Crystalfontz

DISPLAY MODULE DATASHEET

Crystalfontz America, Incorporated

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GENERAL INFORMATION
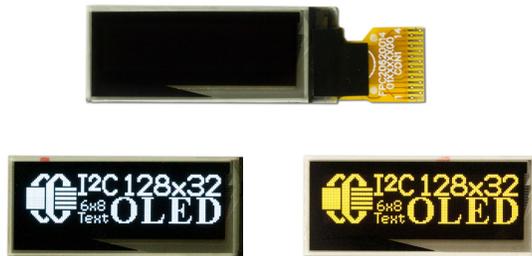
Datasheet Revision History
Datasheet Release: 2016-04-29 First datasheet for the new CFAL12832D-C* series display modules: CFAL12832D-CW and CFAL12832D-CY.

Product Change Notifications
To check for Product Change Notifications for this series of display modules, see the *Product Notices* tab on a product's web page. Product pages without a Product Notices tab do not have Product Change Notifications.

About Variations
Slight variations (for example, contrast, color, or intensity) between lots are normal.

About Volatility
These displays module have volatile memory.

EXPLANATION OF PART NUMBER CODES

CFA	L	-	128	32	D	-	C	*
❶	❷		❸	❹	❺		❻	❼

❶	**Brand**	Crystalfontz America, Incorporated
❷	**Module Type**	L – OLED
❸	**Active Area Pixels Wide**	128 pixels wide
❹	**Active Area Pixels High**	32 pixels high
❺	**Module Identifier**	D – Manufacturer's code
❻	**Interface Code**	C – I2C Interface
❼	**Variant Color Code**	** = Foreground color* W – White on black background Y – Yellow on black background

GENERAL SPECIFICATIONS

ITEM	SPECIFICATION
Matrix Size	128 (W) x 32 (H) Pixels
Diagonal	0.91 inches
Pixel Size	0.152 (W) x 0.152 (H) mm
Pixel Pitch	0.175 (W) x 0.175 (H) mm
Active Area	22.384 (W) x 5.584 (H) mm
Module Dimensions Without FPC	
Width and Height	30.00 (W) mm x 11.50 (H) mm
Depth	1.45 mm (D)
Weight	1.3 grams
Display Mode	Passive Matrix
Display Color	CFAL12832D-CW: White on black background CFAL12832D-CY: Yellow on black background
Duty	1/32 duty
Connector Pitch	0.62 mm

ADDITIONAL FEATURES

❑ Interface to host is I2C. The address to the displays is **"0x78"**.
❑ Sample code is available for download under the *Datasheets & Files* tab on the display web pages.
❑ The FPC has double-sided contacts. The pins are exposed on both sides of the FPC. For high volume manufacturing, the pins can be soldered directly to corresponding pads on your PCB with a hot-bar soldering machine. See Hot Bar Soldering Machine (Pg. 17).
❑ For interface information and other communication details, see the Solomon Systech SSD1306 128 x 64 Dot Matrix OLED/PLED Segment/Common Driver with Controller datasheet on our website.
❑ These displays are RoHS compliant.
❑ Crystalfontz America, Incorporated is ISO 9001:2008 certified.

DISPLAY MODULE OUTLINE DRAWINGS (2 PAGES)

FPC contacts are double-sided. Make connection on either top or bottom.

FPC Details

2.00

14

1

0.32 Width
0.62 Pitch
P0.62*13=8.06
9.00

Pixel Details

0.175
0.152
0.175
0.152
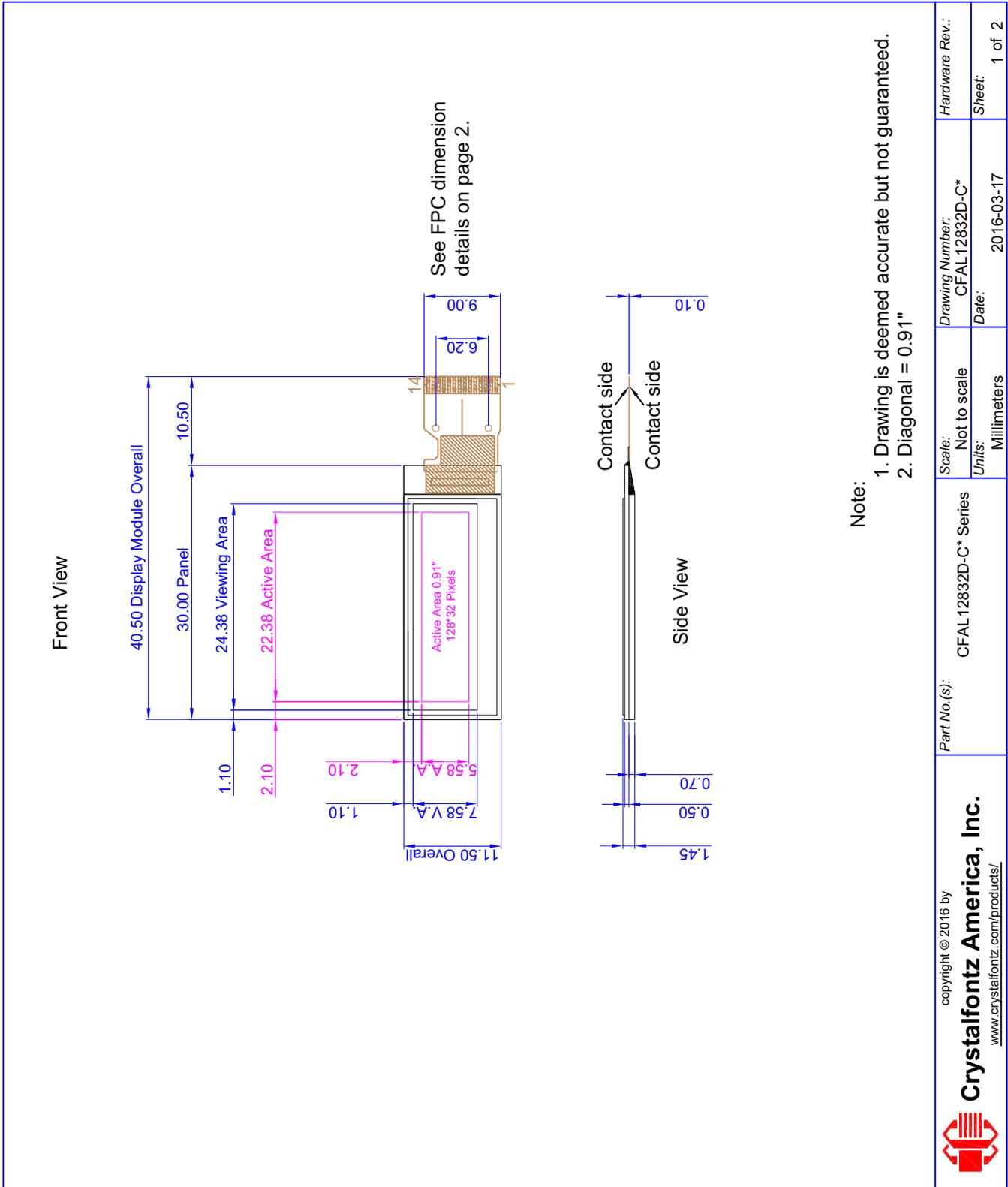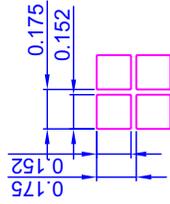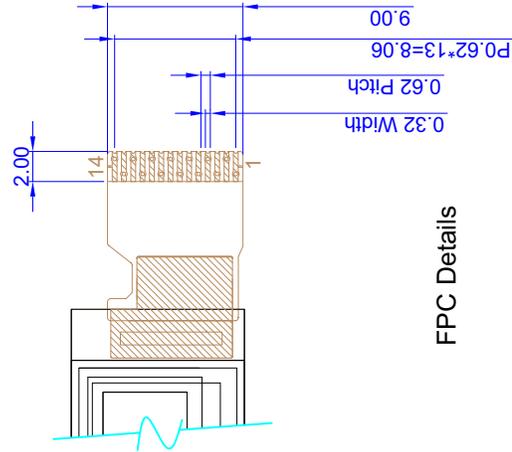
Note:
1. Drawing is deemed accurate but not guaranteed.
2. Diagonal = 0.91"

Part No.(s):	CFAL12832D-C* Series		
Scale:	Not to scale	Drawing Number: CFAL12832D-C*	Hardware Rev.:
Units:	Millimeters	Date: 2016-04-27	Sheet: 2 of 2

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Max	Unit	Notes
Supply Voltage for Logic	VDD, VBAT	0	4	V	1,2
Operating Temperature	TOP	-40	+80	˚C	—
Storage Temperature	TSTG	-40	+80	˚C	—

Note 1: All the above voltages are on the basis of "VSS = 0V = GND".
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 Optics & Electrical Characteristics. If this module is used beyond these conditions, malfunctioning of the module can occur and the reliability of the module may deteriorate.

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

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage for Logic	VDD	—	2.8	3.3	3.3	V
Supply Voltage for Display	VCC	—	7	7.25	8	V
Input High Volt.	VIH	—	0.8×VDD	—	VDDIO	V
Input Low Volt.	VIL	—	0	—	0.2×VDD	V
Output High Volt.	VOH	—	0.9×VDD	—	VDDIO	V
Output Low Volt.	VOL	—	0	—	0.1×VDD	V
Operating Current for VCC (VCC Supplied Externally)	ICC	Vcc =7.25V	7	8	10	mA

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

White On Black Background: CFAL12832D-CW

ITEM	SYMBOL	CONDITION	MINIMUM	TYPICAL	MAXIMUM
Viewing Angle	(V)θ	Vertical		≥160	
	(H)φ	Horizontal			
Contrast Ratio[1]	CR	Dark		2000:1	
Response Time[2,3]	T rise	Ta = 25°C		10 µs	
	T fall	Ta = 25°C			
Display with 50% Checkerboard Brightness			120 cd/m^2	150 cd/m^2	
CIEx (White)		CIE1931		0.28	
CIEy (White)				0.32	

[1]*Contrast Ratio = (brightness with pixels light)/(brightness with pixels dark).*
[2]*Response Time: The amount of time it takes a pixel to go from active to inactive or back again.*
[3]*For reference only.*

*Yellow On Black Background:*CFAL12832D-CY

ITEM	SYMBOL	CONDITION	MINIMUM	TYPICAL	MAXIMUM
Viewing Angle	(V)θ	Vertical		≥160	
	(H)φ	Horizontal			
Contrast Ratio[1]	CR	Dark		2000:1	
Response Time[2,3]	T rise	Ta = 25°C		10 µs	
	T fall	Ta = 25°C			
Display with 50% Checkerboard Brightness			100 cd/m^2	120 cd/m^2	
CIEx (Yellow)		CIE1931		0.47	
CIEy (Yellow)				0.50	

[1]*Contrast Ratio = (brightness with pixels light)/(brightness with pixels dark).*
[2]*Response Time: The amount of time it takes a pixel to go from active to inactive or back again.*
[3]*For reference only.*

DETAILS OF INTERFACE PIN FUNCTIONS

PIN	SIGNAL	DESCRIPTION
1	C2P	Positive terminal of the flying inverting capacitor. Negative terminal of the flying boost capacitor. The charge-pump capacitors are required between the terminals. They must be floated when the converter is not used.
2	C2N	
3	C1P	
4	C1N	
5	V_{BAT} (connect to V_{DD})	Power Supply for DC/DC Converter Circuit. 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. It should be connected to V_{DD} when the converter is not used.
6	NC	Make no connection.
7	V_{SS}	Ground. Must be connected to an external ground.
8	V_{DD} (connect to V_{BAT})	Power supply for logic. This is a voltage supply pin. It must be connected to external source.
9	RES#	Power reset signal. This pin is reset signal input. When the pin is low, initialization of the controller/driver is executed.
10	SCL	I2C mode is selected. D2 and D1 should be tied together and serve as SDA_{OUT} and SDA_{IN} in application. D0 is the serial clock input, SCL.
11	SDA	
12	I_{REF}	Current reference for brightness adjustment. This pin is segment current reference pin. A resistor should be connected between this pin and V_{SS}. Set the current lower than12.5μA.
13	V_{COMH}	Voltage output high level for COM signal. This pin is the input pin for the voltage output high level for COM signals. A capacitor should be connected between this pin and V_{SS}.
14	V_{CC}	Power supply for OLED panel. This is the most positive voltage supply pin of the chip. A stabilization capacitor should be connected between this pin and V_{SS} when the converter is used. It must be connected to external source when the converter is not used.

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, Micriμm, and Segger.

PRODUCT RELIABILITY AND LONGEVITY

DISPLAY MODULE RELIABILITY TEST

Environmental Test			
Test Item	**Content of Test**	**Test Condition**	**Applicable Standard**
High Temperature storage	Endurance test applying the high storage temperature for a long time.	80℃ 240hrs	____
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-40℃ 240hrs	____
High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	80℃ 240hrs	____
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-40℃ 240hrs	____
High Temperature/ Humidity Storage	Endurance test applying the high temperature and high humidity storage for a long time.	60℃,90%RH 240hrs	____
Temperature Cycle	Endurance test applying the low and high temperature cycle. -40℃ 25℃ 80℃ 30min 5min 30min 1 cycle	-40℃/80℃ 100 cycles	____
Mechanical Test			
Vibration test	Endurance test applying the vibration during transportation and using.	10~22Hz→1.5mmp-p 22~500Hz→1.5G Total 0.5hr	____
Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G Half sin wave 11 ms 3 times of each direction	____
Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air.	115mbar 40hrs	____
Others			
Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V,RS=1.5kΩ CS=100pF 1 time	____
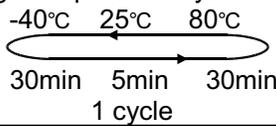
1. All measurements shall not be started until the specimens attain to temperature stability.
   After the completion of the described reliability test, the samples were left at room
   temperature for 2 hrs prior to conducting the failure test at 23±5°C; 55±15% RH.
2. All-pixels-on is used as operation test pattern.
3. The degradation of Polarizer are ignored for High Temperature storage, High Temperature/
   Humidity Storage, Temperature Cycle

Evaluation criteria
1. The function test is OK.
2. No observable defects.
3. Luminance: > 50% of initial value.
4. Current consumption: within ± 50% of initial value.

APPENDIX:
RESIDUE IMAGE
Because the pixels are lighted in different time, the luminance of active pixels
may reduce or differ from inactive pixels. Therefore, the residue image will occur.
To avoid the residue image, every pixel needs to be lighted up uniformly.

DISPLAY MODULE RELIABILITY

PART NUMBERS	SPECIFICATION
CFAL12832D-CW	Brightness will be >50% of a new display module's initial brightness for at least 20,000 hours of operation at typical 150 cd/m^2.
CFAL12832D-CY	Brightness will be >50% of a new display module's initial brightness for at least 50,000 hours of operation at typical 120 cd/m^2.

DISPLAY MODULE LONGEVITY (EOL / REPLACEMENT POLICY)

Crystalfontz is committed to making all of our display 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 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 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 display 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 display 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.* 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 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 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 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. Contamination, including fingerprints may make soldering difficult, and the reliability of the soldered connection poor.

- Repeated sharp bends can damage the FPC. As long as the FPC bend stays within the FPC elastic region, it can be bent multiple times. To tell if a bend is completely elastic, the FPC 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 more sharply. For instance, to pass the tail through a slot in a PCB. However these sharper bends will force the FPC 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 through its plastic region will cause it to fatigue and eventually fail. Here is an example of minimum plastic bend radius for the FPC cable:

R5.00 mm Maximum
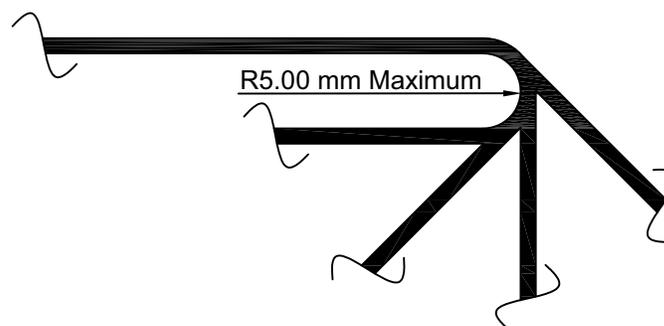
TAB SOLDERING

This display module uses a "TAB" (tape automated bonding) or "COF" (chip on flex) style flex tail mated with a "COG" (chip on glass) display controller. The TAB is soldered directly to corresponding pads on your PCB by using a hot-bar soldering machine. High volume contract manufacturers will be familiar with this type of construction and its assembly methods.

Hot-bar soldering machines designed for prototype, rework, or repair of TAB connections are available from equipment suppliers at reasonable cost. The TAB style connection requires no separate connector so the cost is very low and the ultra-thin profile of the display is maintained.Here is a photo of typical tab solder tail construction:
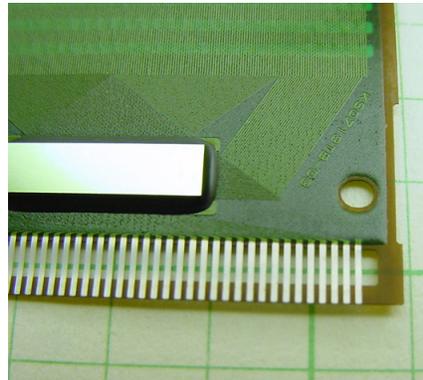
Hot Bar Soldering Machine

There are Bondmaster machines made by APE that are designed for prototype, rework or repair work. We have had good experience with the APE Bondmaster, and their price is very reasonable.

Here are some other possible solutions:
   PBS Series Hot Bar Soldering Equipment by Manncorp
   Hot Bar Soldering Machine by Cherusal
   Hot Bar Solding Machines by Fancort Industries Inc.

The process is:
   1. The pads on the PCB are tinned.
   2. The tail is aligned to the PCB using the alignment holes or visually.
   3. Tail is held in place relative to the PCB with Kapton® tape.
   4. Bondmaster head is lowered, applying pressure between the tail and the PCB.
   5. Bondmaster is "cycled", which means it heats up to the point of melting the solder and then cools down.
   6. Bondmaster head is raised.

Hand Soldering The FPC To The PCB

For prototype work, hand soldering may be acceptable. Preset soldering iron to <260°C. Do not apply heat for more than 3 to 4 seconds. The FPC flexible tail is quite fragile; use extreme care when soldering by hand. Great care must be taken since the conductors of the tail are completely exposed in the area where they are soldered. Solder only to the exposed contacts. The use of Kapton® tape to help locate and secure the end of the tail may be useful.

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 modules.
- Do not place weight or pressure on the display modules.

CAUTION

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

OPERATION

- We do not recommend connecting these display modules 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.
- Changes in voltage can result in changes in contrast.
- Observe the operating temperature limitations, non-condensing 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.

VIEWING AREA AND ACTIVE AREA DEFINITIONS
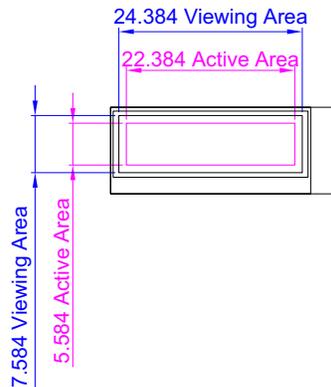
DEFECTS CLASSIFICATION

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 (mm)*	*Acceptable Qty*		Minor
	Defect size = (A + B)/2	≤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		
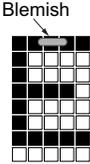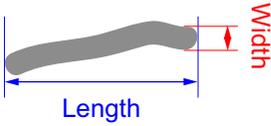
#	DEFECT TYPE	ACCEPTANCE STANDARDS CRITERIA (Continued)	MAJOR / MINOR
8	Display pattern defect		Minor

Dot Size (mm)	Acceptable Qty
((A+B)/2)$\leq$0.2	
C>0	$\leq$3 total defects
((D+E)/2)$\leq$0.25	$\leq$2 pinholes per digit
((F+G)/2)$\leq$0.25	

#	DEFECT TYPE	ACCEPTANCE STANDARDS CRITERIA	MAJOR / MINOR
9	Backlight defects	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. 20), and dark lines or scratches (see test 6, Pg. 20). *Minor if display functions correctly. Major if the display fails.*	Minor
10	Soldering defects	1. Un-melted 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.*	Minor