Locus Engineering Inc. E1832/3

Alphanumeric LCD Display Switch Interface

FEATURES

- simple 3 pin serial LCD interface; clock, data, enable
- allows fast byte writes to standard alphanumeric LCD display
- contrast potentiometer for LCD
- user selectable backlight current limiting resistor
- two tactile switches with pullups
- standard and reverse 16 pin LCD pinout
- CMOS/TTL compatible inputs
- 2.0V to 5.5V operation
- 1.6” x 0.8” size

DESCRIPTION

The E1832 E1833 Alphanumeric LCD Display Switch Interface uses only 3 microcontroller pins to write bytes to a standard character LCD and 2 pins to read two tactile switches such as for Select and Enter functions, making it a simple user interface for small microcontrollers where few port pins are available. LCD instructions or data are sent serially as eight data bits plus the Register Select bit where they are converted to parallel format at the LCD connector. A single pulse on the LCD Enable completes the write. The board is available is standard and reverse pinouts to accommodate either LCD connector pinout placement.

APPLICATIONS

- microcontroller user interfaces
- industrial controls
- robotics

Table 1. Absolute Maximum Ratings

Parameter	Rating
Input Voltage to GND	-0.3 to +7.0V
Operating temperature range	-40 to +85°C
Storage temperature range	-65 to +150°C
Maximum output current	+/-25mA

Table 2. Electrical Characteristics

Test Conditions: Supply Voltage V_{dd} = +5.0V, $T_{ambient}$ = 25° C, unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{dd}	Supply voltage	2.0	5.0	5.5	V
I_{dd}	Supply current, no LCD		1.1		mA
V_{IH}	Digital high input voltage	0.7Vdd			V
V_{IL}	Digital low input voltage			0.3Vdd	V
V_{OH}	Digital high output voltage			Vdd	V
V_{OL}	Digital low output voltage	0			V
T_{su}	Data setup time before clock	8.5			nsec
T_h	Data hold time after clock	0			nsec
F_{max}	Maximum clock rate			45	MHz
W_{ch}	Character write time		60		µsec

General Precautions

Charged devices and circuit boards can discharge without warning. Proper ESD precautions should be followed to avoid failure.

This device is not authorized for use in any product where the failure or malfunction of the product can reasonably be expected to cause failure in a life support system or to significantly affect its operation. Locus Engineering Inc. reserves the right to make changes at any time without notice to improve product features or reliability.

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Power Supply

The E1832/3 module will operate from voltages between +2.0V to +5.5V, and uses approximately 1mA of current when both switches are closed. The LCD uses additional current as well if the backlight is used. The microcontroller driving the E1832/3 module should operate from the same supply voltage as the LCD to prevent logic level incompatibilities.

Digital I/O

The microcontroller pins driving the LCD interface SD (Serial Data), SK (Serial Clock), and LE (LCD Enable) should be set to push-pull. If these pins are set to open-drain, the timing waveforms will not be correct. The LCD interface signals are all active high. The microcontroller pins monitoring the Select and Enter switches should be set to open-drain inputs. The switches produce an active low output when pressed, otherwise the 10K pullup resistors keep the switch outputs high.

LCD Reset

The LCD module should be initialized as per the manufacturer's recommendations. In addition, wait 100msec following power-up before initializing the LCD to ensure a proper reset.

LCD Contrast

A potentiometer allows the display contrast to be set using a fine blade flat screwdriver.

LCD Backlight

Check the manufacturer's datasheet for the backlight characteristics. The module has two through-hole pads for a backlight resistor. The backlight resistor can be calculated from the supply voltage V_{DD}, the LED forward voltage V_{LED}, and the LED current I_{LED} as follows:

$$R_{bl}=(V_{dd}-V_{led})/I_{led}$$

For example, for V_{dd}=3.3V, V_{led}=3.0V, I_{led}=15mA, then R_{bl}=20Ω

The backlight resistor wattage should be rated at least 2x (V_{dd}-V_{led}) x I_{led}, in this case 9mW, so a 1/16W or 1/8W can be used.

Select & Enter Key Switches

The two tactile keyswitches on the E1832/3 module are pulled up to Vdd but are not debounced. For applications requiring key switching with no contact bounce, a variety of debounce methods are available.

Mechanical

The module measures 1.6"L0.8"H. The header connectors are 0.6" apart. The switch centers are 1.25" apart.

Table 3. Microcontroller Interface Pin Descriptions

Pin#	Name	Function
1	0V	Ground
2	V+	+2.0V to +5.5V
3	SD	Serial data, 8 bits + register select bit
4	SK	Serial clock, 8 pulses, 40MHz maximum
5	LE	LCD enable pulse, active high, typically 3µsec
6	SL	Select switch, active low with 10K pullup to V_{DD}
7	EN	Enter switch, active low with 10K pullup to V_{DD}

Table 4. LCD Interface Pin Descriptions

Pin#	Name	Function
1	0V	Ground
2	V+	+2.0V to +5.0V
3	VC	Contrast voltage adjusted by trimpot
4	RS	Register Select, low for commands, high for data
5	RW	Read/$\overline{\text{Write}}$ internally tied low for writes only
6	LE	Latch Enable active high pulse after data D0-D7 and Register Select are loaded
7-14	D0-D7	Data, 8 bits
15	L+	Backlight LED anode
16	L-	Backlight LED cathode

Module Operation- LCD Interface

Most alphanumeric displays have a parallel data interface based on the HD44780 LCD driver or equivalent. These displays have either 14 or 16 pins depending on the presence of a LED backlight which uses the last two pins. Of these pins, 11 signal lines are needed to communicate instructions or character data. To reduce the microcontroller port pin count, the E1832/3 display interface converts serial data from the microcontroller to parallel data at the LCD using only 3 pins at the microcontroller side. The typical module connection is as follows, however if it is different from your LCD, simply connect the pins according to function rather than by pin number.

The alphanumeric LCDs have a pair of module power pins 0V and V+, a contrast input VC, eight data pins D0-D7, a register select input RS for instruction write or character write, a read/$\overline{\text{write}}$ input RW, an enable input E, and optionally a pair of LED backlight power pins L+ and L-. LCD module power is usually +3.3V or +5.0V, and the contrast voltage is set between the supply voltage and ground using the contrast potentiometer on the E1832/3 module. The eight data pins are used for writing instruction or character data depending on the state of the register select input. As the LCD will be written to only, the RW line is internally grounded on the E1832/3 module. Once the eight data bits and register select line to the LCD are stable, the enable line is pulsed which executes the write function.

Module Selection and Connections

The E1832/3 module allows a simple connection to any alphanumeric character LCD on a protoboard. Use a 7 pin male-male header for the input side, and a 14/16 pin header on the LCD side. For the most common LCDs with the 14/16 pin connection at the top of the display, use the E1833 module. The E1833 can also be mounted behind this display. Use the E1832 for LCDs with the 14/16 pin connection at the bottom of the display.

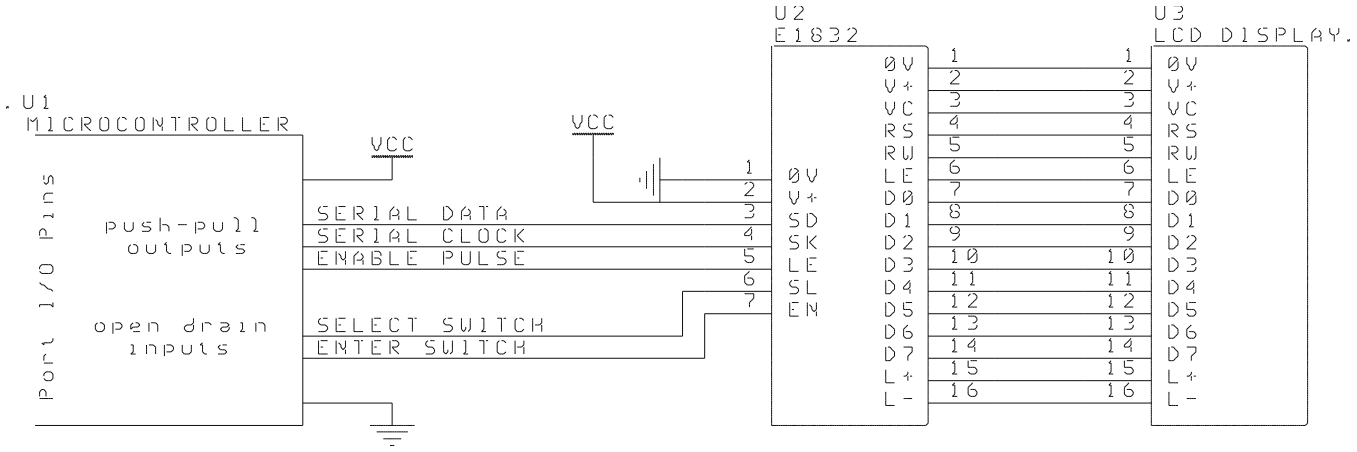

Figure 2. E1832/3 Module Connection

Figure 3. E1833 Breadboard Connection

LCD Interface Timing

The timing and signal states timing is provided in Figure 4. The microcontroller port pins are set high or cleared low according to the timing diagram. In detail, a byte is shifted serially out of a port pin, most significant bit D7 first to the serial data input SD of the E1832/3 module. For each of the D7-D0 bits, another port pin to the module clock input SK is pulsed which shifts the serial data into the serial to parallel shift register on the E1832/3 module. Following the eight bits D7-D0, the register select bit is sent; this bit tells the LCD whether the byte represents character data or an instruction. Note that there is no clock pulse for this 9th bit. At this point, the byte is available at the LCD module as well as the register select setting. Following a short 3µsec delay, a 3rd port pin to the module enable input LE is pulsed active high for 3µsec to load the LCD data and register select information and start the operation. Most LCD operations such as character writes and character placement require about 40µsec after the LE pulse to complete before the next operation can start. LCD initialization instructions such as resetting and homing the cursor can take several milliseconds. Check the LCD datasheet and add sufficient timing margin (1.5x to 2x) to ensure stable operation.

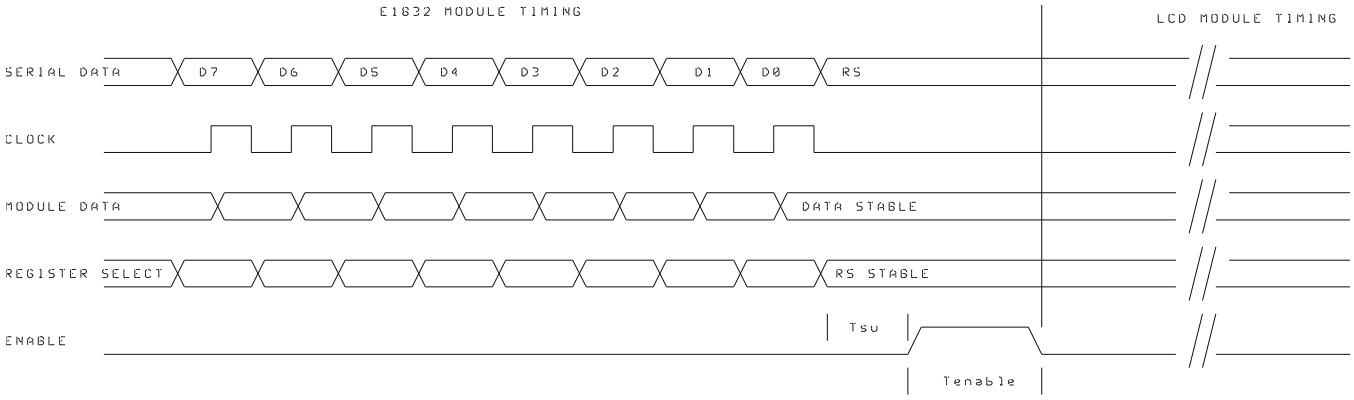

Figure 4. E1832/3 Signal Timing

The timing information presented is typical, however check the LCD module's characteristics to ensure that the timing requirements are met, otherwise there will be missing characters or erratic operation. The serial data to the E1832/3 module can be clocked in at up to 45MHz to load the serial to parallel shift register with the data bits D7-D0 and the register select bit. Following this, a short setup time T_{su} of a few µsec is required before pulsing the enable line active high for a period T_{enable} of a few µsec. Even with the LCD module being busy for several tens of microseconds for each operation, character writes can be done up to 16,000 characters per second. A complete update of a four line by 20 character display would take about 5msec assuming 60µsec per character. The serial interface has minimal impact on LCD update rates while reducing port I/O requirements with only a small amount of additional coding.

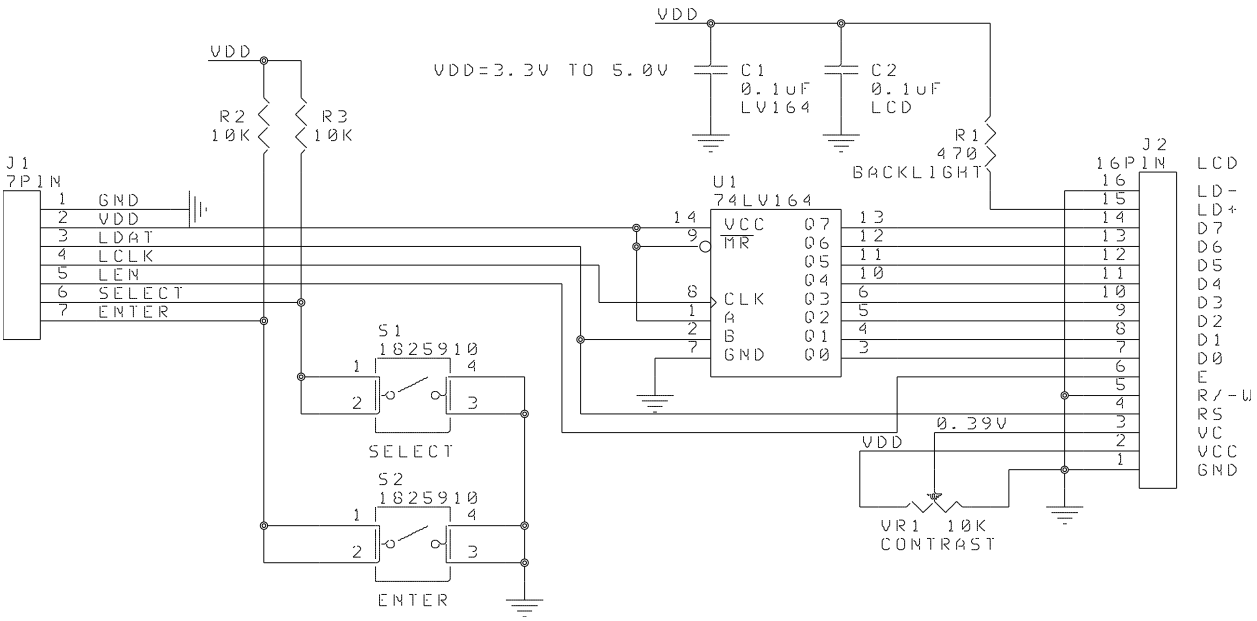

Figure 5. E1832/3 Schematic