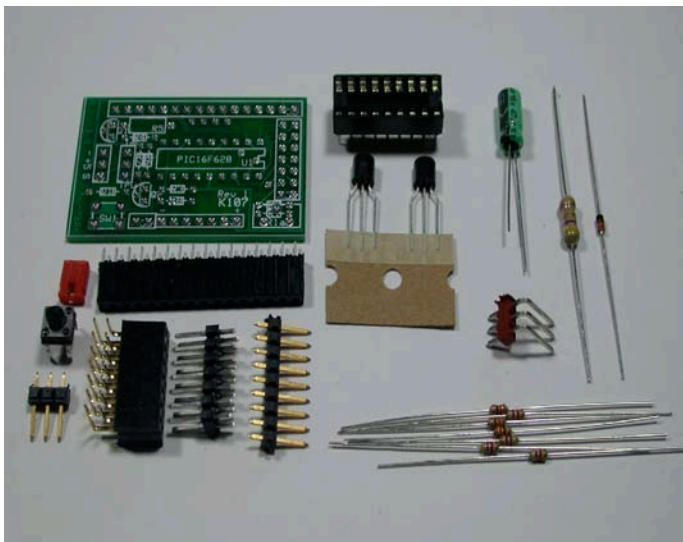# K107
LCD Controller Board

A Flexible Serial Backpack Kit

Revised: 2/24/2011

Russ Ferguson (KD5MTN)
Brian Riley (N1BQ)

Current for Rev's 1, 2, 3 & 4

The latest copy of this document can always be found at;

<http://www.wulfden.org/downloads/manuals/k107manual.pdf>

K107 Manual Rev 4.00
includes K107RA details

Table of Contents

1 Overview

Genesis

The K107 LCD Controller Board provides a serial interface to a standard LCD display. It is based upon a controller chip (PIC 16F628/16F648/16F1827) and circuit designed by Professor Peter Anderson (www.phanderson.com) at Morgan State University.

The K107 board design came about when Russ Ferguson and Brian Riley 'met' online in one of the Parallax Corporation User Forums (forums.parallax.com) and started a back channel discussion about taking Peter Anderson's design which had been promoted as a quick breadboard project to copper and glass.

With some minor changes to the circuit and components the K107 offers a permanent *serial backpack* PCB for an LCD display. The K107 board will accept Professor Anderson's LCD 106, 107, 108, 117, 117C and the 118 version controller chips.

The success of the first round of the K107 was a bit overwhelming. It sold out 400 units in just about one month. One question that kept coming back was "2400 baud" and "Picaxe." The PICAXE is a Basic Stamp variant from England. It is popular in England and Australia as well as in the US. Professor Anderson has a special variant of the 107/117 series chips, the #108/#118 LCD chips. Due to some stringent requirements of the PICAXE the Anderson design runs the PIC with an external 4 MHz resonator instead of the internal oscillator. This requires shifting around connections to pins 12,13,15, and 16 on the PIC. Thus came about the Revision 2 of the K107 which is set up to accommodate all five of the Anderson chips. The wiring shifts are

accomplished by a series of solder pads with fine connecting traces that can be cut or open pads that can be solder bridged to achieve the variations. The details of this will be dealt with at the appropriate places in the manual. These changes, in addition to their obvious benefits, also add to the flexibility and utility of this board to the Do-It-Yourself element of its audience.

Note: As of the last week in April 2010 selection of 2400 baud no longer requires the LCD 118 chip and 4 MHz resonator. All kits requested in 2400 baud will receive an LCD117/2400 chip. These chips will be marked with two white dots and will NOT have a resonator accompanying. The process of cutting traces and solder balling two others detailed on page 6 is no longer required.

Rev 3 of the K107 added very little in terms of electrical performance. It restored access to Out6/Out7 when using the Anderson 107/117 series chips. mechanically the board jumped from 1.8 inches long to 2.1 inches long. This accomodates a strip on each end of the board with three mounting holes. The holes will accomodate a #2 screw. Four of the holes, two at each end line up perfectly to support Hantronix miniature 2x16 display, leaving the remaiing two holes to secure the board in its housing.

Rev 4 took the 2 row electrical/mechanical connector from 2x7 to 2x8, adding pins 15 and 16 for backlit displays of this type which are more readily available now.

The K107 board is rather unique among its peers in that it is designed to accommodate a broad range of

physical types of LCD displays. Coupled with Professor Anderson's superb firmware it also is capable of handling, in software, a broad range of display geometries.

One may build spartan versions of the board for dedicated use with a specific display and application, or full featured boards with multiple connectors to use on the bench with a variety of displays and applications.

The Board

The design provides an interface between a character LCD (having an HD44780 interface) and a device supporting a 2400, 4800, 9600 or 19200 baud serial output line. The Microchip PIC, Parallax Basic Stamp, NetMedia BX24 are examples of devices that may be used.

The serial interface is TTL. That is, the idle state is a TTL logic one, or near +5 VDC. This is often termed non-inverting or true. It provides direct compatibility with the UART associated with a PIC, the SEROUT command on a Basic Stamp and Com3 on a BX24. When interfacing with a PC or

similar at RS232C levels, the logic is inverted. To this end the K107 has a logic inverter and level shift circuit that may be selected by jumper.

In the interest of simplicity and reliability, the baud rate is fixed at one of the aforementioned values. The ability to change the baud rate in firmware can be a bad design as it opens the possibility of the unit inadvertently assuming a baud rate which is not compatible with the interfacing circuitry and not being able to recover.

Variable backlight intensity is provided by controlling the backlight current by pulse width modulating a 2N4401 transistor through a series limiting resistor.

The PIC firmware provides a 64 character buffer. To avoid framing errors, it is suggested the user initially provide a one millisecond delay between each character or pause in milliseconds equal to the number of characters sent after bursts of characters

A source of +5 VDC with a minimum current of 10 mA is required for this design. If the interfacing LCDs LED back light feature is used, the back light current must be limited to less than 250 mA.
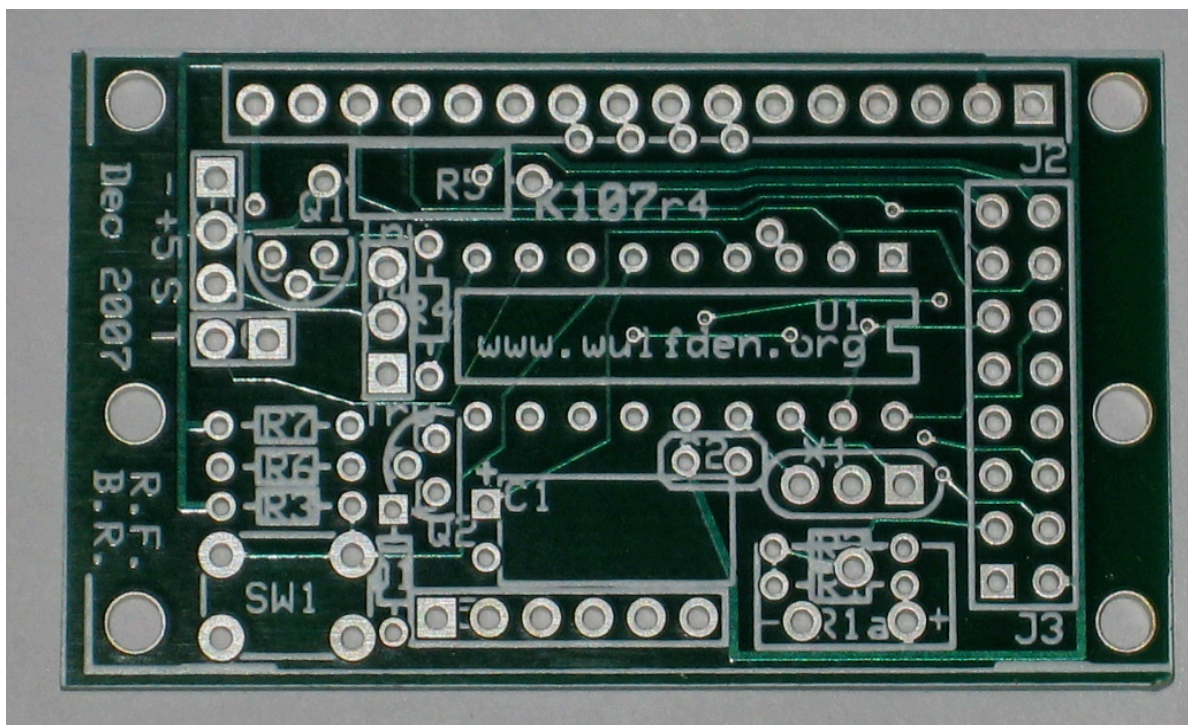
2 Hardware

Parts Layout

Schematic

	K107R Board	
	LCD Controller	
Russ Ferguson	Rev 4 — 11/3/2007	Brian Riley
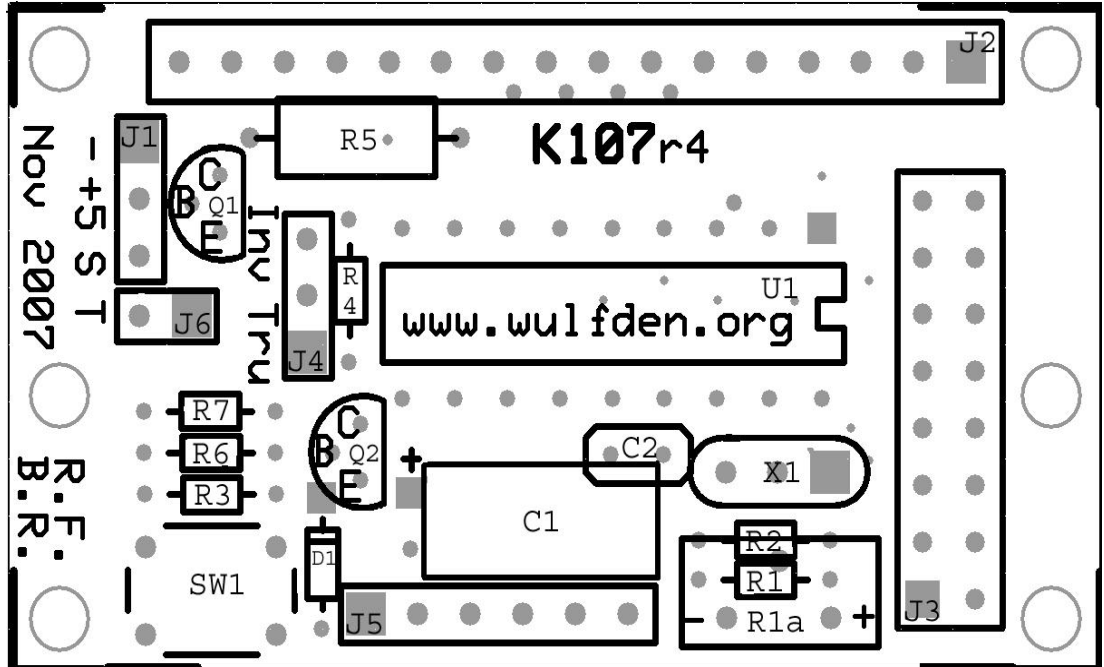
2 Hardware

Bill of Materials

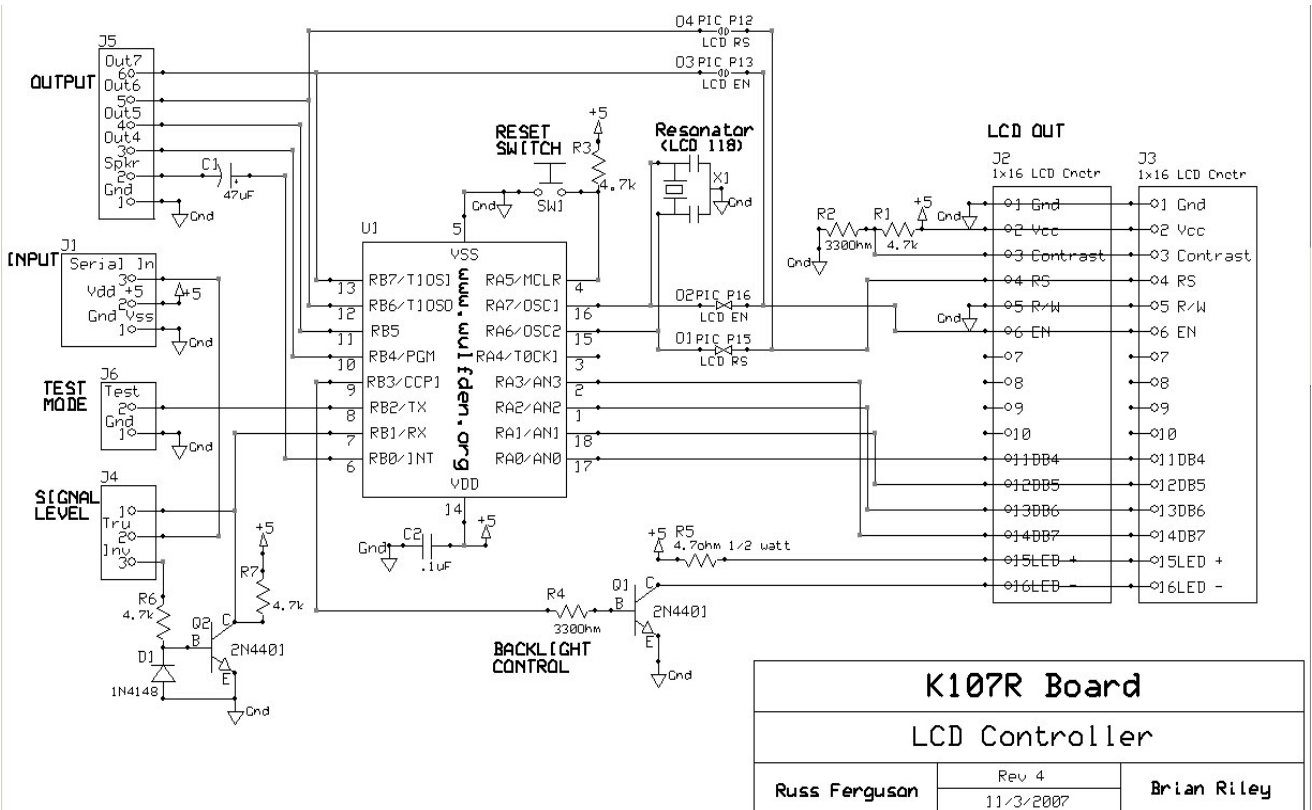| R1,R3,R6,R7	4.7 Kohm - 1/8 watt resistor (see text)
R2,R4	330 ohm - 1/8 watt resistor (see text)
R5	4.7 ohm - 1/2 watt resistor
C1	47 uF Tantalum or electrolytic capacitor (see text)
C2	0.1 uF monolithic capacitor
D1	small signal diode - 1N4148 or 1N 914
Q1, Q2	NPN switching transistor - 2N4401
U1	pre-programmed PIC 16F628/16F648A/16F1827
S1	N.O. pushbutton switch (DigiKey P8006S-ND)
X1	4 MHz Resonator - used with Anderson 108/118
J1	.100 pin header right angle - 1x3
J2	.100 socket or pin header - 1x16 (see text)
J3	.100 socket or pin header - 2x8 (see text)
J4	.100 pin header - 1x3
J5	.100 pin header - 1x6 (see text)
J6	.100 pin header - 1x2 (see text)
n/a	18 pin DIP socket for U1
n/a	push on jumper

Overview

The K107 LCD Controller Board comes as a kit so that the user may assemble and configure it to his own specifications and purposes

LCD Interfacing

This circuit requires an LCD display controlled by a Hitachi HD44780 controller. It is laid out to accept connections to the display board via 1x10, 1x14, 1x16 (LED backlight), 2x7 or 2x8 .100" spaced pin headers. The orientation of the pins in the 1x14(16) linear fashion conforms to the more or less standard arrangement found in most displays. It is such that the K107 attaches to the back of the display module with the PIC chip facing away from the display. However, there are a number of displays available with non standard pin arrangements When the builder selects an LCD module for use he should obtain a data sheet for the display and check the pin configuration against the board arrangement. I suggest taking the mating connector to the display and plug it on, taking note of where pins 1 and 14 (10 or 16) are located and then determine which side and orientation the board must be relative to the connector pins.

For example, I had one display whose pins 1-14 were reversed so that instead of the setup shown in example #1 below. I had to mount the female socket header on the component side of the K107 board and this necessitated mounting the reset switch on the solder side of the board so it would be accessible when the board was mounted facing the back of the display.

When looking at the bottom of the K107 board with

the long row of pins/sockets running along the top, Pin 1 is to the left, Pin 16 to the right. The 2x7 connector has Pin 1 bottom right and Pin 14 top left. The odd numbers are in the right column and even numbers in the left column. The four common connections would be:
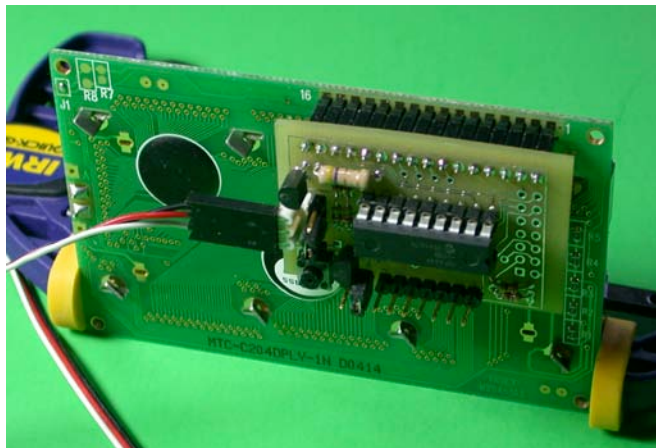

(1) 1x14 or 1x16 (J2) , socket header, inserted from bottom of board soldered on top (component) side. Despite the fact that pins 7-10 are usually unused, it is recommended to use a socket (or pin) header with all 14-16 pins as this provides the most rugged mounting rarely requiring anything further to secure the lightweight K107 to the display.

(2) 1x10 (J2) socket header, inserted from the bottom side and soldered on the top. Pins 7, 8, 9, 10 each have an extra hole adjacent to it to allow jumpering to 11, 12, 13, 14 respectively. Some displays shift the pin functions down four positions to the oft unused pins 7-10.

(3) 2x8 (J3) socket or pin header direct to display, inserted on bottom of board, soldered on top side.
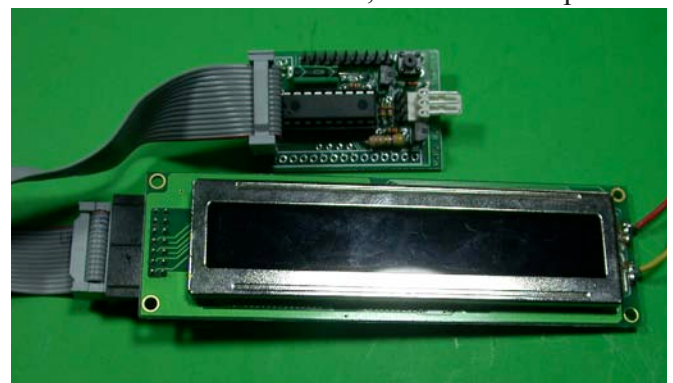

(4) 2x8 (J3) pin header to connect to ribbon cable, inserted on top side, soldered on bottom side. Holding the K107 board with chip writing readable and J3 on the left, J3-1 will be the upper right pin.

On a display with 2x7 connectors, make sure they plug into the top 7 rows leaving pins 15 and 16 unused.

The Anderson chip firmware supports displays with 2 lines by 16, 20, 24, or 40 characters as well as 4 lines by 16 or 20 characters. There is a software command (see the software interfacing section of this manual) to tell the chip what the geometry of the LCD so that it can set parameters for xy-positioning and line wrap.

An example of a not so common connection might be this VFD display. While it has a standard 2x7 connection, the female connectors are tiny, accepting a pin similar to those on a solder tail machine pin DIP socket. (see picture on next page)
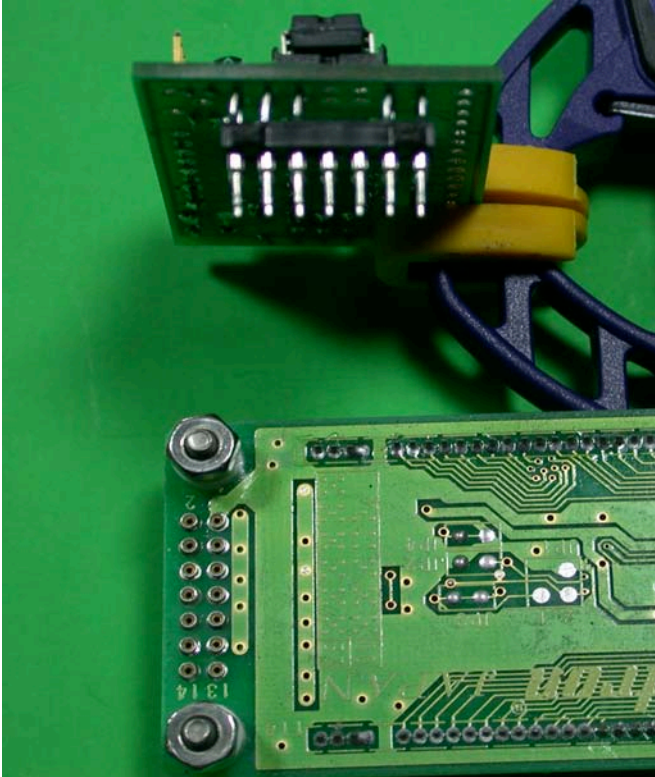
A connector was fabricated by taking a 14 position open frame type machine pin DIP socket and cutting it into two 1x7 strips. Some Krazy Glue (cyanoacrylate) was used to glue them togther back to back. They were then inserted into the female receptacles on the display and short pieces (2-3 cm) of bare #22 solid hookup wire were inserted one by one into the dip socket receptacles and soldered in place. There is no need to do all 14, 1-6 and 11-14 are sufficient. When done, trim the wires to the same length and try to straighten them up. Place the K107 board, component side facing up away from the back of the display down on the wires and carefully guide the wires to the correct holes. Adjust height as needed and solder the wires to the K107. When done, you will find that the support of 10 #22 wires, 2 cm or less long and soldered at each end is quite rigid. The board may now be removed from the display and easily plugged back in as needed.
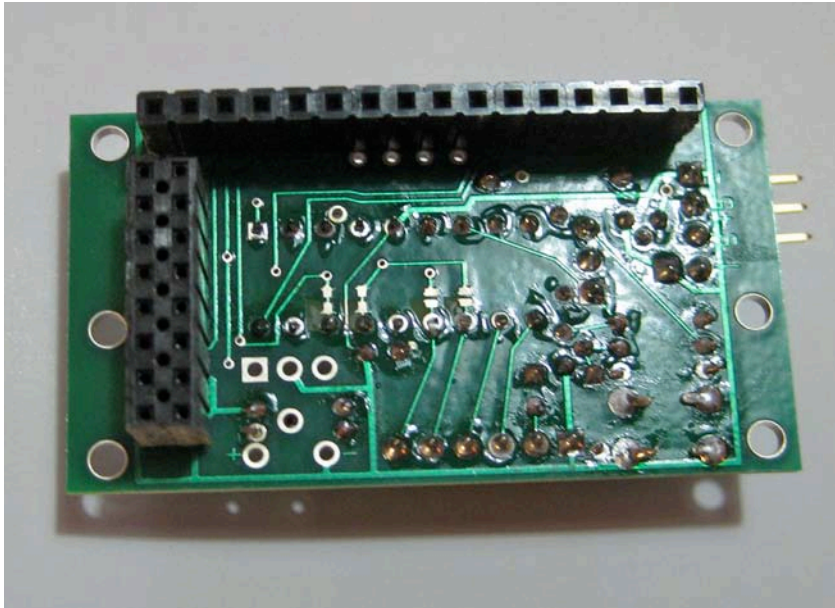
The K107 PCB has two sets of holes for connection to the LCD display, a 1x16(J2) and a 2x8 (J3). Gnerally the board is assembled and either one or the other socket header is soldered into place depending on the connectors required for the intended display. However since both connectors are supplied with the complete kit there is no reason that both connectors cannot be soldered into place. Mechanically there should be no conflict with the mounting and since only one display will be connected at a time there is no electrical conflict.

Now you have a more flexible board that can be used on many different displays.

Assembly and Options

It is highly recommended the PIC chip be socketed. All the resistors and the diode are spaced to be able to be laid down flat on the PCB. Before proceeding to assembly, please read all of the options below.

Use of Resonator

If you will be using the #106, #107, or #117 (in 19200, 9600, or 2400 baud) you can skip this step. If you are using a pre-May 2010 LCD108 or LCD118, or are supplying your own chip and it requires a resonator you have to do some rewiring.

Take the K107 pcboard in hand with the solder side facing towards you and oriented as the picture below. From left to right you are looking at PIC pins 16 through 12 Although you cannot see it, there are two fine traces connecting the two pairs of oblong shaped solder pads above pins 15 and 16. With a fine blade scrape the solder mask away and cut these fine traces. Test continuity with a meter. This disconnects pins 15 and 16 from J2 pins 4 and 6. Now carefully clean the pairs of half-circle shaped pads above PIC pins 12 and 13 and bridge each pair with solder or a small bit of wire soldered across them. This connects 12 and 13 to J2 pins 4 and 6. You now can turn the board over and solder the resonator in the three holes marked "X1."

Display Contrast

Pin 3 (on most displays) supplies a low voltage (approximately +0.3vdc) that controls the display contrast. In general, most displays will produce a good readable display with a simple voltage divider R1/R2 (4.7K/330 ohms).

A number of displays may demand that the R2 value, be zero (0), that is replaced by a jumper to ground.
There are three slightly larger holes labeled R1a on the K107 that will permit you to put a 5K or 10K potentiometer, 4 holes labelled R1and R2 for the resistive divider, or just run a jumper from J2/J3 Pin

3 to ground. ***Caution*** - if you place a jumper to ground in place of R2, **DO NOT** place a jumper in place of R1. This will short the +5v to ground.

Backlight Circuit (for LED backlight only)

The backlight circuit is optional. It is only for LED type backlights. It will not power electro-illuminescent (EL) backlights. If you do not have or do not plan to use the backlight, you can simply not install R4, R5, and Q1. If you simply want the backlight on all of the time at full intensity, not under software control, install R5 and jumper J2-16 to GND.

Input Level Shifter

If the input signal will only ever be TTL-level True data, you may leave out R6, R7, D1, Q2, and J4 and solder a jumper between J4-1 and J4-2.

Likewise if you will only ever feed the display from RS232 level Inverted data, then you may install the above mentioned components, leaving out only J4 and soldering a jumper from J4-3 to J4-2.
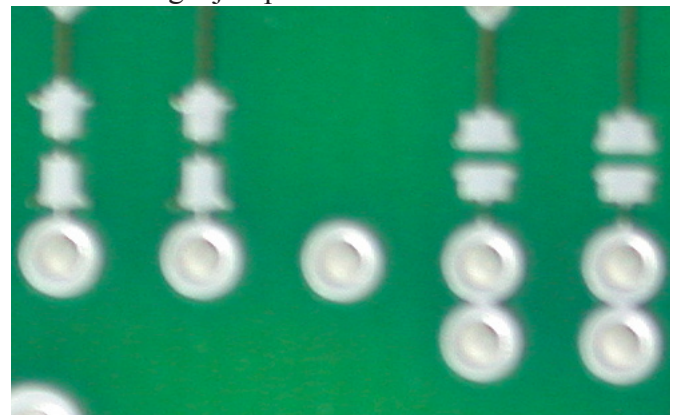
Electrical Interfacing

The K107 can take serial input as (1) **TRU**e at TTL levels and (2) **INV**erted at RS232 levels.

With JP 4 in the **TRU**e position you could feed the K107 by wiring directly from a pin on a Basic Stamp or from a PIC and have the software configured for True . You could not however connect directly to a comport or USB/serial adapter. The data sense will be wrong and the RS232 level voltage will most

probably damage the PIC chip on the K107.

Moving JP4 to the **INV**erted position engages a simple circuit that inverts the data sense and handles the RS232 level voltages. This could then be connected to the Data Out pin of a PC comport.

Construction and Assembly

After determining which options you will employ for your K107 board, you may begin construction. All components with the exception of J2 and J3 are placed on the top side of the board and soldered on the bottom side. While the board can be assembled in any order, the following sequence is suggested;

(1) Place all resistors, capacitors, and the diode on the board. (***Note*** - diode band is away from edge of board) Solder and trim excess leads. Visually check for solder bridges and shorts.

(2) Place in and solder all top side connectors (J1, J4, J5, J6), SW1, and a socket for U1 (if you plan to do so) (***Note*** - J5 and J6 may be soldered in as a single 9 pin header. Visually check for solder bridges and shorts.

(3) Solder in Q1 and Q2. Observe solder mask layout for orientation. Trim excess leads. Then visually check for solder bridges and shorts.

(4) [a] Place in J2 from the bottom and solder from the top. Visually check for solder bridges and shorts. **and/or** [b] Place in J3 from the bottom (or top as appropriate) and solder from the top (or bottom). Visually check for solder bridges and shorts.

(5) If no socket was installed for U1, insert and solder. Observing that the notch goes towards J3. If a socket was installed for U1, insert U1 in the socket.

(6) Check everything, again, visually, for solder bridges and shorts, then, physically with a DMM. Correct any problems.

Test Mode

Connect your display to the K107, place a jumper on J6 and apply power. After a few seconds a stream of characters will scroll across the screen repeating endlessly until it is shut down and the jumper removed.
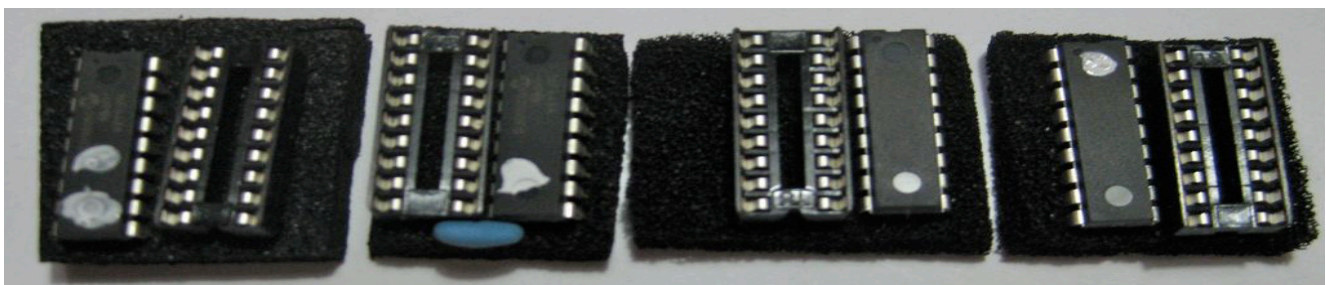
Anderson Chip Markings

The Anderson firmware chips are either PIC-16F648A or, beginning in mid-2010, PIC-16F1827. For purposes of use in the K107 these two chips are interchangeable. The 1827 firmware will identify itself as '**117D.**' The chips come from Anderson unmarked in separate packages grouped by the baudrate. I have adopted the following marking convention in relation to the notch on the Pin 1 end of the chip. Chips are marked for baudrate using 'White-Out.'

 - two white dots, end away from notch, 117D, 2400 baud
 - one white dot, end away from notch and blue resonator 118B/C, 2400 baud (obsolete)
 - no dots, 117C/D, 9600 bd
 - one dot, end near notch, 117C/D, 19200 bd

** the two chips pictured to the right appear to have extra dots that are perfect circles. They are not dots, but rather reflections of the camera flash in the dimples on the chip tops **

2 Hardware

Connector Pin Assignments

Pin	J2/J3 Description
1	Ground
2	Vcc
3	Contrast
4	RS
5	Read/Write
6	Enable
7	Data B0* (not generally used - see text)
8	Data B1*
9	Data B2*
10	Data B3*
11	Data B4
12	Data B5
13	Data B6
14	Data B7
15	LED Backlight +
16	LED Backlight -

Note - since the Anderson controller operates the LCD display in *nibble mode* Data Bits 0-3 are not used, leaving pins 7-10 unused. Some displays (often ones without a backlight) reduce the count of pins from 14 to 10 and put Data Bits 4-7 onto pins 7-10. The K107 board has four extra pads adjacent to J2 pins 7-10 to allow you to use a 1x10 socket header for J2 and then to connect four short jumper wires from these pads to J2 pins 11-14 respectively to permit use of such a display.

Pin	Signal Input - J1 Description
1	Ground
2	+ 5 vdc
3	Data Input

Note - this pin arrangement was made specifically to permit easy use of a three wire black/red/white servo/lcd cable to connect the display controller to a project or breadboard. It is also the same convention used by Parallax Corp. to connect to its serial peripherals**.**

Pin	Signal Invert - J4 Description
1	to U1 - pin 7 (TRU jumper 1-2)
2	Data In from J1-3
3	to R8 (INV jumper 2-3)

Pin	General Outputs - J5 Description
1	Ground
2	Piezo
3	General Output 4 (not 106)
4	General Output 5 (not 106)
5	General Output 6 (107/117 only)
6	General Output 7 (107/117 only)

Pin	Test Mode - J6 Description
1	Ground (TEST jumper 1-2)
2	U1 - pin 8 (normal - no jumper)

Note* - One good way to 'keep track' of the input configuration of the K107 is to use only a single jumper for J4 and J6. Placed on J6 the K107 is in Test Mode. Placed on J4 in one position or another it is in TTL **TRU or RS232 **INV** input mode and you do not need to store the unused Test Mode jumper.

3 Software Interfacing

Controller Chip Differences

The K107 will accept various PH Anderson chips the LCD 106, 107, 108, 117 and 118. The basic command set is the same for all three controller chips. The #107 adds software control of the backlight and 4 general purpose outputs and one beep output to the #106. The newer #117 adds a large character set display, in two different widths and a custom boot text display to the #107. The #117 only has two general outputs. The #108 and #118 chips have identical command sets to the #107 and #117.

Note In the LCD Command list that follows, commands shared among all the controller chips are simply listed, those specific to only one or two of the chips will have the chip number in parentheses next to the command title.

Note When started (unless configured otherwise), the Anderson controller will briefly display its configuration settings for its geometry, cursor style and backlight intensity. This takes a finite period of time. If your application displays important information at startup, it should allow at least a three second pause for the display to initialize before attempting to write to the display.
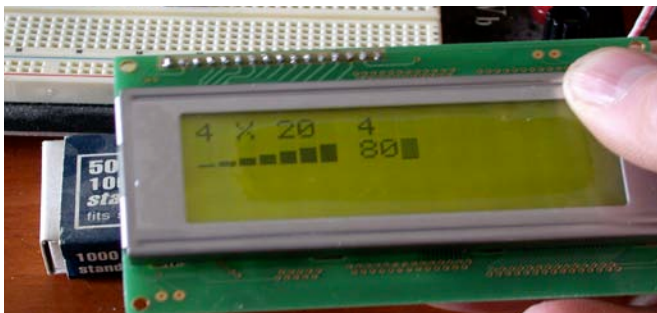
Caution As previously stated, the Anderson chip has a 64 byte buffer. Generally speaking, typical LCD screen displays will rarely tax this limit,

?a	set cursor to home position
?b	destructive backspace
?f	clear screen and leave cursor at home position
?g	beep (50 ms of 500 hz from J5-2)
?h	non-destructive backspace
?i	forward cursor
?j	down cursor
?k	up cursor
?l	clear current line, cursor at start of line
?m	carriage return, cursor to start of current line
?n	CRLF, cursor at start of next line, line cleared
?t	tab, advance one tab position
??	display a "?"

but display updates with cursor positioning strings might over run the buffer. But this could happen if you were to, say, try to do a time display to tenths of seconds in real time. You need to consider this when programming the display outputs.

Note In late 2008 Peter Anderson re;leased verison 117C, in 9600 and 19200 baud. This fimware is significantly faster than earlier versions. This somewhat lessens the concerns of the prior paragraph, but does not eliminate them altogether.

Note Any software command to the Anderson controller chip that causes a write to the EEPROM must be followed by a pause of approximately 100 milliseconds (e.g. in PBASIC **PAUSE 100**) This would include commands to set Tabs, Display geometry, startup screen, etc.

Basic LCD Commands

A partial list of various commands is in the chart to above. Note that all commands are prefaced with

a **"?"** and the commands are case sensitive. The cursor may be set to any position using the x and y commands;

> **?y0**
> **?x15**

Note that the line number, follows the '**y**' command and the column number, consisting of two digits, follows the '**x**' command. Thus, outputting the string;

> **"?y1?x10**Hello**?n"**

positions the cursor at column 10 of line 1 and then prints "Hello", followed by a newline which also clears the next line.

Note that the line and column numbers begins with 0. Thus, for a 4 X 20 LCD, valid lines are 0 - 3 and valid columns are 00 - 19. Any of eight user defined characters may be displayed using the digits 0 - 7. Thus;

> **"?5?2"**

causes user defined character 5 followed by user character 2 to be displayed on the LCD. Defining the user characters is discussed below.

Configuration Commands

A number of parameters are stored in the processors EEPROM. This includes the geometry of the LCD, the type of cursor, the number of spaces in a tab and the eight user defined characters. The settings of all of these are displayed briefly on the LCD when the processor boots.

The default is a 20 X 4 LCD, a tab size of 4, a full blinking cursor (3) and the eight special characters consisting of a single horizontal line, two horizontal lines, etc.

All of these parameters may be modified. Note that when the modifications are made, the new val-

ues are written to the processor's EEPROM. Thus, the user defined characters and the geometry of the LCD need only be modified one time.

Set LCD Geometry

Setting the geometry defines the configuration of the interfacing LCD.

> **"?G**yxx**"**

For example;

> **"?G216"**

indicates the LCD is a 2X16 configuration.

Note that appropriate configurations include
2X16 2X20   2X24,
2X40 4X16   4X20.
The configuration is important for the processor to properly position the cursor after each text character is displayed and in executing such commands as backspace, up cursor, down cursor, new line, etc.

Set Tab

The tab size may be set;

> **"?s5"**

In this case, the tab size is set to five. Valid values of the tab are 1 - 8. When this command is received by the processor, the new tab size is written to EEPROM and this value is used thereafter when executing the **?t** command.

When executing the **"?t"** command, the cursor is advanced, and any characters in its path are overwritten with a space. For example, if the cursor is in column 3 and the tab size is 5, the cursor will advance to column 5. Anything in columns 3 and 4 will be replaced with spaces.

Backlight Intensity (107, 108, 117, 118)

The intensity of an LED backlight on the associated LCD may be adjusted;

"?B80"

Note that the digits following the **"?B"** are two digit hexadecimal, ranging from **00** (back light off) to **FF** (back light full on). This command causes an output to change duty cycle over the range of 0 to 255/256. The output may be used to switch a power transistor which then controls the average backlight current.

Note with most displays you will not see any noticeable increase in intensity beyond $80.

Set Cursor Style

The style of the cursor may be set using the ?c command.

"?c3"

where the number is in the range of 0-3. A 0 configures as no cursor, a 2 as a non blinking cursor and a 3 as a blinking cursor. As with the set geometry and set tab, the style of the cursor is saved to EEPROM.

User Defined Characters

User defined characters may be defined using the **?D** command;

"?D300000000001f1f1f"

The number after the **"?D"** is the number associated with the user defined character, in this case user defined character 3. This is then followed by the eight data bytes expressed in two digit hexadecimal. Note that the hexadecimal letters must be lower case. In this example, lines 0, 1, 2, 3 and 4 consist of no pixels and lines 5, 6 and 7 consist of all five pixels. Thus, when user defined character

3 is displayed using the command **"?3"**, a character consisting of the lower three lines will be displayed.

Each user defined character is saved in EEPROM. The design provides a 64 byte serial receive buffer. However, be careful. If one is defining all eight user defined characters, this involves sending 19 * 8 or 152 characters. Writing each of the eight bytes to EEPROM requires 15 ms or more and thus, one can easily over run the buffer. Rather, provide a one second delay after defining each character.

Direct Control of the LCD

Commands may be directly passed to the LCD using the ?! command;

"?!01"

In this example the command **01** is sent directly to the LCD which clears the LCD.

A word of caution. With all other commands the program keeps track of the current cursor position. This is not done with commands sent directly to the LCD using the **"?!"** command. Thus, if the user configures the LCD such that the cursor is located at some point, subsequent line feeds and similar will not work correctly, since the controller will not know the current cursor location.

Clearly, if the **"?!"** command is used to place the LCD in a mode such that the cursor is decremented with each character or the display itself is scrolled, the subsequent operation of the LCD which assumes an incrementing cursor and a fixed display will give unpredictable results.

General Purpose Outputs (107, 108, 117, 118)

The LCD #107/117 provides four/two general purpose TTL outputs. Any of these outputs, (4, 5, 6 & 7 for the 107/117 chip and 4 &5 for the 108/118 chip), may be brought high or low using the **"?H#"** and **"?L#"** commands.

"?H4?L7"

The above brings output 4 high and output 7 low. Note that outputs 0, 1, 2 and 3 are not valid. On power up, all outputs are at a high impedance (configured as inputs). As each output is addressed, it is taken out of the high impedance state. The initial high impedance state permits the user to use either pull up or pull down resistors to avoid "bounce" when the processor is powered up.The current (source or sink) by any output should be limited to 15 mA.

* Note * - While OUT6 and OUT7 have outlets on the Rev 3 board. They will not be available if the board is wired for LCD 108/118.

Big Number Mode (117, 118)

The LCD #117 design provides both three and four block wide characters. This command will be ignored unless the display geometry command is set to a 4 line mode (4x16 or 4x20) The big number mode is entered;

"?>3" or **"?>4"**

On receipt of either of the **"?>3"** or **"?>4"** commands, the processor will download to the LCD the special character set required to display the big numbers. These are probably different from any user defined characters which the user may have defined. Thus, don't attempt to display any previously defined special characters after having invoked the "big number" format. You will need to reload these characters if they are needed.

Caution The 64 byte buffer limit needs to be considered here. In 'BigNum' mode the display is sending 16 screen blocks (4x3 plus 4 blanks in **"?>3"** mode) or 20 screen blocks (4x4 plus 4 blanks in **"?>4"** mode) to the actual display. So when considering the timing think 16 or 20 charac-

ters NOT just a single character.

Note The improved code of 117C made some improvements here. I had a loop displaying Big-Nums tha required a dleay of 200 milliseconds to keep the display stright. I was able to cut the delay t 30 milliseconds!
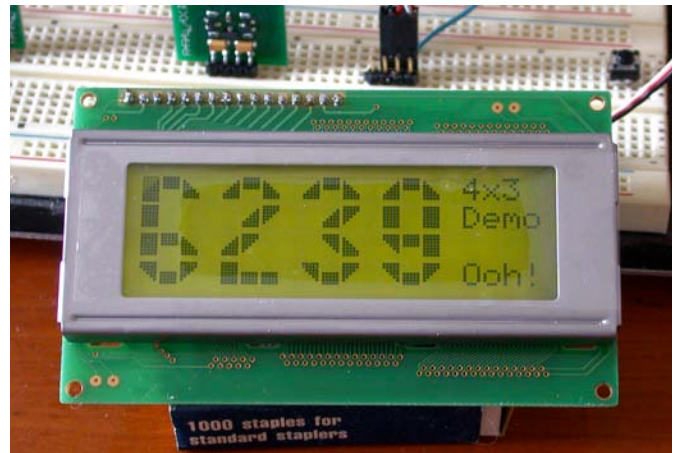
In the **"?>3"** mode, as each numeric digit is received, it will erase anything appearing in the three column wide by four high space and display the number in the big number format. In addition, it will clear the column to the right of the character. The cursor will then be located at the top row for display of the next digit. Note that for the three block wide mode, this is four columns to the right of the upper left of the previous character. Thus, each digit uses four columns, three for the display of the digit and one for the spacing between digits. Display of the minus sign, colon and decimal point use two columns; one for the display of the symbol plus one space.
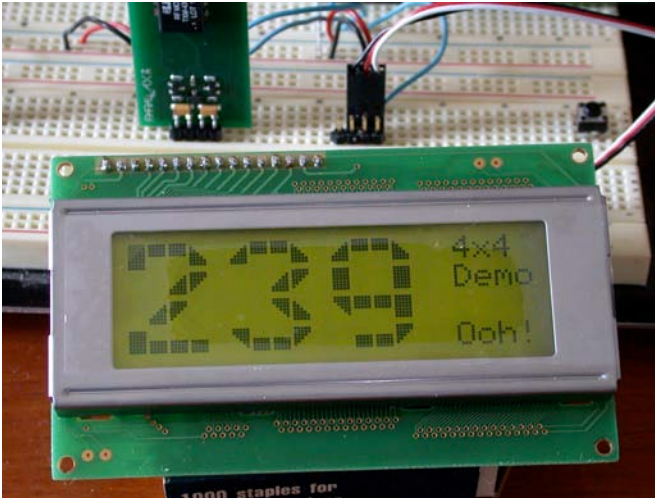
The **"?>4"** mode is similar, except that each digit is four wide plus one space.

There is no intelligent "wrapping" provision for the "big number" mode. Thus, if there are only two columns remaining before the end of the LCD and you attempt to display a "7", part of the "7" will appear on the right side of the LCD, and the rest on the beginning of the display.

The big number mode may be exited at any time:

   "?<"

This may be used to display ordinary text along with the "big number" characters. For example, in one of the photos, the message "4X4 Demo" appears. This might be done;

   "?y0?x164X4**"**   ' row 0, beginning at col 16
   "?y1?x16 Demo**"** ' row 1, beginning at col 16

Note that the **"?<"** command simply exits the "big number" mode. It does not download the user defined characters that might be used for graphics. If one later wishes to use the user defined characters;

   "?R"   ' restore the user defined characters.

Again, note that the characters associated with the display of the "big number" characters are not compatible with the user defined characters one might use for plotting and thus, "big numbers" and graphics type applications using specially defined characters cannot coexist on the display.

Custom Boot Text Screen(117, 118)

The customized text screen may be an advertisement which is displayed on boot or a template which may be displayed at any time. It is set using the **?C** command, followed by the row, followed by the twenty characters which are to appear on the row. For example, the following sequence defines the custom screen shown in the photo.

   "?C0abcdefghijklmnopqrst**"**
   "?C1ABCDEFGHIJKLMNOPQRST**"**
   "?C201234567890123456789**"**
   "?C398765432109876543210**"**

Note that this custom screen may be displayed at any time;

   "?*"

Boot Screen Selection (117, 118)

The screen which is displayed on boot may be specified using the **"?S**#**"** command followed by a number, 0, 1 or 2 will display, on boot

   "?S0" ' blank screen
   "?S1" ' the configuration settings
   "?S2" ' the user custom text screen

4 Hackers Guide to the K107

The entire presentation of the K107 LCD Controller Board to this point has been as an end product employing one of the Anderson LCD controller chips. This board was conceived for just that purpose. That not withstanding, as this manual began to evolve it became clear that the board could be used generically. If you wish to create a program taking simple serial input and displaying output to an LCD display it becomes a simple matter of writing a program and burning it to a PIC 16F628, 16F648, or even a 16F84.

The k107 as you receive it is configured to connect PIC Pins 15/16 to LCD Pins 4/6 and make use of the PICs internal oscillator. However, in the Rev 2 design provision was made to accommodate a resonator on PIC pins 15/16 and connect PIC pins 12/13 to LCD 4/6. Flipping the pcb over to the solder side, you wll observe two sets of two pair of pads adjacent to PIC pins 12/13 and 15/16. As it stands there is a fine trace connecting the pairs adjacent to PIC pins 15/16. If you take a fine knife and slice these two fine traces you may then insert and solder a three pin resonator in the holes marked X1. Then bridge the pairs of pads adjacent to PIC pins 12/13 with a small piece if wire or just a bead of solder, thus connecting them instead to LCD pins 4/6.

There is an internal hardware USART in the 16F628/648. The K107 uses pin 7 (RB1/RX) for serial input, but pin 8 (RB2/TX) is used as a "Test Mode" enable in the original Anderson design. The design in Rev 2 was specific to bring the TX pin out next to the RX pin. J6 is now at right angles to J1 with its active pin in line with the 3 pins of J1. Simply leaving out J6 and making J1 four pins instead of three permits a single 4 pin connector to the outside world. (GND, +5, RX, TX

U1 pin	PIC Designation	Connected to
1	RA2/AN2	J1-13 (LCD - DB6)
2	RA3/AN3	J1-14 (LCD - DB7)
3	RA4/T0CKI	NC
4	RA5/MCLR	Reset Circuit
5	Vss	GND
6	RB0/INT	R8/C1
7	RB1/RX	J4-1
8	RB2/TX	J6-2
9	RB3/CCP1	R4
10	RB4/PGM	J5-3 (Out4)
11	RB5	J5-4 (Out5)
12	RB6/OSO	(Out6) J2-4 (LCD - RS)
13	RB7/OSI	(Out7) J2-6 (LCD - EN)
14	Vdd	+5 vdc
15	RA6/OSC2	J2-4 (LCD - RS) Resonator
16	RA7/OSC1	J2-6 (LCD - EN) Resonator
17	RA0/AN0	J2-11 (LCD - DB4)
18	RA1/AN1	J2-12 (LCD - DB5)

in that order looking at the connector.

So to get at the USART for bidirectional serial use you may want to consider leaving out J1, J4, R6, R7, D1 and Q2 altogether and interface via TTL, doing level shifting, if required on the board to which you connect the k107.

Unless you have a need to do software control of a backlight, you can drop R4 and Q1, and run a ground from the collector hole for Q1 to the hole for J1-1. This makes available U1 Pin 9 (RB3/

CCP1) which is accessible via the hole for R4 closest to the chip U1.

If you chose not to reroute the connectors and use the resonator, you will find that PIC pins 12/13 as well as pin 3 have been orphaned. To make them accessible you will note that next to each of these PIC pins there is a plated through via that is attached to its respective PIC pin. The via may be used to hand wire to that pin for some purpose.

5 K107RA - assembly and mounting

The K107RA - K107 Ribbon Adapter is a board and connector set for attaching a Flat Flex Cable (FFC) to a standard 1x16 .100" center pin header setup. Pictured to the right is the basic kit; a pcb board, an 16 pin FFC connector and a 1x16 .100" spaced pin header.
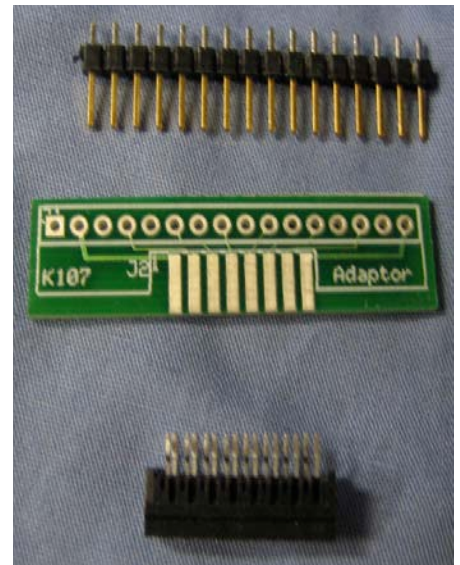
The 16 .100" spaced holes number 1 to 16 left to right, pin 1 having a square pad. Pin 1 of the FFC connector is on the bottom beneath the silk-screened "1" just visible above and right of the "J2" silk-screen. The first FFC pin visible on the top is #2.

As you look down from above the actual contacts of the FFC connector will be on the bottom of the connector facing up.
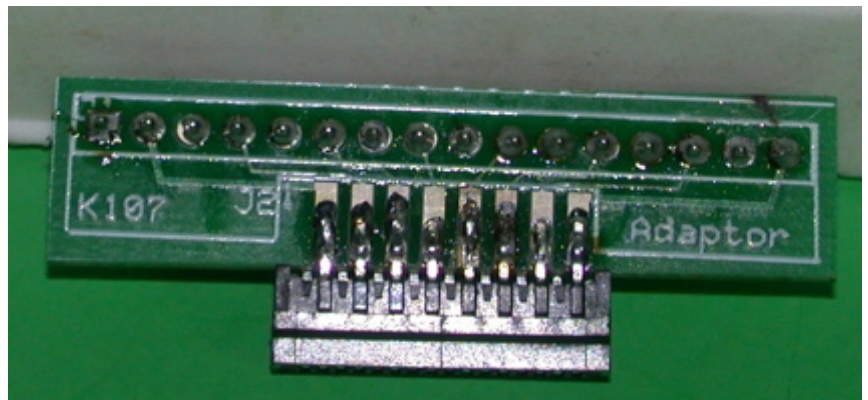
If you mess up the FFC connector and get it aligned wrong, this tip frm custrmer John Brayton may help ... "The method I used to un-solder the connector: I took a very small hypo-dermic needle, 1.5" long, 29 gauge, and gentle inserted it under every tang as I applied heat. Because the solder doesn't stick to stainless steel I was able to work across each side of the connector, slowly and carefully, until it popped off."
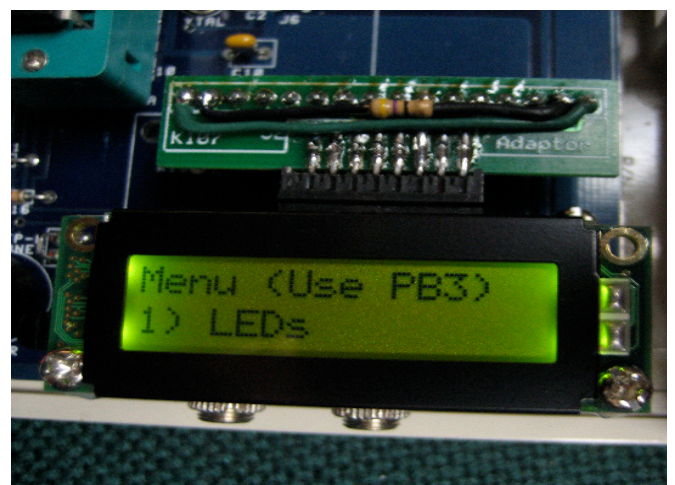
K107RA (PE) Option

The K107RA PIC-EL Upgrade is for use with the AMQRP Elmer 160 Project Board know as the PIC-EL. The original board came with a 1x8 character, 1x14 pin display. Subsequent upgrades to normal 2x16 displays were never satisfactory as the displays hung off the side. The Hantronix mini-2x16 display (2x16 in a 2x8 footprint) was a perfect fit, but it used a 1x16 FFC connection. The K107RA kit with the addition of a 4.7 ohm 1/2 watt resistor made it all feasible.

First, assemble board and FFC connector as above.

Then wire pin 15, LED+ to Pin 2 Vcc through the 4.7 ohm resistor, use insulation on the resistor leads. Then wire Pin 16, LED-, directly to Pin 1, Vss (GND).

Now clip the 1x16 pin header to 14 pins and insert and solder, pins down solder on top.
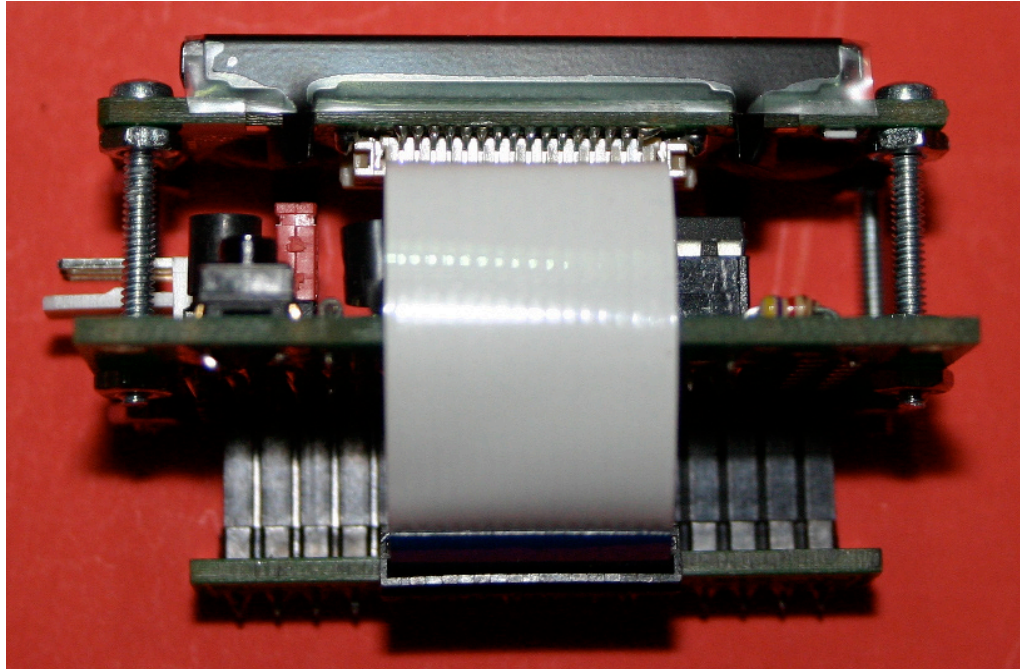
The K107RA can be applied to the K107R3/R4 in a number of different configurations. First there is the consideration of the mount, permanent or removable. The picture above shows the K107 assembled with a 1x16 female socket header inserted down on the solder side and soldered in on top. The 1x16 pin header in the K107RA is inserted into the socket header and the board generally mounted on top of the component side of the K107. In the picture below the 1x16 socket header has been left off and the pins on the K107RA inserted through the holes, soldered and the excess pin length clipped. There is plenty of clearance to mount the display on the top or the bottom.
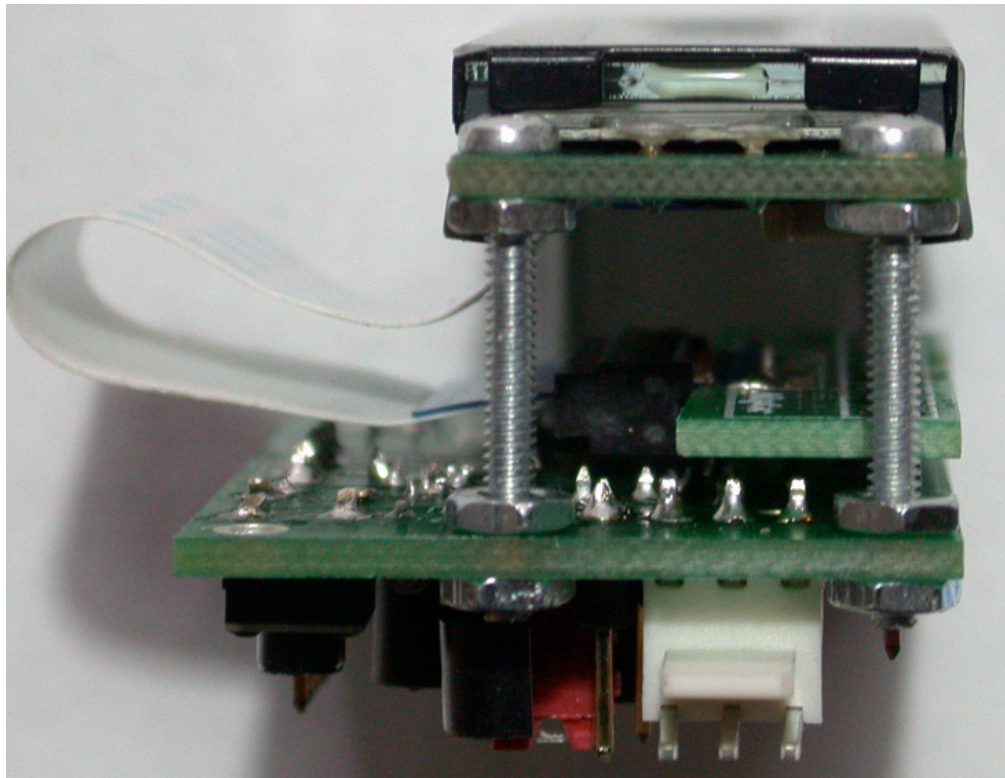
A Hardware - K107 - Rev 3

Parts Layout

J2

J1

J6

J4

J3

J5

Schematic

K107 Board - LCD Controller

<http://www.wulfden.org/k107/>
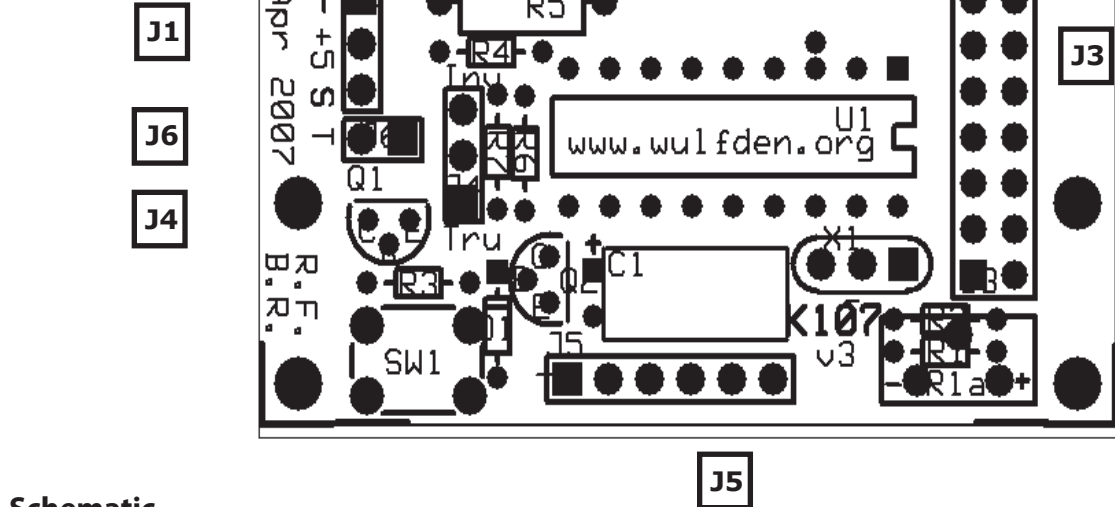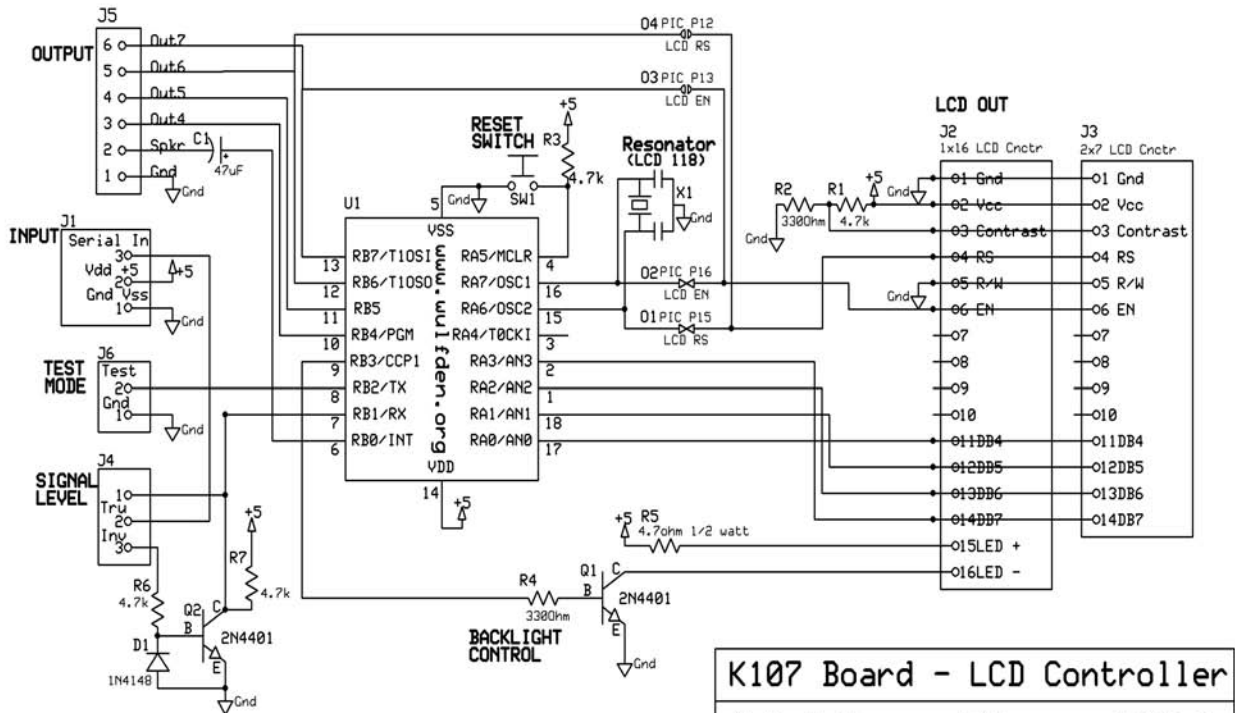
| Russ Ferguson | Rev 3 | Brian Riley |
| | April 2007 | |

B

Hardware - K107 - Rev 2

Parts Layout
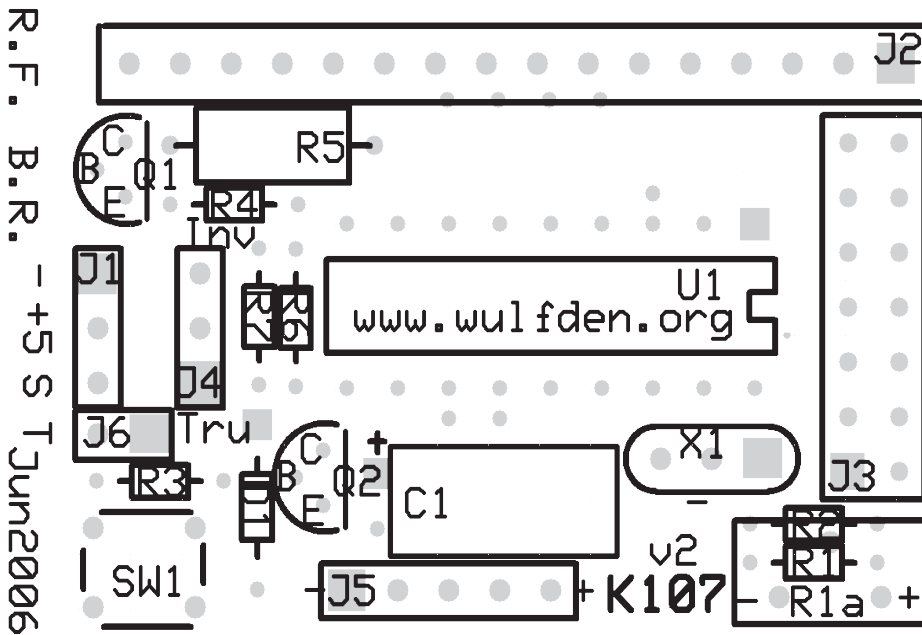
Schematic
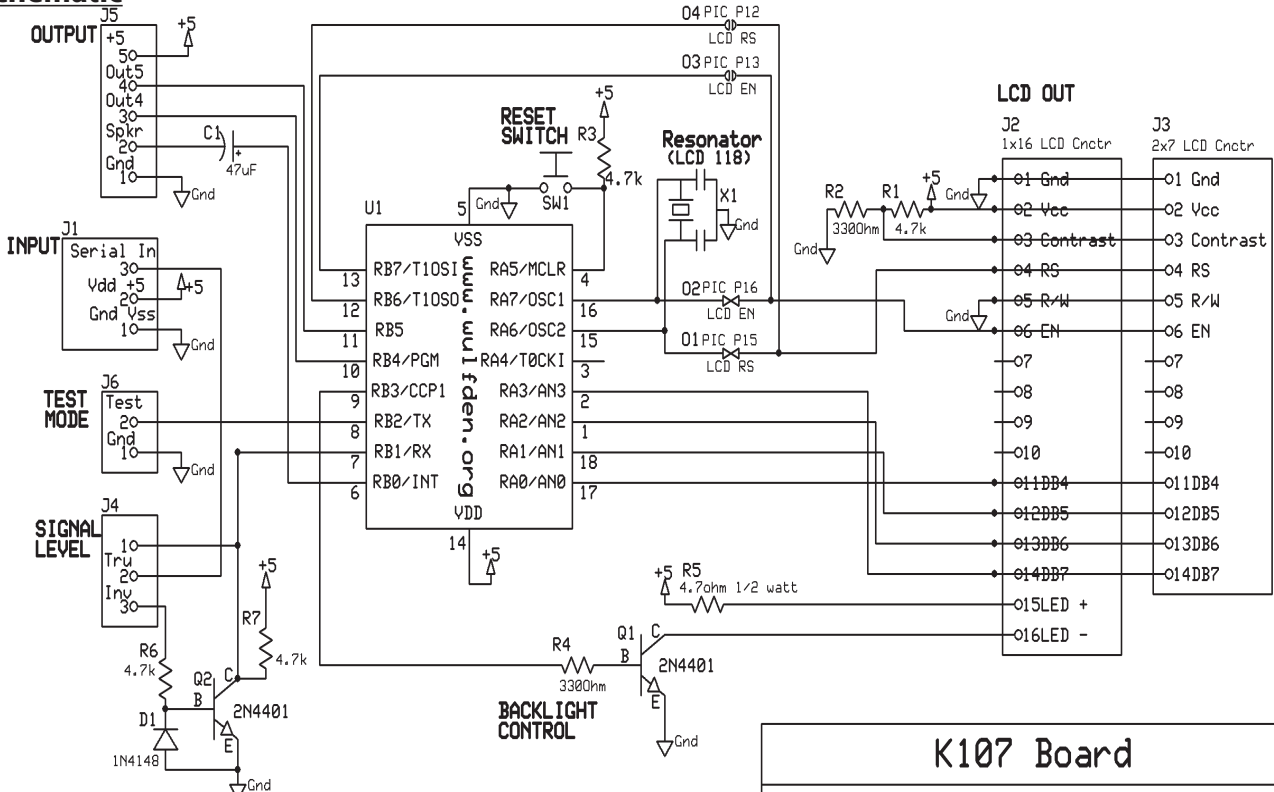
K107 Board		
LCD Controller		
Russ Ferguson	Rev 2 / 5/29/2006	Brian Riley

C Hardware - K107 - Rev 1

Parts Layout

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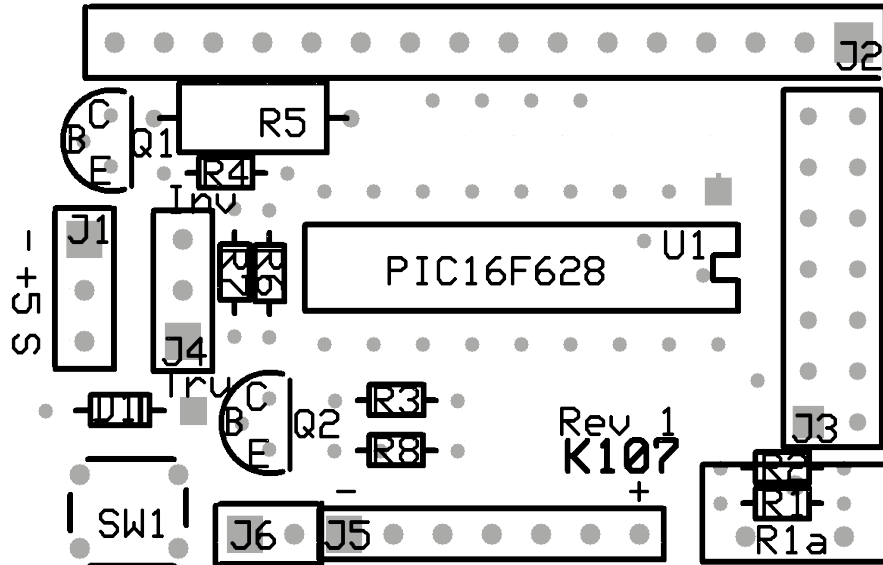
Schematic

D HD44780 Character Set