CHARACTER DISPLAY MODULE DATA SHEET

Data Sheet Release 2015-05-19
for
CFAH2002L Series:
CFAH2002L-TFH-ET
CFAH2002L-TMI-ET
CFAH2002L-YYH-ET

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Data Sheet Revision History

Data Sheet Release: 2015-05-19

- Combined the previous data sheets for the three display modules into one updated data sheet for CFAH2002L-TFH-ET, CFAH2002L-TMI-ET, and CFAH2002L-YYH-ET.
- The revised Display Module Outline Drawings (Pg. 7) shows the typical display module overall depth.
- In Recommended DC Characteristics (Pg. 19) for CFAH2002L-TMI-ET, Output Low Voltage Minimum changed from 2.4v to 3.9v.
- Due to an alternate backlight manufacturer, slight specifications changes were made. See LED BACKLIGHT CHARACTERISTICS (Pg. 25).
- Expanded information to match current data sheet standards. Please be sure to read DISPLAY MODULE RELIABILITY AND LONGEVITY (Pg. 27) and CARE AND HANDLING PRECAUTIONS (Pg. 29) sections.

Data Sheet Release: No date or version number. Released 2006-12-11.
New products. Individual data sheets were published for the three display modules in this series: CFAH2002L-YYH-ET, CFAH2002L-TMI-ET, and CFAH2002L-TFH-ET.

Hardware Updates

To see update notices, check the Product Notices tab on the product page. Product pages without a tab do not have product notices.

About Variations

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

About Volatility

These display modules have nonvolatile 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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GENERAL CHARACTERISTICS

This character display series has three variants: *CFAH2002L-TFH-ET*, *CFAH2002L-TMI-ET*, and *CFAH2002L-YYH-ET*.

- ❑ The *CFAH2002L-TFH-ET* displays dark (near-black) characters on light (near-white) background. The display can be read in normal office lighting, in dark areas, and in bright sunlight.
- ❑ The *CFAH2002L-TMI-ET* displays light (near-white) characters on blue background. The display can be read in normal office lighting and in dark areas. May be difficult to read in direct sunlight.
- ❑ The *CFAH2002L-YYH-ET* displays dark (near-black) characters on yellow-green background. The display can be read in normal office lighting, in dark areas, and in bright sunlight.

GENERAL SPECIFICATIONS

CFAH2002L-TFH-ET

Item	Dimension	Unit
Number of Characters	20 characters x 2Lines	—
Module dimension	180.0 x 40.0 x 13.9(MAX)	mm
View area	149.0 x 23.0	mm
Active area	142.8 x 20.64	mm
Dot size	1.12 x 1.12	mm
Dot pitch	1.22 x 1.22	mm
Character size	6.0 x 9.66	mm
Character pitch	7.2 x 10.98	mm
LCD type	FSTN, Positive, Transflective (In LCD production, It will occur slightly color difference. We can only guarantee the same color in the same batch.)	
Duty	1/16	
View direction	6 o'clock	
Backlight Type	LED White	

CFAH2002L-TMI-ET

LCD type	STN Negative, Blue Transmissive (In LCD production, It will occur slightly color difference. We can only guarantee the same color in the same batch.)

The other Physical Characteristic specifications are the same as CFAH2002L-TFH-ET.

CFAH2002L-YYH-ET

LCD type	STN Positive, Yellow Green Transflective (In LCD production, It will occur slightly color difference. We can only guarantee the same color in the same batch.)
Backlight Type	LED, Yellow Green

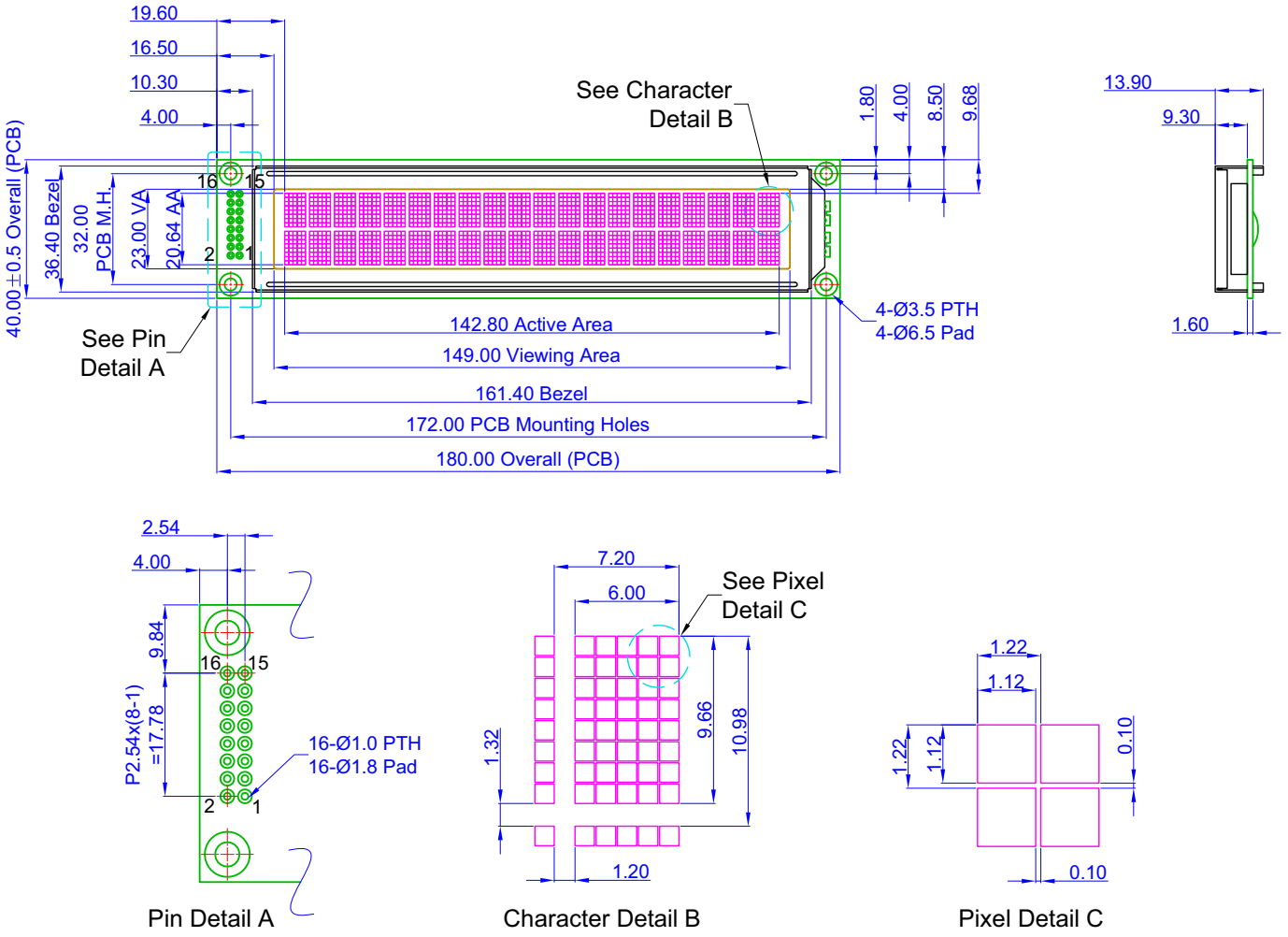
The other Physical Characteristic specifications are the same as CFAH2002L-TFH-ET.

ADDITIONAL FEATURES

- ❑ These display modules have an integrated Sitronix ST7066U or equivalent controller. See the controller data sheet here on our website.
- ❑ Host Interface: 4-bit or 8-bit parallel.
- ❑ RoHS compliant.
- ❑ Crystalfontz America is ISO certified.

DISPLAY MODULE OUTLINE DRAWINGS

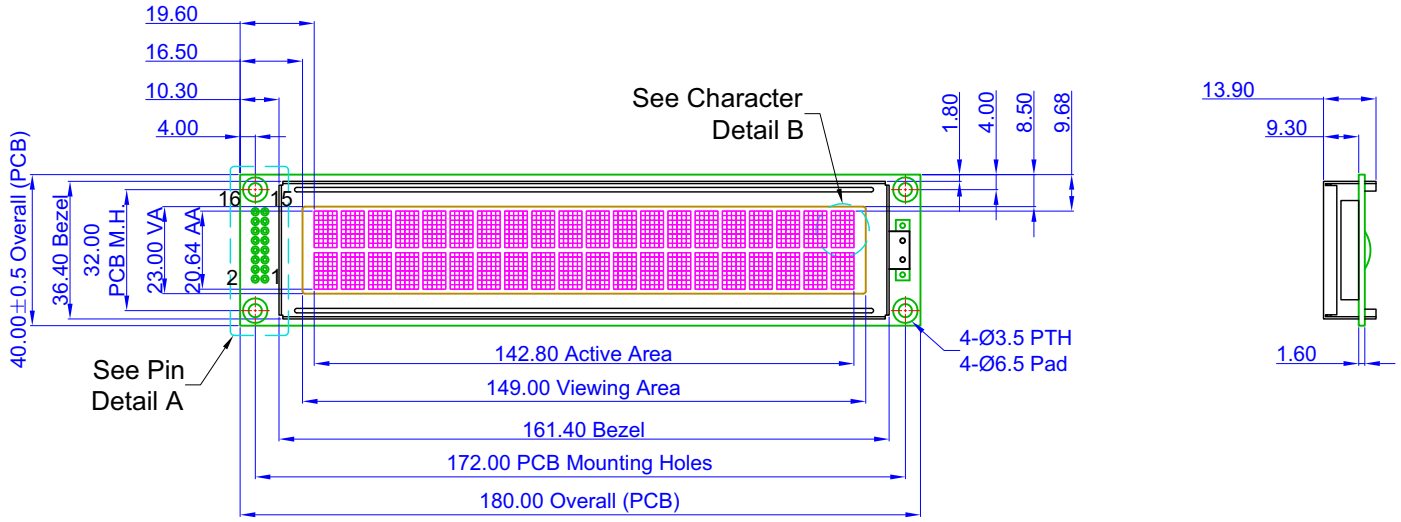
CFAH2002L-TFH-ET And CFAH2002L-TMI-ET

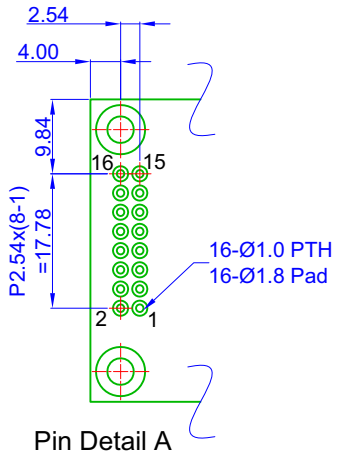


Note:
Drawing is deemed accurate but not guaranteed.

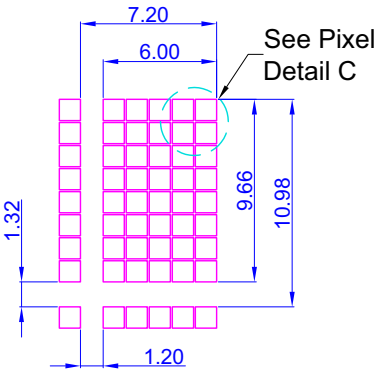
Crystalfontz America, Inc.
www.crystalfontz.com/products/

Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAH2002L-TFH CFAH2002L-TMI	Not to scale	CFAH2002L_master	
	Units: Millimeters	Date: 2015-04-10	Sheet: 1 of 1

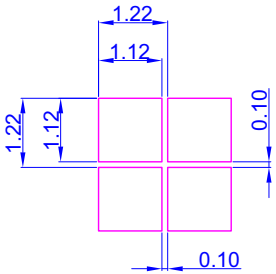




Pin Detail A



Character Detail B



Pixel Detail C

Note:
Drawing is deemed accurate but not guaranteed.

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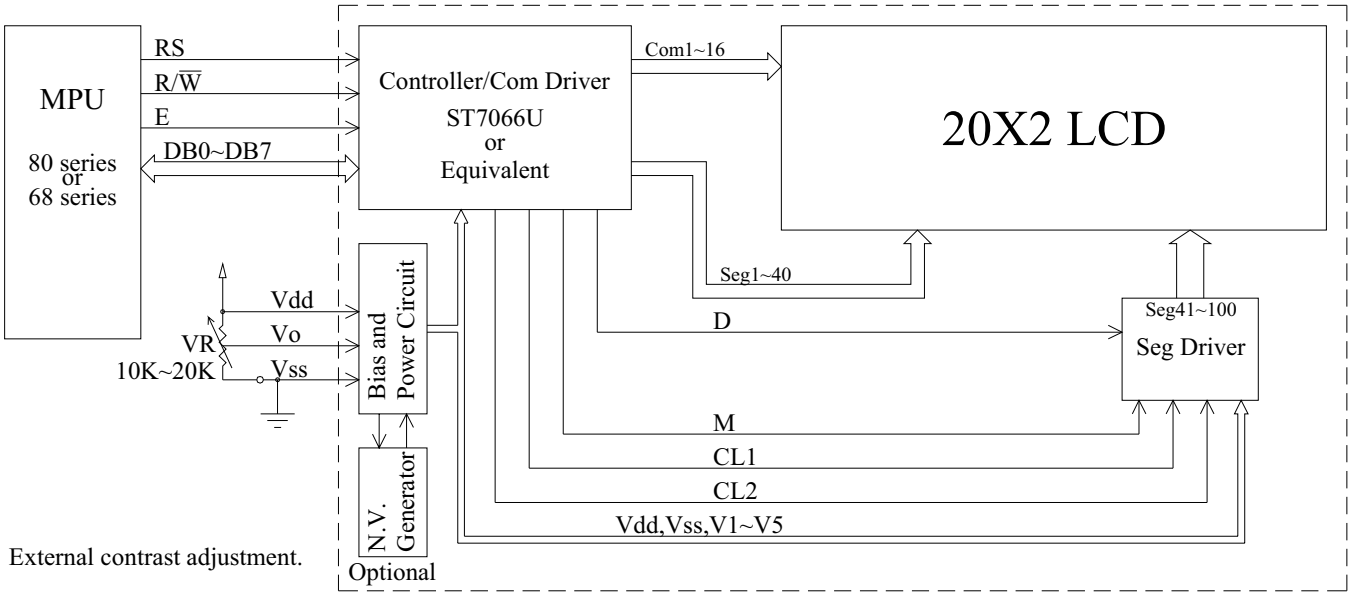
Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAH2002L-YYH	Not to scale	CFAH2002L_master	
	Units: Millimeters	Date: 2015-04-10	Sheet: 1 of 1

SYSTEM BLOCK DIAGRAM



Character located	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DDRAM address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13
DDRAM address	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53

FUNCTION DESCRIPTION

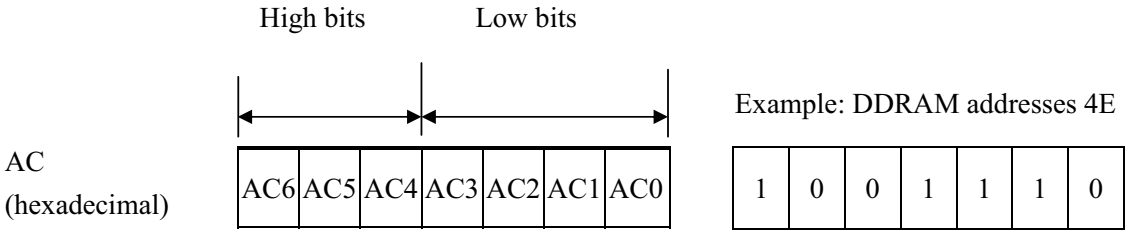
The LCD display Module is built in a LSI controller, the controller has two 8-bit registers, an instruction register (IR) and a data register (DR).
The IR stores instruction codes, such as display clear and cursor shift, and address information for display data RAM (DDRAM) and character generator (CGRAM). The IR can only be written from the MPU. The DR temporarily stores data to be written or read from DDRAM or CGRAM. When address information is written into the IR, then data is stored into the DR from DDRAM or CGRAM. By the register selector (RS) signal, these two registers can be selected.

RS	R/W	Operation
0	0	IR write as an internal operation (display clear, etc.)
0	1	Read busy flag (DB7) and address counter (DB0 to DB7)
1	0	Write data to DDRAM or CGRAM (DR to DDRAM or CGRAM)
1	1	Read data from DDRAM or CGRAM (DDRAM or CGRAM to DR)

Busy Flag (BF)
When the busy flag is 1, the controller LSI is in the internal operation mode, and the next instruction will not be accepted. When RS=0 and R/W=1, the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.

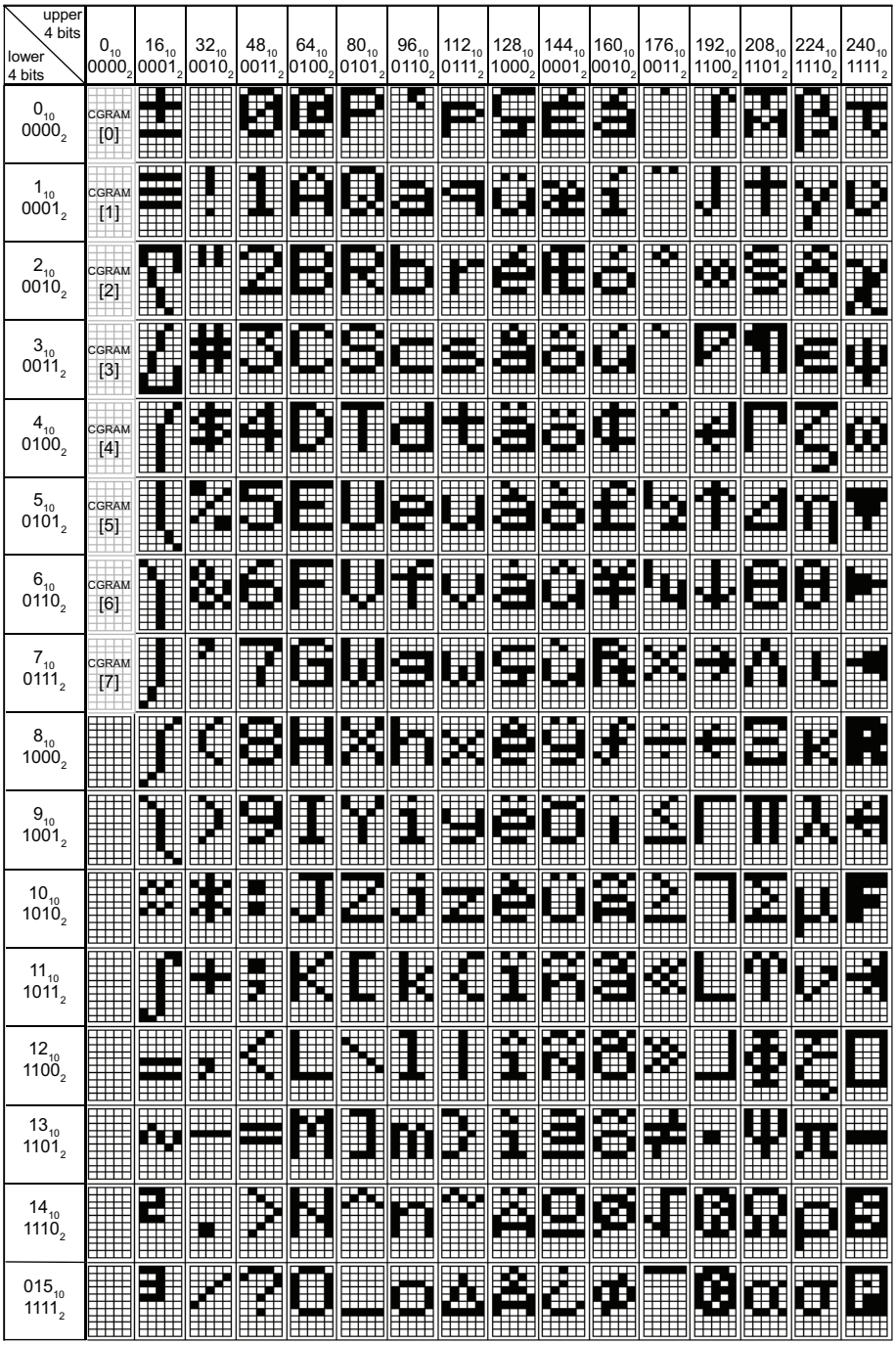
Address Counter (AC)
The address counter (AC) assigns addresses to both DDRAM and CGRAM

Display Data RAM (DDRAM)
This DDRAM is used to store the display data represented in 8-bit character codes. Its extended capacity is 80×8 bits or 80 characters. Below figure is the relationships between DDRAM addresses and positions on the liquid crystal display.



Character Generator ROM (CGROM)

The CGROM generate 5×8 dot or 5x10 pixel character patterns from 8-bit character codes.



Character Generator RAM (CGRAM)

In CGRAM, the user can rewrite characters by program. For 5×8 pixels, eight character patterns can be written. For 5×10 dots, four character patterns can be written.

Write into DDRAM the character code at the addresses shown as the left column of the table below to show the character patterns stored in CGRAM.

Relationship Between CGRAM Addresses, Character Code (DDRAM), and Character Patterns

For 5 * 8 dot character patterns

Character Codes (DDRAM data)	CGRAM Address	Character Patterns (CGRAM data)	
7 6 5 4 3 2 1 0	5 4 3 2 1 0	7 6 5 4 3 2 1 0	
High Low	High Low	High Low	
0 0 0 0 * 0 0 0	0 0 0 0 0 0	* * * 0 0 0 0 0	Character pattern(1)
	0 0 1	* * * 0 0 0 0 0	
	0 1 0	* * * 0 0 0 0 0	
	0 1 1	* * * 0 0 0 0 0	
	1 0 0	* * * 0 0 0 0 0	
	1 0 1	* * * 0 0 0 0 0	
	1 1 0	* * * 0 0 0 0 0	
	1 1 1	* * * 0 0 0 0 0	Cursor pattern
0 0 0 0 * 0 0 1	0 0 1 0 0 0	* * * 0 0 0 0 0	Character pattern(2)
	0 0 1	* * * 0 0 0 0 0	
	0 1 0	* * * 0 0 0 0 0	
	0 1 1	* * * 0 0 0 0 0	
	1 0 0	* * * 0 0 0 0 0	
	1 0 1	* * * 0 0 0 0 0	
	1 1 0	* * * 0 0 0 0 0	
	1 1 1	* * * 0 0 0 0 0	Cursor pattern
	0 0 0	* * *	
	0 0 1		
0 0 0 0 * 1 1 1	1 1 1 1 0 0		
	1 0 1		
	1 1 0		
	1 1 1	* * *	

For 5 * 10 dot character patterns

Character Codes (DDRAM data)	CGRAM Address	Character Patterns (CGRAM data)	
7 6 5 4 3 2 1 0	5 4 3 2 1 0	7 6 5 4 3 2 1 0	
High Low	High Low	High Low	
0 0 0 0 * 0 0 0	0 0 0 0 0 0 0	* * * 0 0 0 0 0	Character pattern
	0 0 0 1	* * * 0 0 0 0 0	
	0 0 1 0	* * * 0 0 0 0 0	
	0 0 1 1	* * * 0 0 0 0 0	
	0 1 0 0	* * * 0 0 0 0 0	
	0 1 0 1	* * * 0 0 0 0 0	
	0 1 1 0	* * * 0 0 0 0 0	
	0 1 1 1	* * * 0 0 0 0 0	
	1 0 0 0	* * * 0 0 0 0 0	
	1 0 0 1	* * * 0 0 0 0 0	
	1 0 1 0	* * * 0 0 0 0 0	Cursor pattern
	1 1 1 1	* * * * * * * *	

■ : " High "

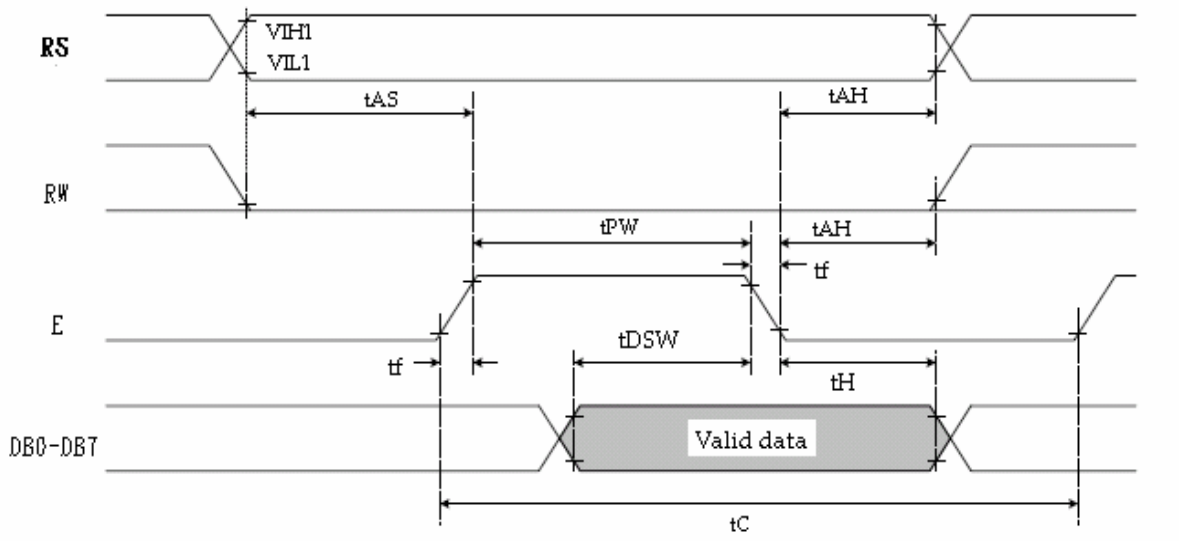
INSTRUCTION CODE

Instruction	Instruction Code										Description	Execution time (fosc=270Khz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write “00H” to DDRAM and set DDRAM address to “00H” from AC	1.53ms
Return Home	0	0	0	0	0	0	0	0	1	—	Set DDRAM address to “00H” from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.53ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and enable the shift of entire display.	39 μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C), and blinking of cursor (B) on/off control bit.	39 μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	—	—	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.	39 μs
Function Set	0	0	0	0	1	DL	N	F	—	—	Set interface data length (DL:8-bit/4-bit), numbers of display line (N:2-line/1-line)and, display font type (F:5×11 dots/5×8 dots)	39 μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39 μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	39 μs
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0 μs
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43 μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43 μs

＊ ”—”：don’t care

TIMING CHARACTERISTICS

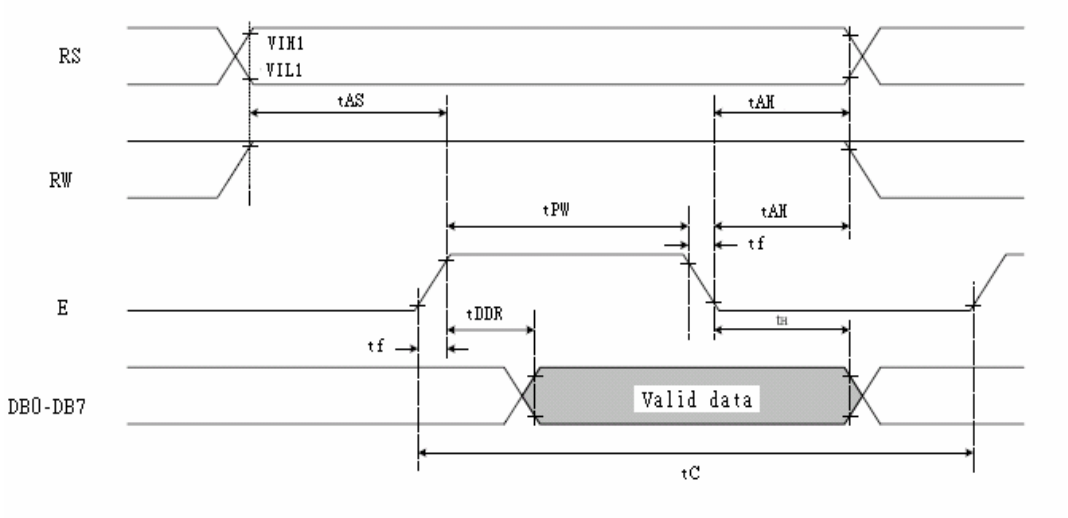
WRITE DATA FROM HOST



Ta=25℃, VDD=5.0V

Item	Symbol	Min	Typ	Max	Unit
Enable cycle time	T_C	1200	—	—	ns
Enable pulse width	T_{PW}	140	—	—	ns
Enable rise/fall time	T_R,T_F	—	—	25	ns
Address set-up time (RS, R/W to E)	t_{AS}	0	—	—	ns
Address hold time	t_{AH}	10	—	—	ns
Data set-up time	t_{DSW}	40	—	—	ns
Data hold time	t_H	10	—	—	ns

READ DATA FROM DISPLAY MODULE'S CONTROLLER

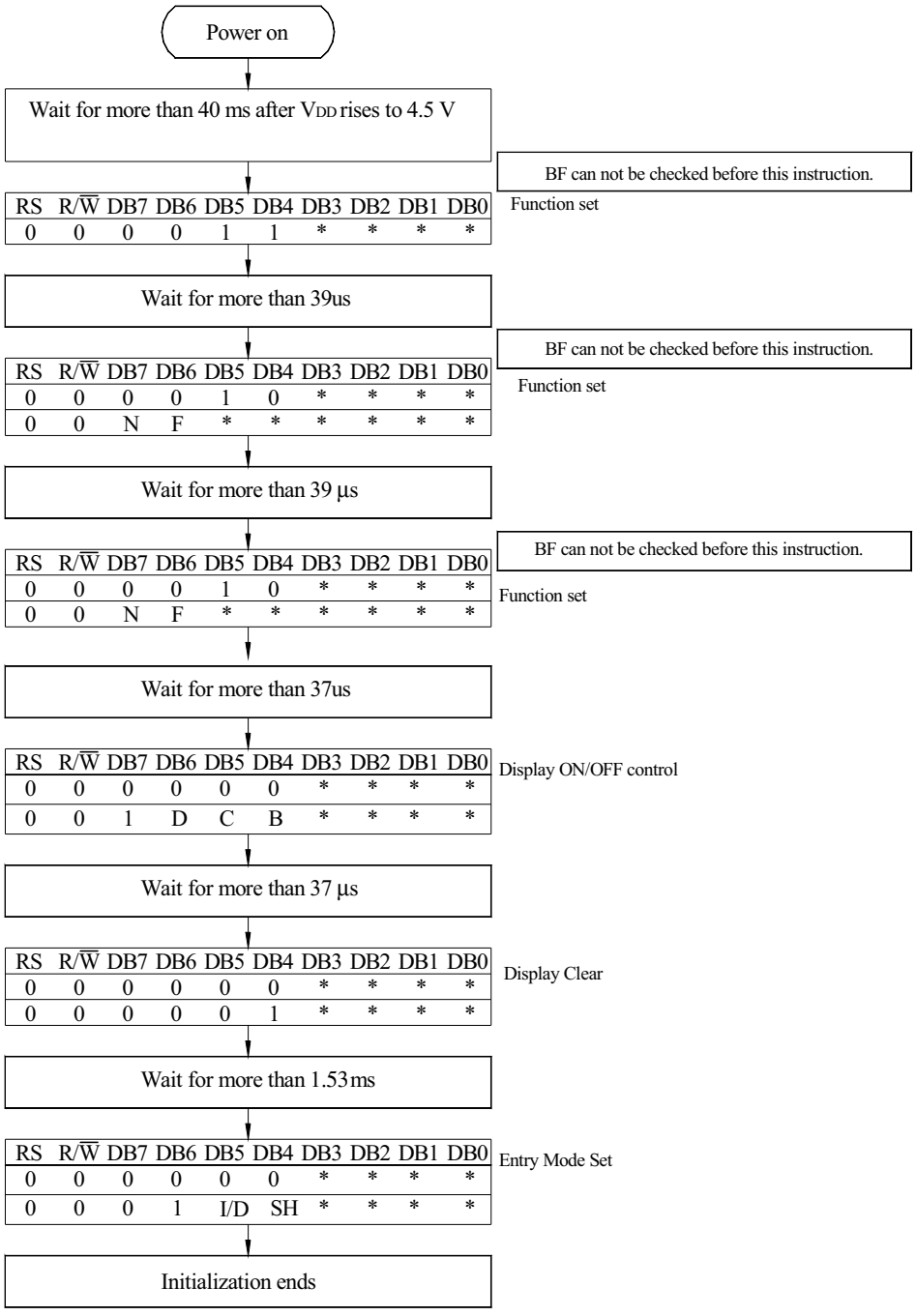


Ta=25℃, VDD=5V

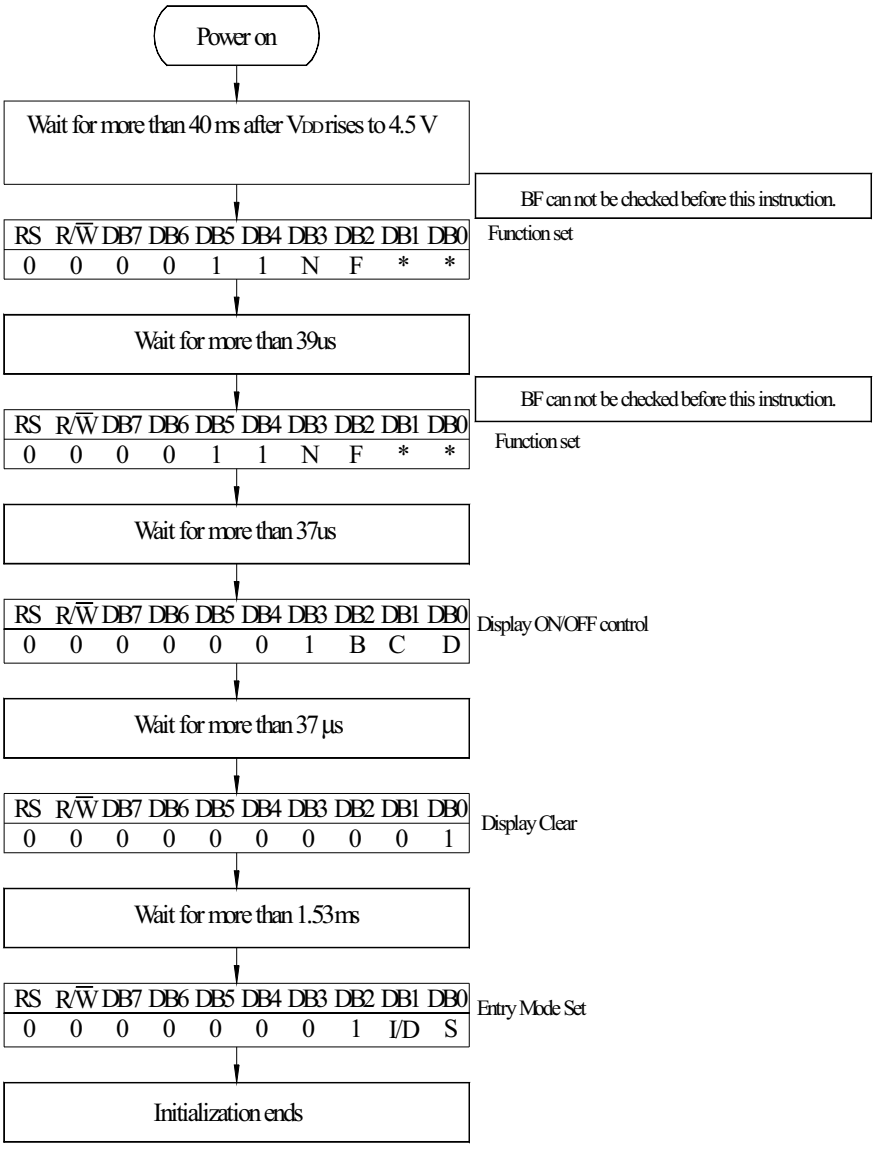
Item	Symbol	Min	Typ	Max	Unit
Enable cycle time	T_C	1200	—	—	ns
Enable pulse width (high level)	T_{PW}	140	—	—	ns
Enable rise/fall time	T_R,T_F	—	—	25	ns
Address set-up time (RS, R/W to E)	t_{AS}	0	—	—	ns
Address hold time	t_{AH}	10	—	—	ns
Data delay time	t_{DDR}	—	—	100	ns
Data hold time	t_H	10	—	—	ns

INITIALIZE THE DISPLAY MODULE

4-BIT INTERFACE



8-BIT INTERFACE



ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	T_{OP}	-20	—	+70	℃
Storage Temperature	T_{ST}	-30	—	+80	℃
Input Voltage	V_I	V_{SS}	—	V_{DD}	V
Supply Voltage For Logic	V_{DD}-V_{SS}	-0.3	—	7	V
Supply Voltage For LCD	V_{DD}-V_0	-0.3	—	13	V

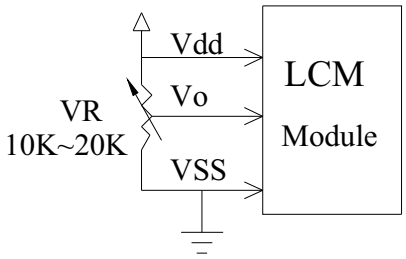
RECOMMENDED DC CHARACTERISTICS

Do not exceed +5.5v maximum.

*Below is a summary of the major operating parameters. For detailed information s*ee the Sitronix ST7066U controller data sheet here on our website.

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	V_{DD}-V_{SS}	—	4.5	5.0	5.5	V
Supply Voltage For LCD *Note	V_{DD}-V_0	Ta=-20℃	—	—	5.7	V
		Ta=25℃	—	4.5	—	V
		Ta=70℃	3.5	—	—	V
Input High Volt.	V_{IH}	—	0.7 V_{DD}	—	V_{DD}	V
Input Low Volt.	V_{IL}	—	V_{SS}	—	0.6	V
Output High Volt.	V_{OH}	—	3.9	—	—	V
Output Low Volt.	V_{OL}	—	—	—	0.4	V
Supply Current	I_{DD}	V_{DD}=5V	—	1.6	2.0	mA

* Note: Please design the VOP adjustment circuit on customer's main board



DETAILS OF INTERFACE PIN FUNCTIONS

Pin No.	Symbol	Level	Description
1	V_{SS}	0V	Ground
2	V_{DD}	5.0V	Supply Voltage for logic
3	VO	(Variable)	Operating voltage for LCD
4	RS	H/L	H: DATA, L: Instruction code
5	R/W	H/L	H: Read(MPU→Module) L: Write(MPU→Module)
6	E	H,H→L	Chip enable signal
7	DB0	H/L	Data bus line
8	DB1	H/L	Data bus line
9	DB2	H/L	Data bus line
10	DB3	H/L	Data bus line
11	DB4	H/L	Data bus line
12	DB5	H/L	Data bus line
13	DB6	H/L	Data bus line
14	DB7	H/L	Data bus line
15	A	—	LED +
16	K	—	LED -

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

Ambient Temperature during optical tests (Ta): 25°C

CFAH2002L-TFH-ET

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	(V) θ	CR≧2	30	—	60	deg
	(H) φ	CR≧2	-45	—	45	deg
Contrast Ratio	CR	—	—	5	—	—
Response Time	T rise	—	—	150	200	ms
	T fall	—	—	150	200	ms

CFAH2002L-TMI-ET

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	θ	CR≧2	0	—	20	$\phi = 180^\circ$
	θ	CR≧2	0	—	40	$\phi = 0^\circ$
	θ	CR≧2	0	—	-30	$\phi = 90^\circ$
	θ	CR≧2	0	—	30	$\phi = 270^\circ$
Contrast Ratio	CR	—	—	3	—	—
Response Time	T rise	—	—	150	200	ms
	T fall	—	—	150	200	ms

CFAH2002L-YYH-ET

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	θ	CR≧2	0	—	20	$\phi = 180^{\circ}$
	θ	CR≧2	0	—	40	$\phi = 0^{\circ}$
	θ	CR≧2	0	—	30	$\phi = 90^{\circ}$
	θ	CR≧2	0	—	30	$\phi = 270^{\circ}$
Contrast Ratio	CR	—	—	3	—	—
Response Time	T rise	—	—	150	200	ms
	T fall	—	—	150	200	ms

OPTICAL DEFINITIONS

CFAH2002L-TFH-ET And CFAH2002L-YYH-ET

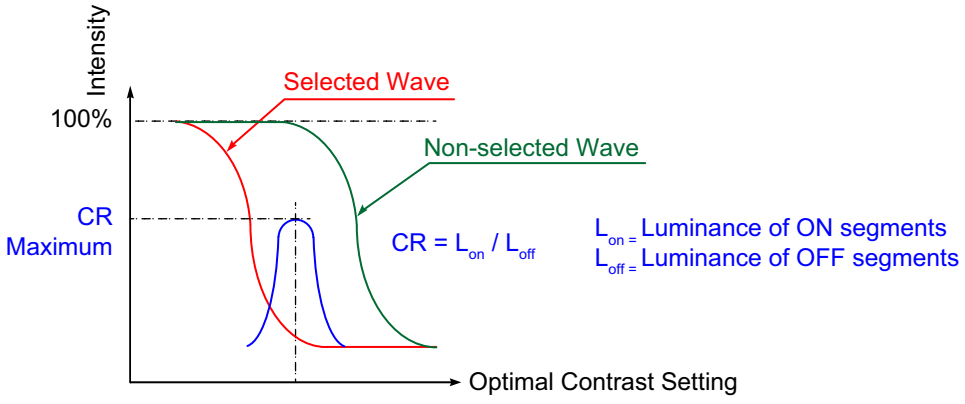


Figure 1. Definition Of Optimal Contrast Setting (Positive)

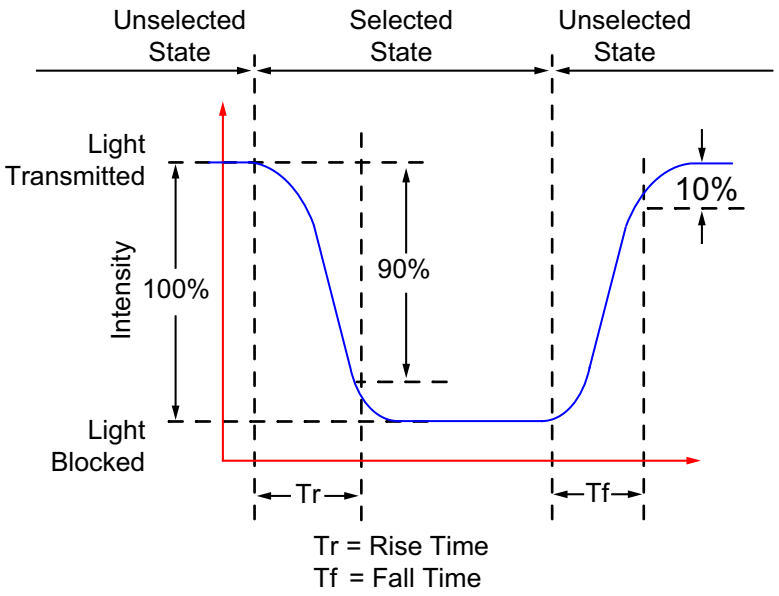


Figure 2. Definition Of Response Time (Positive)

CFAH2002L-TMI-ET

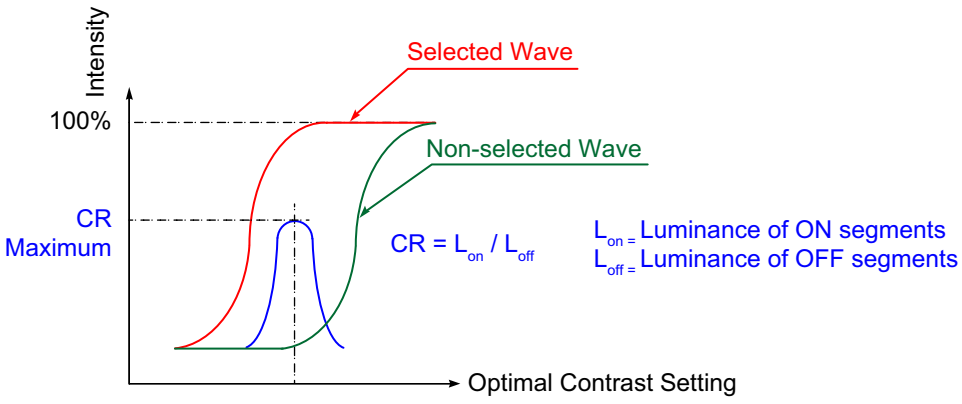


Figure 3. Optimal Contrast Setting (Negative)

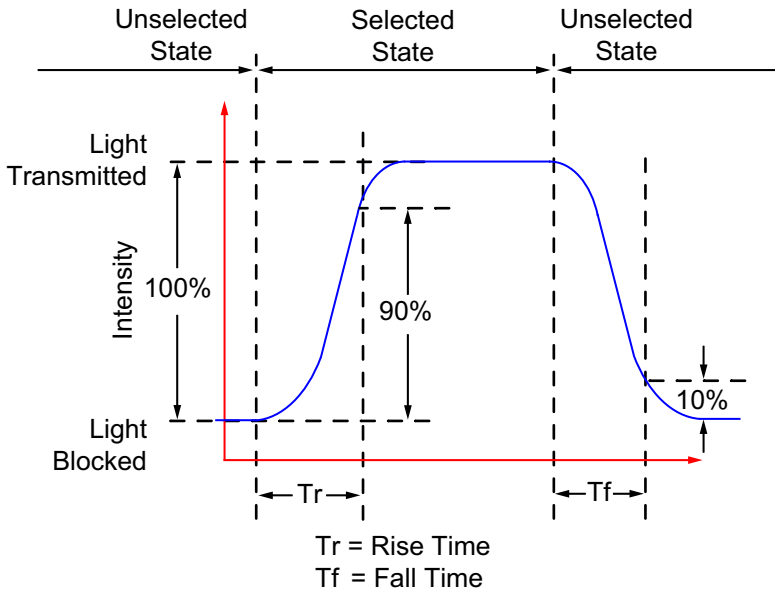
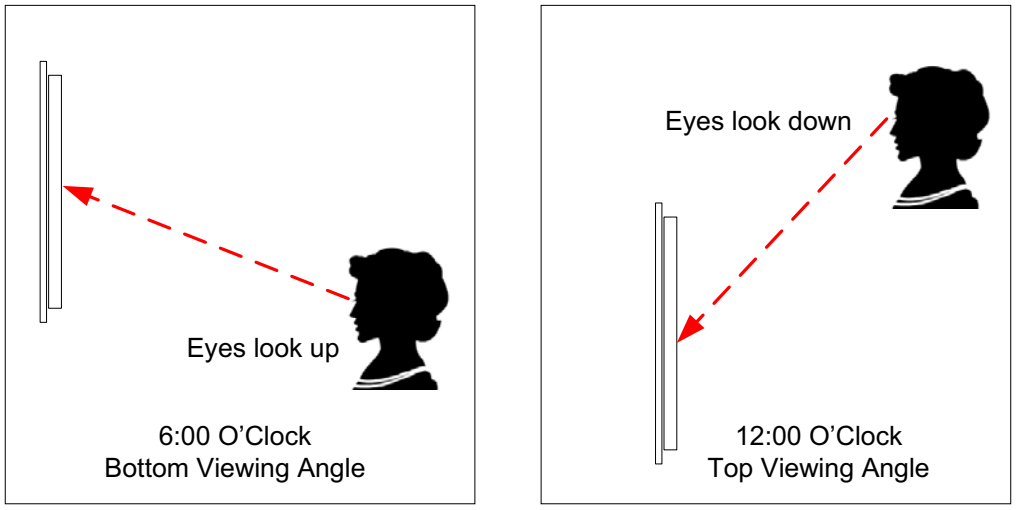


Figure 4. Definition Of Response Time (Negative)

Definition Of Viewing Angle (All In Series)

The series has a 6 o'clock viewing angle.



Response Time

Response Time is the amount of time it takes a liquid crystal cell to go from active to inactive or back again.

LED BACKLIGHT CHARACTERISTICS

CFAH2002L-TFH-ET

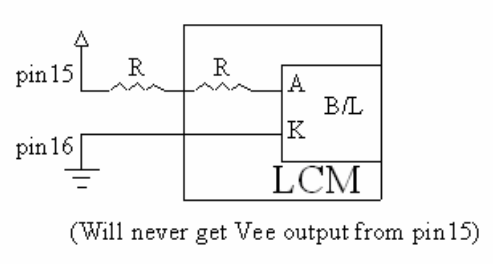
PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Supply Current	ILED	43.2	48	75	mA	V=3.5V
Supply Voltage	V	3.4	3.5	3.6	V	—
Reverse Voltage	VR	—	—	5	V	—
Luminous Intensity	IV		TBD	—	CD/M^2	ILED=48mA
Chromaticity	X	—	0.300	—		
	Y		0.310			
Color	White					

CFAH2002L-TMI-ET

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Supply Current	ILED	—	48	60	mA	V=3.5V
Supply Voltage	V	3.4	3.5	3.6	V	—
Reverse Voltage	VR	—	—	5	V	—
Luminance	IV		TBD	—	CD/M^2	ILED=48mA
Color	White					

CFAH2002L-YYH-ET

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Supply Current	ILED	288	360	432	mA	V=4.1V
Supply Voltage	V	3.9	4.1	4.3	V	—
Reverse Voltage	VR	—	—	8	V	—
Luminance	IV		TBD	—	CD/M^2	ILED=360mA
Wave Length	λ p	568	—	574	nm	ILED=360mA
Color	Yellow Green					



CAUTION

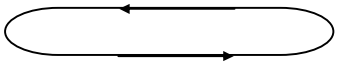
Ensure that you have proper current and voltage control for your backlight before connecting the backlight circuit.

NOTE

For the display modules with white LEDs, we recommend that the backlight be dimmed or turned off during periods of inactivity to conserve its lifetime.

DISPLAY MODULE RELIABILITY AND LONGEVITY

RELIABILITY TEST RESULTS

Test Item	Content of Test	Test Condition
High Temperature storage	Endurance test applying the high storage temperature for a long time.	80℃ 200hrs
Low Temperature storage	Endurance test applying the high storage temperature for a long time.	-30℃ 200hrs
High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	70℃ 200hrs
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20℃ 200hrs
High Temperature/ Humidity Operation	The module should be allowed to stand at 60 ℃,90%RH max For 96hrs under no-load condition excluding the polarizer, Then taking it out and drying it at normal temperature.	60℃,90%RH 96hrs
Thermal shock resistance	The sample should be allowed stand the following 10 cycles of operation -20℃ 25℃ 70℃  30min 5min 30min 1 cycle	-20℃/70℃ 10 cycles
Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V,RS=1.5kΩ CS=100pF 1 time

Note: Test conducted after 4 hours storage at the normal temperature and humidity after removal from the test chamber.

RELIABILITY SPECIFICATIONS

Values listed below are approximate and represent typical lifetime.

CFAH2002L-TFH-ET AND CFAH2002L-TMI-ET	SPECIFICATION	
LCD portion, excluding white LEDs	50,000 to 100,000 hours	
Backlights with White LEDs	***Power-On Hours***	***% of Initial Brightness (New Module)***
	<10,000 hours	>70%
	<50,000 hours	>50%

Notes
Under operating and storage temperature specification limitations, humidity non-condensing) RH up to 65%, and no exposure to direct sunlight.

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

CFAH2002L-YYH-ET	SPECIFICATION
Including yellow-green LED backlight	Brightness will be >50% of a new module's initial brightness for at least 50,000 hours of operation when supply to each LED is below 360 mA.

Notes
Under operating and storage temperature specification limitations, humidity non-condensing) RH up to 65%, and no exposure to direct sunlight.

LONGEVITY (EOL/REPLACEMENT POLICY)

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

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

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

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

- *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 module and to prolong its life, please follow the precautions below. Excessive voltage will shorten the life of the module. You must drive the display within the specified voltage limit. See Absolute Maximum Ratings (Pg. 18).

HANDLING CAUTION FOR MODULES SHIPPED IN TRAYS

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

ESD (ELECTRO-STATIC DISCHARGE)

The circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard anti static precautions as you would for any other static sensitive devices such as expansion cards, motherboards, or integrated circuits. Ground your body, work surfaces, and equipment.

DESIGN AND MOUNTING

- The controller maintains its internal registers until something happens to change it (host sends a command, etc.). Excessive external noise (EMI, RFI) can change these internal registers. In your application and system design, suppress or prevent the noise from influencing the controller and your product. One method of mitigating this problem is to periodically re-initialize the controller to help 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 module ships with a protective film over the polarizer. Please peel off the protective film slowly. Peeling off the protective film abruptly may generate static electricity.
- The polarizer is made out of soft plastic and is easily scratched or damaged. When handling the module, avoid touching the polarizer. Finger oils are difficult to remove.
- To protect the soft plastic polarizer from damage, place a transparent plate (for example, acrylic, polycarbonate, or glass) in front of the module, leaving a small gap between the plate and the display surface. We use GE HP-92 Lexan, which is readily available and works well.
- Do not disassemble or modify the module.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the module.
- Use care to keep the exposed terminals clean. Contamination, including fingerprints may make soldering difficult, and the reliability of the soldered connection poor.

AVOID SHOCK, IMPACT, TORQUE, OR TENSION

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

IF PANEL BREAKS

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

HOW TO CLEAN

1. Turn display 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 thepolarizer 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 thepolarizer 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. 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.)
6. The plastic is easily scratched or damaged. Use a light touch as you clean th polarizer. Wipe gently.
7. Gently wash the microfiber cloths in warm, soapy water and air dry before reuse.

OPERATION

- We do not recommend connecting this module to a PC's parallel port as an end product. This module is not “user friendly” and connecting it to a PC's parallel port is often difficult, frustrating, and can result in a “dead” display due to mishandling. For more information, see our forum thread at http://www.crystalfontz.com/forum/showthread.php?s=&threadid=3257.
- Your circuit should be designed to protect the module from ESD and power supply transients.
- Observe the operating temperature limitations. Operation outside of these limits may shorten life and/or harm display. 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. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Do not allow weight to be placed on the modules while they are in storage.
- Please recycle your outdated Crystalfontz modules at an approved facility.

APPENDIX A: QUALITY ASSURANCE STANDARDS

INSPECTION CONDITIONS

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

COLOR DEFINITIONS

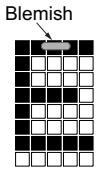
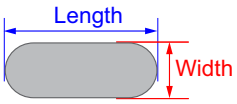
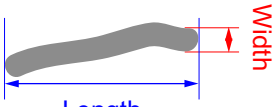
We try to describe the appearance of our modules as accurately as possible. For the photos, we adjust for optimal appearance. Actual display appearance may vary due to (1) different operating conditions, (2) small variations of component tolerances, (3) inaccuracies of our camera, (4) color interpretation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

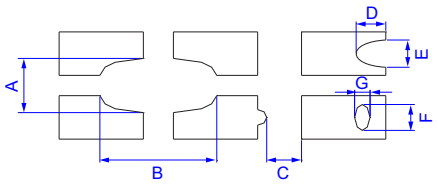
DEFECTS CLASSIFICATION

Defects are defined as:

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

ACCEPTANCE STANDARDS

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

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

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

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