GRAPHIC OLED MODULE DATASHEET

Datasheet Release 2015-07-16
for
CFAL12832D-B

Crystalfontz America, Incorporated

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GENERAL INFORMATION

Datasheet Revision History

Datasheet Release: 2015-07-16
This datasheet replaces the preliminary datasheet (no revision date). Images and text were added to improve usability. Display module physical specifications and the interfaces described in the previous datasheet have not changed.

Improvements in specifications are:

- Operating and Storage Temperatures are wider. See Absolute Maximum Ratings (Pg. 8).
- Contrast Ratio increased. See Optical Specifications (Pg. 10).

New information added includes:

- Display module weight in Physical Characteristics (Pg. 4).
- New Application Example (2 pages) (Pg. 15).
- Improved Application Example (2 pages) (Pg. 15).
- Table lists Interface Pinout for SPI and I2C (Pg. 20).
- Provided SOURCES FOR DRIVER LIBRARIES AND SAMPLE CODE (Pg. 20).
- Lifetime specifications are included in PRODUCT RELIABILITY AND LONGEVITY (Pg. 21). This section replaces the previous shorter Reliability section.
- The CARE AND HANDLING PRECAUTIONS (Pg. 22) section replaces the previous Cautions In Using OLED Module.

Also, minor specification changes were made in:

- See Absolute Maximum Ratings (Pg. 8).
- See Recommended DC Characteristics (Pg. 9).
- See Optical Specifications (Pg. 10)

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

This display module has 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.

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DISPLAY MODULE SPECIFICATIONS

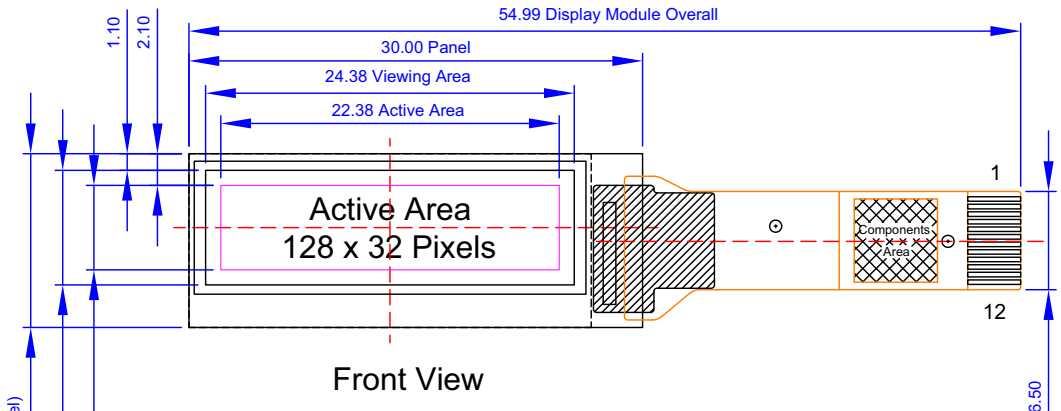
PHYSICAL CHARACTERISTICS

No.	Items:	Specification:	Unit
1	Diagonal Size	0.91	Inch
2	Display Mode	Passive Matrix OLED Display	-
3	Resolution	128(H)x 32 (V)	Dots
4	Active Area	22.384 (W) x 5.584 (H)	mm^2
5	Outline Dimension	30.0 (W) x 11.5(H)x1.45(D)	mm^3
6	Pixel Pitch	0.175 (W) x 0.175 (H)	mm^2
7	Pixel Size	0.159 (W) x 0.159 (H)	mm^2
8	Driver IC	SSD1306	-
9	Display Color	Monochrome (White)	-
11	Interface	3/4-wire SPI/I2C	-
12	Weight	1.3 grams	g
13	Duty	1/64	-

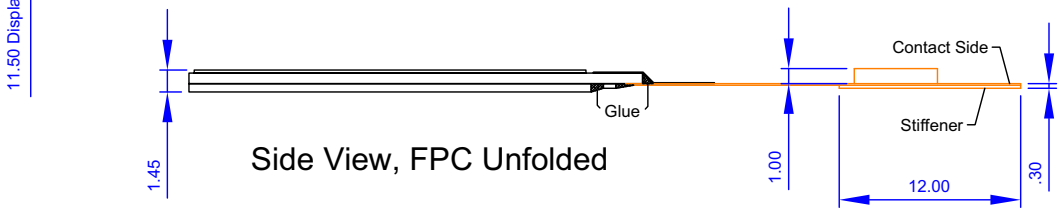
ADDITIONAL FEATURES

- For interface information and other details, see the Solomon Systech SSD1306 128 x 64 Dot Matrix OLED/PLED Segment/Common Driver with Controller datasheet our website
- This display is an add-on option in the Internet Ready Linux SOM development kit CFA920-TS and CFA921-TS.
- RoHS compliant.
- Crystalfontz is ISO certified.

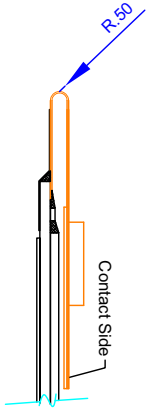
DISPLAY MODULE OUTLINE DRAWINGS



Front View



Side View, FPC Unfolded



FPC Bend Detail

Note:

1. Drawing deemed accurate but not guaranteed.
2. FPC = Flexible Printed Circuit. Dimensions may vary.
3. Diagonal = 0.91"

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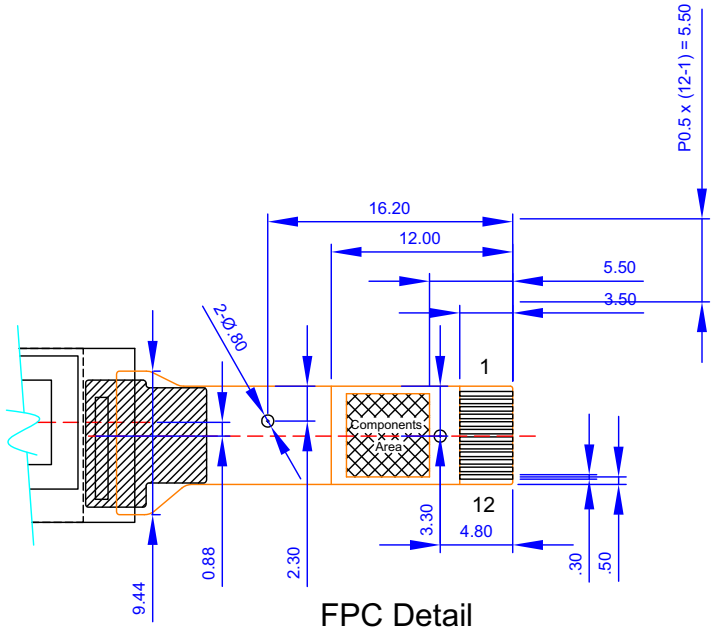
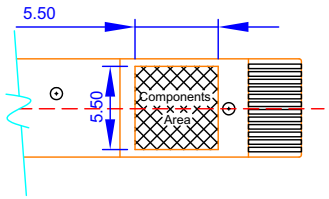
Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAL12832D-B	Not to scale	CFAL12832D-B	
	Units: Millimeters	Date: 2014-12-02	Sheet: 1 of 3



FPC Detail



Components Area
Keep Out

Note:

1. Drawing deemed accurate but not guaranteed.
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3. Diagonal = 0.91"

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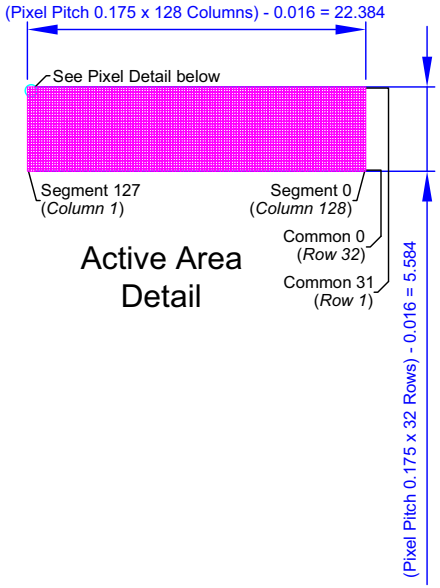
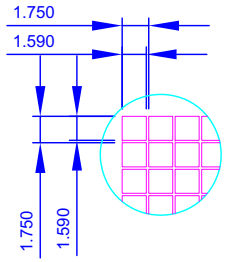
Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAL12832D-B	Not to scale	CFAL12832D-B	
	Units: Millimeters	Date: 2014-12-02	Sheet: 2 of 3



Active Area Detail



Pixel Detail

Note:

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Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAL12832D-B	Not to scale	CFAL12832D-B	
	Units: Millimeters	Date: 2014-12-02	Sheet: 3 of 3

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

Items	Symbol	Min	Typ.	Max	Unit	Notes
Supply voltage for logic	V_{DD}	-0.3	-	4	V	1,2
Supply voltage for DC/DC	V_{DDB}	-0.3	-	5.0	V	1,2
Operating temperature	T_{OP}	-40	-	70	℃	-
Storage temperature	T_{ST}	-40	-	85	℃	3

Note 1: All the above voltages are on the basis of "V_{SS} = 0V".

Note 2: When this module is used beyond the above absolute maximum ratings, permanent breakage of the module may occur.Also,for normal operations,it is desirable to use this module under the conditions according to electro-optical characteristics .If this module is used beyond these conditions,malfunctioning of the module can occur and the reliability of the module may deteriorate.

Note 3: The defined temperature ranges do not include the polarizer. The maximum withstood temperature temperature of the polarizer should be 80°C.

Caution:
These are stress ratings only. Functional operation of the display module at these or any other conditions beyond those listed under Recommended DC Characteristics (Pg. 9) is not implied.

Extended exposure to the absolute maximum ratings listed above may affect device reliability. Stresses beyond those listed above can cause permanent damage.

RECOMMENDED DC CHARACTERISTICS

Items	Symbol	Conditions	Min	Typ.	Max	Unit
Supply voltage for logic	V_{DD}		1.65	2.8	3.3	V
Supply voltage for DC/DC	V_{BAT}	Internal DC/DC enable	3.0	-	4.2	V
High level input	V_{IH}	I_{OUT} = 100µA, 3.3MH	0.8 x V_{DD}	-	V_{DD}	V
Low level input	V_{IL}	I_{OUT} = 100µA, 3.3MH	0	-	0.2 x V_{DD}	V
High level output	V_{OH}	I_{OUT} = 100µA, 3.3MH	0.9 x V_{DD}	-	V_{DD}	V
Low level output	V_{OL}	I_{OUT} = 100µA, 3.3MH	0	-	0.1x V_{DD}	V
Operating current for V_{DD}	I_{DD}		-	180	300	µA
Operating current for V_{BAT} (V_{CC} Generated by internal DC/DC)	I_{BAT}	Note 4	-	13.3	16.6	mA
		Note 5	-	21.7	27.1	mA
Sleep mode current for V_{DD}	$I_{DD,SLEEP}$		-	1	5	µA
Sleep mode current for V_{CC}	$I_{CC,SLEEP}$		-	2	10	µA

Note 4: V_{DD}= 2.8V, 50% Display Area Turn on.

Note 5: V_{DD} = 2.8V, 100% Display Area Turn on.

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.

OPTICAL CHARACTERISTICS

OPTICAL SPECIFICATIONS

OLEDs use quickly evolving, cutting edge technology. Each manufacturing lot can have slight differences, including display color. If you need modules with consistent color, please ask for a custom order and order all modules that you need at one time.

Items		Symbol	Min.	Typ.	Max.	Unit	Remark
Operating Luminance		L	120	150	-	cd /m^2	White
Color Coordinate	White	CIE x	0.25	0.29	0.33	CIE1931	Darkroom
		CIE y	0.27	0.31	0.35		
Contrast Ratio*		Cr	10000 :1	-	-		Darkroom
Viewing Angle Uniformity		△ θ	-	Free	-	Degree	-

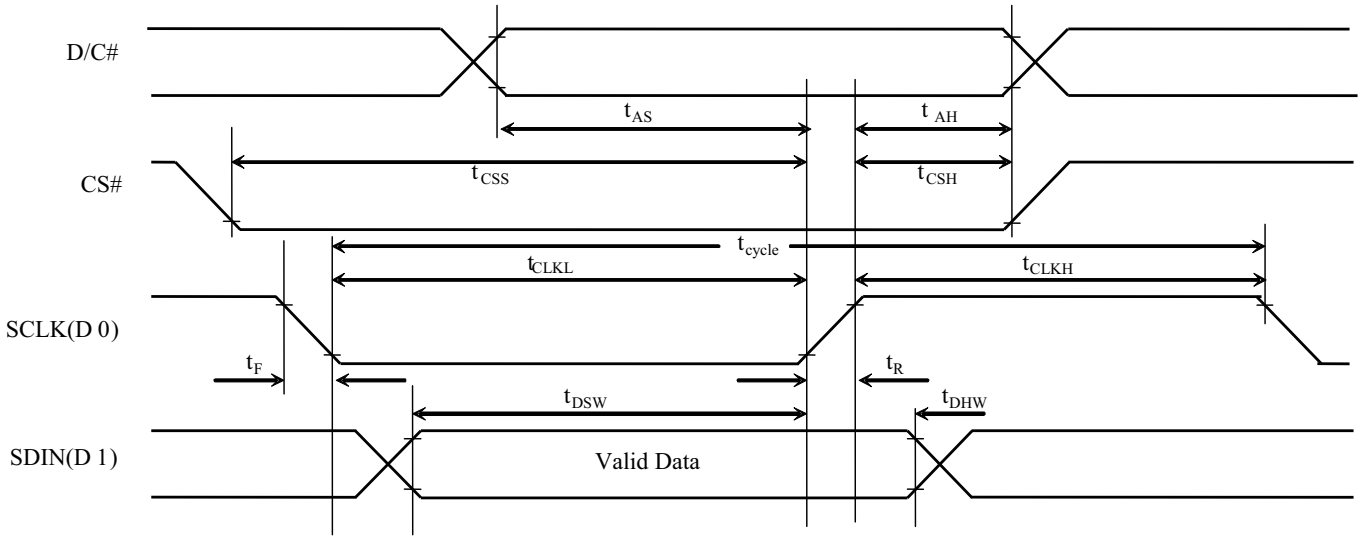
* Optical measurement taken at V_{DD} = 2.8V.
Software configuration follows Actual Application Example .

AC CHARACTERISTICS – SPI AND I2C INTERFACE TIMING

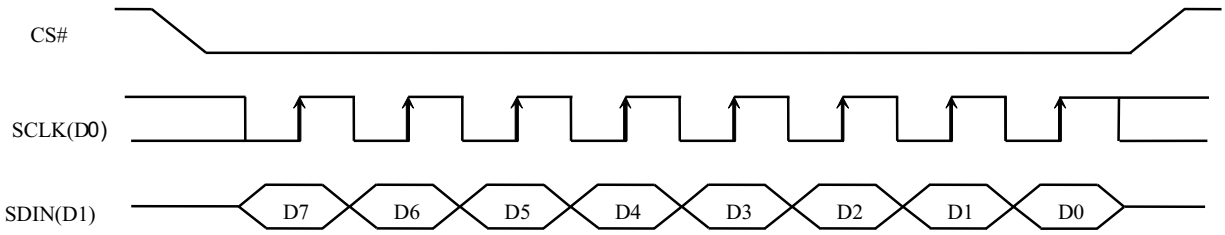
(V_{DD} - V_{SS} = 1.65V to 3.3V, T_A = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	100	-	-	ns
t_{AS}	Address Setup Time	15	-	-	ns
t_{AH}	Address Hold Time	15	-	-	ns
t_{CSS}	Chip Select Setup Time	20	-	-	ns
t_{CSH}	Chip Select Hold Time	10	-	-	ns
t_{DSW}	Write Data Setup Time	15	-	-	ns
t_{DHW}	Write Data Hold Time	15	-	-	ns
t_{CLKL}	Clock Low Time	20	-	-	ns
t_{CLKH}	Clock High Time	20	-	-	ns
t_R	Rise Time	-	-	40	ns
t_F	Fall Time	-	-	40	ns

4-wire Serial Interface Timing Characteristics



4-wire Serial interface characteristics

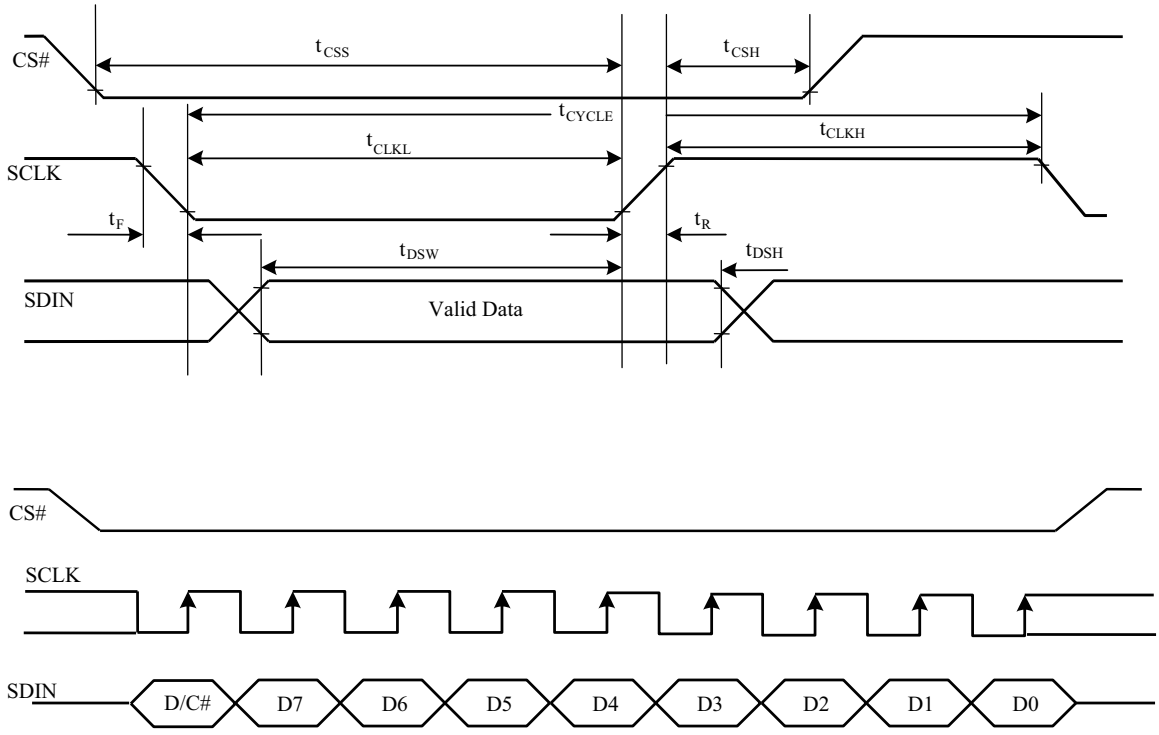


4-wire Serial interface characteristics

(V_{DD} - V_{SS} = 1.65V to 3.3V, T_A = 25°C)

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	100	-	-	ns
t_{CSS}	Chip Select Setup Time	20	-	-	ns
t_{CSH}	Chip Select Hold Time	10	-	-	ns
t_{DSW}	Write Data Setup Time	15	-	-	ns
t_{DHW}	Write Data Hold Time	15	-	-	ns
t_{CLKL}	Clock Low Time	20	-	-	ns
t_{CLKH}	Clock High Time	20	-	-	ns
t_R	Rise Time	-	-	40	ns
t_F	Fall Time	-	-	40	ns

3-wire Serial Interface Timing Characteristics



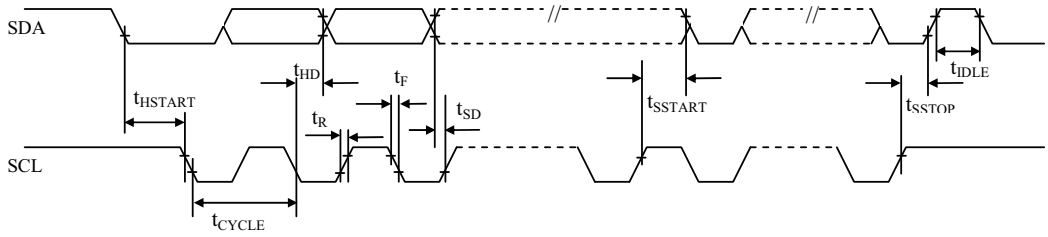
3-wire Serial interface characteristics

Conditions:

V_{DD} - V_{SS} = V_{DD} - V_{SS} = 1.65V to 3.3V
T_A = 25°C

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	2.5	-	-	us
t_{HSTART}	Start condition Hold Time	0.6	-	-	us
t_{HD}	Data Hold Time (for "SDA_{OUT}" pin)	0	-	-	ns
	Data Hold Time (for "SDA_{IN}" pin)	300	-	-	ns
t_{SD}	Data Setup Time	100	-	-	ns
t_{SSTART}	Start condition Setup Time (Only relevant for a repeated Start condition)	0.6	-	-	us
t_{SSTOP}	Stop condition Setup Time	0.6	-	-	us
t_R	Rise Time for data and clock pin	-	-	300	ns
t_F	Fall Time for data and clock pin	-	-	300	ns
t_{IDLE}	Idle Time before a new transmission can start	1.3	-	-	us

I²C Interface Timing Characteristics



I²C interface Timing characteristics

Timing Of Power Supply

1.1 Commands

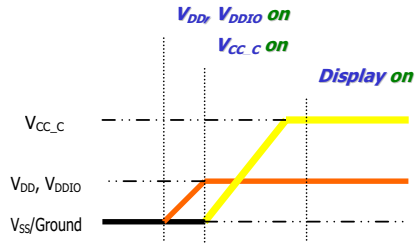
Refer to the Technical Manual for the SSD1306

1.2 Power down and Power up Sequence

To protect OEL panel and extend the panel life time, the driver IC power up/down routine should include a delay period between high voltage and low voltage power sources during turn on/off. It gives the OEL panel enough time to complete the action of charge and discharge before/after the operation.

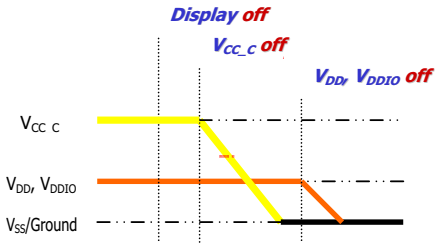
1.2.1 Power up Sequence:

1. Power up V_{DD} & V_{DDIO}
2. Send Display off command
3. Initialization
4. Clear Screen
5. Power up V_{CC_C}
6. Delay 100ms
   (When V_{CC_C} is stable)
7. Send Display on command



1.2.2 Power down Sequence:

1. Send Display off command
2. Power down V_{CC_C}
3. Delay 100ms
   (When V_{CC_C} is reach 0 and panel is completely discharges)
4. Power down V_{DD} & V_{DDIO}



Note 8:

1) Since an ESD protection circuit is connected between V_{DD}, V_{DDIO} and V_{CC_C} inside the driver IC, V_{CC_C} becomes lower than V_{DD} & V_{DDIO} whenever V_{DD} & V_{DDIO} is ON and V_{CC_C} is OFF.
2) V_{CC_C} should be kept float (disable) when it is OFF.
3) Power Pins (V_{DD}, V_{DDIO}, V_{CC_C}) can never be pulled to ground under any circumstance.
4) V_{DD} & V_{DDIO} should not be power down before V_{CC_C} power down.

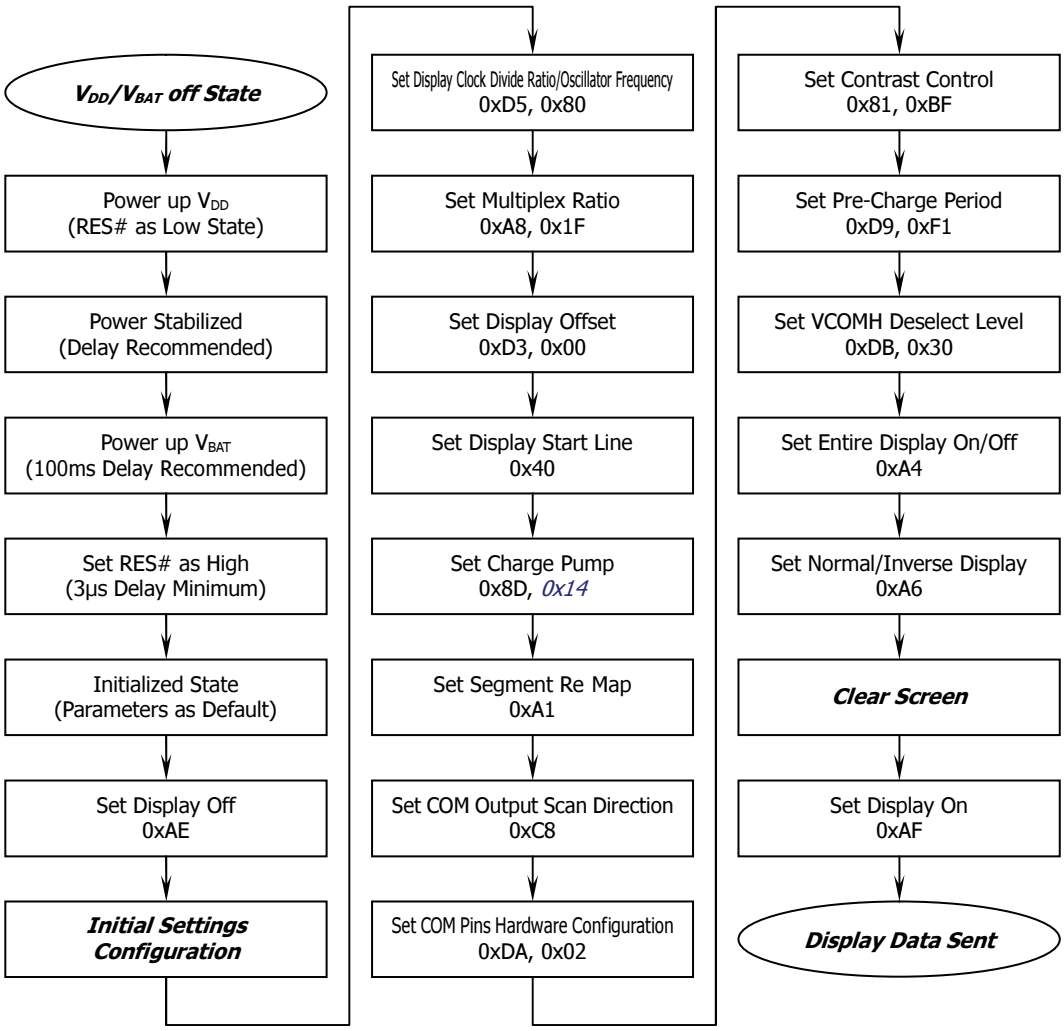
1.3 Reset Circuit

When RES# input is low, the chip is initialized with the following status:

1. Display is OFF
2. 128×64 Display Mode
3. Normal segment and display data column and row address mapping (SEG0 mapped to column address 00h and COM0 mapped to row address 00h)
4. Shift register data clear in serial interface
5. Display start line is set at display RAM address 0
6. Column address counter is set at 0
7. Normal scan direction of the COM outputs
8. Contrast control register is set at 7Fh
9. Normal display mode (Equivalent to A4h command)

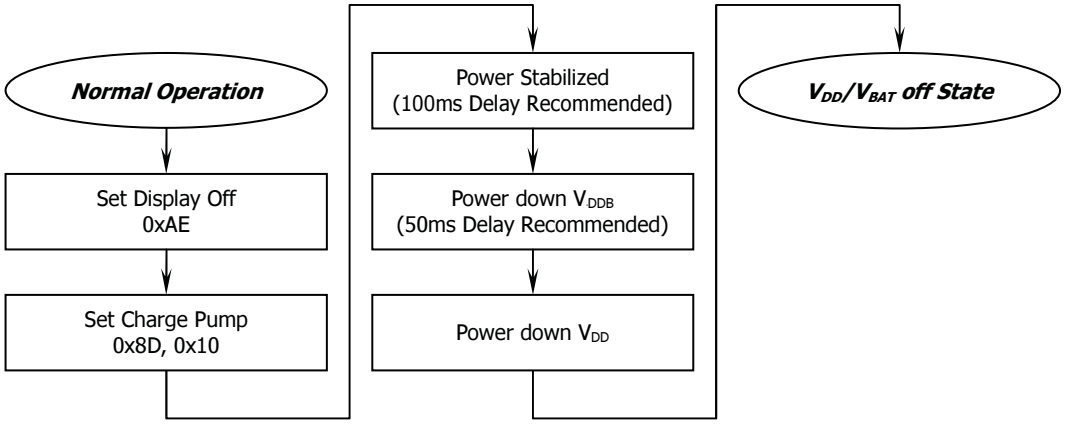
APPLICATION EXAMPLE (2 PAGES)

<Power up Sequence>

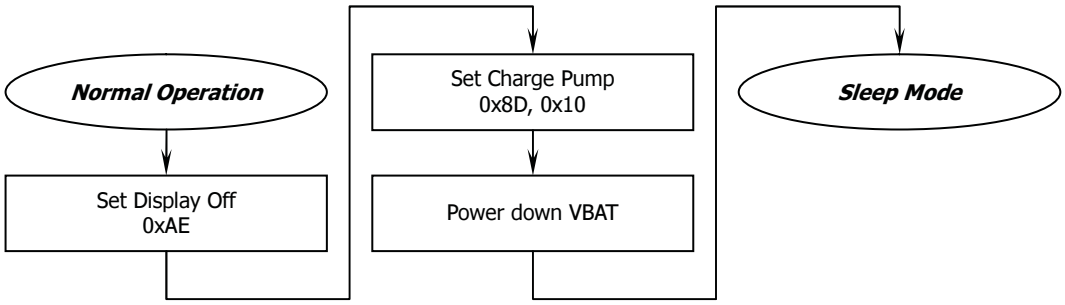


If the noise is accidentally occurred at the displaying window during the operation, please reset the display in order to recover the display function.

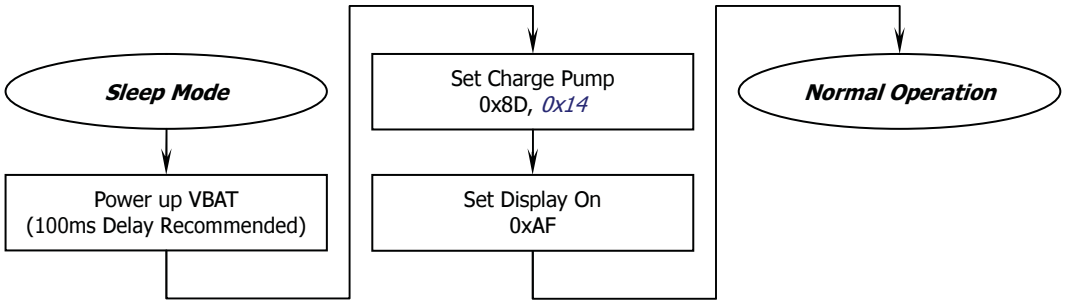
<Power down Sequence>



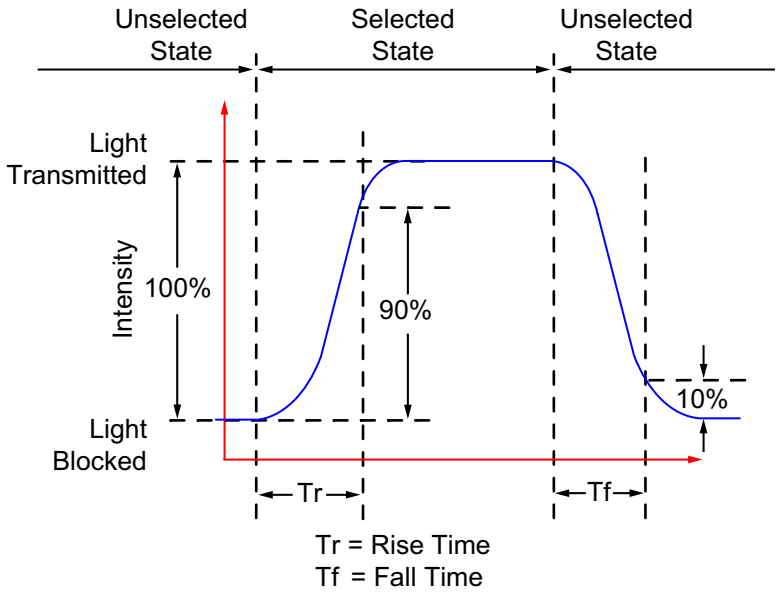
<Entering Sleep Mode>



<Exiting Sleep Mode>



Definition of Response Time (Tr, Tf) (Negative)

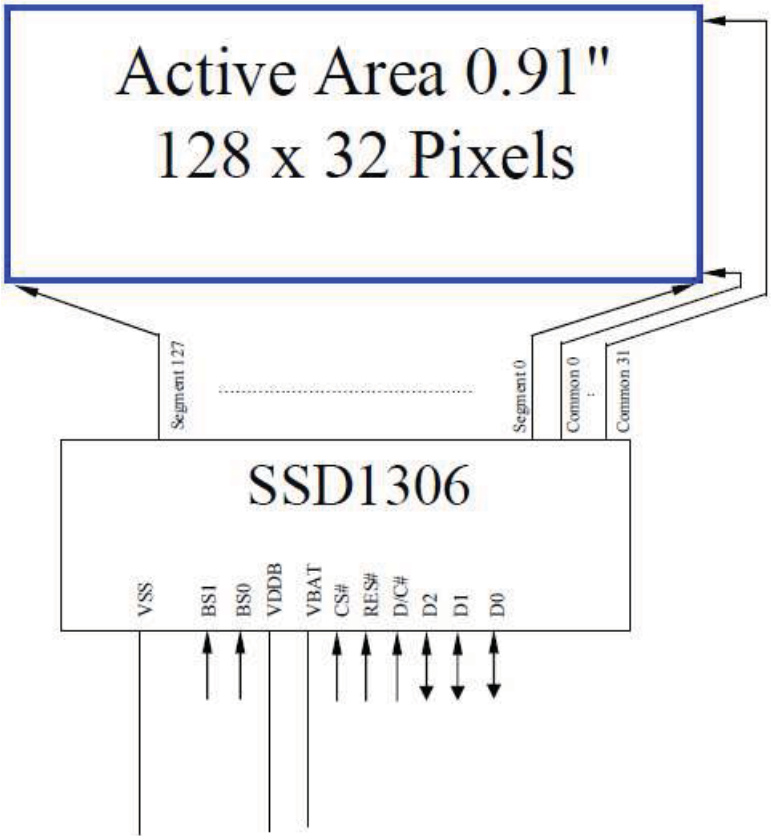


DETAILS OF INTERFACE PIN FUNCTIONS

PIN DESCRIPTIONS

<table>
<tr><th>Pin Number</th><th>Symbol</th><th>Type</th><th>Function</th></tr>
<tr><td>1,12</td><td>GND</td><td>P</td><td>This is a ground pin. It also acts as a reference for the logic pins, the OEL driving voltages, and the analog circuits. It must be connected to external ground.</td></tr>
<tr><td>2-4</td><td>D2-D0</td><td>I/O</td><td>These are 3-bit bi-directional data bus to be connected to the microprocessor's data bus. When serial interface mode is selected, D0 will be the serial clock input: SCLK; D1 will be the serial data input: SDIN and D2 should be kept NC. When I^2C mode is selected, D2, D1 should be tied together and serve as SDA_{out}, SDA_{in} in application and D0 is the serial clock input, SCL.</td></tr>
<tr><td>5</td><td>D/C#</td><td>I</td><td>This pin is Data/Command control pin. When the pin is pulled high and serial interface mode is selected, the data at SDIN is treated as data. When it is pulled low, the data at SDIN will be transferred to the command register. For detail relationship to MCU interface signals, please refer to the Timing Characteristics Diagrams.</td></tr>
<tr><td>6</td><td>RES#</td><td>I</td><td>This pin is reset signal input. When the pin is low, initialization of the chip is executed.</td></tr>
<tr><td>7</td><td>CS#</td><td>I</td><td>This pin is the chip select input. The chip is enabled for MCU communication only when CS# is pulled low.</td></tr>
<tr><td>8-9</td><td>BS1-BS0</td><td>I</td><td><table><tr><th>Pin Name</th><th>I^2C Interface</th><th>4-wire Serial interface</th><th>3-wire Serial interface</th></tr><tr><td>BS0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>BS1</td><td>1</td><td>1</td><td>0</td></tr></table></td></tr>
<tr><td>10</td><td>VDD</td><td>P</td><td>This is a voltage supply pin. It must be connected to external source.</td></tr>
<tr><td>11</td><td>VBAT</td><td>P</td><td>This is the power supply pin for the internal buffer of the DC/DC voltage converter. It must be connected to external source when the converter is used.</td></tr>
</table>

CIRCUIT DIAGRAM



MCU Interface Selection: BS0, BS1
Pins connected to MCU interface: CS#, RES#, D/C#, and D0~D2

INTERFACE PINOUT FOR SPI AND I2C

		Interface		
Pin No	Sym	3 Wire SPI	4 Wire SPI	I2C
1	GND	**GND**	**GND**	**GND**
2	D2	NC	NC	SDA*
3	D1	SDA	SDA	SDA*
4	D0	CLK	SCLK	SCL
5	D/C#	NC	D/C	**Vcc**
6	RES#	RESET	RESET	RESET
7	CS#	**GND**	**GND**	**GND**
8	BS1	**GND**	**GND**	**Vcc**
9	BS0	**Vcc**	**GND**	**GND**
10	Vdd	**Vcc****	**Vcc****	**Vcc****
11	Vbat	**Vcc****	**Vcc****	**Vcc****
12	GND	**GND**	**GND**	**GND**

Microcontroller	Control lines defined by layout / code
+3.3v	Supply voltage
Ground	Supply ground

Notes:

*	Tie D2 and D1 together
**	Okay to Tie Vdd and Vbat together

SOURCES FOR DRIVER LIBRARIES AND SAMPLE CODE

SOURCES FOR DRIVER LIBRARIES

Driver libraries may save you a lot of time and help you develop a more professional product. Possible library sources are easyGUI, RAMTEX, Micrium, and Segger

SAMPLE CODE

Free downloadable sample code is available under the Datasheets & File tab on the web page for this display module.

PRODUCT RELIABILITY AND LONGEVITY

DISPLAY MODULE RELIABILITY TEST RESULTS

Item	Condition	Criterion
High Temperature Storage (HTS)	80±2℃, 240 hours	1. After testing, the function test is ok. 2. After testing, no addition to the defect. 3. After testing, the change of luminance should be within +/- 50% of initial value. 4. After testing, the change for the mono and area color must be within (+/-0.02, +/- 0.02) and for the full color it must be within (+/-0.04, +/-0.04) of initial value based on 1931 CIE coordinates. 5. After testing, the change of total current consumption should be within +/- 50% of initial value.
High Temperature Operating (HTO)	70±2℃, 240 hours	
Low Temperature Storage (LTS)	-40±2℃, 240 hours	
Low Temperature Operating (LTO)	-30±2℃, 240 hours	
High Temperature / High Humidity Storage (HTHHS)	60±3℃, 90%±3%RH, 120 hours	
Thermal Shock (Non-operation) (TS)	-40±2℃ ~ 25℃ ~ 85±2℃ (30min) (5min) (30min) 10cycles	

Note： 1) For each reliability test, the sample quantity is 3, and only for one test item.

DISPLAY MODULE RELIABILITY.

PART NUMBER	SPECIFICATION
CFAL12832D-B	Brightness will be >50% of a new module's initial brightness for at least 30,000 hours of operation at 60 cd/m^2.
	Brightness will be >50% of a new module's initial brightness for at least 20,000 hours of operation at 90 cd/m^2.
	Brightness will be >50% of a new module's initial brightness for at least 10,000 hours of operation at 120 cd/m^2.
Under operating and storage temperature specification limitations, humidity non-condensing) RH up to 65%, and no exposure to direct sunlight. Value listed above isapproximate and represents typical lifetime.	

DISPLAY MODULE LONGEVITY (EOL / REPLACEMENT POLICY)

Crystalfontz is committed to making all of our OLED modules available for as long as possible. Occasionally, a supplier discontinues a component, or a process used to make the module becomes obsolete, or the process moves to a more modern manufacturing line. In order to continue making the module, we will do our best to find an acceptable replacement part or process which will make the "replacement" fit, form, and function compatible with its predecessor.

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 datasheet 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 publish Part Change Notices (PCN) as soon as possible.

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. 8)

HANDLING CAUTION FOR DISPLAY MODULES SHIPPED IN TRAYS

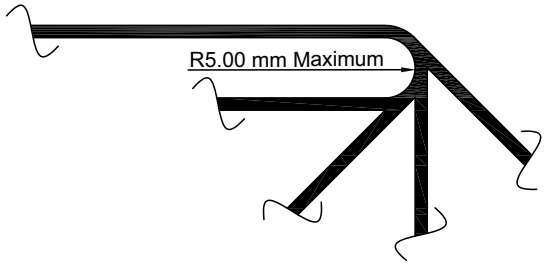
If you receive display modules packed in trays, handle trays carefully by supporting the entire tray. Trays were made to immobilize the display modules inside their packing carton. Trays are not designed to be rigid. Do not carry trays by their edges; trays and display modules may be damaged.

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 micro-controller/driver 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.
- The display module can be mounted vertically onto a front panel using a variety of methods. If the enclosure is plastic, it can be molded to have the display module snap into place. A metal enclosure can use a milled faceplate with mounting tabs to secure the display module. Adhesives can be used, as long as they are not similar to “super-glue” because these emit vapors that can damage the display module over time.
- 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.
- Repeated sharp bends can damage the FPC/FFC tail. (FPC = Flexible Printed Circuit, FFC = Flat Flex Cable) As long as the FPC/FFC bend stays within the FPC/FFC elastic region, it can be bent multiple times. To tell if a bend is completely elastic, the FPC/FFC will return 100% to its pre-bent state. Typically this is around a 5mm radius, or 10mm from side-to-side for a 180° bend. You may bend the FPC/FFC more sharply. For instance, to pass the tail through a slot in a PCB. However these sharper bends will force the FPC/FFC into its plastic region, where it will not return to its pre-bent state on its own. The key is to make sharper bends only once and leave them. Repeatedly bending and unbending the FPC/FFC through its plastic region will cause it to fatigue and eventually fail.



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 DISPLAY MODULE 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 with minimal fluctuations. 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 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.

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

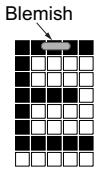
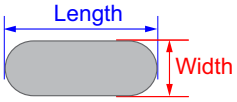
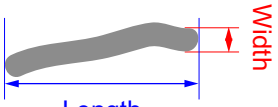
We try to describe the appearance of our modules as accurately as possible. For the photos, we adjust for optimal appearance. Actual display appearance may vary due to (1) different operating conditions, (2) small variations of component tolerances, (3) inaccuracies of our camera, (4) color interpretation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

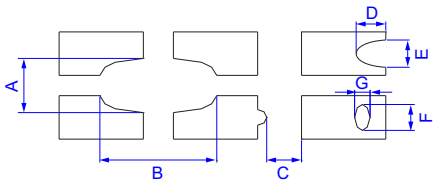
DEFECTS CLASSIFICATION

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. 26), and dark lines or scratches (see test 6, Pg. 26).
*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>