CHARACTER LCD MODULE SPECIFICATIONS

Model Number	**SSC2F16DLNR-S**
Hardware Version	**Revision A**
Data Sheet Version	**Revision 2.0, July 2008**
Product Pages	www.411techsystems.com/html/ssc2f16dlnr-s.html

Email: support@411techsystems.com
URL: www.411techsystems.com

REVISION HISTORY

HARDWARE
Current hardware version: **vA**

DATA SHEET	
2008/07/01	Current Data Sheet version: **v2.0** Changes since last revision (v1.0): ▪ Improved drawings, tables, and text. ▪ Module specifications have not changed.
2007/10/15	Data Sheet version: v1.0 New Data Sheet

The Fine Print

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CONTENTS

LIST OF FIGURES

MAIN FEATURES

- 16 characters by 2 lines LCD has a large display area in a compact 80.0 (W) x 36.0 (H) x 13.5 (D) millimeter pack- age (3.15” (W) x 1.42” (H) x 0.53” (D)).
- 4-bit or 8-bit parallel interface.
- Standard Hitachi HD44780 equivalent controller.
- Red LED backlight with FSTN, negative, near-black, transmissive mode LCD (displays red characters on dark background).
- RoHS compliant.

ORDERING INFORMATION

PART NUMBER	FLUID	LCD GLASS COLOR	IMAGE	POLARIZER FILM	BACKLIGHT COLOR/TYPE
SSC2F16DLNR-S	FSTN	near-black	Negative	Transmissive	Red LED
Additional variants (same form factor, different LCD mode or backlight):					
SSC2F16DLNY-S	STN	Yellow/Green	Positive	Transflective	Yellow-Green LED
SSC2F16DLNW-S	STN	Blue	Negative	Transmissive	White LED

MECHANICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS

ITEM	SIZE
Number of Characters and Lines	16 Characters x 2 Lines
Module Dimensions	80.0 (W) x 36.0 (H) x 13.5 (D) mm
Viewing Area	66.0 (W) x 16.0 (H) mm
Active Area	56.2 (W) x 11.5 (H) mm
Character Size	2.95 (W) x 5.55 (H) mm
Character Pitch	3.55 (W) x 5.95 (H) mm
Dot Size	0.55 (W) x 0.65 (H) mm
Dot Pitch	0.60 (W) x 0.70 (H) mm
Weight	33 grams (typical)

MODULE OUTLINE DRAWING

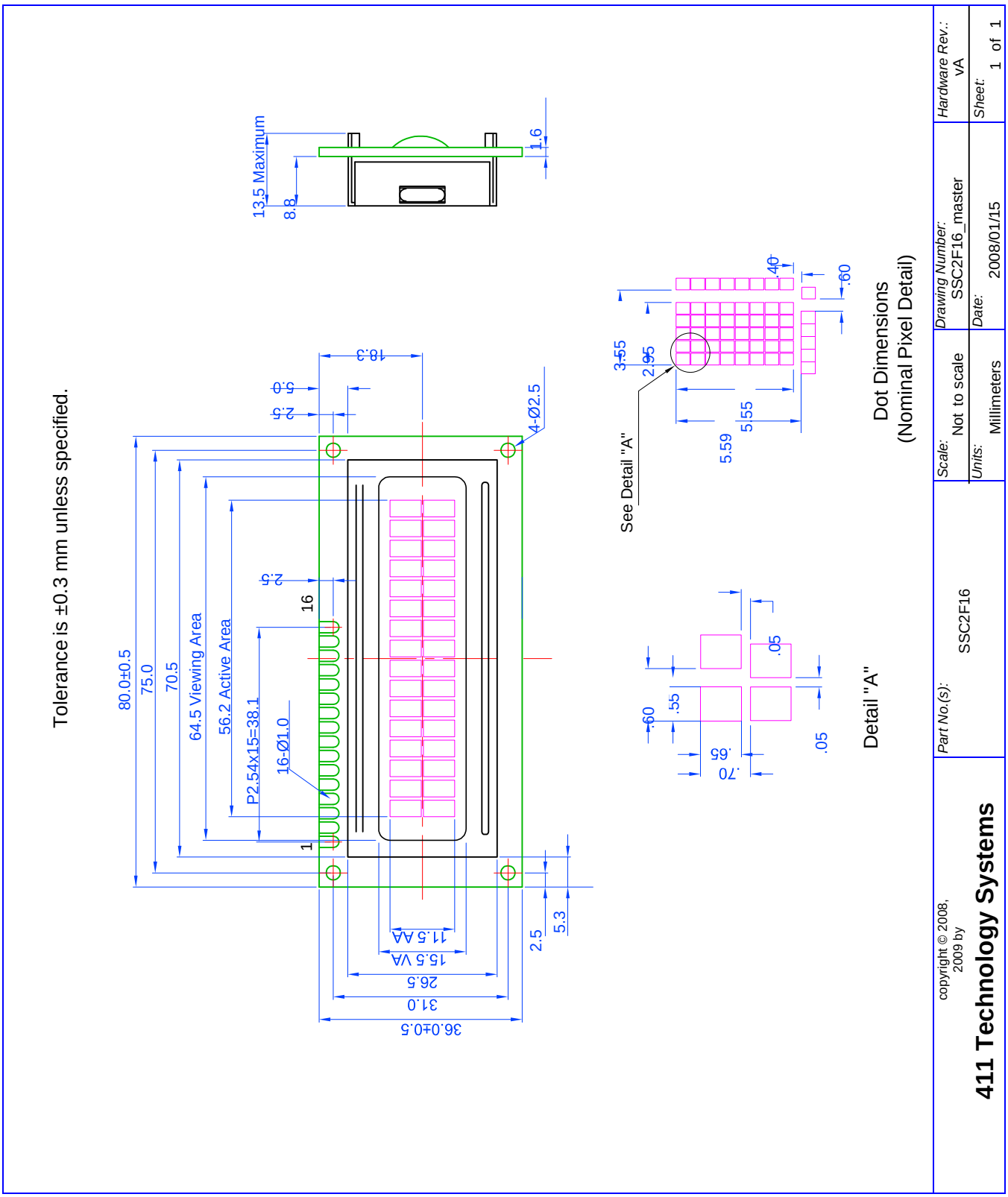


Figure 1. Module Outline Drawing

ELECTRICAL SPECIFICATIONS

SYSTEM BLOCK DIAGRAM

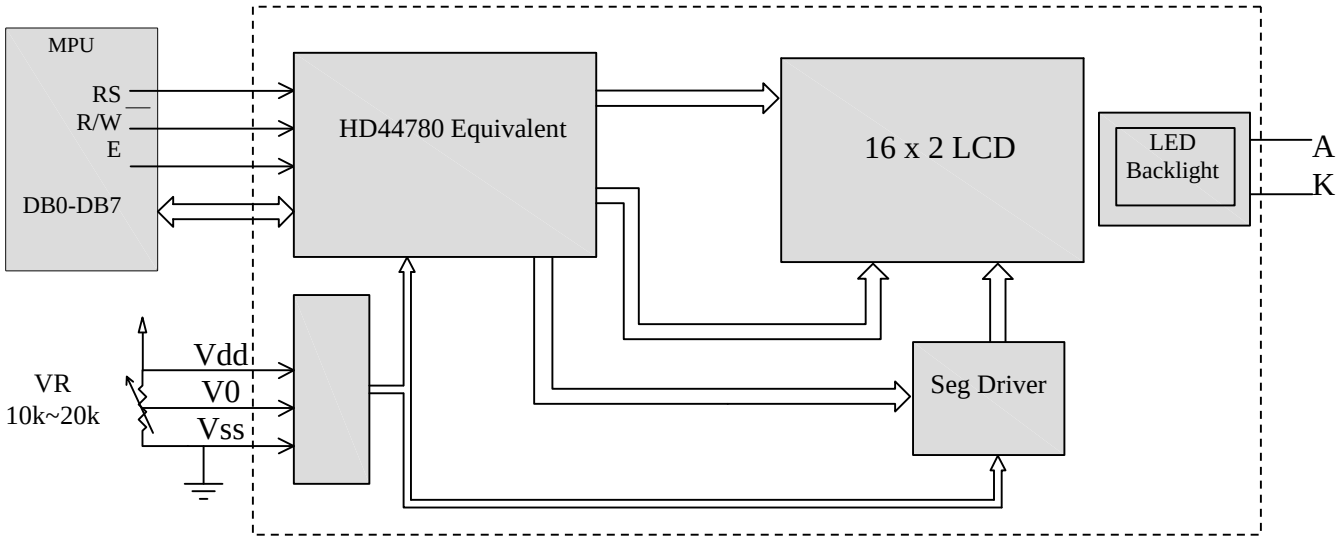


Figure 2. System Block Diagram

DRIVING METHOD

DRIVING METHOD	SPECIFICATION
Duty	1/16
Bias	1/5

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
Input Voltage	V_I	V_{SS}	V_{DD}
Supply Voltage for Logic	V_{DD} - V_{SS}	-0.3v	+7v
Supply Voltage for LCD	V_{DD} - V_O	-0.3v	+13v
**Note: Prolonged exposure at temperatures outside of this range may cause permanent damage to the module.*			

DC CHARACTERISTICS

5V OPERATION							
PART	**DC CHARACTERISTICS** ***(4.5 to 5.5 volts)***	**TEST CONDITION**	**SYMBOL**	**MINIMUM**	**TYPICAL**	**MAXIMUM**	**NOTES**
Controller and Board	Supply Voltage for Logic		V_{DD} - V_{SS}	+4.5v	+5.0v	+5.5v	
	Input High Voltage		V_{IH}	+2.2v		V_{DD}	Pins: E, RS, R/W, DB0 - DB7
	Input Low Voltage		V_{IL}			+0.6v	
	Output High Voltage		V_{OH}	+2.4v			I_{OH} = - 0.1 mA Pins: DB0 - DB7
	Output Low Voltage		V_{OL}			+0.4v	I_{OL} = 0.1 mA Pins: DB0 - DB7
	Supply Current	without backlight	I_{DD}		1.2 mA		
LCD Glass	Supply Voltage for Driving LCD	TA = -20ºC	V_{DD} - V_O			+4.2v	
		TA = +25ºC			+3.8v		
		TA = +70ºC		+3.6v			

DETAILS OF INTERFACE PIN FUNCTIONS

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
1	V_{SS}	0v		Ground
2	V_{DD}	+5.0v		Supply voltage for logic
3	V_O	variable		Supply voltage for driving LCD
4	RS	H/L	I	Register selection input. H: Data register (for read and write) L: Instruction code (for write)
5	R/$\overline{W}$	H/L	I	H: Read (MPU⇦Module) L: Write (MPU⇨Module)
6	E	H,H⇨L	I	Read/write enable signal. H: Read data is enabled by a high level. H⇨L: Write data is latched on the falling edge.
7	DB0	H/L	I/O	Data bit 0
8	DB1	H/L	I/O	Data bit 1
9	DB2	H/L	I/O	Data bit 2
10	DB3	H/L	I/O	Data bit 3
11	DB4	H/L	I/O	Data bit 4
12	DB5	H/L	I/O	Data bit 5
13	DB6	H/L	I/O	Data bit 6
14	DB7	H/L	I/O	Data bit 7
15	A (LED +)			Supply voltage for LED. “A” (anode) or “+” of LED backlight
16	K (LED -)			Supply voltage for LED. “K” (cathode or kathode for German and original Greek spelling) or “-” of LED backlight
For backlight connections, please refer to LED Backlight Characteristics (Pg. 15).				

TYPICAL VO CONNECTIONS FOR DISPLAY CONTRAST

Adjust V_O to +1v (V_{LCD} = +4v) as an initial setting. When the module is operational, readjust V_O for optimal display appearance.

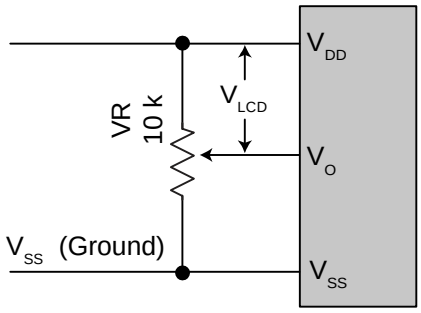


Figure 3. Typical V_O Connections

We recommend allowing field adjustment of V_O for all designs. The optimal value for V_O will change with temperature, variations in V_{DD}, and viewing angle. V_O will also vary module-to-module and batch-to-batch due to normal manufacturing variations.

Ideally, adjustments to V_O should be available to the end user so each user can adjust the display to the optimal contrast for their required viewing conditions. At a minimum, your design should allow V_O to be adjusted as part of your product's final test.

Although a potentiometer is shown as a typical connection, V_O can be driven by your microcontroller, either by using a DAC or a filtered PWM. Displays that require V_O to be negative may need a level-shifting circuit. Please do not hesitate to contact our application support team for design assistance on your application.

ESD (ELECTRO-STATIC DISCHARGE) SPECIFICATIONS

This circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard antistatic precautions as you would for any other PCB such as expansion cards or motherboards. For more information, see CARE AND HANDLING PRECAUTIONS (Pg. 21).

OPTICAL SPECIFICATIONS

OPTICAL CHARACTERISTICS

ITEM	SYMBOL	CONDITION	MINIMUM	TYPICAL	MAXIMUM
Viewing Angle (6 o'clock) (Vertical, Horizontal)	(V)?	CR≥2	-20°		35°
	(H)?	CR≥2	-30°		30°
Contrast Ratio	CR			3	
LCD Response Time*	T rise	Ta = 25°C			250 ms
	T fall	Ta = 25°C			250 ms
**Response Time: The amount of time it takes a liquid crystal cell to go from active to inactive or back again.*					

OPTICAL DEFINITIONS

- Operating Voltage (V_{LCD}): V_{OP}
- Viewing Angle
  - Vertical (V)? : 0°
  - Horizontal (H)? : 0°
- Frame Frequency: 64 Hz
- Driving Waveform: 1/16 Duty, 1/5 Bias
- Ambient Temperature (Ta): 25°C

Definition of Operation Voltage (Vop)

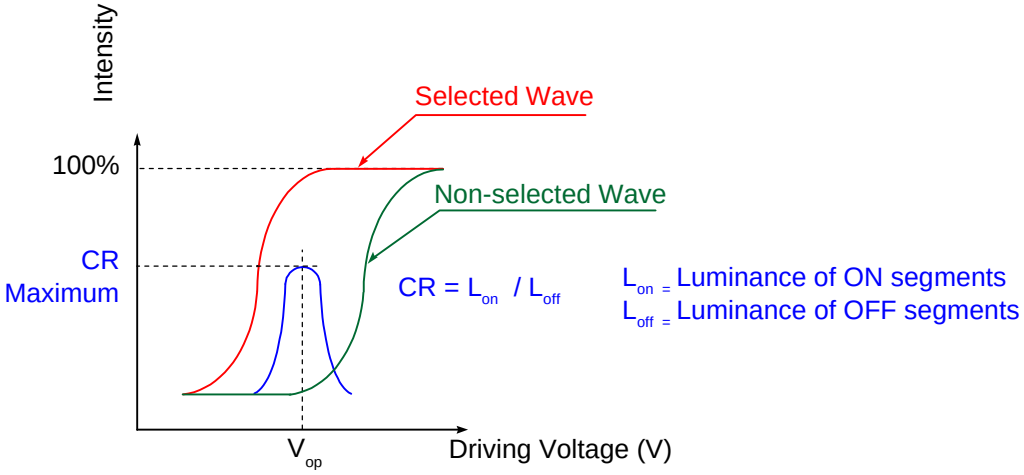


Figure 4. Definition of Operation Voltage (V_{OP}) (Negative)

Definition of Response Time (Tr, Tf)

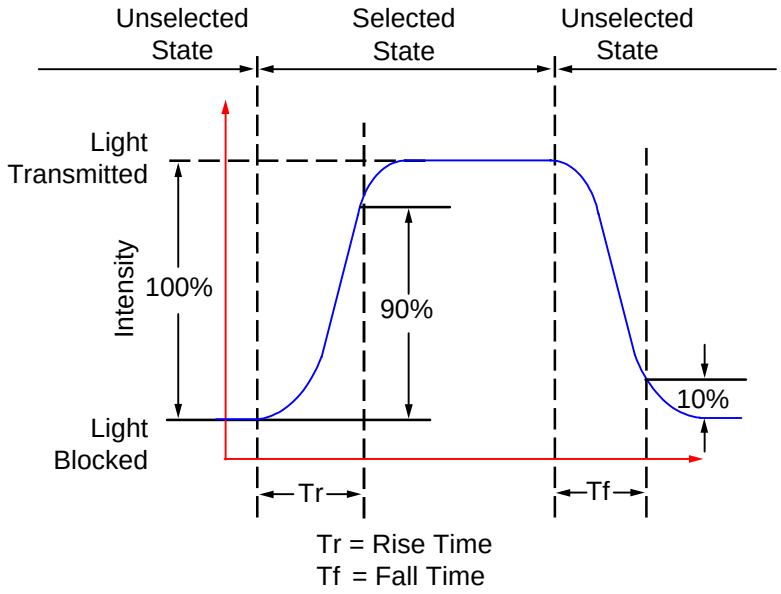


Figure 5. Definition of Response Time (Tr, Tf) (Negative)

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

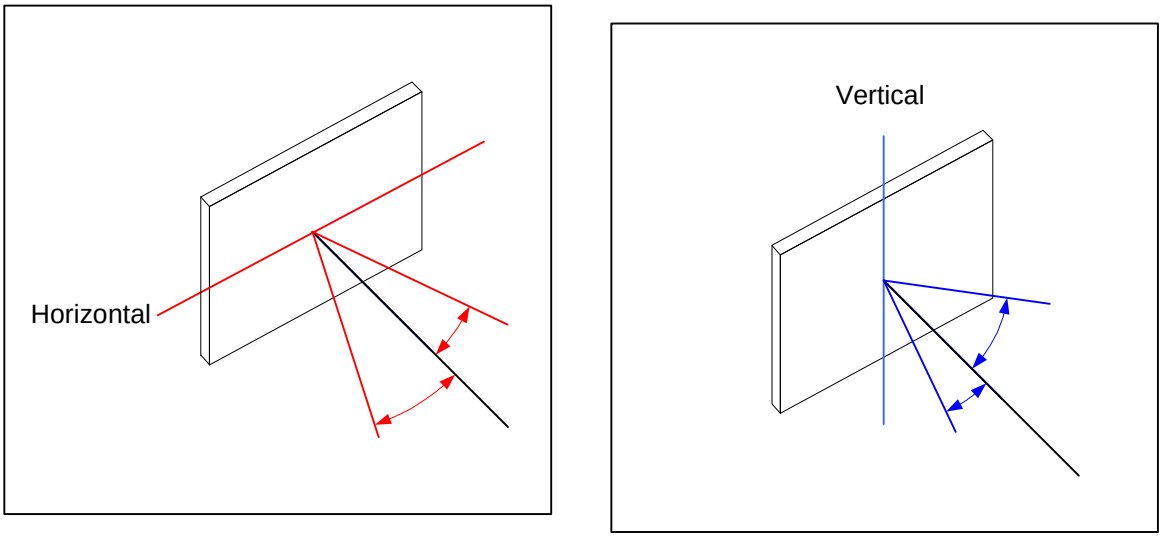


Figure 6. Definition of Horizontal and Vertical Viewing Angles (CR>2)

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

This module has a 6:00 o'clock viewing angle. A 6:00 o'clock viewing angle is a bottom viewing angle like what you would see when you look at a cell phone or calculator. A 12:00 o'clock viewing angle is a top viewing angle like what you would see when you look at the gauges in a golf cart or airplane.

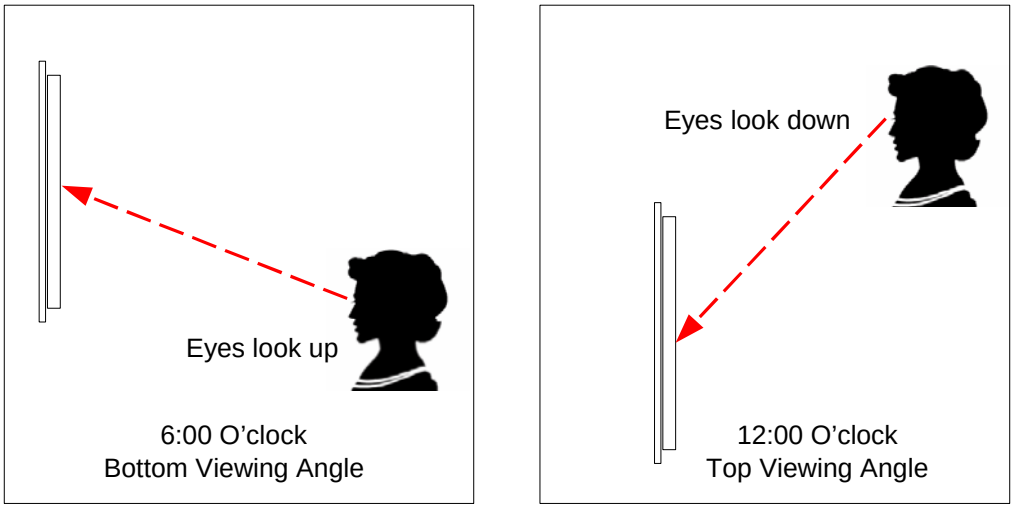


Figure 7. Definition of 6:00 O'Clock and 12:00 O'Clock Viewing Angles

LED BACKLIGHT CHARACTERISTICS

The SSC2F16DLNR-S uses an LED backlight. LED backlights are easy to use, but they are also easily damaged by abuse.

> **NOTE**
> Do not connect +5v directly to the backlight terminals. This will ruin the backlight.

LEDs are “current” devices. The important aspect of driving an LED is 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 in line from a voltage source will work well in most applications and is much less complex than a current source.

You need to know what the forward voltage of the LEDs is so you can calculate the current limiting resistor (R_{LIMIT}). The forward voltage will vary slightly from display to display.

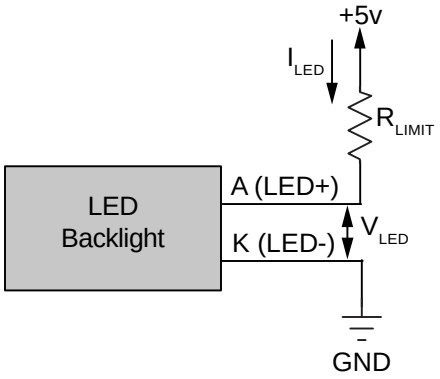


Figure 8. Typical LED Backlight Connections for “Always On”

The equation to calculate R_{LIMIT} is:

$$R_{LIMIT} \text{ (minimum)} = \frac{V_{DD} \text{ (Supply Voltage)} - V_{LED} \text{ (Typical LED Forward Voltage)}}{I_{LED} \text{ (Typical LED Forward Current)}}$$

The specific R_{LIMIT} calculation for the SSC2F16DLNR-S at V_{DD} = +5v is:

$$R_{LIMIT} = \frac{5v - 4.1v}{0.12\ A} = 7.5?\ \text{(minimum)}$$

The backlight may be dimmed by PWM (Pulse Width Modulation). The typical range for the PWM frequency is from 100 to 300 Hz.

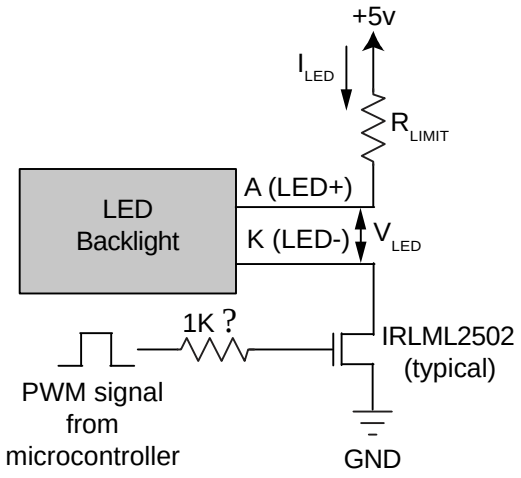


Figure 9. Example of LED Backlight Connections for PWM Dimming

Backlight Characteristics ***Red dots on black background***			
PARAMETER	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Forward Current (I_{LED}) V = 3.9v		120 mA	
Forward Voltage (V_{LED})	+3.8v	+4.1v	+4.4v
Reverse Voltage (V_R)		+8.0v	
Luminous Intensity* (I_V) I_{LED} = 120 mA		116 cd/m^2	
Wavelength* (l ?) I_{LED} = 120 mA		632 nm	
**Direct measurement of backlight–the backlight is not measured through the LCD.*			

LCD CONTROLLER INTERFACE

This module uses a Sunplus SPLC780Dcontroller. The Sunplus SPLC780D is compatible with the industry standard Hitachi HD44780 controller. Software written for modules that use the HD44780 should work without modification.

DISPLAY POSITION DDRAM ADDRESS

The following table shows the relationship between the controller's addresses and the corresponding character location on the module.

		COLUMN															
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
ROW	**0**	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07	0x08	0x09	0xA	0xB	0xC	0xD	0xE	0xF
	1	0x40	0x41	0x42	0x43	0x44	0x45	0x46	0x47	0x48	0x49	0x4A	0x4B	0x4C	0x4D	0x4E	0x4F

CHARACTER GENERATOR ROM (CGROM)

To find the code for a given character, add the two numbers that are shown in bold for its row and column. For example, the lowercase “h” is in the column labeled “96_{10}” and in the row labeled “8_{10}”. So you would add 96 + 8 to get 104. When you send a byte with the value of 104 to the display, then a lowercase “h” will be shown.

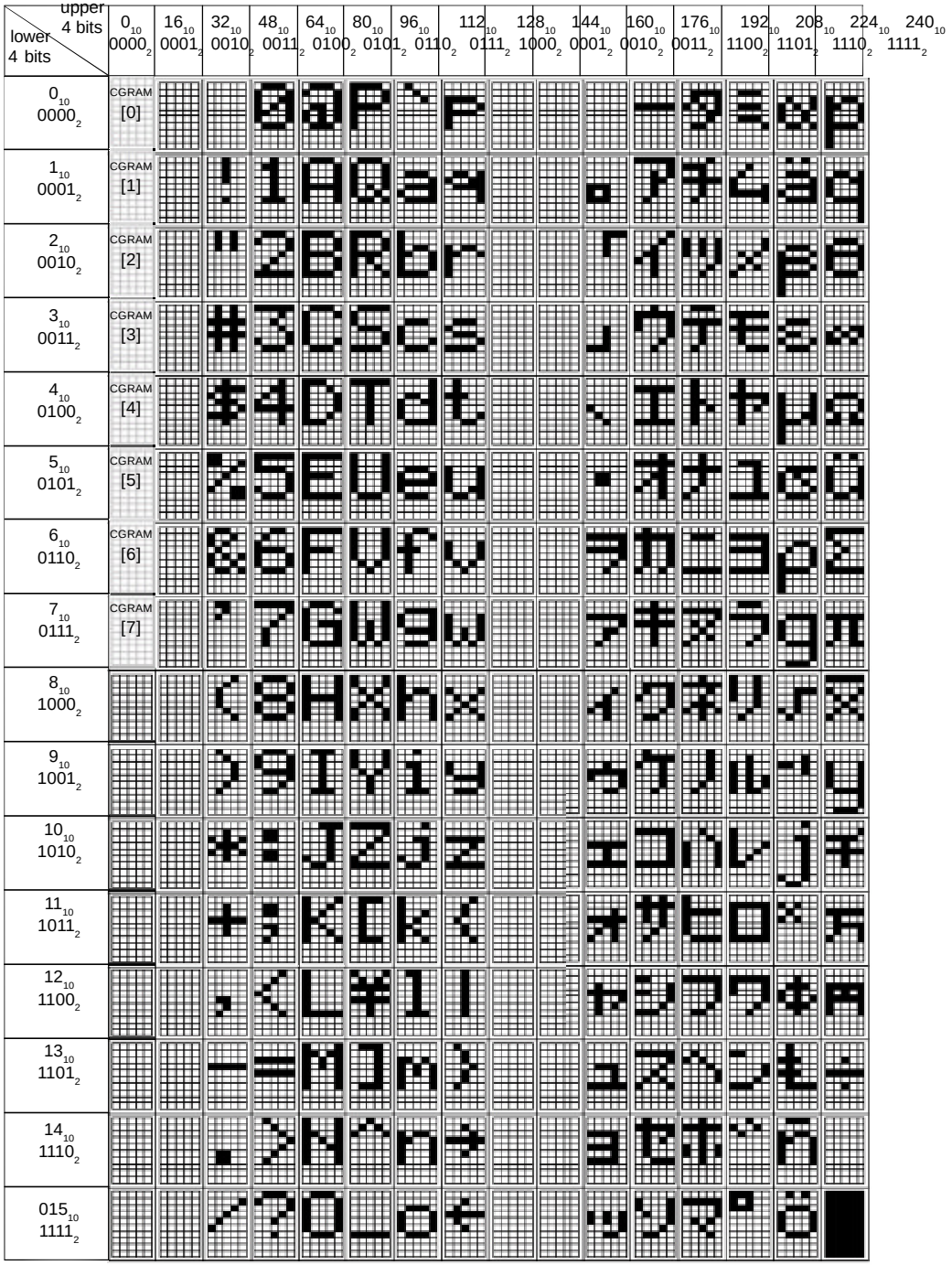


Figure 10. Character Generator ROM (CGROM)

MODULE RELIABILITY

MODULE RELIABILITY

ITEM	SPECIFICATION
LCD including red LED backlight	50,000 to 100,000 hours (typical)

MODULE PRODUCTION LIFE (EOL / REPLACEMENT POLICY)

411 Technology Systems is committed to making all of our LCD 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 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 Typical V_O Connections for Display Contrast (Pg. 11)).
- *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 webpage as soon as possible. If interested, you can subscribe to future part change notifications.

CARE AND HANDLING PRECAUTIONS

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

ESD (ELECTRO-STATIC DISCHARGE)

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

DESIGN AND MOUNTING

- The exposed surface of the LCD “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 modify the tab of the metal holder or make connections to it.
- Solder only to the I/O terminals. Use care when removing solder—it is possible to damage the PCB.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the module.

AVOID SHOCK, IMPACT, TORQUE, AND TENSION

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

IF LCD PANEL BREAKS

- If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or eyes.
- If the liquid crystal fluid touches your skin, clothes, or work surface, wash it off immediately using soap and plenty of water.
- Do not eat the LCD panel.

CLEANING

The polarizer (laminated to the glass) is soft plastic. The soft plastic is easily scratched or damaged. Be very careful when you clean the polarizer.

- Do not clean the polarizer with liquids. Do not wipe the polarizer with any type of cloth or swab (for example, Q- tips).
- Use the removable protective film to remove smudges (for example, fingerprints) and any foreign matter. If you no longer have the protective film, use standard transparent office tape (for example, Scotch® brand “Crystal Clear Tape”). If the polarizer is dusty, you may carefully blow it off with clean, dry, oil-free compressed air.

OPERATION

- We do not recommend connecting this module to a PC's parallel port as an "end product." This module is not "user friendly" and connecting them to a PC's parallel port is often difficult, frustrating, and can result in a "dead" display due to mishandling.
- Your circuit should be designed to protect the module from ESD and power supply transients.
- Observe the operating temperature limitations: from -20°C minimum to +70°C maximum with minimal fluctuations. Operation outside of these limits may shorten the life and/or harm the display.
    - 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.
- Observe the storage temperature limitations: from -30°C minimum to +80°C maximum with minimal fluctuations. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Do not allow weight to be placed on the modules while they are in storage.
- Please recycle your outdated 411 Technology Systems LCD modules at an approved e-waste facility.

APPENDIX A: QUALITY ASSURANCE STANDARDS

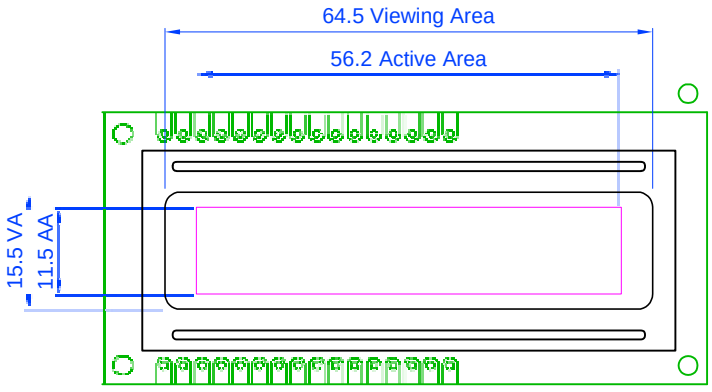
INSPECTION CONDITIONS

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

DEFINITION OF ACTIVE AREA AND VIEWING AREA



ACCEPTANCE SAMPLING

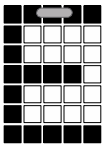
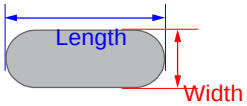
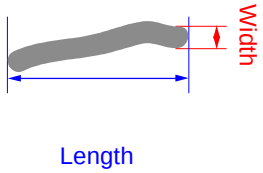
DEFECT TYPE	AQL*
Major	≤0.65%
Minor	<1.0%
* Acceptable Quality Level: maximum allowable error rate or variation from standard	

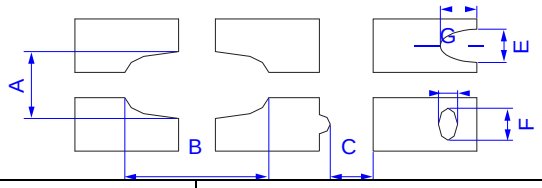
DEFECTS CLASSIFICATION

Defects are defined as:

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

ACCEPTANCE STANDARDS

<table>
<tr><th>#</th><th>DEFECT TYPE</th><th colspan="3">CRITERIA</th><th>MAJOR / MINOR</th></tr>
<tr><td>1</td><td>Electrical defects</td><td colspan="3">1. No display, display malfunctions, or shorted segments.
2. Current consumption exceeds specifications.</td><td>Major</td></tr>
<tr><td>2</td><td>Viewing area defect</td><td colspan="3">Viewing area does not meet specifications.</td><td>Major</td></tr>
<tr><td>3</td><td>Contrast adjustment defect</td><td colspan="3">Contrast adjustment fails or malfunctions.</td><td>Major</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Blemishes or foreign matter on display segments</td><td rowspan="3">  </td><td>Defect Size</td><td>Acceptable Qty</td><td rowspan="3">Minor</td></tr>
<tr><td>≤0.30 mm</td><td>3</td></tr>
<tr><td colspan="2">≤2 defects within 10 mm of each other</td></tr>
<tr><td rowspan="5">5</td><td rowspan="5">Blemishes or foreign matter outside of display segments</td><td rowspan="5">Defect Size = (Width + Length)/2
  </td><td>Defect Size</td><td>Acceptable Qty</td><td rowspan="5">Minor</td></tr>
<tr><td>≤0.15 mm</td><td>Ignore</td></tr>
<tr><td>0.15 to 0.20 mm</td><td>3</td></tr>
<tr><td>0.20 to 0.25 mm</td><td>2</td></tr>
<tr><td>> 0.30 mm</td><td>1</td></tr>
<tr><td rowspan="6">6</td><td rowspan="6">Dark lines or scratches in display area
  </td><td>Defect Width</td><td>Defect Length</td><td>Acceptable Qty</td><td rowspan="6">Minor</td></tr>
<tr><td>≤0.03 mm</td><td>≤3.0 mm</td><td>3</td></tr>
<tr><td>0.03 to 0.05</td><td>≤2.0 mm</td><td>2</td></tr>
<tr><td>0.05 to 0.08</td><td>≤2.0 mm</td><td>1</td></tr>
<tr><td>0.08 to 0.10</td><td>=3.0 mm</td><td>0</td></tr>
<tr><td>≥0.10</td><td>>3.0 mm</td><td>0</td></tr>
</table>

<table>
<tr><th>#</th><th>DEFECT TYPE</th><th>CRITERIA</th><th>MAJOR / MINOR</th></tr>
<tr><td>7</td><td>Bubbles between polarizer film and glass</td><td><table>
<tr><td>Defect Size</td><td>Acceptable Qty</td></tr>
<tr><td>≤0.20 mm</td><td>Ignore</td></tr>
<tr><td>0.20 to 0.40 mm</td><td>3</td></tr>
<tr><td>0.40 to 0.60 mm</td><td>2</td></tr>
<tr><td>≥0.60 mm</td><td>0</td></tr>
</table></td><td>Minor</td></tr>
<tr><td>8</td><td>Display pattern defect</td><td> 

<table>
<tr><td>Dot Size</td><td>Acceptable Qty</td></tr>
<tr><td>((A+B)/2)≤0.20 mm</td><td rowspan="4">≤3 total defects
≤2 pinholes per digit</td></tr>
<tr><td>C>0 mm</td></tr>
<tr><td>((D+E)/2)≤0.25 mm</td></tr>
<tr><td>((F+G)/2)≤0.25 mm</td></tr>
</table></td><td>Minor</td></tr>
<tr><td>9</td><td>Backlight defects</td><td>1. Light fails or flickers. (Major)
2. Color and luminance do not correspond to specifications. (Major)
3. Exceeds standards for display's blemishes, foreign matter, dark lines or scratches. (Minor)</td><td>See list</td></tr>
<tr><td>10</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. (Minor)
4. Solder (if any) on bezel, LED pad, zebra pad, or screw hole pad is not smooth. (Minor)
*Minor if display functions correctly. Major if the display fails.</td><td>See list</td></tr>
<tr><td>11</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. Residue or solder balls.
5. Solder flux is black or brown.
*Minor if display functions correctly. Major if the display fails.</td><td>Minor</td></tr>
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