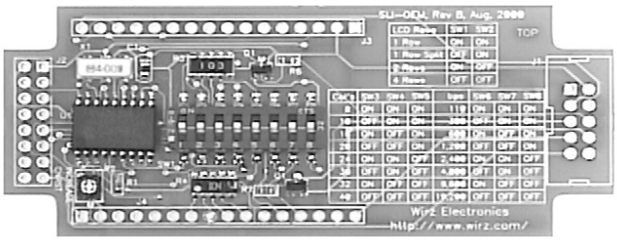
Wirz Electronics

SLI-OEM, Rev B



General Description

The Wirz Electronics' SLI-OEM is the lowest cost and most flexible Serial LCD Interface on the market today. It is designed to provide a simple and fast ASCII interface to a Hitatchi 44780 compatible LCD's while still retaining the ability to interface with all the special functions of the 44780, including custom character generation and cursor movement.

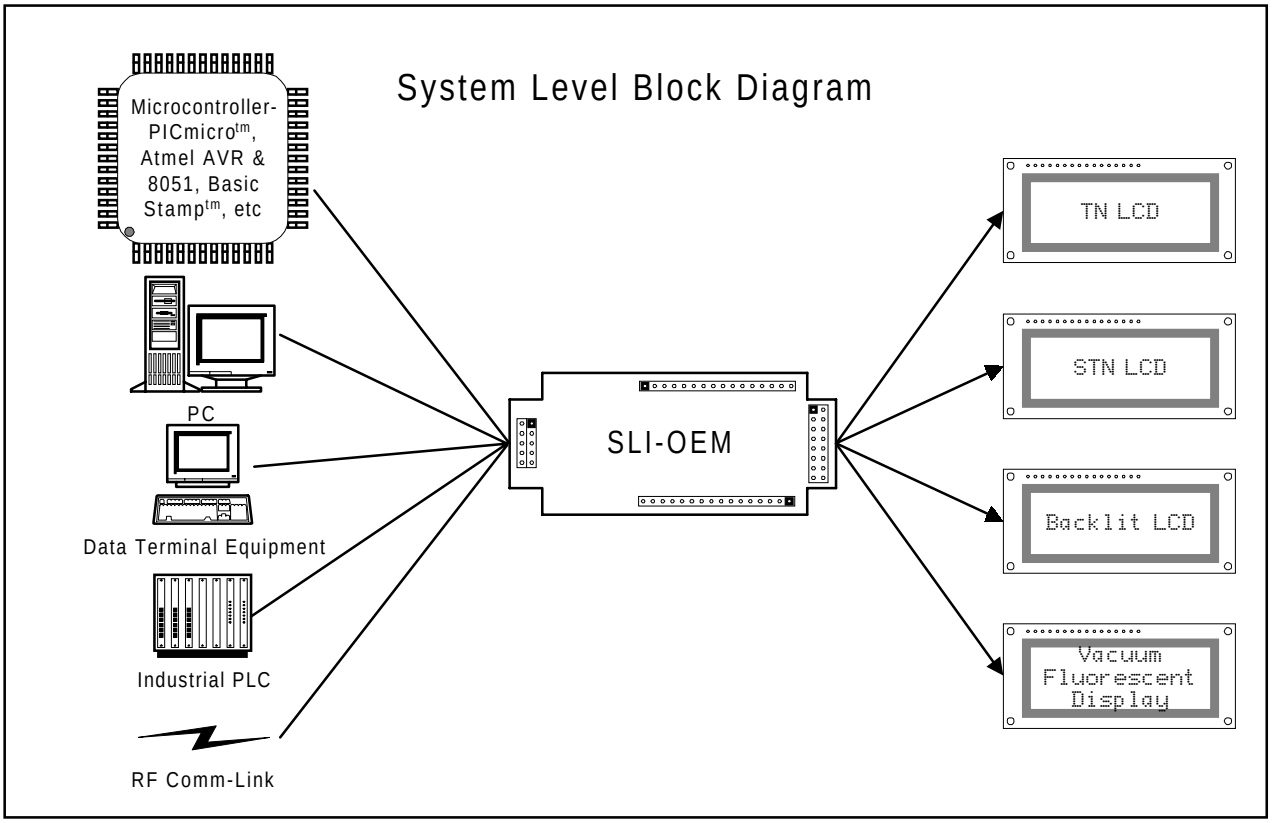
For LCD's with multiple line, horizontal scrolling is automatically supported, thus reducing the development time and memory required to provide this function in the system controller. The asynchronous serial input supports positive or negative TTL and CMOS, as well as RS232 logic levels.

SLI-OEM is a completely assembled module that is manufactured in modern ISO 9002 certified SMT facilities. The customer can purchase our module and add the LCD of their choice or custom units can also be built to the customer's specifications for volume applications.

Features

* Asynchronous Serial Input
* Full DIP switch configuration
* 8 data speeds: 110 to 19,200 bps
* Sixteen byte character buffer
* RS232 and TTL compatible with data polarity detection on power-up
* Allows direct control of the LCD functions
* Serially controlled low side driver for software backlight control
* Complete access to LCD mounting holes
* Designed for all alphanumeric HD44780 controlled LCDs and VFDs
* Many different LCD sizes supported:

One line LCDs: 1 x 8, 10, 16, 20, 24, 30, 32 & 40
Two line LCD's with scrolling: 2 x 8, 10, 16, 20, 24, 30, 32 & 40
Four line by 20 LCD's with scrolling



SERIAL LCD INTERFACE

Specifications

Section	Characteristic	Symbol	Min	Typ	Max	Units
Power Supply	Positive Supply	V_{CC}	4.5	5.0	5.5	V
	Supply Current 1	I_{CC}		2.5		mA
Backlight Supply	Backlight Current 2	I_B			1500	mA
!Out Pin	Sink Current	$I_{!OUT}$			-400	mA
	Pin Voltage	$V_{!OUT}$			20	V
Serial Input	Input Current	I_S				mA
	Bit Rate		110		19,200	bps
	Bit Rate Error				+/-1.5	%
	Character Buffer			16		characters
	Character Protocal			8-N-1		
Positive Logic (TTL or Inverted RS232) 3	Logic Low		-13.0		0.8	V
	Logic High		2.0		13.0	V
Negative Logic (RS232) 3	Logic Low		2.0		13.0	V
	Logic High		-13.0		0.8	V
Miscellanous	Power Up Delay	t_P		110		mS
	Operating Temp 4	T_A	0^o		80	C
	Storage Temp 4	T_S	0^o		80	C

1) Does not include LCD current.
2) The actual current draw of the backlighting is dependent on the particular LCD used. This figure reflects the maximum current handling capability of the module.
3) The serial input data polarity is detected on device power up.
4) The LCD is typically the limiting factor on temperature specifications.

Connectors

J1

Pin#	Function	Pin#	Function
1	V+	2	Vcc
3	V-	4	Gnd
5	!OUT	6	Serial Input
7	V-	8	Gnd
9	V+	10	Vcc

V+ and V- of J1 are directly connected to J2, J3, and J4 for powering backlit LCDs. The pins are passed through and not connected to the SLI circuitry.

J2, J3, & J4

Pin#	Function	Pin#	Function
1	Gnd	2	+5V
3	LCD Contrast	4	R/S
5	R/W	6	E
7	Data Bit 0	8	Data Bit 1
9	Data Bit 2	10	Data Bit 3
11	Data Bit 4	12	Data Bit 5
13	Data Bit 6	14	Data Bit 7
15	V+	16	V-

Dipswitch Settings

Row Setting

LCD Rows	SW1	SW2
1 Row	ON	ON
1 Row Split	OFF	ON
2 Rows	ON	OFF
4 Rows	OFF	OFF

Example Setting: 4 Row by 20 Character LCD at 2,400 bps

Column Setting

LCD Columns	SW3	SW4	SW5
8	ON	ON	ON
10	OFF	ON	ON
16	ON	OFF	ON
20	OFF	OFF	ON
24	ON	ON	OFF
30	OFF	ON	OFF
32	ON	OFF	OFF
40	OFF	OFF	OFF

Baud Rate Setting

Data Rate	SW6	SW7	SW8
110 bps	ON	ON	ON
300 bps	OFF	ON	ON
600 bps	ON	OFF	ON
1,200 bps	OFF	OFF	ON
2,400 bps	ON	ON	OFF
4,800 bps	OFF	ON	OFF
9,600 bps	ON	OFF	OFF
19,200 bps	OFF	OFF	OFF

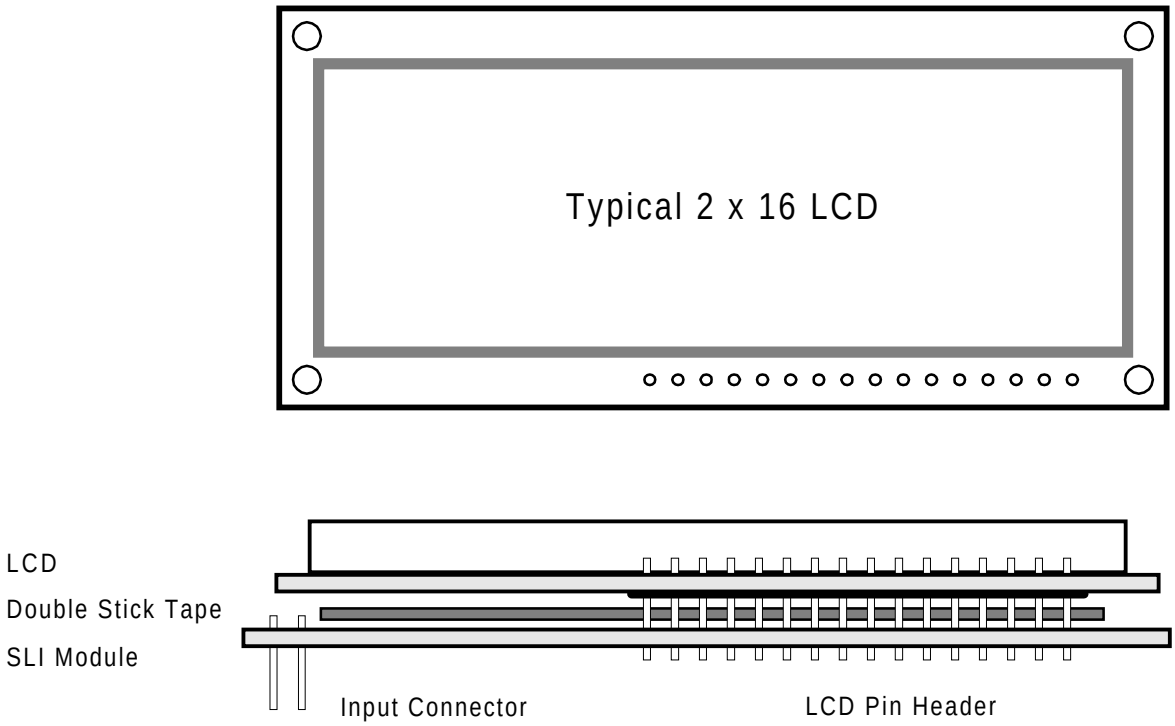
LCD Mounting

The LCD is mounted to the SLI-OEM module using an unshrouded pin header. The header has .025" (.64 mm) square posts on .1" (2.54 mm) centers. Most LCD's require one of 4 header configurations: 1 row by 14 pins, 1 row by 16 pins, 2 rows by 7 pins, or 2 rows by 8 pins. The SLI-OEM supports all four configurations. The SLI module is additionally designed to allow full access to most LCD mounting holes.

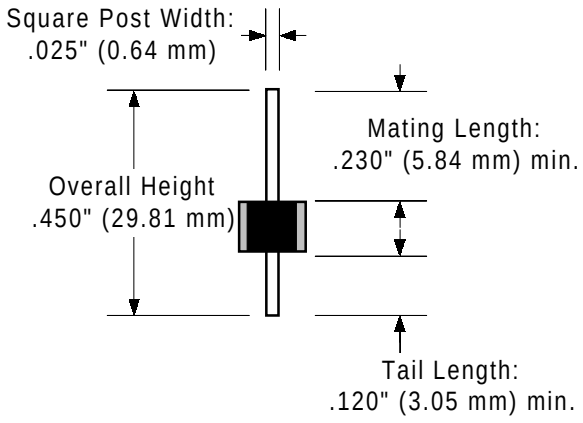
LCD's with 2 x 7 and 2 x 8 header sizes should be mounted at J2. LCD's with 1 x 14 or 1 x 16 headers should be mounted at either J3 or J4 depending on the header's location. The important consideration is to match pin #1 of SLI with pin #1 of the LCD. Pin #1 is denoted with a square pad on SLI.

The SLI-OEM and the LCD are mounted solder side to solder side. The pin header forms the mechanical and electrical connection between the two. A piece of double sided tape should also be placed between the SLI and the LCD for further mechanical strength and insulation.

Mounted LCD (Not to Scale)



Suggested Pin Header Post (Not to Scale)



The Mating Length and Tail Length are suggested minimum values. The Mating Length should be selected based on the thickness of the tape used.

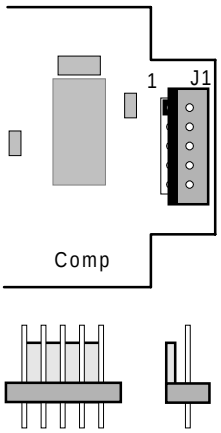
This type of Pin Header is sometimes known as a 'Berg' connector and is now part of 3M's 'Board Mount Interconnect Product' line. See the Appendix for a listing of suggested connectors by manufacturer..

J1 Input Connector Selection:

The SLI-OEM supports several different types of input connectors depending on the user's needs. In addition to power and the serial input, the LCD's backlight may be able to be powered through connector J1. A 2 x 5 pin connector is generally used with a backlit LCD and either a 1 x 5 or 2 x 5 pin connector may be selected for non-backlit LCD's.

1 x 5 Configuration:

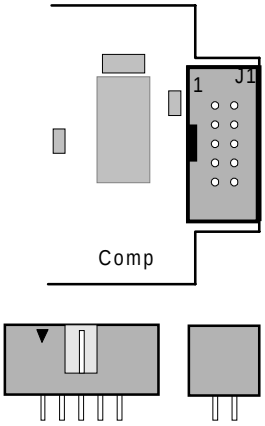
The 1x5 connector provides the most cost effective solution in many cases. When using a discrete wire connector, it is important to install all 5 terminals, even when wires are not connected to each terminal. The extra connectors provide mechanical locking strength to the connection.



Pin#	Function
2	Vcc
4	Gnd
6	Serial Input
8	Gnd
10	Vcc

2 x 5 Configuration:

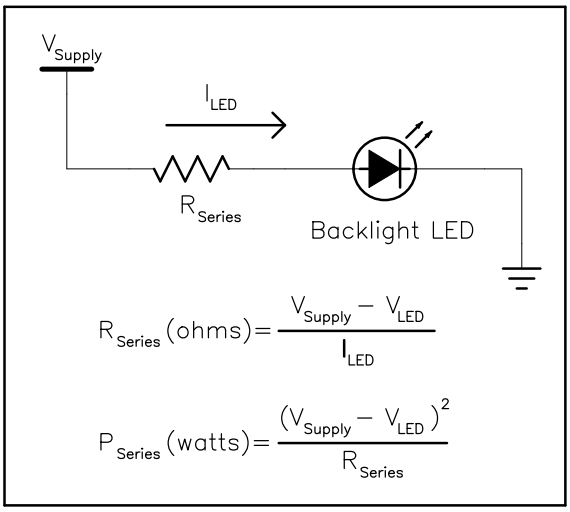
A 2 x 5 configuration has the advantage that connectors are available for both ribbon cable and discrete wires. 2x5 connectors may also have more holding friction and be available with positive locking tabs, thus providing a more secure connection.



Pin#	Function	Pin#	Function
1	V+	2	Vcc
3	V-	4	Gnd
5	!OUT	6	Serial Input
7	V-	8	Gnd
9	V+	10	Vcc

LED Backlit LCD's

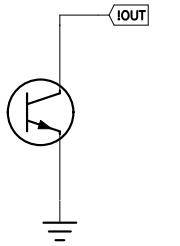
LCD's are available in both backlit and no-backlit configurations. Backlighting enhances readability in low light conditions and is commonly used. There are several different types of LCD backlighting available including LED, EL, and CCFL. The most common and easiest to use method is LED backlighting. EL and CCFL backlit LCD's both require an inverter circuit but are generally more power efficient then LED backlights. An LED backlit LCD has a matrix of light emitting diodes which illuminate the LCD screen and are available in a variety of different colors. By using the V+ & V- pins on the J1 connector, any type of LCD backlighting can be driven with a compatible LCD. Compatible LCD's will have the LCD backlight power brought out to pins 15 & 16 of the LCD connector. SLI-OEM simply passes theses pins through to the J1 connector. Not all LCD manufacturers support backlight powering through pins 15 and 16, the user should verify this with the manufactures data sheet when selecting an LCD.



LED Backlit LCD's must be powered with a constant current supply just as normal LED's do. There are many methods for doing this, the simplest being to simply install a current limiting resistor in series with the LED backlight power supply. The pair of equations given here will aid you in selection of an appropriate series current limiting resistor.

!Out Low Side Driver

Model of !OUT



J1 has a low side driver output which can be used to switch a LCD's Backlight on and off from software control. The Low Side driver could also be used to control an off board LED or other devices within its current rating. Sending an decimal 17 or hex 0x11 enables the !OUT output and decimal 18 or hex 0x12 disables the output.

Electrical Connection:

The SLI-OEM requires a 5 V regulated power supply. If 5 V is not available, it can be produced with a 7805 linear regulator or similar power supply.

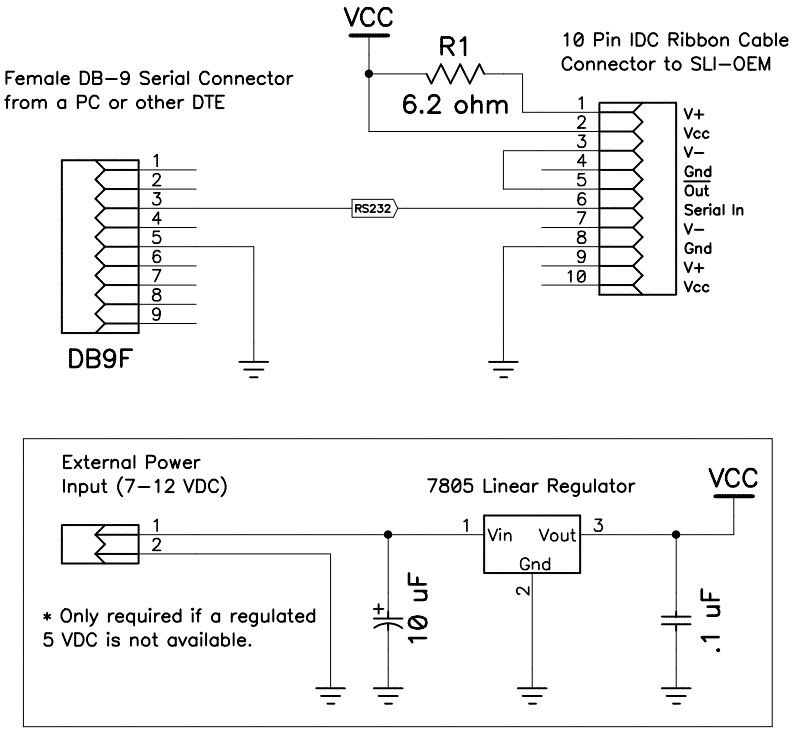
In this wiring example, a Truly Semiconductor MSC-C162DGLY-1N LCD was selected. It is a 2 row by 16 column yellow LED backlit LCD. The Truly data sheet specs a typical LED forward current of 80 mA and a forward voltage of 4.5 VDC-.

Example Wiring Diagram

$$R_{Series} = \frac{V_{Supply} - V_{LED}}{I_{LED}} = \frac{5.0\ V - 4.5\ V}{.080\ A} = 6.25\ ohms$$

$$P_{Series} = \frac{(V_{Supply} - V_{LED})^2}{R_{Series}} = \frac{(5.0\ V - 4.5\ V)^2}{6.20\ Ohms} = .040\ W$$

A 6.2 ohm 1/8 W axial lead resistor soldered in line with the ribbon cable was selected for this application. The resistor can be insulated with heat shrink tubing as needed.



Contrast Control

The contrast of the LCD must be adjusted using the potentiometer R1. The required contrast setting varies from manufacturer to manufacturer and can even vary within the same batch of LCD's. The contrast should be set by turning R1 fully counter clockwise, and then slowly turning it clockwise until the desired level is obtained.

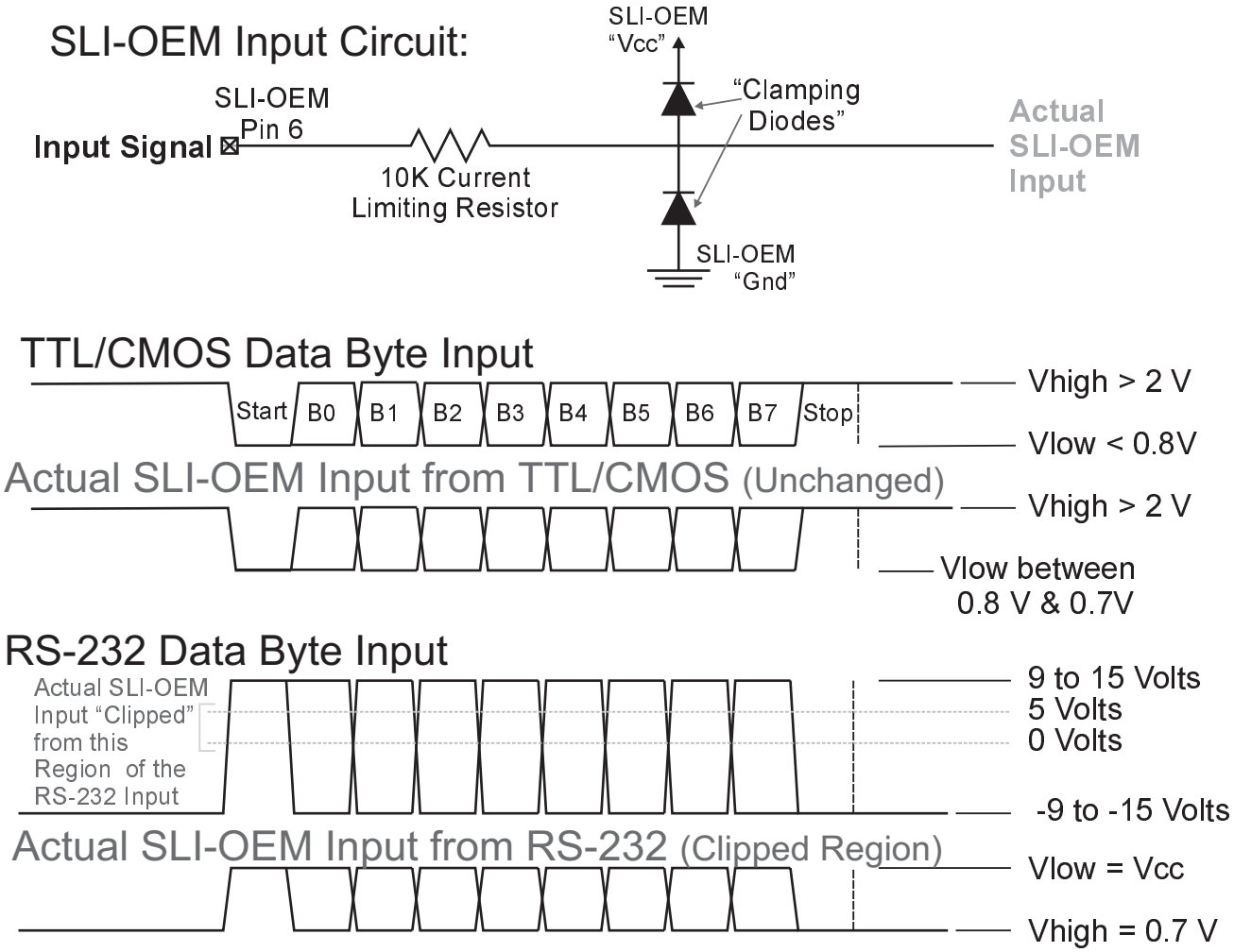
Data Polarity

When no information is beginning sent, an RS-232 transmitter drives an idle state known as a "mark". The mark voltage depends on the polarity of the serial signal. For RS-232, it corresponds to an negative voltage and for a TTL/CMOS input it is a positive voltage. The different types of serial "Inputs" are shown in diagram below to demonstrate how the SLI-OEM processes them.

SLI-OEM will work with both TTL/CMOS RS-232 and inverted RS-232 serial input signal levels. The polarity of the signal is auto detected on power up and the serial input must be its marking state at power up or the polarity may be incorrectly detected.

The SLI-OEM Input Circuit (shown in the diagram below) will "clip" the voltage levels of the incoming signals to Vcc (power input) and to Ground plus 0.7 Volts. This simple circuit allows both RS-232 as well as TTL/CMOS voltage level signals to be accepted without any additional hardware.

SLI-OEM Automatic Polarity Detection



In the case of a microcontroller that is directly connected to the SLI-OEM, the application designer must verify that the serial input is in its marking state at power up. This note has been made because the SLI-OEM checks data input polarity 75 mS after power up and many microcontrollers take longer than this to initialize. If the microcontroller's I/O pins are configured as inputs or tristated on power up, a pull-up resistor is recommended to drive the SLI-OEM input to a "high" voltage marking state until the microcontroller is able to drive a marking voltage.

SLI-OEM Power Up Sequence

The SLI-OEM executes the following power up sequence of events before it can be written to by a controlling device:

Time	Length	Event Description
0 mS	75 mS	Hitachi 44780 LCD and built in Microcontroller power up and initialization. At this point, the 44780 is initialized into a single line mode.
75 mS	20 mS	The DIP Switch and the "mark" polarity are read by the microcontroller and the initial configuration of the 44780 takes place.
95 mS	6 mS	LCD Character memory is cleared and the LCD is put into the default state. At this point, the SLI-OEM is receiving and storing data.
101 mS	N/A	SLI-OEM is operational and ready for serial input.

* Note that any data sent to the SLI-OEM will be ignored until roughly 95 mS into its power up sequence.

Data Protocol

SLI-OEM accepts an ASCII formatted 8-N-1 serial stream with a speed of 110 to 19,200 bps. 8-N-1 refers to the protocol with which the data is encoded. It means 8 data bits, no parity bit, and 1 stop bit. The data format can be seen in the previous diagram and is standard for modern serial communications.

The period of each data bit is the reciprocal of the data speed (i.e. 1200 bps is 833.3 uS per bit). The speed is set by the onboard dip switch and changes to the dip switch will only take effect when the SLI-OEM's power is cycled on and off.

Software Interface Overview

For basic operation, there are very few software requirements imposed by SLI-OEM. For the most part, a user can simply send it an ASCII formatted serial stream and the text sent will be displayed on the LCD. As an example, a user can run a Terminal Program on a PC and whatever is typed at the keyboard will appear on the LCD assuming the speed, parity, and stop bits are correctly configured and the display is properly connected. SLI-OEM implements vertical and horizontal scrolling as well as supporting cursor movement as a standard terminal would.

SLI-OEM also supports direct LCD commands which are useful for implementing advanced features such as turning the cursor off, moving the cursor to a specific location, or clearing the screen. The majority of basic interfacing can be accomplished with simple ASCII characters but you will find direct commands particularly useful for cursor movement and working with custom characters.

Basic Pseudo Code Example

The following basic Pseudo code example initializes the microcontrollers UART and then prints "Hello World" on the LCD.

```
Begin:
    output_high (serial_pin)        //Serial output high to ensure correct polarity detection
    setup_UART(2400, 8N1)           //Setup the microcontroller UART
    delay(110 mS)                   //Wait the Power Up Delay
    print("Hello World")            //Send the text to be displayed on the LCD
```

Scrolling

SLI-OEM is unique among Serial LCD Controllers in that it implements correct Vertical and Horizontal Scrolling. Horizontal Scrolling means that as characters are received the cursor is moved one position to the right for each received character. Vertical Scrolling means that if the cursor reaches the end of the row on the bottom line of the display that the current row is shifted up one row and the cursor is moved to the first character in the bottom row. If the cursor is not on the bottom row the cursor will be moved to the first character of the next row down. A vertical scroll can also be forced by sending an Carriage Return <CR> or Line Feed <LF>. If both characters are sent to the SLI-OEM, the display will only scroll up one character. SLI-OEM handles vertical and horizontal scrolling the same as a standard serial terminal does.

SLI-OEM Character Set

The ASCII character set defines 128 characters, 0 to 127 decimal or 0x00 to 0x7F hexadecimal. Characters 0 to 31 are non-printing control characters and characters 32 to 127 are printing characters which will display on the LCD when received. Characters 128 to 255 are Japanese language and special characters.

The first 32 characters are non-printing control characters, such as Return and Line feed. These characters are generated by the host software for character movement and special functions for use with SLI-OEM. You can generate these characters in a terminal program by holding down the Control key while striking another key. For example, Form Feed is decimal 12 or Control plus L, shown in the table as ^L.

ASCII Control Characters

Char	Dec	Hex	Control-Key	Control Action
NUL	0	0	^@	User defined character #1
SOH	1	1	^A	User defined character #2
STX	2	2	^B	User defined character #3
ETX	3	3	^C	User defined character #4
EOT	4	4	^D	User defined character #5
ENQ	5	5	^E	User defined character #6
ACK	6	6	^F	User defined character #7
BEL	7	7	^G	User defined character #8
BS	8	8	^H	Backspace
HT	9	9	^I	N/A
LF	10	a	^J	Line Feed - End Line
VT	11	b	^K	N/A
FF	12	c	^L	Form Feed - Clear Screen
CR	13	d	^M	Carriage Return - End Line
SO	14	e	^N	N/A
SI	15	f	^O	N/A

Char	Dec	Hex	Control-Key	Control Action
DLE	16	10	^P	N/A
DC1	17	11	^Q	!OUT Enable (Backlight On)
DC2	18	12	^R	!OUT Disable (Backlight Off)
DC3	19	13	^S	N/A
DC4	20	14	^T	N/A
NAK	21	15	^U	N/A
SYN	22	16	^V	N/A
ETB	23	17	^W	N/A
CAN	24	17	^X	N/A
EM	25	19	^Y	N/A
SUB	26	1a	^Z	N/A
ESC	27	1b	^[	N/A
FS	28	1c	^\	N/A
GS	29	1d	^]	N/A
RS	30	1e	^^	N/A
US	31	1f	^_	N/A

Direct LCD Control

Commands can be sent directly to the HD44780 controller by first sending a 0xFE or 254d character to the SLI. The next command will be passed directly to the HD44780 as an instruction (not data to be displayed). 0xFE or 254d should never be sent to the SLI as data.

This method of sending control data to the SLI must be used with caution. The commands are not parsed, and the internal variables in the SLI controlling the behavior of the LCD (i.e. scrolling, backspacing, etc.) are not always updated. This may lead to unexpected results after sending data.

Before moving the cursor explicitly, it is recommended that either a Form Feed or Carriage Return is sent to the SLI to ensure that any subsequent data writes do not cause an inadvertent scroll of the display.

A detailed table of the instructions can be found in the Hitatchi HD44780 data sheet, a selection of these are shown in the following table.

Selected Direct LCD Instructions

Instruction	Bits	Comment
Clear Display	0000 0001	Sending a Form Feed (0x0C) will do exactly the same command. The internal SLI cursor position will be updated.
Return Home	0000 001x	Sending this instruction will also update the internal SLI cursor position.
Entry Mode Set	0000 01IS	Sets the cursor move direction and specifies whether or not to shift the display. This command should not be used because it may cause the internal SLI characters to be incorrect.
Display Control	0000 1DCB	Turns on/off the LCD display and cursor. The cursor display can be changed, but it is not recommended that the LCD Display ever be shut off.
Curs/Disp Shift	0001 SRxx	Allows moving the cursor and shifting the display without changing the LCD display RAM contents. Although the cursor position is updated this command is not recommended.
Function Set	001D Nfxx	Initializes the display and sets the interface length. This command is not recommended.
Set CG RAM Addr	01pp pppp	Allows the user to start writing at a specific location in CG RAM. After this command, a “Set DD Addr” command should be executed.
Set DD RAM Addr	1ppp pppp	Allows the user to move the cursor anywhere on the LCD. The internal SLI cursor position is updated after this command. Note that the top line starts at 0 and the bottom line starts at address 0x40. Up to 40 characters on each line can be written.

Example Direct LCD Control Operations

Move the Cursor to the First Line:

Send 0xFE
Send 0x80 //Add 0 - 39 to put cursor at different columns of the line

Move the Cursor to the Second Line:

Send 0xFE
Send 0xC0 //Add 0 - 39 to put cursor at different columns of the line

Clear the Screen:

Send 0xFE
Send 0x01

User-Definable Characters

The SLI-OEM provides for up to 8 user defined characters. Each of these characters can be displayed on the screen using Hex Codes 0x00 through 0x07. They are actually infrequently used ASCII Control Characters.

Each character is setup as an 8 x 5 pixel box, requiring 8 bytes of data in the CG RAM Area. Each byte is a row in the box. The top most row being the lowest address. Accessing the CG RAM from DD RAM, which contains the Hex/ASCII Codes for each character, is accomplished by moving the cursor into the CG RAM area by the instruction 0b001xxxxxx. "xxxxxx" is the address within the CG RAM. The address of the 8 Row Bytes in CG RAM starts at 8x the character address. If the Character Graphic RAM is being written to and the Escape, CR, LF, FF, & BS commands are sent. The SLI may behave unpredictably. OR'ing 0x20 to all the CG data writes guarantees this will never happen.

For example, to make custom character 0x02 a "\", which isn't in the LCD Character Set, the following sequence of instructions would be sent:

```
Send( 0xFE )                          ; Move the Cursor into the CG RAM Area
Send( 0x40 plus 8 plus 8 = 0x50 )     ; for Character 2
Send( 0x10 OR 0x20 = 0x30 )           ; Slash: X _ _ _ _
Send( 0x10 OR 0x20 = 0x30 )           ;        X _ _ _ _
Send( 0x08 OR 0x20 = 0x28 )           ;        _ X _ _ _
Send( 0x04 OR 0x20 = 0x24 )           ;        _ _ X _ _
Send( 0x02 OR 0x20 = 0x22 )           ;        _ _ _ X _
Send( 0x01 OR 0x20 = 0x21 )           ;        _ _ _ _ X
Send( 0x01 OR 0x00 = 0x21 )           ;        _ _ _ _ X
Send( 0x00 OR 0x20 = 0x20)            ;        _ _ _ _ _
Send( 0xFE )                          ; Move Cursor Back to Start of DD RAM Area
Send( 0x80 )
```

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1. Life support devices or systems are those which (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform properly can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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Using SLI-OEM with a PC Terminal Emulator

SLI-OEM can be rapidly tested using a PC, Terminal Emulator Program, and simple adapter cable. Controlling SLI-OEM from a PC not only allows verification of proper electrical operation and LCD compatibility but it also lets the user quickly experiment with SLI-OEM's software interface. A sample wiring diagram is included in the data sheet for making this connection. HyperTerminal is the Terminal Emulator Program which has been included with all recent versions of the Microsoft Windows operating system. While there are literally hundreds of terminal emulators available, our examples here will focus on HyperTerminal while including generic information on setting up the other emulators.

Terminal Setup

The Terminal Program must be set to the correct serial data rate, format, and to a free serial port on the PC. Most PC's include one or more Serial Port's known as COM1, COM2, etc. The ports are generally brought out with DB-9 or DB-25 connectors on the back of the PC. If you have an external modem it may already be connected to one of these ports.

Start by configuring the serial connection with the following settings:

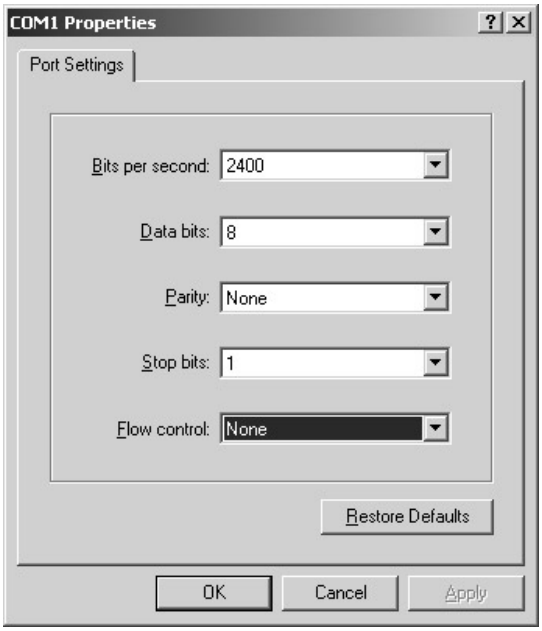
Data Rate: 2,400 bits per second
Data Bits: 8
Parity: None
Stop Bits: 1
Flow Control: None

1) Start HyperTerminal and make a new Connection.
2) Set the Connection Method to Direct to COM1 or COM2 based on your free port.
3) Change the Port Settings as listed above.

These settings can be changed at a latter time through the Properties option in HyperTerminal. If they are changed it is important to Disconnect and Reconnect the port so the changes are applied. There are several other configuration options which won't effect basic operation but you may want to turn on the Local Echo function which will cause everything sent to the SLI-OEM to be also printed in the Terminal Window.

Once the SLI-OEM is connected, characters typed in the Terminal Window will be displayed on the LCD Screen. The terminal is limited to ASCII character generation. A user could not program a custom character for example but most basic commands can be generated with the Terminal Program.

HypterTerminal Port Settings



HyperTerminal Window