GRAPHIC DISPLAY MODULE DATA SHEET

Data Sheet Release 2015-05-29
for the CFAO4265A Series:
CFAO4265A-TFK
CFAO4265A-TTL

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Data Sheet Revision History

Data Sheet Release: 2015-05-29

- Combined the previous data sheets for the two display modules into one updated data sheet.
- Expanded information to match current data sheet standards.
- Due to a change in the integrated controller from Sitronix ST7565P to ST7565R, minor changes were made in the ELECTRICAL SPECIFICATIONS (Pg. 11).
- Luminous Intensity specifications Backlight Characteristics (Pg. 22) were corrected. The *CFAO4265A-TTL* is brighter than the *CFAO4265A-TFK.*
- Please read revised information in CARE AND HANDLING PRECAUTIONS (Pg. 25).

Data Sheet Release: 2013-02-26
Modified module outline drawing to include dimensions for mounting pegs and backlight tabs. A few additional changes were made to bring the drawing up to current standards.

Data Sheet Release: 2011-10-21
First Data Sheets for new display series.

Hardware Updates

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

About Variations

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

About Volatility

This display module has volatile memory.

The Fine Print

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

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CONTENTS

MAIN FEATURES - - - - - - **6**
Features - - - - - - 6
Module Classification Information - - - - - - 7
Ordering Information - - - - - - 7
MECHANICAL SPECIFICATIONS - - - - - - **8**
Physical Characteristics - - - - - - 8
Module Outline Drawings - - - - - - 9
ELECTRICAL SPECIFICATIONS - - - - - - **11**
System Block Diagram - - - - - - 11
Driving Method - - - - - - 12
Absolute Maximum Ratings - - - - - - 13
DC Characteristics - - - - - - 14
Details of Interface Pin Functions - - - - - - 15
Photo with Pins Labeled (Contact Side of FFC) - - - - - - 16
ESD (Electro-Static Discharge) - - - - - - 16
OPTICAL SPECIFICATIONS - - - - - - **17**
Test Conditions and Definitions for Optical Characteristics - - - - - - 17
LED BACKLIGHT - - - - - - **21**
Location of A (LED+) and K (LED-) - - - - - - 21
Backlight Characteristics - - - - - - 22
Circuit Example Using LED Driver NCP5007 - - - - - - 23
DISPLAY MODULE RELIABILITY - - - - - - **24**
Display Module Reliability - - - - - - 24
Display Module Longevity (EOL / Replacement Policy) - - - - - - 24
CARE AND HANDLING PRECAUTIONS - - - - - - **25**
ESD (Electro-Static Discharge) - - - - - - 25
Operation - - - - - - 27
Storage and Recycling - - - - - - 27
APPENDIX A: QUALITY ASSURANCE STANDARDS - - - - - - **28**

LIST OF FIGURES

Figure 1. Module Outline Drawings (2 pages) - - - - - 9
Figure 2. System Block Diagram - - - - - 11
Figure 3. Photo with Pins Labeled (Contact Side of FFC) - - - - - 16
Figure 4. CFAO4265A-TFK Definition of Positive Operation Voltage (V_{OP}) - - - - - 18
Figure 5. CFAO4265A-TTL Definition of Negative Operation Voltage (V_{OP}) - - - - - 18
Figure 6. CFAO4265A-TTL Definition of Positive Response Time (Tr, Tf) - - - - - 19
Figure 7. CFAO4265A-TTL Definition of Negative Response Time (Tr, Tf) - - - - - 19
Figure 8. Definition of Horizontal and Vertical Viewing Angles (CR>2) - - - - - 20
Figure 9. 6:00 O'Clock and 12:00 O'Clock Viewing Angles - - - - - 20
Figure 10. Location of Backlight Tabs A and K - - - - - 21
Figure 11. Circuit Example Using LED Driver NCP5007 - - - - - 23
Figure 12. Example Of Minimum Plastic Bend Radius For FPC/FFC - - - - - 26

MAIN FEATURES

FEATURES

- ❑ 42 x 65 display module consists of an LCD panel, a COG (Chip On Glass) display, a driver IC, and an FFC (Flat Flexible Cable).
- ❑ Module Dimensions:
  - Active Area is 13.84 (W) x 21.43 (H) millimeters.
  - Overall dimension in millimeters is 22.40 (W) x 34.00 FFC folded (H) x 4.8 (D), excluding backlight tabs.
- ❑ Integrated LCD controller. See the Sitronix ST7565R controller data sheet on our website.
- ❑ Requires only a single source 3.3v for both power supply and logic.
- ❑ Host interface: SPI (4-wire Serial Peripheral Interface).
- ❑ Two color choices:
  - *CFAO4265A-TFK:* White edge-lit LED backlight with FSTN light-gray glass positive transflective mode display. Displays dark pixels on an illuminated light gray background. Display is sunlight readable and also readable in dark areas.
  - *CFAO4265A-TTL*: White edge-lit LED backlight FSTN black glass negative transmissive mode display. Displays illuminated white pixels on a dark background. Display can be read in normal office lighting and in dark areas. Not recommended for use in bright sunlight; may be washed out.
- ❑ Operating temperature range is-20°C to +70°C.
- ❑ 12 o'clock viewing angle (polarizer viewing direction). Use in portrait or landscape orientation.
- ❑ Choices for ZIF connectors include these Hirose connectors from Digi-Key:
  - Digi-Key HFN420CT-ND, Hirose Electric Co Ltd. FH19C-20S-0.5SH(05)
  - Digi-Key HFK120CT-ND, Hirose Electric Co Ltd. FH12A-20S-0.5SH(55)
  - Digi-Key HFJ120CT-ND, Hirose Electric Co Ltd. FH12-20S-0.5SH(55)
- ❑ RoHS compliant.
- ❑ Crystalfontz America, Incorporated is ISO certified.
- ❑ To make prototyping quick and easy, we offer these graphic display modules mounted on carrier boards CFAO4265A-TFK-CB and CFAO4265A-TTL-CB.The carrier boards support a current driver for the LED backlight of the display.

MODULE CLASSIFICATION INFORMATION

CFA	O	42	65	A	-	T	*	*
❶	❷	❸	❹	❺		❻	❼	❽

❶	Brand	Crystalfontz America, Inc.
❷	Display Type	O – Chip On Glass
❸	Number of Pixels (Width)	42 Pixels
❹	Number of Pixels (Height)	65 Pixels
❺	Model Identifier	A
❻	Backlight Type & Color	T – LED, white
❼	Fluid Type, Image (Positive or Negative), & LCD Glass Color	F – FSTN, positive light gray T – FSTN, negative, black
❽	Polarizer Film Type, Wide Temperature (WT) Range, and Viewing Angle (O 'Clock)	K – Transflective, WT, 12:00[1] L – Transmissive, WT, 12:00[1]

[1] *Note: For more information on Viewing Angle, see Definition of 6:00 O'clock and 12:00 O'clock Viewing Angles (Pg. 20).*

ORDERING INFORMATION

PART NUMBER	FLUID	LCD GLASS COLOR	IMAGE	POLARIZER FILM	BACKLIGHT COLOR/TYPE	
CFAO4265A-TFK	FSTN	light gray	positive	transflective	white edge LEDs	
CFAO4265A-TTL		black	negative	transmissive		

MECHANICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS

ITEM	SPECIFICATION
Pixels	
Number of Pixels	42 x 65 = 2,730 pixels
Pixel Size	0.02 (W) x 0.02 (H) mm
Pixel Pitch	0.31 (W) x 0.31 (H) mm
Active Area	
Active Area Diagonal	Millimeters: 25.5 mm Inches: 1.00"
Active Area Width	Millimeters: 13.84 Inches: 0.54"
Active Area Height	Millimeters: 21.43 Inches: 0.84"
Viewing Area	
Viewing Area Width	Millimeters: 19.0 Inches: 0.75"
Viewing Area Height	Millimeters: 23.35 Inches: 0.92"
Display Module Outline Dimensions	
Overall Module Width	Millimeters: 22.40 Inches: 0.88"
Overall Module Height	*With FPC/FFC tail folded:* Millimeters: 34.00 (H) mm Inches: 1.34" (H) *With FPC/FFC tail unfolded:* Millimeters: 52.25 (H) mm Inches: 2.06" (H)
Module Depth	*Excludes backlight tabs:* Millimeters: 4.80 (D) mm Inches: 0.19" (D)
Weight	6 grams (typical)
FFC/FPC Flexible Tail	>R.5.0 mm Mates with standard ZIF sockets

MODULE OUTLINE DRAWINGS

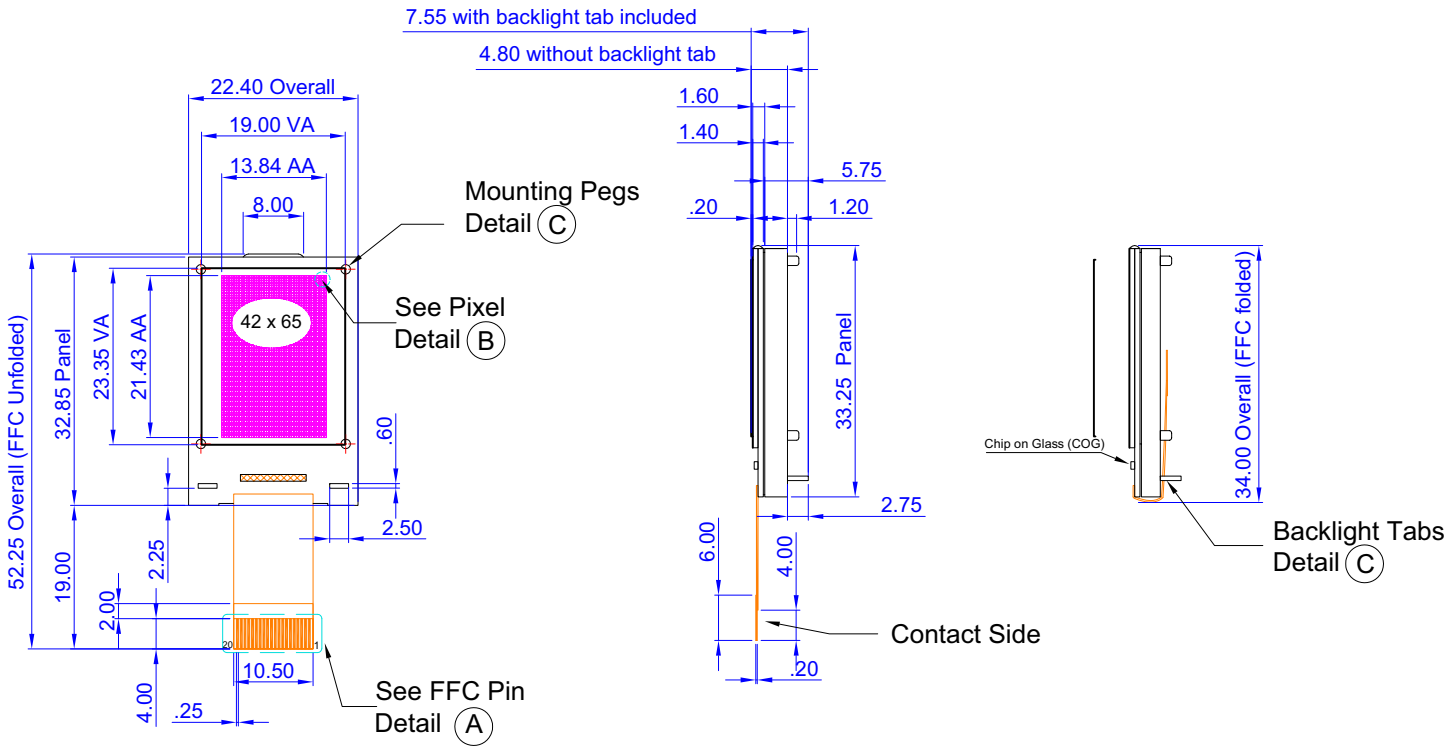
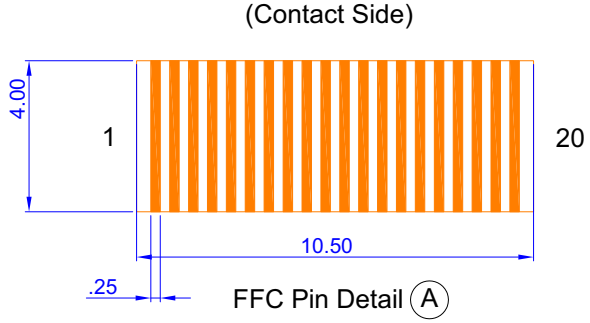


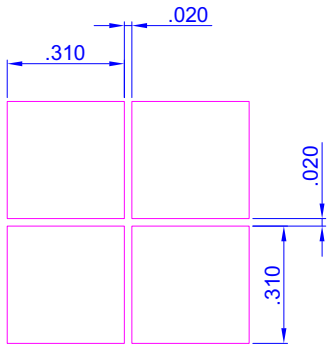
Figure 1. Module Outline Drawings (2 pages)

Notes:
1. Drawing is deemed accurate but not guaranteed.
2. FFC = Flat Flexible Cable mates with ZIF connector.
3. VA = Viewing Area
4. AA = Active Area
5. 1" Diagonal Viewing Area

Part No.(s):	Scale:	Drawing Number:	
CFAO4265A Series	Not to scale	CFAO4265A_master	
	Units: Millimeters	Date: 2015-05-28	Sheet: 1 of 2



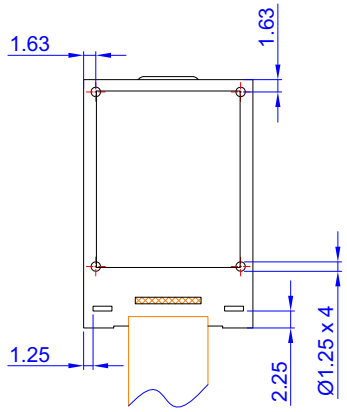
FFC Pin Detail (A)



Pixel Detail (B)

Pin Descriptions:

PIN	SYMBOL
1	$\overline{CS}$
2	$\overline{RST}$
3	A0
4	SCL
5	SI
6	VDD (V_{LOGIC})
7	VDD (V_{LOGIC})
8	VSS (GND)
9	VSS (GND)
10	V_{OUT}
11	CAP3P
12	CAP1N
13	CAP1P
14	CAP2P
15	CAP2N
16	V4
17	V3
18	V2
19	V1
20	**V0**



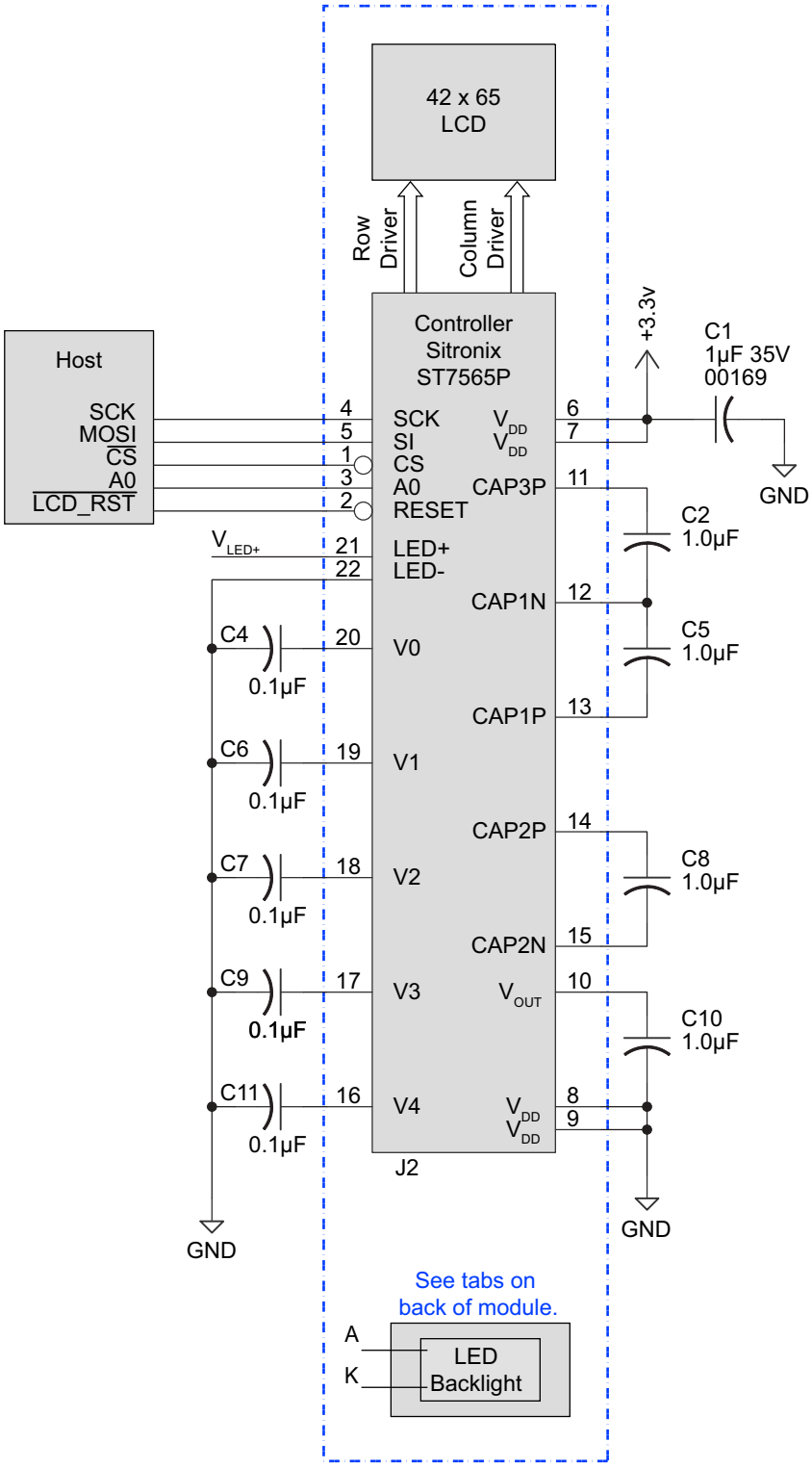
Mounting Pegs
and
Backlight Tabs (C)

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

Part No.(s):	Scale:	Drawing Number:	
CFAO4265A series	Not to scale	CFAO4265A_master	
	Units:	Date:	Sheet:
	Millimeters	2015-05-28	2 of 2

ELECTRICAL SPECIFICATIONS

SYSTEM BLOCK DIAGRAM



You must provide and connect capacitors C1 to C11 in order for the Sitronix ST7565 controller to generate the supply voltages for the LCD.

Figure 2. System Block Diagram

DRIVING METHOD

DRIVING METHOD	SPECIFICATION
Duty[1]	1/65
Bias[2]	1/9

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

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

ABSOLUTE MAXIMUM RATINGS

ABSOLUTE MAXIMUM RATINGS	SYMBOL	MINIMUM	MAXIMUM
Operating Temperature*	T_{OP}	-20°C	+70°C
Storage Temperature*	T_{ST}	-30°C	+80°C
Humidity (Non-condensing)	RH	0%	90%
Input Voltage	V_I	0v	V_{LOGIC}
Supply Voltage for Logic	V_{DD}	-0.3v	+3.6v
Supply Voltage for LCD	V_{DD}-V_O	-0.3v	+14.5v

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 (3.0v Operation) (Pg. 20) 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.

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

DC CHARACTERISTICS

	DC CHARACTERISTICS	TEST CONDITIONS	SYMBOL	MINIMUM	TYPICAL	MAXIMUM
			$V_{LOGIC} = V_{DD}$	GND = V_{SS}		
CONTROLLER AND BOARD	Supply Voltage for Logic	TOP =-20°C to +70°C	V_{DD} - GND		+3.0v	+3.3v[1]
	Input High Voltage	V_{DD} = +3.0	V_{IH}	+2.0v		V_{Logic} (V_{DD})
		V_{DD} = +3.0v		+0.8 * V_{DD} V_{DD} = +3.0v V_{IH} = +2.4v		
	Input Low Voltage		V_{IL}	0v (GND)		+0.2v
	Output High Voltage		V_{OH}	+0.8 * V_{DD} V_{DD} = +3.0v V_{IH} = +2.4v		V_{Logic} (V_{DD})
	Output Low Voltage		V_{OL}	0v (GND)		+0.2v
	Supply Current	Logic only, not including backlight	V_{LOGIC}	0.6 mA	0.8 mA	1.5 mA

[1] *Do not exceed +3.3v maximum.*

This is a summary of the module's major operating parameters. For detailed information, see the Sitronix ST7565R controller data sheet on our website.

DETAILS OF INTERFACE PIN FUNCTIONS

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
1	$\overline{CS}$	H/L	I	*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.
2	$\overline{RST}$	L	I	Reset signal input. *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.
3	A0	H/L	I	R/W = Low: A0 = High: Command Write. A0 = Low: Data Write. R/W = High: A0 = High: Status Read. A0 = Low: Data Read.
4	SCL		I	Display clock input.
5	SI		I	Serial data input.
6-7	V_{DD} (V_{LOGIC})	+3.3v	–	Supply voltage for logic.
8-9	V_{SS} (GND)	0v	–	Ground. Must be connected to an external ground.
10	V_{OUT}		O	DC/DC voltage converter. Connect a capacitor between this terminal and V_{SS} (GND) or V_{DD} (V_{LOGIC}).
11	CAP3P			DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1N terminal.
12	CAP1N			DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1P terminal.
13	CAP1P			DC/DC voltage converter. Connect a capacitor between this terminal and the CAP1N terminal.
14	CAP2P			DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2N terminal.
15	CAP2N			DC/DC voltage converter. Connect a capacitor between this terminal and the CAP2P terminal.
16-20	V4-V0			Multilevel power supply to drive the LCD. The voltage settings are selected using the LCD bias set command.
Note: Backlight pins A (LED+) and K (LED-) are separate tabs on the back of the module. See figure Location of Backlight Tabs A and K (Pg. 21).				

PHOTO WITH PINS LABELED (CONTACT SIDE OF FFC)

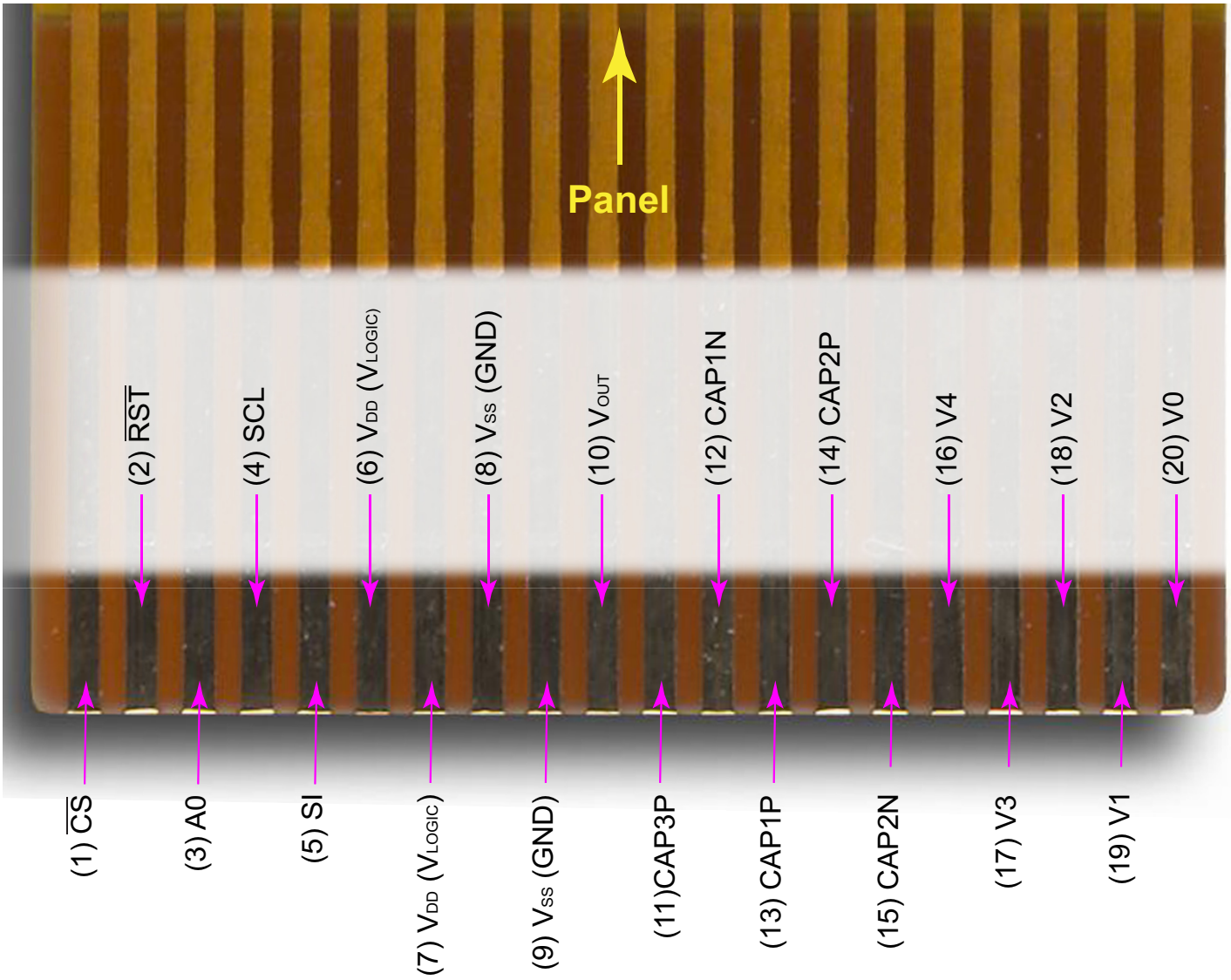


Figure 3. Photo with Pins Labeled (Contact Side of FFC)

Note: Backlight pins A (LED+) and K (LED-) are separate tabs on the back of the module. See figure Location of Backlight Tabs A and K (Pg. 21).

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 SPECIFICATIONS

ITEM	SYMBOL	TEST CONDITION	MINIMUM	TYPICAL	MAXIMUM
View Angle (Vertical, Horizontal)	(V)θ	CR≥2	-40°		+40°
Contrast Ratio	CR		2	4	
LCD Response Time*	T rise	Ta = 25°C		200 ms	200 ms
	T fall	Ta = 25°C		300 ms	300 ms
**Response Time: The amount of time it takes a liquid crystal cell to go from active to inactive or back again.* *For reference only.*					

TEST CONDITIONS AND DEFINITIONS FOR OPTICAL CHARACTERISTICS

We work to continuously improve our products, including backlights that are brighter and last longer. Slight color variations from module to module and batch to batch are normal. If you need modules with consistent color, please ask for a custom order.

Test Conditions.

- Operating Voltage ($V_{LCD)}$: V_{OP}
- Viewing Angle
  - Vertical (V)θ: 0°
  - Horizontal (H)φ): 0°
- Frame Frequency: 64 Hz (nominal)
- Driving Waveform: 1/65 Duty, 1/9 Bias
- Ambient Temperature (Ta): 25°C

Definition of Operation Voltage (V_{op})

CFAO4265A-TFK

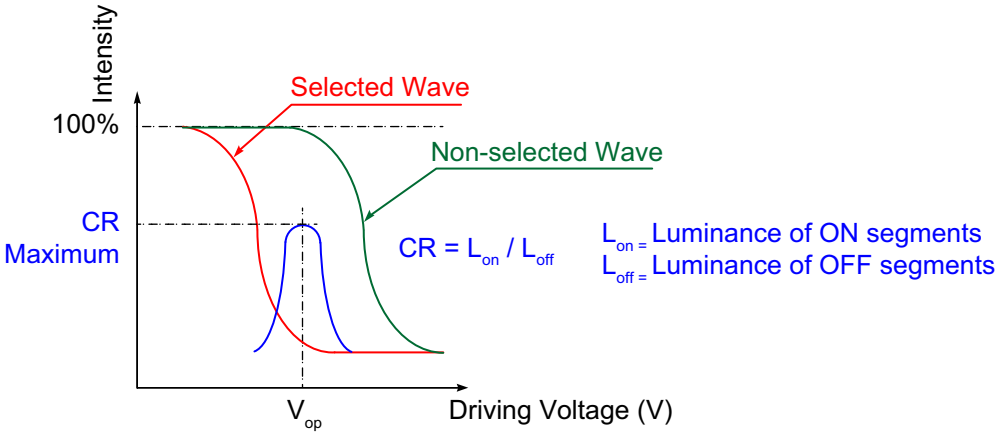


Figure 4. CFAO4265A-TFK Definition of Positive Operation Voltage (V_{OP})

CFAO4265A-TTL

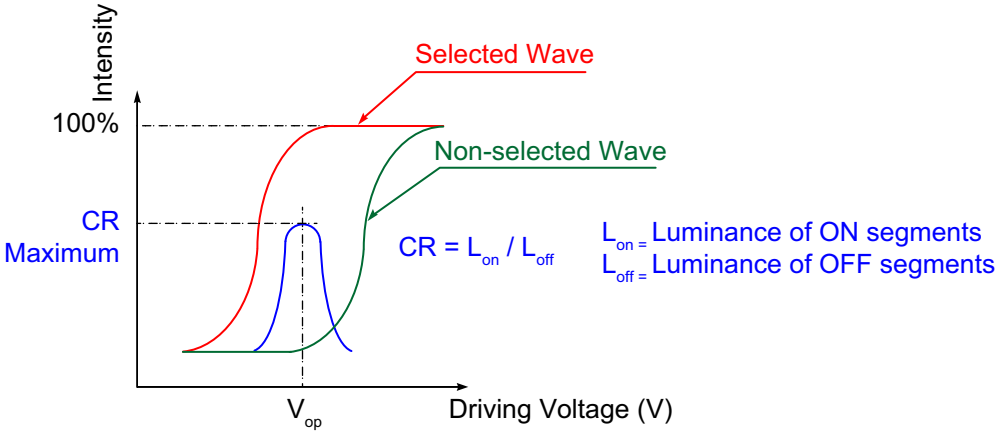


Figure 5. CFAO4265A-TTL Definition of Negative Operation Voltage (V_{OP})

Definition of Response Time (Tr, Tf)

CFAO4265A-TFK

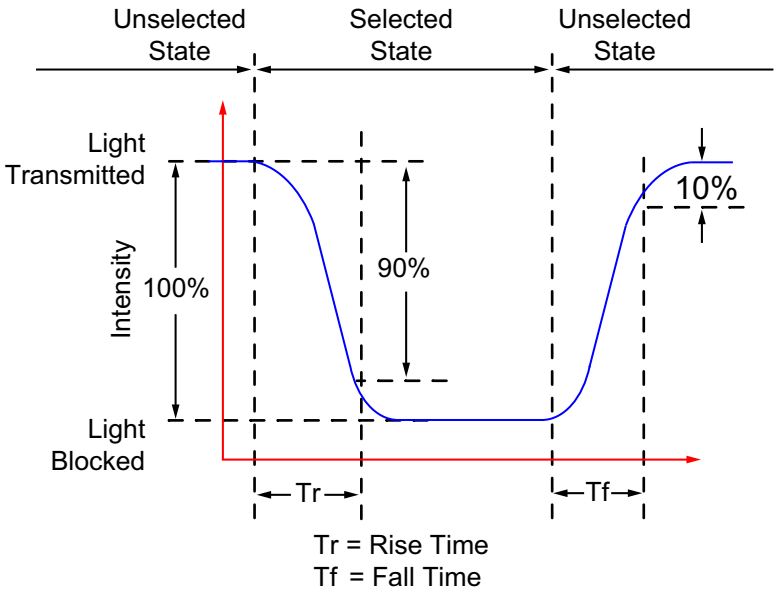


Figure 6. CFAO4265A-TTL Definition of Positive Response Time (Tr, Tf)

CFAO4265A-TTL

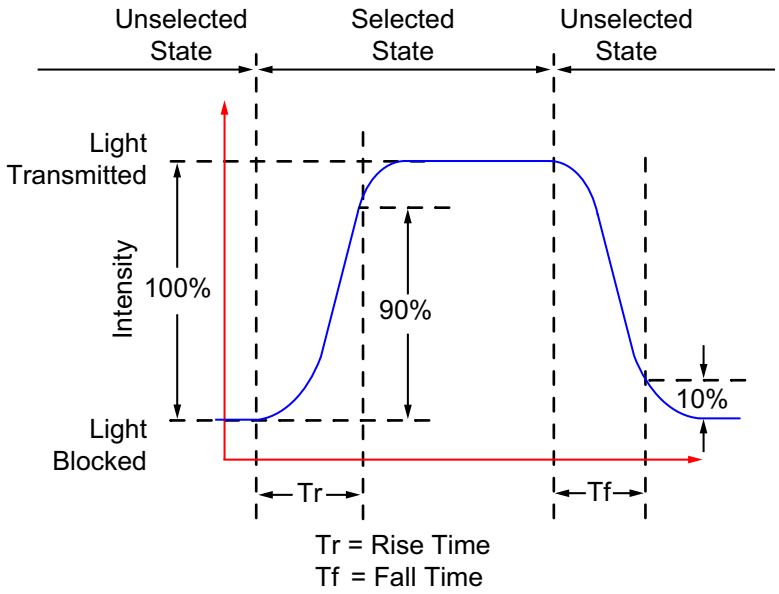


Figure 7. CFAO4265A-TTL Definition of Negative Response Time (Tr, Tf)

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

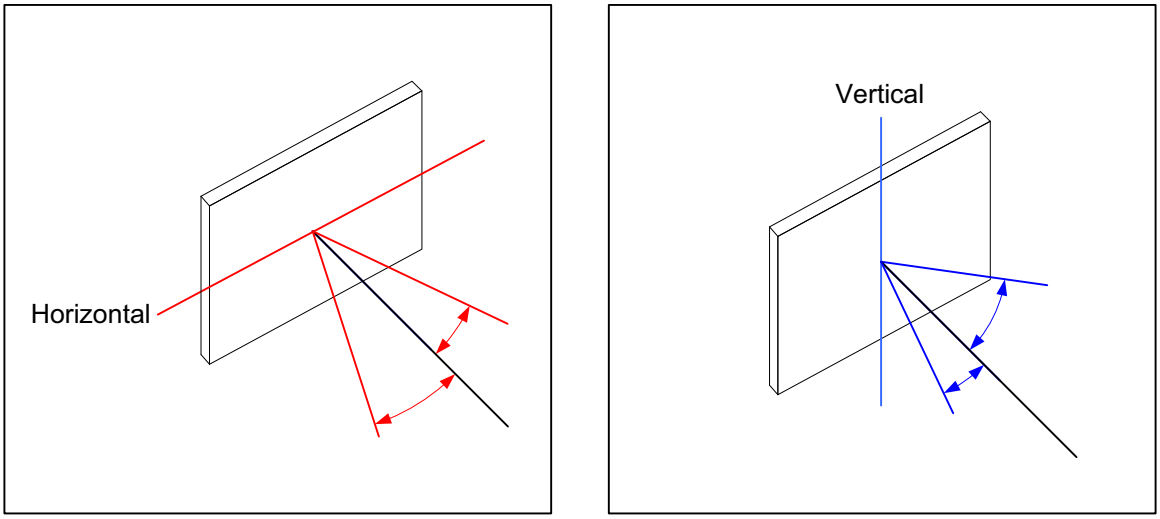


Figure 8. Definition of Horizontal and Vertical Viewing Angles (CR>2)

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

The CFAO4265A series graphic display modules have a 12:00 o'clock viewing angle.

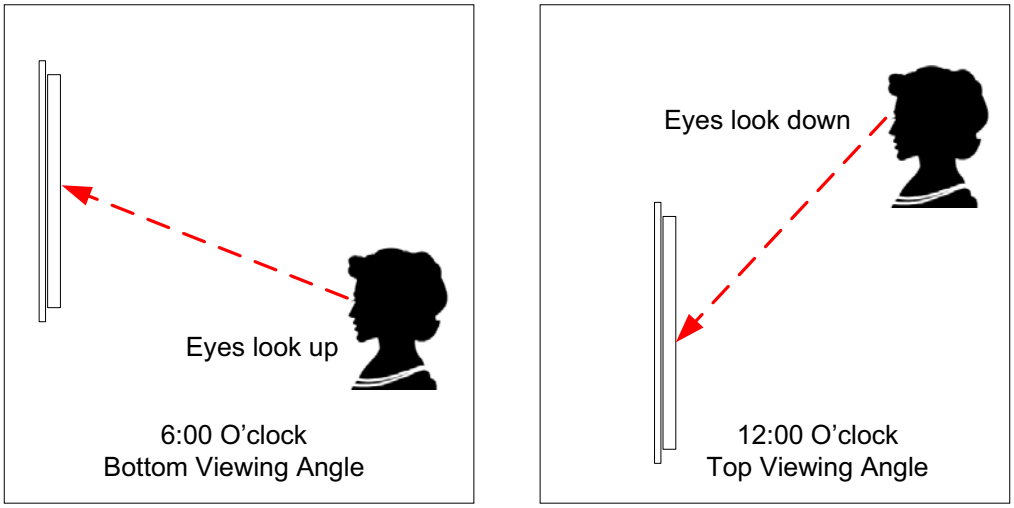


Figure 9. 6:00 O'Clock and 12:00 O'Clock Viewing Angles

LED BACKLIGHT

LOCATION OF A (LED+) AND K (LED-)

Make connections to your PCB using the tabs A (LED+) and K (LED+) on the back of the module.

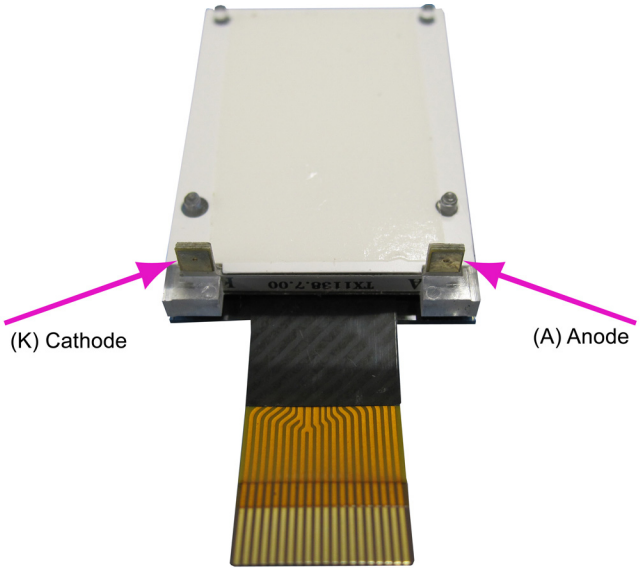


Figure 10. Location of Backlight Tabs A and K

BACKLIGHT CHARACTERISTICS

LED Backlight Characteristics *Edge-lit LED backlight has three LEDs.*					
ITEM	**SYMBOL**	**TEST CONDITION**	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Forward Current (V_{LED} ≈ 3.0v)	I_{LED}			12 mA	15 mA
Driving the backlight above 15 mA may shorten its lifetime.					
Forward Voltage	V_{LED}			+9.6v	+10.8v
Reverse Voltage ($V_{R)}$	V_R				+15v
White Chromaticity	x	CIE (1931)	0.27	0.31	0.35
	y		0.25	0.30	0.35
Luminous Intensity* *CFAO4265A-TFK* *CFAO4265A-TTL*	IV	I_{LED} = 15 mA	150 cd/m^2 200 cd/m^2	170 cd/m^2 315 cd/m^2	
Uniformity (minimum/maximum x 100%)	C		70%		
**The backlight is measured through the LCD. Direct backlight measurement is significantly brighter.*					

The CFAO4265A series backlights use LEDs. The backlight is easy to use properly but it is also easily damaged by abuse.

Note

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

Note

We recommend that the white LED backlight be dimmed or turned off during periods of inactivity to conserve the LEDs' lifetime.

LEDs are “current” devices. The brightness is controlled by the current flowing through it, not the voltage across it. Ideally, a current source would be used to drive the LEDs. In practice, a simple current limiting resistor will work well in most applications and is much less complex than a current source.

CIRCUIT EXAMPLE USING LED DRIVER NCP5007

The CFAO4265A series uses series connected white LEDs for its backlight. The overall series forward voltage is 9.6v to 10.8v. For long life, we recommend driving the backlight at 12mA. The best way to drive the backlight is to use a switching supply designed to control current. We have used the NCP5007 LED driver on many designs with good results.

Here is an example circuit:

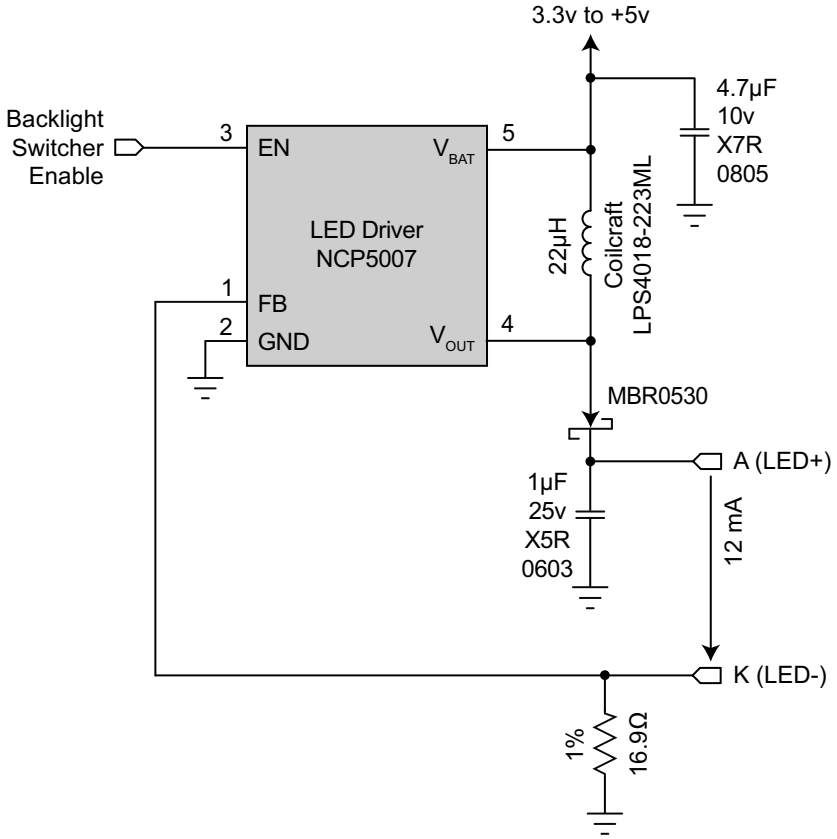


Figure 11. Circuit Example Using LED Driver NCP5007

DISPLAY MODULE RELIABILITY

DISPLAY MODULE RELIABILITY

ITEM	SPECIFICATION	
Module, excluding backlight.	50,000 to 100,000 hours	
White LED Backlight (I_{LED} <15 mA)	*Power-On Hours*	*% of Initial Brightness*
	<10,000	>70%
	<50,000	>50%
Conditions: under operating and storage temperature specification limitations, humidity (non-condensing) RH up to 65%, and no exposure to direct sunlight. *We recommend that the white LED backlight be dimmed or turned off during periods of inactivity to conserve the white LED backlight lifetime.*		

White LEDs do not have the extremely long lifetime typical of red or green LEDs. The white LEDs dim over time, especially if driven with high currents. The dimming may not be noticeable when a single display is installed. However, if a new display is installed next to a display that has been on continuously for a very long time, you will see the difference. To preserve the lifetime of white LEDs, we recommend that white LED backlights be dimmed or turned off when not needed. Also, please do not use more current than you need to achieve your brightness requirements.

DISPLAY MODULE LONGEVITY (EOL / REPLACEMENT POLICY)

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

We recognize that discontinuing a module may cause problems for some customers. However, rapidly changing technologies, component availability, or low customer order levels may force us to discontinue ("End of Life", EOL) a module. For example, we must occasionally discontinue a module when a supplier discontinues a component or a manufacturing process becomes obsolete. When we discontinue a module, we will do our best to find an acceptable replacement module with the same fit, form, and function.

In most situations, you will not notice a difference when comparing a "fit, form, and function" replacement module to the discontinued module it replaces. However, sometimes a change in component or process for the replacement module results in a slight variation, perhaps an improvement, over the previous design.

Although the replacement module is still within the stated Data Sheet specifications and tolerances of the discontinued module, changes may require modification to your circuit and/or firmware. Possible changes include:

- *LCD fluid, polarizers, or the LCD manufacturing process.* These items may change the appearance of the display, requiring an adjustment to V_O. See OPTICAL SPECIFICATIONS (Pg. 17).
- *Backlight LEDs.* Brightness may be affected (perhaps the new LEDs have better efficiency) or the current they draw may change (new LEDs may have a different VF).
- *Controller.* A new controller may require minor changes in your code.
- *Component tolerances.* Module components have manufacturing tolerances. In extreme cases, the tolerance stack can change the visual or operating characteristics.

Please understand that we avoid changing a module whenever possible; we only discontinue a module if we have no other option. We will post Part Change Notices on the product's web-page as soon as possible. If interested, you can subscribe to future part change notifications.

CARE AND HANDLING PRECAUTIONS

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

Excessive voltage will shorten the life of the display module. You must drive the display module within the specified voltage limit.See Absolute Maximum Ratings (Pg. 13).

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 integrated LCD controller maintains its internal operating modes until something happens to change it. Excessive external noise can change these internal modes. In your packaging and system design, suppress or prevent the noise from influencing the controller. Also, refresh the operating modes periodically to prevent the effects of unanticipated noise.
- The exposed surface of the “glass” is actually a polarizer laminated on top of the glass.To protect the soft plastic polarizer from damage, the display module ships with a protective film over the polarizer. Please peel off the protective film slowly. Peeling off the protective film abruptly may generate static electricity.
- The polarizer is made out of soft plastic and is easily scratched or damaged. When handling the display module, avoid touching the polarizer. Finger oils are difficult to remove.
- To protect the soft plastic polarizer from damage, place a transparent plate (for example, acrylic, polycarbonate, or glass) in front of the display module, leaving a small gap between the plate and the display surface. We use GE HP-92 Lexan, which is readily available and works well.
- Do not disassemble or modify the display module.
- 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. 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.

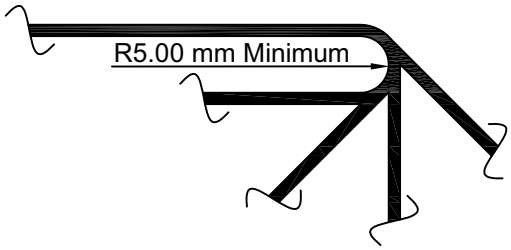


Figure 12. Example Of Minimum Plastic Bend Radius For FPC/FFC

Choices for ZIF connectors include these Hirose connectors from Digi-Key:

- Digi-Key HFN420CT-ND, Hirose Electric Co Ltd. FH19C-20S-0.5SH(05)
- Digi-Key HFK120CT-ND, Hirose Electric Co Ltd. FH12A-20S-0.5SH(55)
- Digi-Key HFJ120CT-ND, Hirose Electric Co Ltd. FH12-20S-0.5SH(55)

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.

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

OPERATION

- We do not recommend connecting this display module to a PC's parallel port as an end product. This display module is not “user friendly” and connecting it to a PC's parallel port is often difficult, frustrating, and can result in a “dead” display module due to mishandling. For more information, see our forum thread at http://www.crystalfontz.com/forum/showthread.php?s=&threadid=3257.
- Your circuit should be designed to protect the display module from ESD and power supply transients.
- Observe the operating temperature limitations: a minimum of -20°C to a maximum of +70°C non-condensing with minimal fluctuation. Operation outside of these limits may shorten life and/or harm the display module. Changes in temperature can result in changes in contrast.
  - At lower temperatures of this range, response time is delayed.
  - At higher temperatures of this range, display becomes dark. (You may need to adjust the contrast.)
- Operate away from dust, moisture, and direct sunlight.

STORAGE AND RECYCLING

- Store in an ESD-approved container away from dust, moisture, and direct sunlight, fluorescent lamps, or any strong ultraviolet radiation. Ensure humidity is less than 90% non-condensing.
- Observe the storage temperature limitations: from -30°C minimum to +80°C maximum with minimal fluctuations. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Do not allow weight to be placed on the display modules while they are in storage.
- Please recycle your outdated Crystalfontz display modules at an approved facility.

APPENDIX A: QUALITY ASSURANCE STANDARDS

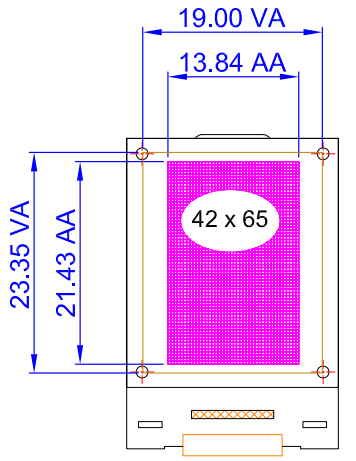
INSPECTION CONDITIONS

- Environment
  - Temperature: 25±5°C
  - Humidity: 30~85% RH (non-condensing)
- For visual inspection of active display area
  - Source lighting: two 20-Watt or one 40-Watt fluorescent light
  - Display adjusted for best contrast
  - Viewing distance: 30±5 cm (about 12 inches)
  - Viewing angle: inspect at 45° angle of vertical line right and left, top and bottom

COLOR DEFINITIONS

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

DEFINITION OF VIEWING AREA AND ACTIVE AREA



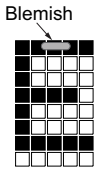
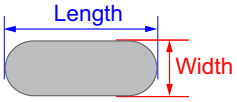
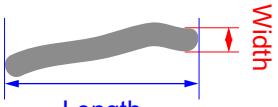
AA = Active Area
VA = Viewing Area

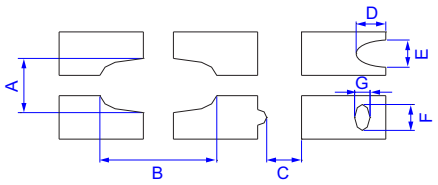
DEFECTS CLASSIFICATION

Defects are defined as:

- Major Defect: results in failure or substantially reduces usability of unit for its intended purpose.
- Minor Defect: deviates from standards but is not likely to reduce usability for its intended purpose.

ACCEPTANCE STANDARDS

#	DEFECT TYPE	ACCEPTANCE STANDARDS CRITERIA			MAJOR / MINOR
1	Electrical defects	1. No display, display malfunctions, or shorted segments. 2. Current consumption exceeds specifications.			Major
2	Viewing area defect	Viewing area does not meet specifications).			Major
3	Contrast adjustment defect	Contrast adjustment fails or malfunctions.			Major
4	Blemishes or foreign matter on display segments		*Defect Size (mm)*	*Acceptable Qty*	Minor
			≤0.3	3	
			≤2 defects within 10 mm of each other		
5	Other blemishes or foreign matter outside of display segments	Defect size = (A + B)/2 	*Defect Size (mm)*	*Acceptable Qty*	Minor
			≤0.15	Ignore	
			0.15 to 0.20	3	
			0.20 to 0.25	2	
			0.25 to 0.30	1	
6	Dark lines or scratches in display area 	*Defect Width (mm)*	*Defect Length (mm)*	*Acceptable Qty*	Minor
		≤0.03	≤3.0	3	
		0.03 to 0.05	≤2.0	2	
		0.05 to 0.08	≤2.0	1	
		0.08 to 0.10	≤3.0	0	
		≥0.10	>3.0	0	
7	Bubbles between polarizer film and glass		*Defect Size (mm)*	*Acceptable Qty*	Minor
			≤0.20	Ignore	
			0.20 to 0.40	3	
			0.40 to 0.60	2	
			≥0.60	0	

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

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

≤2 pinholes per digit</td></tr>
<tr><td>C>0</td></tr>
<tr><td>((D+E)/2)≤0.25</td></tr>
<tr><td>((F+G)/2)≤0.25</td></tr>
</table></td><td>Minor</td></tr>
<tr><td>9</td><td>Backlight defects</td><td>1. Light fails or flickers.*
2. Color and luminance do not correspond to specifications.*
3. Exceeds standards for display’s blemishes or foreign matter (see test 5, Pg. 29), and dark lines or scratches (see test 6, Pg. 29).
*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>