Serial LCD 4

by Rho Enterprises

Features

- Accepts 24 character by 2 line display module with other sizes selectable
- Serial input and output are TTL level signals connectable to RS-232
- Four push button switches send ASCII codes
- Accepts power input of 6 volts to 12 volts DC at about 5ma without backlight on and about 50ma with backlight
- Separate switches for power and backlight power
- A single input/output pin accessed serially
- Piezo beeper for bell sound and button clicks
- Single PC board that parts for separate display and keyboard assemblies
- Uses PIC16C84 microcontroller with EEPROM setup storage

Bill of Material

Item	Qty	Description	Ref desig
1	1	BOARD, SERIAL LCD	-
2	3	CAP, MONO .10UF 50V	C1,2,7
3	4	CAP, ELECT 22UF 25V, SHORT	C3,4,5,6
4	1	CONN, BATTERY CLIP, 9V	J1
5	1	CONN, HEADER 2 PIN, SINGLE, STRAIGHT	J5
6	1	CONN, HEADER 3 PIN, SINGLE, FEMALE	J4
7	1	CONN, HEADER 3 PIN, SINGLE, STRAIGHT	P4
8	1	CONN, HEADER, 14 PIN, FEMALE	J3
9	1	CONN, HEADER, 14 PIN, STRAIGHT	P3
10	1	CONN, MOLEX 4 PIN	(J7 OPTIONAL)
11	1	CONN, PHONE, JACK, 3.5MM, STEREO, PC	J2
12	6	DIODE, HSS, 1N4448	D1,2,3,4,5,6
13	1	DISPLAY, LCD, 24X2	DSP1
14	1	IC, PROG, PIC16C84 4MHZ, SERLCD4	U1
15	1	IC, REGULATOR, LM2931AZ-5.0, TO-92	U2
16	1	JUMPER, 2 INCH X .1 SPACE X 5 COND	J6
17	2	RES 330 OHM, 1/4W, 5%	R5,7
18	1	RES 33K, 1/4W, 5%	R4
19	2	RES 180K, 1/4W, 5%	R2,3
20	1	RES, VAR 20K, TOP, CHEAP	R1
21	1	SOCKET, DIP, 18 PIN	(U1)
22	4	SWITCH, PUSHBUTTON, N.O., RND	S3,4,5,6
23	2	SWITCH, TOGGLE, SPDT, PC, HORIZ, R.A.	S1,2
24	1	TRANSDUCER, BEEPER, PZT, 4KHZ, PC	SP1
25	1	XTAL, CERAMIC RESONATOR, 4MHZ	Y1

Assembling and testing the Serial LCD 4 Starter Kit

Getting started

Before you solder any parts into the Printed Circuit Board (PCB), some decisions and preparations must be done. Read this entire set of instructions before starting any assembly.

First decide if the Serial LCD 4 is to be a stand alone terminal.

If the Serial LCD 4 is in a case with a battery and connects by an external phone cable to the other RS-232 device it should be assembled as a stand alone terminal. See the section “Assembling and testing the stand alone terminal” for the details on how to do this.

If the Serial LCD 4 is wired inside another assembly using its regulated power supply then it is should be assembled for embedded use. See the section “Assembling and testing the embedded terminal” for the details to do this.

Also see the section titled "Options" for other variations of the Serial LCD 4.

Assembling and testing the embedded terminal

Decide if you want to detach the switch PCB assembly from the display PCB assembly. The instructions assume that you will separate the two.

You will also need to make a cable to connect power and the RS-232 signals to J7 of the Serial LCD Terminal for testing.

Assembling the embedded terminal

1. Preparing the LCD module

Be careful not to get solder or flux on the display.

Solder the 14-pin straight header connector to the back side of the LCD module. The connector should mount on the opposite side of the board from the display.

The 3-pin header goes into the two holes are at the far end of the board from the 14-pin header. Remove the center pin from the 3-pin SIP header and solder it into the two backlight holes from the side of the board away from the display. This is the same side of the board as the 14-pin header. (Displays without a backlight may not have holes to install this connector).

2. Push button switch assembly

The switch portion of the PCB is normally separated from the display section of the PCB. This is done because the switches are too short to extend beyond the height of the LCD module enough to reach through the front panel. The display section is mounted on different length spacers than the switch section.

An alternate way is to leave the PCB as one piece and extend the height of the push button switches. This can be done by sticking some adhesive mount rubber feet on the tops of the switches. 3M makes Bumpons that are 0.5″ diameter by 0.14″ tall. Try using one or two on top of each switch to get the desired height.

To break the switch section away from the display section of the printed circuit board, bend and tear along the lines of holes.

Install the diodes and push button switches into the switch part of the PCB.

3. Assembly of the display section

The toggle switches (S1 and S2), the regulator (U2), the battery connector (J1) and the stereo phone jack (J2) are not used in the embedded terminal. Pull them from the kit.

Set aside the LCD module and the PIC microcontroller (U1) for later assembly. If the display does not have a backlight then also set aside resistors R8 and R9, they are not used.

Install the parts, that were not set aside, onto the display section of the PCB. Use the bill of material and the silkscreen on the board.

Double check the orientation of the diodes, capacitors and regulator IC.

The potentiometer (R1) may be either 10K or 20K ohms. If the holes for the pot are oversized then use extra care to get good solder joints.

Install jumpers in place of Switches S1, S2 and U2 (the regulator):

Solder the S1 and S2 jumpers between the pads that have traces and solder the U2 jumper from “I” to “O” on U2.

4. Connecting the two PCB assemblies together

The jumper cable is installed on the circuit side of the PCB. Insert the jumper cable into the display section of the PCB from the circuit side of the board leaving about 1/16″ of the wire exposed for soldering.

Solder the leads to the pads being careful not to melt the insulation of the jumper cable. The jumper cable is very brittle and flexing it more than a few times will break the wires.

The jumper cable is soldered on the circuit side of the switch section of the board just like was done on the display section. Again leave about 1/16″ of exposed wire to allow soldering to the PCB pads. Use care when moving the unmounted PCB assemblies around since this applies stress to the jumper cable.

5. Testing the embedded LCD terminal

Center the adjustment of the pot.

Connect a 5 volt power supply to J7, the 4 pin Molex connector, with +5 volts to pin 4 and ground to pin 1.

Turn on the power and test for +5 volts on the IC socket. Pin 5 is ground and pin 14 is +5 volts.

Turn off the power and plug in the PIC microcontroller (U1). Pin 1 should be by C7 and J2.

Plug in the LCD module. Make sure that all the pins are aligned on both connectors.

Verify that there is about 9 volts across the outside contacts of the potentiometer.

Adjust the pot until black squares are just visible on the display.

Turn off the power.

While holding one of the push buttons switches pressed, turn on the power.

When the button is released, the display will show “Rho Enterprises” for an instant and then show the present display size setting. Use the second button from the right to select the display type you have installed.

Press the rightmost button until a Baud rate is shown. Use the second button from the right to select 1200 Baud. Press the rightmost button to accept this Baud rate.

Connect the computer RS-232 port to J7 of the Serial LCD Terminal for testing. See the schematic for the pinouts of the connectors.

Test the operation of the display at 1200 Baud, 8 bits, 1 stop bit.

Note that at speeds faster than about 2400 Baud, characters can be lost during carriage returns, line feeds and form feeds. Pad characters (Nul's) can be used to allow faster Baud rates.

Assembling and testing the stand alone terminal

Decide if you want to detach the switch PCB assembly from the display PCB assembly. The instructions assume that you will separate the two.

You will also need to make a cable to connect from a computer RS-232 port to the Serial LCD Terminal for testing.

Assembly of the stand alone terminal

1. Preparing the LCD module

Be careful not to get solder or flux on the display.

Solder the 14-pin straight header connector to the back side of the LCD module. The connector should mount on the opposite side of the board from the display.

The 3-pin header goes into the two holes are at the far end of the board from the 14-pin header. Remove the center pin from the 3-pin SIP header and solder it into the two backlight holes from the side of the board away from the display. This is the same side of the board as the 14-pin header. (Displays without a backlight may not have holes to install this connector).

2. Push button switch assembly

The switch portion of the PCB is normally separated from the display section of the PCB. This is done because the switches are too short to extend beyond the height of the LCD module enough to reach through the front panel. The display section is mounted on different length spacers than the switch section.

An alternate way is to leave the PCB as one piece and extend the height of the push button switches. This can be done by sticking some adhesive mount rubber feet on the tops of the switches. 3M makes Bumpons that are 0.5″ diameter by 0.14″ tall. Try using one or two on top of each switch to get the desired height.

To break the switch section away from the display section of the printed circuit board, bend and tear along the lines of holes.

Install the diodes and push button switches into the switch part of the PCB.

3. Assembly of the display section

The 4 pin Molex connector (J7) is not used in the stand alone terminal. Pull it from the kit.

If the display does not have a backlight then also remove one of the toggle switches (S1 or S2) and resistors R8 and R9, they are not used.

Set aside the battery clip, the LCD module and the PIC microcontroller.

They are not assembled to the PCB yet.

Install all the parts, that were not set aside, onto the display section of the PCB according to the bill of material and the silkscreen on the board. Make sure to install toggle switch S1 if only on one toggle switch is used.

Double check the orientation of the diodes, capacitors and regulator IC.

The potentiometer (R1) may be either 10K or 20K ohms. If the holes for the pot are oversized then use extra care to get good solder joints.

To install the battery clip, use the hole on the far side of J4 as a strain relief. Feed the wires of the battery clip through the hole from the circuit side of board and then over to the pads for J1. Solder the red wire into the pad labeled”+” and the black into the pad labeled “-”.

4. Connecting the two PCB assemblies together

The jumper cable is installed on the circuit side of the PCB. Insert the jumper cable into the display section of the PCB from the circuit side of the board leaving about 1/16″ of the wire exposed for soldering.

Solder the leads to the pads being careful not to melt the insulation of the jumper cable. The jumper cable is very brittle and flexing it more than a few times will break the wires.

The jumper cable is soldered on the circuit side of the switch section of the board just like was done on the display section. Again leave about 1/16″ of exposed wire to allow soldering to the PCB pads. Use care when moving the unmounted PCB assemblies around since this applies stress to the jumper cable.

5. Testing the stand alone terminal

Center the adjustment of the pot.

Turn off the switches.

Connect the 9-volt battery.

Turn on power switch S1. This is the switch near the center of the PCB.

Leave the backlight power switch off.

Test for +5 volts on the IC socket. Pin 5 is ground and pin 14 is +5 volts.

Turn off the power and plug in the PIC microcontroller (U1). Pin 1 should be by C7 and J2.

Turn on the power and verify that there is about 9 volts across the outside contacts of the potentiometer.

Turn off the power and install the LCD module. Make sure that all the pins are aligned on both connectors.

Turn on the power and adjust the pot until the black squares are just visible on the display.

If the display has a backlight then turn on the backlight power switch. There should be a faint glow on the display.

Turn off the power switch and the backlight power switch (if there is one).

While holding one of the push buttons switches pressed, turn on the power switch.

When the button is released, the display will show “Rho Enterprises” for an instant and then show the present display size setting. Use the second button from the right to select the display type you have installed.

Press the rightmost button until a Baud rate is shown. Use the second button from the right to select 1200 Baud. Press the rightmost button to accept this Baud rate.

Build a DB9 or DB25 adaptor cable for testing with a PC serial port.

See the schematic for the pinouts of the connectors.

Test the operation of the display at 1200 Baud, 8 bits, 1 stop bit.

Note that at speeds faster than about 2400 Baud, characters can be lost during carriage returns, line feeds and form feeds. Pad characters (Nul's) can be used to allow faster Baud rates.

Options

Other display sizes

Other sizes of display modules may be used if the data connector is a 14-pin dual row header on the end of the display. Of course the mounting won't match.

LED backlight

An LED backlight can be used by installing resistors R8 and R9 in place of the EL backlight power module. Connector J4 may not mechanically match so the two connections may have to be hand wired.

Be sure to observe the correct polarity.

LED backlight resistor values 45 ma backlight current

Power supply input voltage

	5 volts	9 volts	12 volts
R8	20 ohms, 1/4 watt	110 ohms, 1/2 watt	180 ohms, 1/2 watt
R9	(none)	(none)	(none)

LED backlight resistor values 90 ma backlight current

Power supply input voltage

	5 volts	9 volts	12 volts
R8	10 ohms, 1/4 watt	110 ohms, 1/2 watt	180 ohms, 1/2 watt
R9	(none)	110 ohms, 1/2 watt	180 ohms, 1/2 watt

Using the Serial LCD 4

The 4 push button switches send ASCII characters 1 through 4 when pressed. The button farthest to the right is button number one.

The keyboard also allows setting special operating modes of the unit.

Invoke keyboard setup by holding any button down for about 1 second during and after power up. When the button is released, a logo will be shown, followed by a prompt for the display size. Button #2 steps through the possible settings and button #1 stores the displayed setting into the EEPROM and moves on to the next setting mode.

The first mode selects from 10 possible display sizes.

The second mode selects one of 4 cursor types.

The third mode sets the release code mode. If the release code is enabled, the release of any button will also send an ASCII Nul character (hex 00).

The fourth mode turns on and off the power up beep.

The last mode selects one of 5 baud rates from 1200 baud through 19200 baud. Pressing button #1 saves the baud rate and exits the setup mode. The data are transferred as 8 bits, no parity and one stop bit.

Control characters that are recognized for display by the LCD

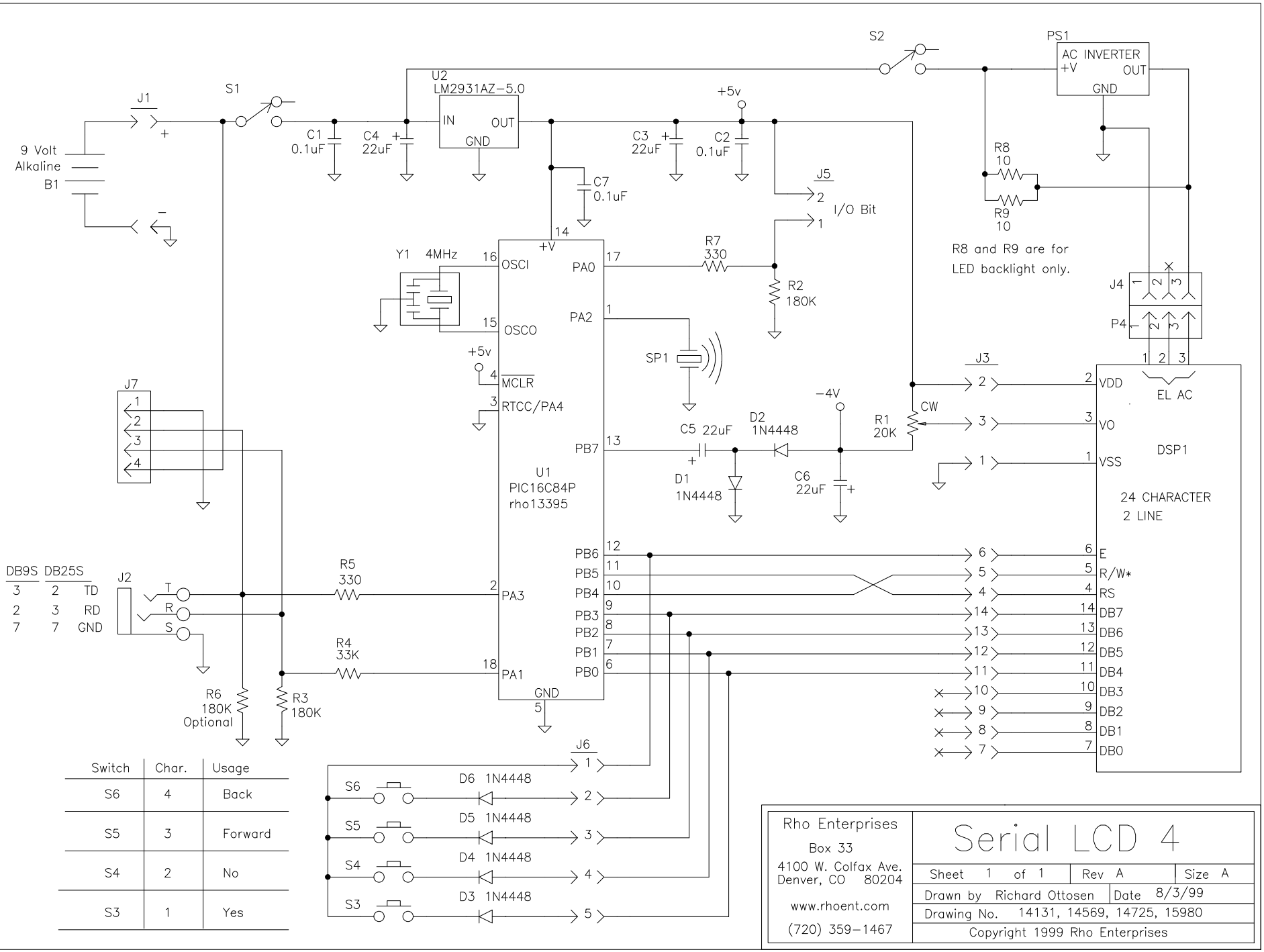
Name	ASCII	Hex	Description
Bell	^G	07	Use the beeper to make a tone.
Back space	^H	08	Move the cursor back one position.
Tab	^I	09	Insert spaces to the next tab column. The columns are fixed at every 4th character.
Line feed	^J	0A	Move the cursor down one line.
Form feed	^K	0C	Clear the screen. Cursor to top, left corner.
Carriage return	^M	0D	Erase to the end of the line and then move the cursor to the start of the line.
Escape	^[	1B	Prefix for commands.
Delete		7F	Delete back one character.

Serial commands for setting operating modes

All the commands are prefixed by an escape (ESC) character. The next character is the command. The final character or characters are the data for the command. Spaces are not allowed in the command.

The form of the command is: <ESC> <command character> <data character> (. . . <data character>)

Command	Description
<ESC>t0	Set Display to 8+8 characters by 2 lines.
<ESC>t1	16 1
<ESC>t2	16 2
<ESC>t3	16 4
<ESC>t4	20 1
<ESC>t5	20 2
<ESC>t6	24 1
<ESC>t7	24 2
<ESC>t8	40 1
<ESC>t9	40 2
<ESC>c0	Invisible cursor.
<ESC>c1	Underline cursor.
<ESC>c2	Blinking square cursor.
<ESC>c3	Blinking square and underline cursor.
<ESC>n0	Disable button release code.
<ESC>n1	Enable Nul character as button release code.
<ESC>b0	Disable power on beep.
<ESC>b1	Enable power on beep.
<ESC>p##	Put cursor at character position ##(2 ASCII decimal digits).
<ESC>p00	Puts the cursor at the top, left corner.
<ESC>r	Read single bit I/O as a "0" or "1" character.
<ESC>w0	Write a low level to the single bit I/O.
<ESC>w1	Write a high level to the single bit I/O.
<ESC>f# . . . #	Fill the font RAM. The command must be followed by exactly 64 bytes of font. This is 128 ASCII hex characters. Each byte holds 5 pixels with the LSB being the rightmost pixel. The first byte holds the top row of the first character's font. There are 8 rows per character counting the underline. The programmable font is accessed by ASCII codes for control P(10 hex) through control W (17 hex).



Switch	Char.	Usage
S6	4	Back
S5	3	Forward
S4	2	No
S3	1	Yes

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Sheet 1 of 1	Rev A	Size A
Drawn by Richard Ottosen	Date 8/3/99	
Drawing No. 14131, 14569, 14725, 15980		