO LCD (LIQUID CRYSTAL DISPLAY) MODULE

The CFAL12864L-Y-B6 is a yellow 128 x 64 dot matrix Organic Light-Emitting Diode (OLED) display module. The small size, and ultrathin form factor of the CFAL12864L-Y-B6 makes it possible to use this OLED module in applications where it would be difficult or impossible to fit a traditional LCD module. Because of the low power requirements, the CFAL12864L-Y-B6 is suitable in battery powered portable devices such as remote controls and scientific meters (for example, temperature, sound, and gas detection).

Compared to most LCD modules, this OLED module has a quicker response time and an extremely wide viewing angle. At the low end of an STN LCD's temperature range, a module's contrast will typically be poor and the response time will be very slow. Unlike an STN LCD module, contrast does not diminish and response time is good at the lower end of an OLED module's operating temperature range, allowing it to operate in cold environments without a heater.

FEATURES

- ❑ 128 x 64 module consists of an OLED panel, a COF (Chip on Flex) driver IC, and an FFC (Flat Flexible Cable) that mates with a ZIF connector.
- ❑ Module Dimensions
  - Active Area is 2.70" diagonal, 61.41 (W) x 30.69 (H) millimeters (2.42" (W) x 1.21" (H)).
  - Overall module dimension is 74.00 (W) x 68.00 (H) x 2.50 maximum (D) mm (2.91" (W) x 2.68 (H) x 0.10" maximum (D)).
- ❑ Requires 3v for logic and a separate supply for V_{PANEL}.
- ❑ 8-bit parallel (8080 or 6800) interface or SPI Interface.
- ❑ Built-in Solomon Systech SSD1305 or compatible controller.
- ❑ Emissive monochrome display. Display yellow pixels on dark area or dark pixels on yellow area (if operating with display pixels reversed/inverted).
- ❑ Very high contrast ratio.
- ❑ Extremely wide viewing angle is >160°.
- ❑ Wide temperature range for operation is -20°C to +70°C.
- ❑ RoHS compliant.

MODULE CLASSIFICATION INFORMATION

CFA ❶ L ❷ 128 ❸ 64 ❹ L ❺ - Y ❻ - B6 ❼

❶	Brand	Crystalfontz America, Inc.
❷	Display Type	L – OLED
❸	Number of Pixels (Width)	128 pixels
❹	Number of Pixels (Height)	64 pixels
❺	Model Identifier	L
❻	Display Color	Y – Yellow
❼	Special Code	B6 – Manufacturer's code

ORDERING INFORMATION

PART NUMBER	COLOR
CFAL12864L-Y-B6	yellow 
Additional modules in this series.	
CFAL12864L-Y-B6TS*	yellow 
CFAL12864L-G-B2	green 
CFAL12864L-G-B2TS*	green
CFAL12864L-Y-B2	yellow 
CFAL12864L-Y-B2TS*	yellow
CFAL12864L-G-B4	green 
CFAL12864L-Y-B4	yellow 
**Touch Screen*	

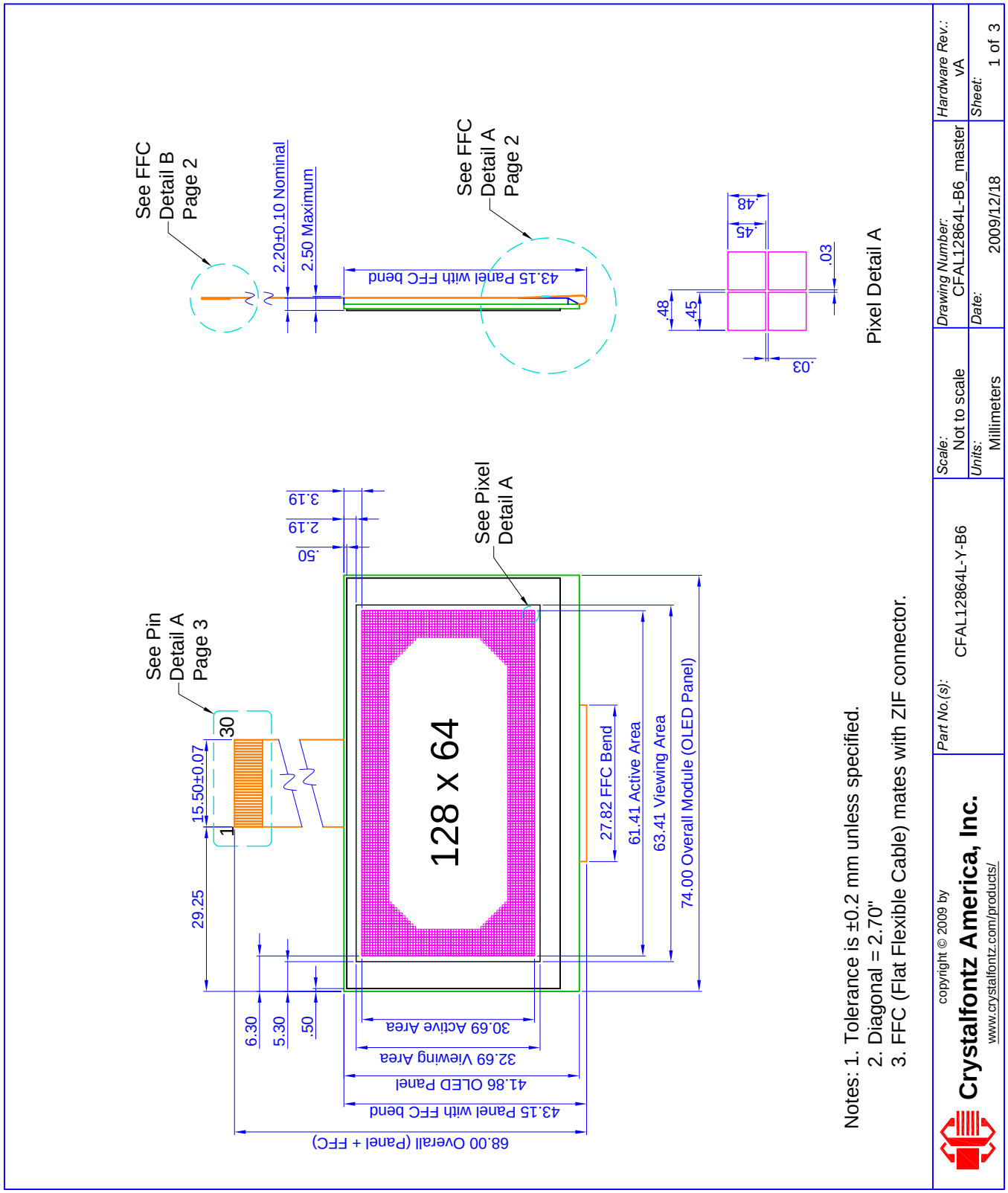
MECHANICAL SPECIFICATIONS

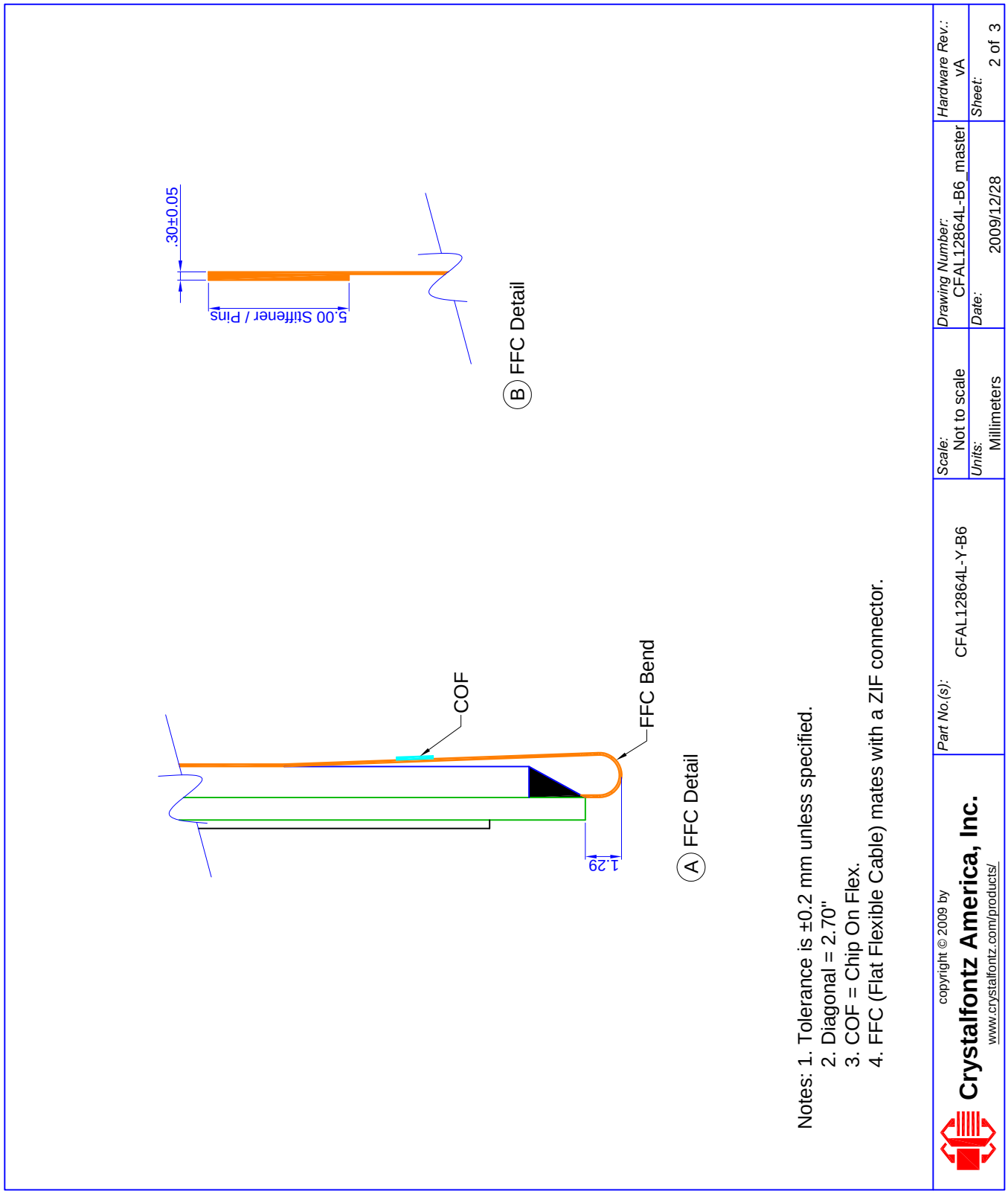
PHYSICAL CHARACTERISTICS

ITEM	SIZE
Pixels	
Number of Pixels	128 x 64 pixels = 8,192 pixels
Pixel Size	0.45 (W) x 0.45 (H) mm
Pixel Pitch	0.48 (W) x 0.48 (H) mm
Viewing Area Width and Height	Millimeters: 63.41 (W) x 32.69 (H) mm Inches: 2.50" (W) x 1.29" (H)
Active Area	
Diagonal	Inches: 2.70"
Width and Height	Millimeters: 61.41 (W) x 30.69 (H) mm Inches: 2.42" (W) x 1.21" (H)
Overall Module Outline Dimensions	
Width	Millimeters: 74.00 mm Inches: 2.91"
Height (includes Panel FFC)	Millimeters: 68.00 mm Inches: 2.68"
Module Depth	Maximum: Millimeters: 2.50 mm Inches: 0.10" Nominal: Millimeters: 2.20 mm Inches: 0.09"
Module Connector Pitch	0.5 mm
Weight	34 grams (typical)

MODULE OUTLINE DRAWING

Figure 1. Module Outline Drawing (3 pages below).




.30±0.05
5.00 Stiffener / Pins
B FFC Detail
COF
FFC Bend
1.29
A FFC Detail
Notes: 1. Tolerance is ±0.2 mm unless specified.
2. Diagonal = 2.70"
3. COF = Chip On Flex.
4. FFC (Flat Flexible Cable) mates with a ZIF connector.
Hardware Rev.: vA
Drawing Number: CFAL12864L-B6_master
Sheet: 2 of 3
Scale: Not to scale
Date: 2009/12/28
Units: Millimeters
Part No.(s): CFAL12864L-Y-B6
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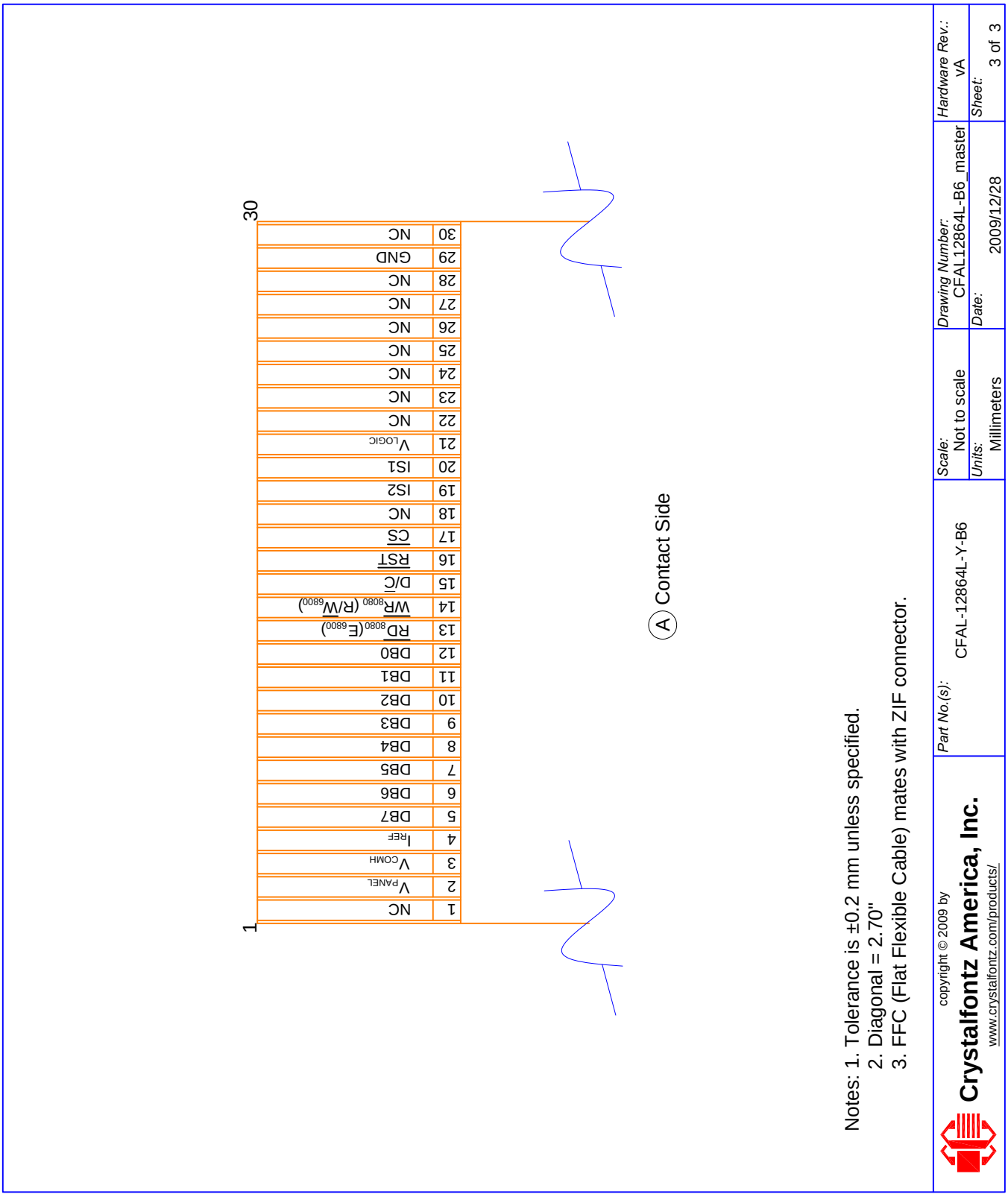
30
1
1 NC
2 VPANEL
3 VCOMH
4 IREF
5 DB7
6 DB6
7 DB5
8 DB4
9 DB3
10 DB2
11 DB1
12 DB0
13 RD8080 (E6800)
14 WR8080 (R/W6800)
15 D/C
16 RST
17 CS
18 NC
19 IS2
20 IS1
21 VLOGIC
22 NC
23 NC
24 NC
25 NC
26 NC
27 NC
28 NC
29 GND
30 NC
A Contact Side
Notes: 1. Tolerance is ±0.2 mm unless specified.
2. Diagonal = 2.70"
3. FFC (Flat Flexible Cable) mates with ZIF connector.
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Part No.(s):
CFAL-12864L-Y-B6
Scale: Not to scale
Units: Millimeters
Drawing Number: CFAL12864L-B6_master
Date: 2009/12/28
Hardware Rev.: vA
Sheet: 3 of 3

ELECTRICAL SPECIFICATIONS

SYSTEM BLOCK DIAGRAM

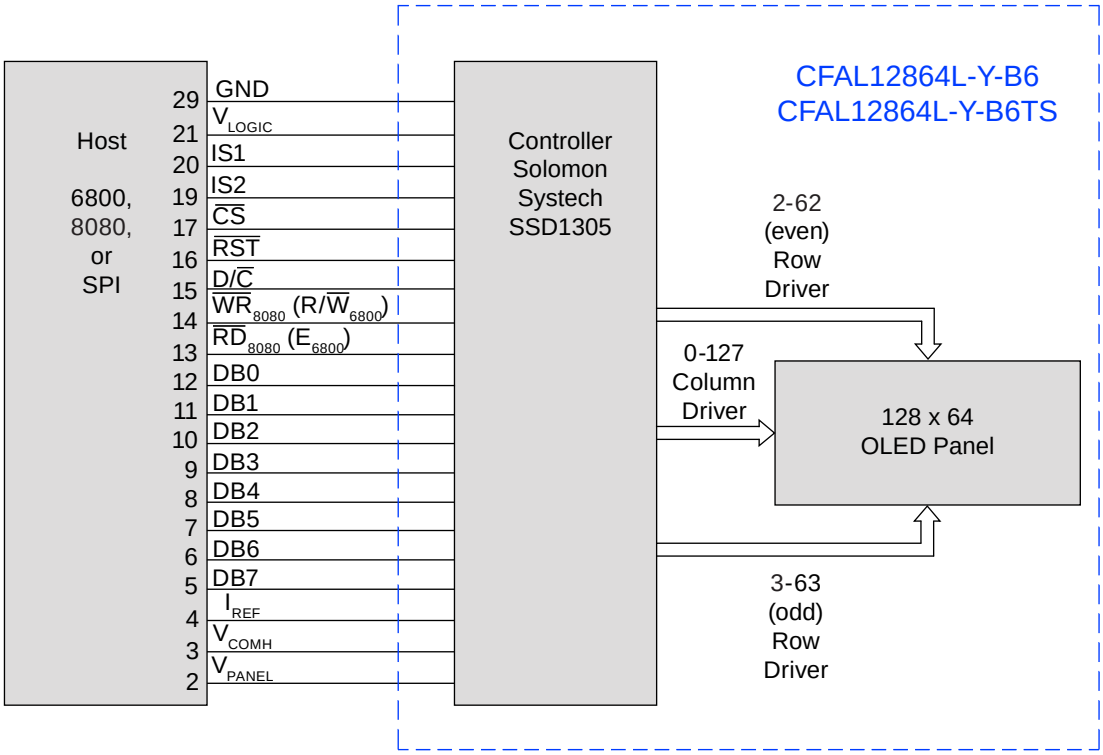


Figure 2. System Block Diagram

CIRCUIT EXAMPLE – V_{PANEL} EXTERNALLY SUPPLIED FOR DISPLAY

The Micrel MIC2290 is one of many possible V_{PANEL} supply solutions.

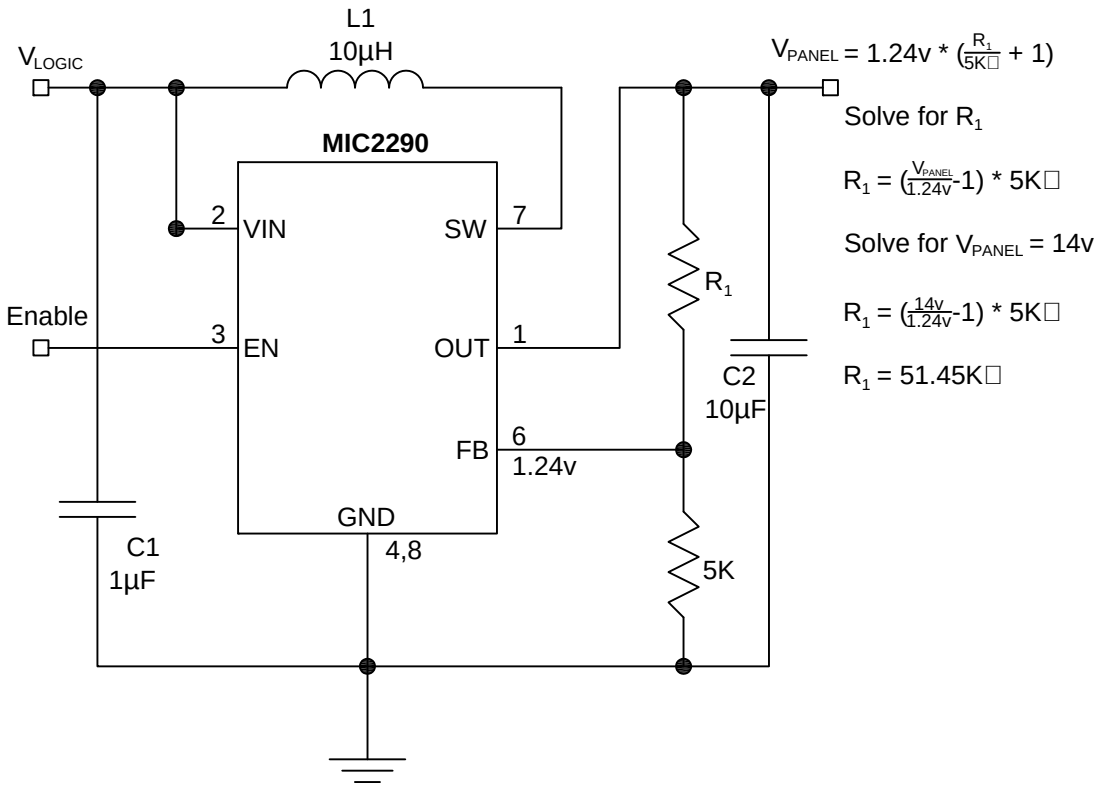


Figure 3. Circuit Example – External Supply for Display

Please refer to the Micrel MIC2290 datasheet for design details. See http://micrel.com/page.do?page=/product-info/products/mic2290.shtml.

POWER UP AND POWER DOWN SEQUENCING

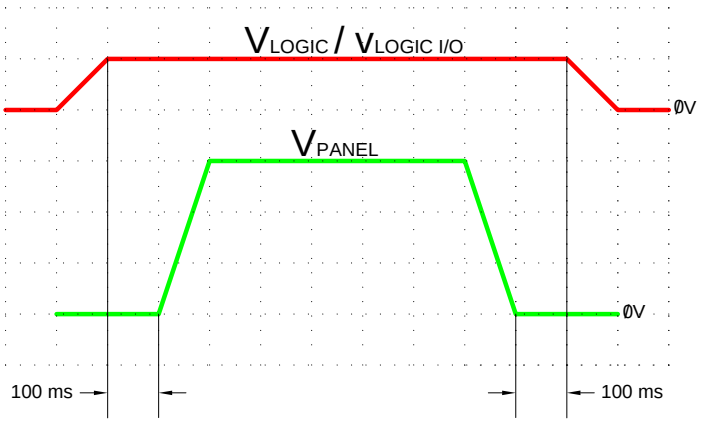


Figure 4. Power Up and Power Down Sequencing

ABSOLUTE MAXIMUM RATINGS

Ambient Temperature (Ta) = 25°C			
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%
Logic Supply Voltage	V_{LOGIC}	-0.3v	+4.0v
Driver Supply Voltage	V_{PANEL}	+0v	+16v
Operating Current for V_{LOGIC} *Test conditions:* All pixels on V_{LOGIC} = +3.0v V_{PANEL} = +14.0v Frame Rate = 104 Hz Contrast Setting = 0xB0	I_{CC}		60 mA
**Prolonged exposure at temperatures outside of this range may cause permanent damage to the module or decrease product lifetime.*			

DC CHARACTERISTICS

DC CHARACTERISTICS	TEST CONDITION	SYMBOL	MINIMUM	TYPICAL	MAXIMUM
Test Conditions for all tests below: All pixels on V_{LOGIC} = +3.0v V_{PANEL} = +14.0v Frame Rate = 104 Hz Contrast Setting = 0xB0					
Logic Supply Voltage	T_{OP} = -20°C to +70°C	V_{LOGIC}	+2.4v	+3.0v	+3.5v[1]
OLED Driver Supply Voltage[1]	T_{OP} = -20°C to +70°C	V_{PANEL}	+12v	+14v	+14.85v
Input High Voltage		V_{IH}	+0.8v x V_{Logic} For V_{Logic} = +3.0v VIH = +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 = +0.60v
Output High Voltage	I_{OUT} = 0.5mA 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} = 0.5mA 3.3MHz	V_{OL}	0v (GND)		+0.1v x V_{Logic} For V_{Logic} = +3.0v V_{OL} = +0.1v x +3.0v = +0.30v

[1] *The V_{PANEL} input must be a stable value with no ripple or noise.*

This is a summary of the module's major operating parameters. For detailed information see APPENDIX D: SOLOMON SYSTECH SSD1305 CONTROLLER SPECIFICATION SHEET (Pg. 36).

DETAILS OF INTERFACE PIN FUNCTION

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
1	NC			No Connection.
2	V_{PANEL}	+12v to +14.85v		Driver supply voltage. Only high voltage input on chip. Power must be supplied externally. *Note: You must observe power sequencing for this signal.* See Power Up and Power Down Sequencing (Pg. 13). *Power Up* – Display must be powered up and initialized before power is applied to the signal. *Power Down* – Power must be removed from this signal before the display is powered off
3	V_{COMH}		O	High level voltage output for common signals. A low ESR capacitor should be connected between this pin and GND. Do not connect external power supply directly to this pin.
4	I_{REF}		O	Segment output current reference for brightness adjustment. A resistor should be connected between this pin and GND. Used to set the current.
5	DB7	H/L	I/O	Bidirectional databus connects to 8-bit standard host databus. *In serial mode (IS1=0, IS2=0):* DB0 serves as the serial clock input signal (SCL) and DB1 serves as the serial data input pin (SI). DB2-DB7 are high impedance. In serial mode, data can be written to the display but not read. Pin 14 ($\overline{WR}_{8080}$ ($R/\overline{W}_{6800}$) and Pin 13 ($\overline{RD}_{8080}$ (E_{6800}) are unused and should be tied low. *In 6800 Parallel mode:* Pin 14 is used as $R/\overline{W}_{6800}$. Pin 13 is used as E_{6800}. Data is input or output on DB0-DB7. *In 8080 Parallel mode:* Pin14 is used as $\overline{WR}_{8080}$. Pin 13 is used as $\overline{RD}_{8080}$. Data is input or output on DB0-DB7.
6	DB6	H/L	I/O	
7	DB5	H/L	I/O	
8	DB4	H/L	I/O	
9	DB3	H/L	I/O	
10	DB2	H/L	I/O	
11	DB1	H/L	I/O	
12	DB0	H/L	I/O	

Continued on next page.

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
13	$\overline{RD}_{8080}$ (E_{6800})	H/L	I	Host interface input. *8080 Host:* Active low. Signal on the databus is latched at the rising edge of $\overline{RD}$ signal. *6800 Host:* Enable control signal input active high. *E = High:* Read or Write Active *E = Low:* No Read or Write Active *SPI (serial) mode:* Connect to ground.
14	$\overline{WR}_{8080}$ ($R/\overline{W}_{6800}$)	H/L	I	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) *SPI (serial) mode:* Connect to ground.
15	D/$\overline{C}$	H/L	I	Data/Command control. Determines whether data bits are data or command. *1 – High:* Addresses the data register. *2 – Low:* Addresses the command register.
16	$\overline{RST}$	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.
17	$\overline{CS}$	H/L	I	Chip select input. *Low:* Controller chip is selected. Communications with the host is possible. *High:* Controller chip is not selected. Host interface signals are ignored by the controller.
18	NC			No Connection.

Continued on next page.

<table>
<tr><th>PIN</th><th>SIGNAL</th><th>LEVEL</th><th>DIRECTION</th><th>DESCRIPTION</th></tr>
<tr><td>19</td><td>IS2</td><td>H/L</td><td>I</td><td rowspan="2"><table><tr><th>IS1</th><th>IS2</th><th>Interface Mode</th></tr><tr><td>0</td><td>0</td><td>Serial</td></tr><tr><td>0</td><td>1</td><td>6800 Parallel</td></tr><tr><td>1</td><td>0</td><td>Not Allowed</td></tr><tr><td>1</td><td>1</td><td>8080 Parallel</td></tr></table></td></tr>
<tr><td>20</td><td>IS1</td><td>H/L</td><td>I</td></tr>
<tr><td>21</td><td>V_{LOGIC}</td><td></td><td></td><td>Power supply input. Must be connected to an external source.</td></tr>
<tr><td>22-28</td><td>NC</td><td></td><td></td><td>No Connection.</td></tr>
<tr><td>29</td><td>GND</td><td></td><td></td><td>Ground.</td></tr>
<tr><td>30</td><td>NC</td><td></td><td></td><td>No Connection.</td></tr>
</table>

PHOTO REFERENCE FOR PIN FUNCTIONS

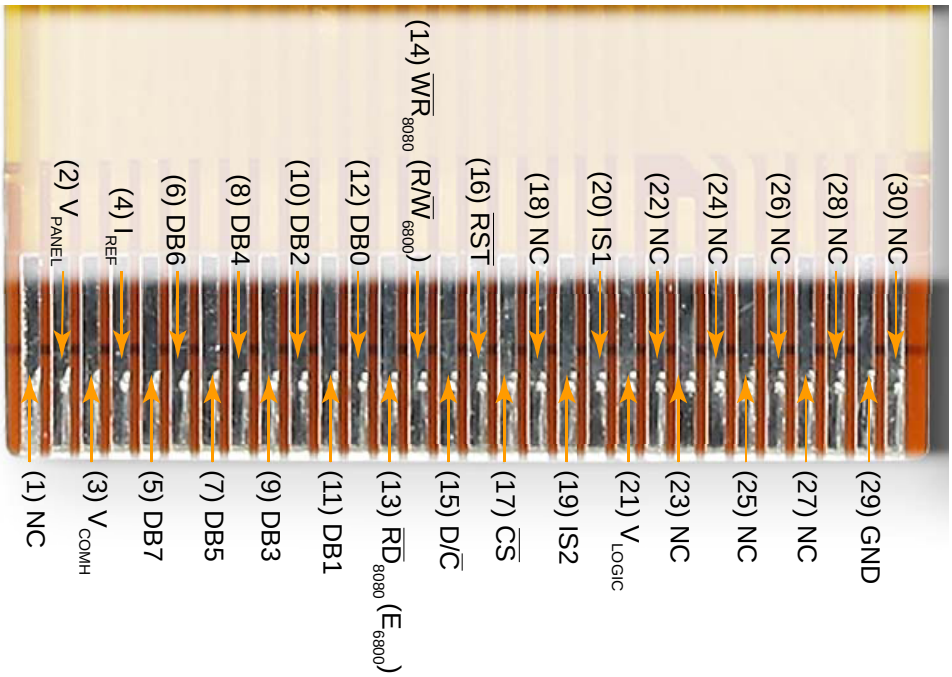


Figure 5. Photo Reference for Pin Functions

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 SPECIFICATIONS

OPTICAL CHARACTERISTICS

ITEM	SYMBOL	TEST CONDITION	TYPICAL
Measurements taken at 1/64 duty, 104 Hz Frame Rate, and 0xB0 Contrast Setting.			
Viewing Angle			>160°
Dark Room Contrast Ratio[1]	CR	80 cd/m^2	>100:1
Response Time[2]			<1 ms
Luminous Intensity (IV)	L_{BR}	with polarizer	40 cd/m^2
Duty	1/64		
Aperture	87.8%		

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

[2]*Response Time: The amount of time it takes a pixel to change from active to inactive or back again.*

[3]Aperture rate is defined by dividing an effective display area with unit pixel area.

Definition of Viewing Angle

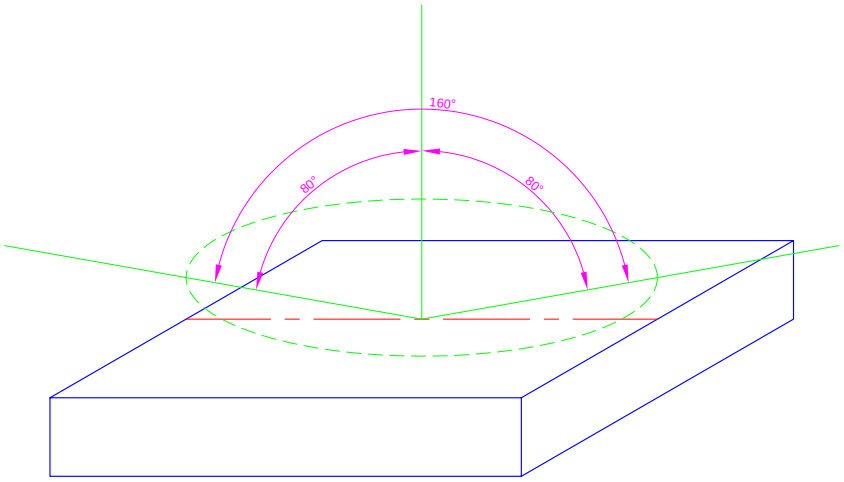


Figure 6. CFAL12864L-Y-B6 has a 160° Viewing Angle

OLED CONTROLLER INTERFACE

This module uses a Solomon Systech SSD1305 controller. For your reference, we added the controller Data Sheet as an appendix to this Data Sheet. See APPENDIX D: SOLOMON SYSTECH SSD1305 CONTROLLER SPECIFICATION SHEET (Pg. 36).

MODULE RELIABILITY AND LONGEVITY

MODULE RELIABILITY

ITEM	SPECIFICATION
CFAL12864L-Y-B6	10,000 hours >50% of initial brightness at typical brightness for a new module.

OLED displays are an emissive technology. Each pixel is susceptible to dimming based on its individual use (burn-in). Frequently used pixels will dim more quickly than pixels that are not used as often. Please avoid using a bright, static, high-contrast image for a long time. If you want to leave the display powered on, please use scrolling text or alternating images to "wear level" the pixels. To conserve power and display lifetime, turn off or dim the display when it is not in use.

MODULE LONGEVITY (EOL/REPLACEMENT POLICY)

Crystalfontz 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.? Excessive voltage will shorten the life of the module. You must drive the display within the specified voltage limit. (See Absolute Maximum Ratings (Pg. 14).

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 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.
- The FFC (Flat Flex Cable) mates with a ZIF connector. Click here to see a typical connector sold by Digi-Key.
- Sharp bends can damage the OLED panel FFC. Do not crease FFC. Do not bend FFC tightly against the edge of the OLED panel.

- Do not repeatedly bend the OLED panel 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 (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 it 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.
- 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.
- Do not allow weight to be placed on the modules while they are in storage.
- Please recycle your outdated Crystalfontz modules at an approved facility.

APPENDIX A: QUALITY ASSURANCE STANDARDS

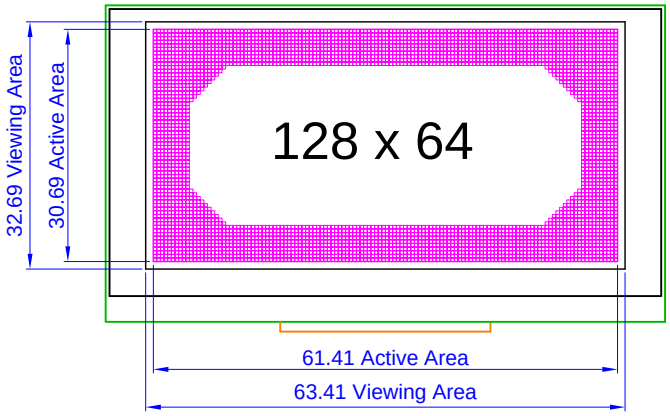
INSPECTION CONDITIONS

- 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

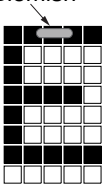
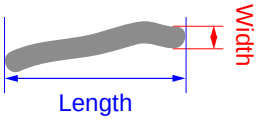
DEFECT TYPE	AQL*
Major	≤.65%
Minor	<1.0%
* Acceptable Quality Level: maximum allowable error rate or variation from standard	

DEFECTS CLASSIFICATION

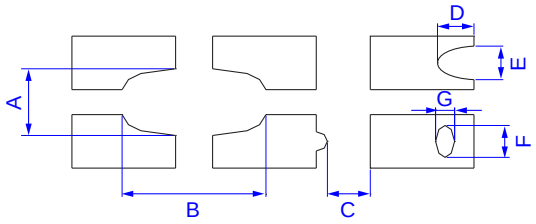
Defects are defined as:

- 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	Blemish 	*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

<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: SAMPLE CODE

SOURCES FOR DRIVER LIBRARIES

Graphic driver libraries may save a lot of time and help you develop a more professional product. Possible library sources are easyGUI, en.radzio.dxp.pl, Gwentech, Micriμm, RAMTEX, and Segger emWin.

SAMPLE CODE

The code shows the boot screen logo, first normally, then inverted. You can download the complete source from this link: http://www.crystalfontz.com/products/document/2021/Demonstration_Code.zip.

Note: Please observe V_{PANEL} sequencing as described in Details of Interface Pin Function (Pg. 16). See also Power Up and Power Down Sequencing (Pg. 13).

```
#include <avr/io.h>
#include <util/delay.h>

// all on PORTC
#define LCD_CD  PC7
#define LCD_RW  PC6// 6800 mode name
#define LCD_E     PC5   // 6800 mode name
#define LCD_WR  PC6// 8080 mode name
#define LCD_RD  PC5// 8080 mode name
#define LCD_CS  PC4
#define LCD_RES PC2

#define CLR_CD PORTC &= ~(1<<LCD_CD);
#define SET_CD PORTC |=  (1<<LCD_CD);

#define CLR_CS PORTC &= ~(1<<LCD_CS);
#define SET_CS PORTC |=  (1<<LCD_CS);

#define CLR_RESET PORTC &= ~(1<<LCD_RES);
#define SET_RESET PORTC |=  (1<<LCD_RES);

// 6800 mode pin functions
#define CLR_RW PORTC &= ~(1 << LCD_RW);  // 6800 mode
#define SET_RW PORTC |=  (1 << LCD_RW);  // 6800 mode
#define CLR_E  PORTC &= ~(1 << LCD_E);   // 6800 mode
#define SET_E  PORTC |=  (1 << LCD_E);   // 6800 mode

// 8080 mode pin functions
#define CLR_WR PORTC &= ~(1 << LCD_WR);  // 8080 mode
#define SET_WR PORTC |=  (1 << LCD_WR);  // 8080 mode
#define CLR_RD PORTC &= ~(1 << LCD_RD);  // 8080 mode
#define SET_RD PORTC |=  (1 << LCD_RD);  // 8080 mode

#define MODE68000

// for bmp function
typedef uint8_t bitmap_t[8][128];

void delay(uint32_t twait)
{
        while (twait--)
        asm volatile ("nop");
}
```

```
// ********************************************************************************************* //
uint8_t boot_logo[8][128] =
{
        See full code listing
};
// ********************************************************************************************* //
void oled_cmd(uint8_t cmd)
{

        PORTA = cmd;// set up data on bus
        CLR_CS;   // chip selected
        CLR_CD;   // command mode

#ifdef MODE6800

        CLR_RW;

        // clock E
        SET_E;
        CLR_E;

#else

        SET_RD;

        // clock WR
        CLR_WR;
        SET_WR;

#endif

        SET_CS;   // unselect chip
}
// ********************************************************************************************* //
void oled_data(uint8_t dat)
{
        PORTA = dat;// set up data on bus
        SET_CD;       // data mode
        CLR_CS;       // chip selected

#ifdef MODE6800

        CLR_RW;

        // clock E
        SET_E;
        CLR_E;

#else           // 8080 mode

        SET_RD;

        // clock WR
        CLR_WR;
        SET_WR;

#endif

        SET_CS;       // unselect chip
}
// ********************************************************************************************* //
void lcd_clr(uint8_t color)
{
        int i,p;
```

```
        oled_cmd(0x40);

        for (p=0;p<8;p++) // pages
        {
                oled_cmd(0xB0 + p);   // set page address
                oled_cmd(0x10);       // set high column address
                oled_cmd(0x00);       // set low column address
                for (i=0;i<132;i++)
                {
                        oled_data(color);
                }
        }
}
// ********************************************************************************************* //
void bmp(bitmap_t b)
{
        unsigned int j=0;
        unsigned int page=0;

        oled_cmd(0x00);       // set high column address
        oled_cmd(0x10);       // set low column address

        oled_cmd(0xB0);  // set page address

        for(page=0;page<8;page++)
        {
                for(j=0;j<128;j++)
                {
                        oled_data(b[page][j]);
                }
                // 132x64 logically, lazy, pad the data sent
                oled_data(0);
                oled_data(0);
                oled_data(0);
                oled_data(0);
        }
}
// ********************************************************************************************* //
void init_OLED()
{
        PORTD = 0;     // all off
        DDRD |= (1<<3);// VPP output

        DDRA = 0xFF;    // set PORTA for output

#ifdef MODE6800
        PORTC = 0b11011110;
#else
        PORTC = 0b11111110;
#endif
        DDRC = 0xFE;

        DDRD |= 0x06;// oled pins output

        delay(20000L);

        // reset the display
        CLR_RESET;
        delay(10000);
        SET_RESET;

        delay(20000);

        // enable VPP
        PORTD |= (1<<3);
```

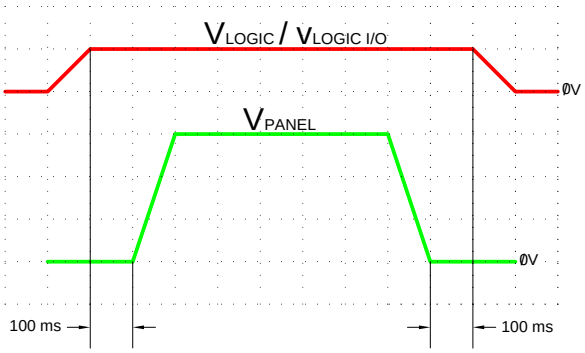
```
        delay(200000L);

        oled_cmd(0xA8);     // Set multiplex ratio
        oled_cmd(0x3F);     // set for 64

        oled_cmd(0x20);     // Set Memory Addressing Mode
        oled_cmd(0x00);     // Horizontal

        oled_cmd(0x81);    // Contrast control mode set
        oled_cmd(0x88);    // (0x00 - 0xFF valid)

        oled_cmd(0xAF);    // Display on

        delay(5000L);

        lcd_clr(0x00);     // clear display
}
// ************************************************************************************** //
int main( void )
{
        init_OLED();

        delay(200000L);

        while (1)
        {
                oled_cmd(0xA6);    // Display normal
                bmp(boot_logo);
                delay(5000000L);
                oled_cmd(0xA7);    // Display inverted
                bmp(boot_logo);
                delay(5000000L);
        }

        return 0;
}
```

APPENDIX C: OLED MODULE TERMS AND SYMBOLS

Crystalfontz Symbol	Equivalents	Description
C		Capacitor
cd/m^2	nit	Candela meter squared is the standard unit of measurement for luminous intensity (photometric brightness).
CIE		A color model based on human perception developed by the CIE (Commission Internationale de l'Eclairage) committee.
CLS		Clock select pin.
COF	COT TAB	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.
COM		Common driver. Common signal output for OLED display.
CR		Contrast Ratio = (brightness with pixels light)/(brightness with pixels dark).
$\overline{CS}$	CS# CSB	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.
D		Diode
DB0 ~ DB*n*	D0 ~ D*n*	Bidirectional databus connects to 8-bit or 16-bit standard host databus. When SPI (serial interface) is selected, DB0 serves as the serial clock input signal (SCL or SCLK) and DB1 serves as the serial data input signal (SI or SDIN). DB2 to DBn are set to high impedance.
D/$\overline{C}$	RS A0 CD or 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.
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.
FB		Feedback input for the booster circuit. Use to adjust booster output voltage level, V_{PANEL}.
FFC		Flat Flex Cable. Used for Touch Screen connection. Also called "pigtail."

<table>
<tr><th>Crystalfontz Symbol</th><th>Equivalents</th><th>Description</th></tr>
<tr><td>FG</td><td></td><td>Frame Ground.</td></tr>
<tr><td>FPC</td><td></td><td>Flexible Printed Circuit. Also called “flex tail.” Typically much thicker than the “flex” film of COF (Chip On Flex).</td></tr>
<tr><td>GDR</td><td></td><td>Gate Drive. Output signal drives the gate of the external NMOS of the booster circuit.</td></tr>
<tr><td>GND</td><td>V_{SS}</td><td>Ground. Must be connected to an external ground.</td></tr>
<tr><td>I_{LOGIC}</td><td>I_{DD}</td><td>Operating current for V_{LOGIC}.</td></tr>
<tr><td>$I_{LOGIC, SLEEP}$</td><td>$I_{DD, SLEEP}$</td><td>Sleep mode current for V_{LOGIC}.</td></tr>
<tr><td>I_{PANEL}</td><td>I_{CC}</td><td>Supply current for V_{PANEL}.</td></tr>
<tr><td>$I_{PANEL, SLEEP}$</td><td>$I_{CC, SLEEP}$</td><td>Sleep mode current for V_{PANEL}.</td></tr>
<tr><td>I_{REF}</td><td></td><td>Segment output current reference for brightness adjustment. A resistor should be connected between this pin and GND. Used to set the current.</td></tr>
<tr><td>I/O</td><td></td><td>Input/Output.</td></tr>
<tr><td>IS1</td><td>BS1
C86
M80</td><td rowspan="2"><table><tr><th>IS1</th><th>IS2</th><th>Interface Mode</th></tr><tr><td>0</td><td>0</td><td>SPI (Serial), if available</td></tr><tr><td>0</td><td>1</td><td>6800 Parallel, if available</td></tr><tr><td>1</td><td>0</td><td>Not Allowed</td></tr><tr><td>1</td><td>1</td><td>8080 Parallel</td></tr></table></td></tr>
<tr><td>IS2</td><td>BS2
P/S
MS
$\overline{MS}$
M/S#</td></tr>
<tr><td>$L_{BRNORMAL}$</td><td>IV</td><td>Luminous Intensity Brightness, NORMAL operation.</td></tr>
<tr><td>$L_{BRSTANDBY}$</td><td>IV</td><td>Luminous Intensity Brightness, STANDBY.</td></tr>
<tr><td>mm</td><td></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></td><td>Milliwatt is equal to one thousandth of a Watt.
Watts = Volts x Amps.</td></tr>
<tr><td>NC</td><td>nc</td><td>No Connection.</td></tr>
<tr><td>OLED</td><td></td><td>Organic light-emitting diode.</td></tr>
<tr><td>$P_{OPERATION}$</td><td>P_T</td><td>Normal mode Power consumption.</td></tr>
<tr><td>$P_{STANDBY}$</td><td></td><td>Standby mode Power consumption.</td></tr>
<tr><td>Q</td><td></td><td>Transistor, including FET and MOSFET.</td></tr>
</table>

Crystalfontz Symbol	Equivalents	Description
R		Resistor
$\overline{RD}_{8080}$ (E_{6800})	$\overline{RD}$ (E) E ($\overline{RD}$) E RDB	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.
RH	Rh	Relative Humidity.
RoHS		Restriction of Hazardous Substances Directive, an environmental standard.
$\overline{RST}$	$\overline{RES}$ RST# RES# RSTB	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	SCK	Serial Clock signal.
SEG		Segment driver. Segment signal output for OLED display.
SENSE		Source current for external NMOS of booster circuit.
SI	SDA MOSI	Serial data Input signal.
SW		Switch output drives the gate of the external NMOS of the booster circuit.
Ta	TA	“Ambient temperature” is the temperature of the air that surrounds a component.
T_{OP}		Operating temperature.
T_{ST}	T_{STG}	Storage Temperature.
V_{BREF}		Internal voltage reference for booster circuit. A decoupling capacitor, typically 1µF, should be connected to GND.
V_{COMH}		High level voltage output for common signals. A low ESR capacitor should be connected between this pin and GND. Do not connect external power supply directly to this pin.
V_{IH}	V_{ICH}	High level input voltage.

Crystalfontz Symbol	Equivalents	Description
V_{IL}	V_{LCH}	Low level input voltage.
V_{LOGIC}	V_{DD} V_{DD1} V_{CC} (if it has PCB)	Power supply input. Must be connected to an external source.
$V_{LOGIC\ I/O}$	$V_{DD\ I/O}$ $V_{I/O}$ V_{CCIO}	Supply voltage for I/O signals.
V_{OH}	V_{OHC}	High level output voltage.
V_{OL}	V_{OLC}	Low level output voltage.
V_{PANEL}	V_{PP} V_{CC} (if no PCB)	Driver supply voltage. Only high voltage input on chip. Power must be supplied externally. *Note: You must observe power sequencing for this signal.* *Power Up* – Display must be powered up and initialized before power is applied to the signal. *Power Down* – Power must be removed from this signal before the display is powered off. 

Crystalfontz Symbol	Equivalents	Description
V_{REF}		Voltage reference pin for pre-charge voltage in driving OLED device. Voltage should be set to match with the OLED driving voltage in current drive phase. It can either be supplied externally or by connecting to $V_{PANEL.}$
V_{SL}		Segment voltage reference pin. This pin should be left open.
$\overline{WR}_{8080}$ (#R/$\overline{W}_{6800}$)	R/$\overline{W}$ ($\overline{WR}$) $\overline{WR}$ (R/$\overline{W}$) R/W# WRB	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)

APPENDIX D: SOLOMON SYSTECH SSD1305 CONTROLLER SPECIFICATION SHEET

The complete *Advance Information 132 x 64 Dot Matrix OLED/PLED Segment/Common Driver with Controll*er Data Sheet revision 1.9 (70 pages) follows.