Appendix

A3

QWIK&LOW BOARD IN DETAIL

The Qwik&Low board was designed by the author, with creative insights from Rick Farmer who developed the board layout and from Bill Kaduck and Dave Cornish of MICRODESIGNS who are producing the board. The Gerber files for the board artwork are freely available from www.qwikandlow.com along with the schematic and parts list for the board.

What follows are a few comments to explain some of the circuitry. The UART circuitry shown in the top left of Figure A3-1 includes an (unpopulated) 3-pin header, H1. The cuttable link on the back of the board between the pins labeled **PC** and **RX** provide the default connection. If a user wants to add a transducer to the board that has a UART output, the link between the **PC** and **RX** pins is cut, a 3-pin header is added to the board, and the UART output from the new device is connected to the **RX'** pin of the header (using #30 wirewrap wire). Then a jumper (i.e., the 100-mil shunt, H2X, in the parts list of Figure A3-2) can be used to connect **PC** to **RX** for downloading user code. The jumper can be moved between **RX'** and **RX** to run the user code.

The **RX'** pin is connected to a 100kΩ pull-up resistor, R4, to ensure that the **RX** input does not float. The input is pulled high to match a transducer with a normal idle-high UART output. In this case, the application program must reinitialize the UART so that **RXDTP** = 0 in the **BAUDCON** register. This undoes QwikBug's inversion of

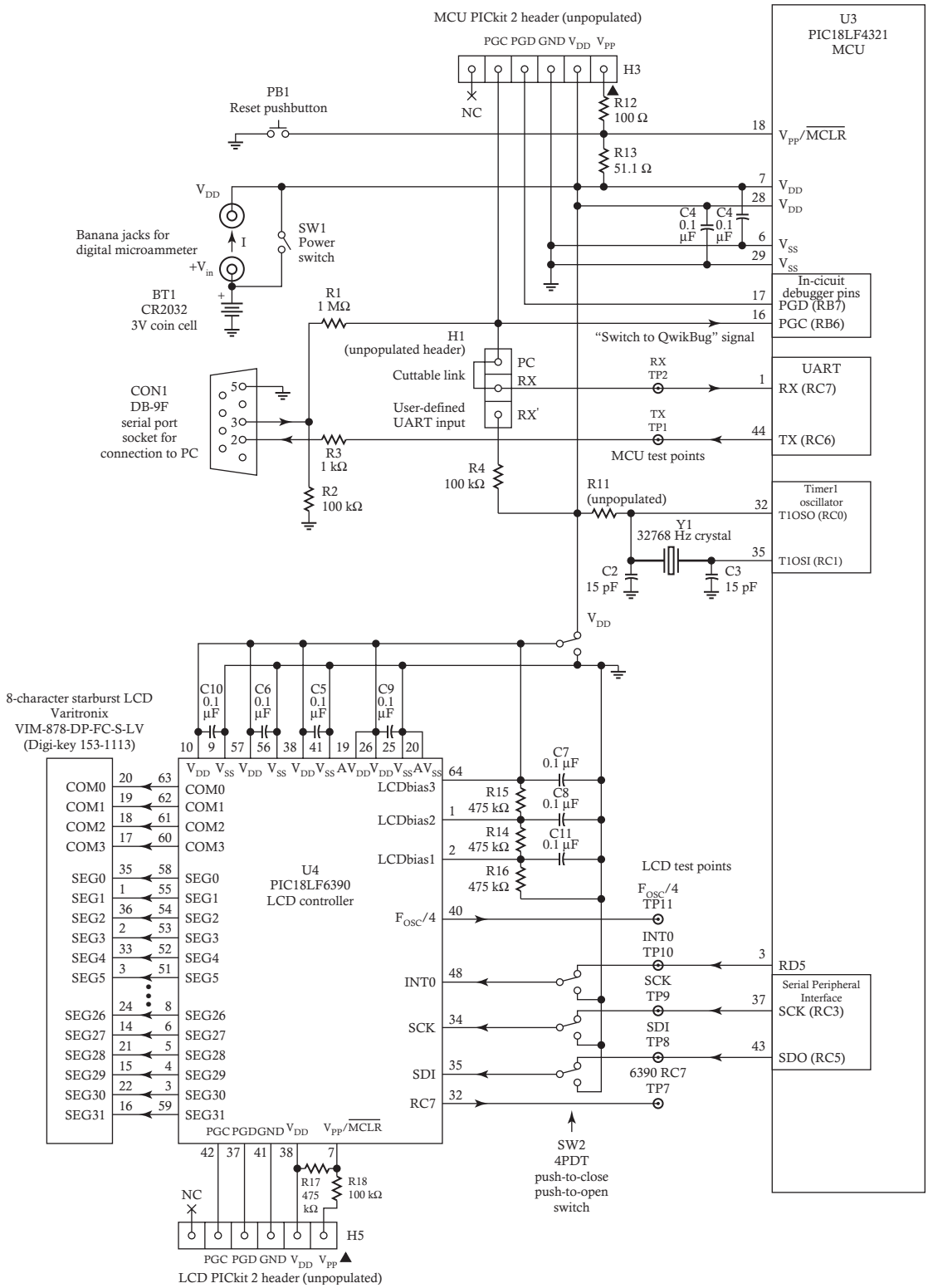

FIGURE A3-1 Qwik&Low schematic

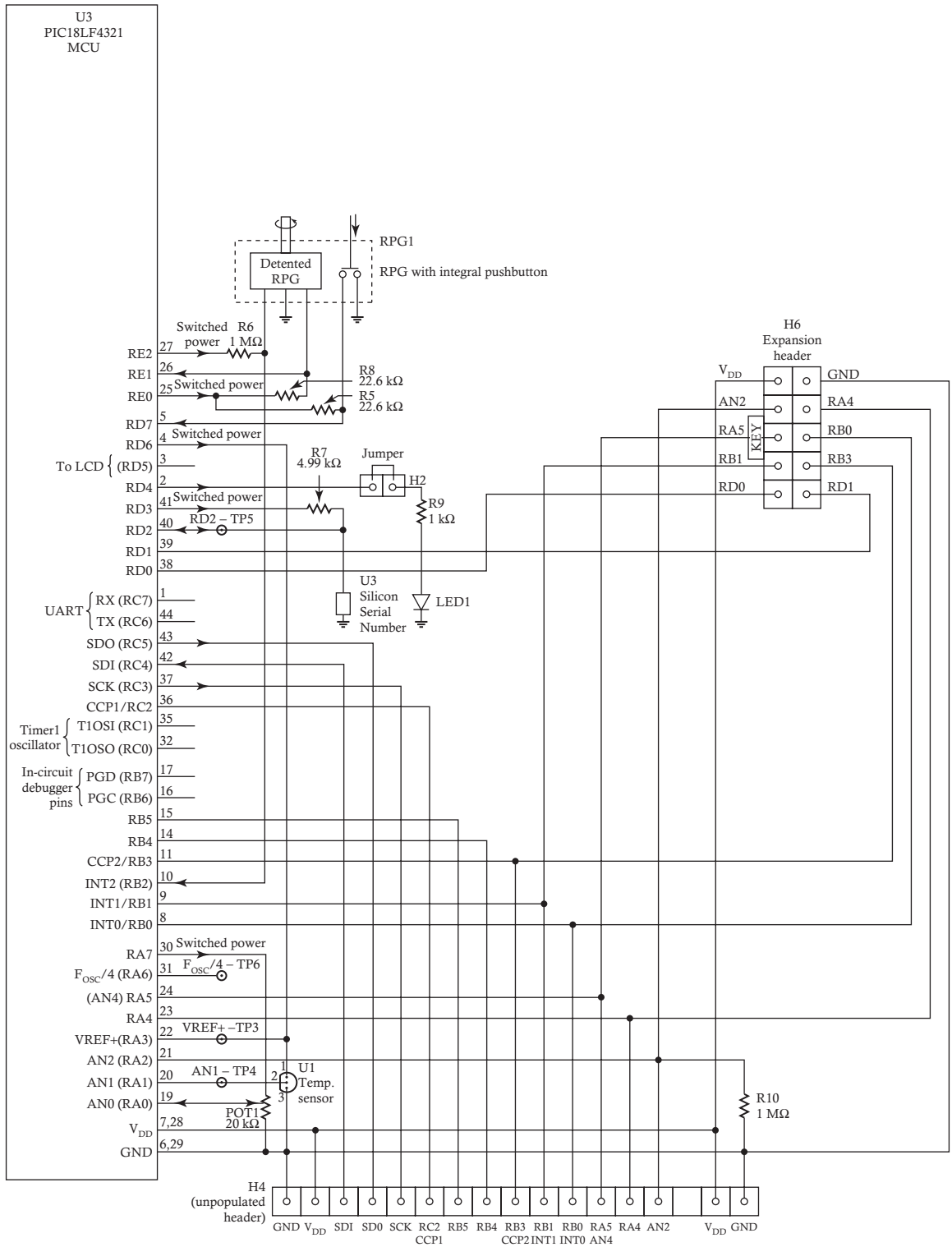

FIGURE A3-1 *(continued)*

Quantity	Order Number	Distributor	Designation	Footprint	Part Description	Manufacturer	Manufacturer's Part Number	Cost Each	Total Cost
1					Qwik&Low board	PCBCART			6.00
2	BC1305CT	Digi-Key	C2,3	1206	15 pf 50V NPO ceramic capacitor	BC Comp.	VJ1206A150JXACW1BC	0.15	0.30
9	311-1179-1	Digi-Key	C1,4,5,6,7,8,9,10,11	1206	0.1uF 50V X7R ceramic capacitor	Yageo	CC1206KRX7R9BB104	0.10	0.90
2	311-100FRCT	Digi-Key	R12,18	1206	100 ohm 1/4W 1% thick film resist.	Yageo	RC1206FR-07100RL	0.09	0.18
2	311-1.00KFRCT	Digi-Key	R3,9	1206	1.00K 1/4W 1% thick film resistor	Yageo	RC1206FR-071KL	0.09	0.18
1	311-4.99KFRCT	Digi-Key	R7	1206	4.99K 1/4W 1% thick film resistor	Yageo	RC1206FR-074K99L	0.09	0.09
2	311-22.6KFRCT	Digi-Key	R5,8	1206	22.6K 1/4W 1% thick film resistor	Yageo	RC1206FR-0722K6L	0.09	0.18
1	311-51.1KFRCT	Digi-Key	R13	1206	51.1K 1/4W 1% thick film resistor	Yageo	RC1206FR-0751K1L	0.09	0.09
2	311-100KFRCT	Digi-Key	R2,4	1206	100K 1/4W 1% thick film resistor	Yageo	RC1206FR-07100KL	0.09	0.18
4	311-475KFRCT	Digi-Key	R14,15,16,17	1206	475K 1/4W 1% thick film resistor	Yageo	RC1206FR-07475KL	0.09	0.36
3	311-1.00MFRCT	Digi-Key	R1,6,10	1206	1.00M 1/4W 1% thick film resistor	Yageo	RC1206FR-071ML	0.09	0.27
		Digi-Key	R11	1206	(leave this unpopulated)				
1	535-9166-1	Digi-Key	Y1		32768 Hz watch crystal	Abracon	ABS25-32.768KHZ-T	1.05	1.05
1	PIC18LF4321-I/PT	Digi-Key	U3	TQFP-44	Microcontroller	Microchip	PIC18LF4321-I/PT	3.37	3.37
1	DS2401P+	Digi-Key	U2	TSOC-6	Silicon Serial Number	Dallas Semi.	DS2401P+	1.52	1.52
1	PIC18LF6390-I/PT	Digi-Key	U4	TQFP-64	LCD controller	Microchip	PIC18LF6390-I/PT	3.27	3.27
								Back of board components =	17.94
1	P605	Digi-Key	LED1	T-1	Red LED, through-hole mounting	Panasonic	LN28RALXU	0.38	0.38
1	AD22103KTZ	Digi-Key	U1	TO-92	Temperature sensor	Analog Dev.	AD22103KTZ	2.86	2.86
1	P4D2203	Digi-Key	POT1	POT_HFAA	20K Thumbwheel POT	Panasonic	EVL-HFAA06B24	2.07	2.07
1	A32117	Digi-Key	CON1		Female DB-9 socket	Tyco AMP	5747844-4	2.72	2.72
1	153-1113	Digi-Key	LCD1	2" x 1"	8-char starburst LCD	Varitronix	VIM-878-DP-FC-S-LV	2.92	2.92
1	BH32T-C	Digi-Key	BT1		CR2032 coin cell holder	MPD	BH32T-C	1.04	1.04
1	P189	Digi-Key	BT1X		CR2032 coin cell	Panasonic	CR2032	0.25	0.25
2	J147	Digi-Key		1/4" Dia hole	Nickel plated banana jack	Johnson	108-0740-001	1.48	2.96
1	EG1874	Digi-Key	SW2		4PDT push-on, push-off switch	E-Switch	TL4201EEYA	2.44	2.44
1	A26512-40	Digi-Key	H1	SIP100_3P	(leave this unpopulated)				
1	A26512-40	Digi-Key	H2	SIP100_2P	Male straight 2-pin header	Tyco AMP	4-103239-0	0.10	0.10
1	S9001	Digi-Key	H2X		100 mil shunt	Sullins	SPC02SYAN	0.12	0.12
2	A26512-40	Digi-Key	H3,5	SIP100_6P	(leave these unpopulated)				
1	A26512-40	Digi-Key	H4	SIP100_17P	(leave this unpopulated)				
1	HRP10H	Digi-Key	H6		Male shrouded 5x2 pin header	Assmann	AWHW10G-0202-T-R	0.59	0.59
1	855-0017	Allied	PB1		Sealed pushbutton switch	Cannon	KSA0M211 LFT	0.34	0.34
1	688-EC11G1524402	Mouser	RPG1		Detented RPG-PB switch comb.	ALPS	EC11G1524402	2.19	2.19
1	108-0051-EVX	Mouser	SW1	SIP100_3P	SPDT toggle switch	Mountain Sw.	108-0051-EVX	1.97	1.97
4	517-SJ-5003BK	Mouser			Four rubber bumpers for feet	3M	SJ-5003 (BLACK)	0.13	0.52
								Remaining components =	23.47
								Total =	41.41

FIGURE A3-2 Qwik&Low parts list

the **RX** input. If a transducer is used with a UART output that idles low, the R4 resistor should be removed from the board.

One interesting addition to the board is a 12-key (0–9, *, #) keypad with an 80¢, 14-pin PIC16F505 microcontroller providing:

- The decoding of the keypad.
- A bit-banged UART interface.

The CPU clock of the PIC16F505 is 1 MHz ± 2%. This is sufficiently accurate so that if an output pin is changed appropriately at intervals of

$$1{,}000{,}000/19{,}200 = 52.08333\ \mu s \approx 52\ \mu s$$

then the MCU will read this serial input exactly as it would from a 19,200 baud UART.

The Timer1 crystal oscillator circuitry shown in Figure A3-1 immediately below the UART circuitry includes pads labeled R11. The intent is to make it possible to add a high-impedance (e.g., ≈ 3 MΩ) resistor, to try to get the Timer1 oscillator to run reliably with the

```
# pragma config LPT10SC = ON
```

configuration choice. This choice, the reliability of which has not been thoroughly explored, would decrease the current draw of the Timer1 oscillator and the Timer1 counter from about 6 μA to 1 μA. That low-power oscillator configuration is meant to run with a 5 V supply, not the 3 V supply of the Qwik&Low board. A Microchip application engineer intimately involved with the oscillator design suggested this pull-up resistor modification.

The unpopulated H4 header provides test points for the pin of a scope probe, to test user-generated outputs (e.g., for a pulse-width measurement on the **RC2** or **RB0** pin). The unpopulated header also provides solder points for an add-on part installed on the surface-mount pads located on the front or the back of the board. Point-to-point wiring with #30 wirewrap wire can produce a clean job of the addition. Be sure to remove any solder flux, especially if water-soluble (i.e., conductive) flux is used.

The prototype area on the board allows DIP parts and discrete parts to be added easily. For surface-mount parts that do not fit on the available surface-mount patterns (e.g., an SOIC part with up to 28 pins), consider the use of one of the surface-mount-to-DIP adapters available from www.beldynsys.com.

The test points dispersed over the board are designed for the pin probe of a scope. $F_{OSC}/4$, the CPU clock for each of the PIC microcontrollers on the board, allows a user to gauge the awake/sleep behavior of each chip under varying circumstances.

An output pin on the MCU can be employed in a user program to monitor time intervals of interest. In like manner, one of the few free output pins of the LCD controller, **RC7**, can be monitored. TP7 is such a test point, located near the right edge of the board below TP8. It is unlabeled (but can be probed) on the front of the board. It is labeled on the back of the board. The intent is to be unobtrusive for normal use of the board, but available for users who wish to explore modifications to the LCD controller's program code.

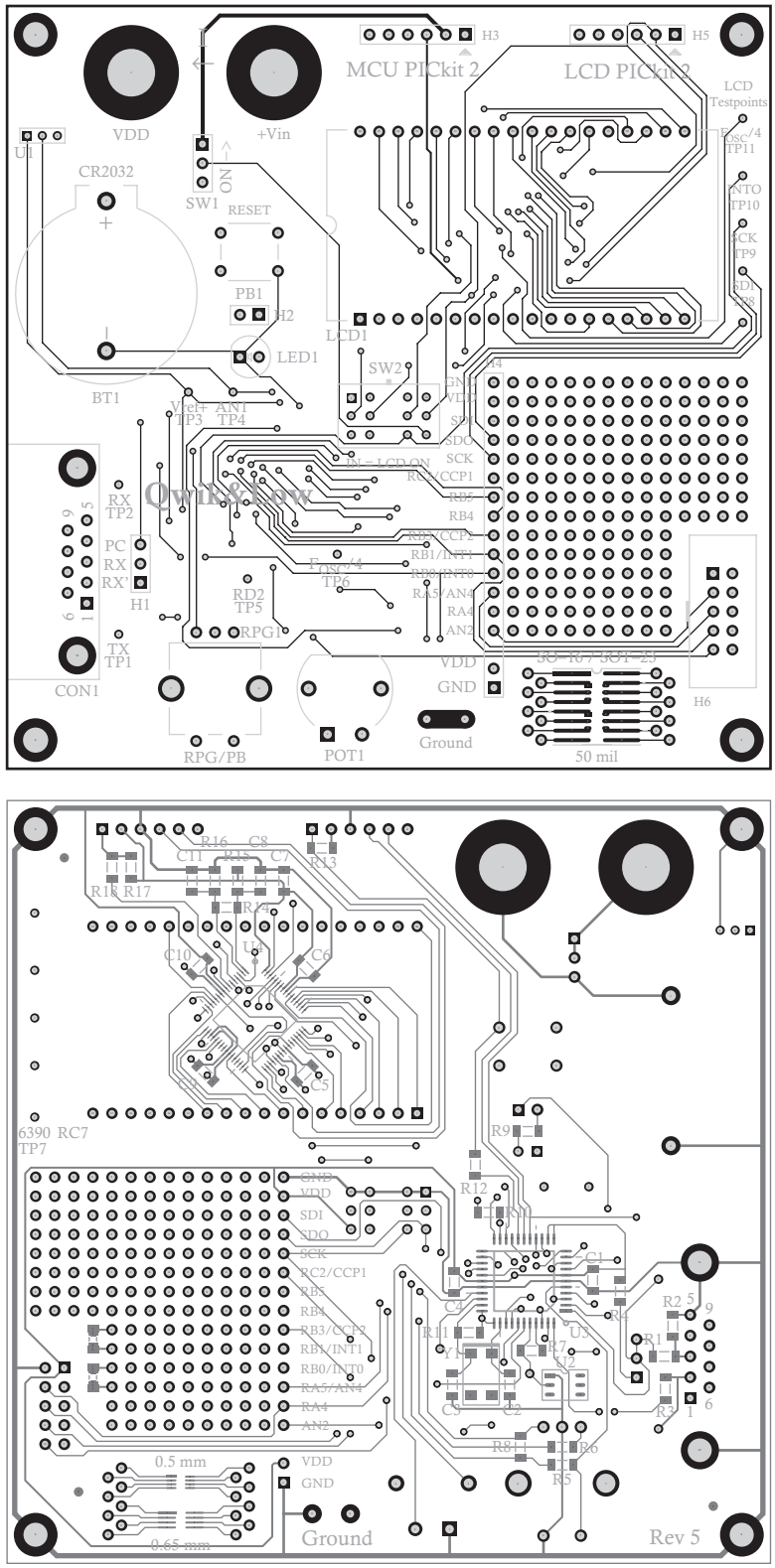

FIGURE A3-3 Front and back of Qwik&Low board

The parts list includes the same Digi-Key part number, A26512-40, for all of the single-in-line (SIP) headers, H1, H2, H3, H4, and H5. This part is actually a 40-pin strip that is designed to be cut with diagonal cutters into headers having the desired number of pins.

The parts list shows the Qwik&Low board as being manufactured by PCBCART (www.pcbcart.com), a vendor for having low-cost, high-quality boards made in China with a nominal two-week delivery schedule. The $6.00 price shown in Figure A3-2 was the approximate unit price with an order for 30 boards. The Gerber files on the www.qwikandlow.com website can be used to place an order for boards. However, proceed cautiously! As the artwork of Figure A3-3 for the front and the back of the board illustrates, the surface-mount parts for the back of the board, particularly the two PIC microcontrollers, call for considerable experience in dealing with fine-pitch parts. Also, when completed, a PICkit 2 programmer must be available to program the two chips. Before undertaking such a venture, be sure to consider the alternative of purchasing a built and tested board from www.microdesignsinc.com.

Chris Bruhn and Peter Ralston have developed a Performance Verification program, PV.c, available from the www.qwikandlow.com website. This program can be compiled, loaded via QwikBug, and run. It initially sends the serial number from the DS2401 chip (Chapter Fifteen) to the QwikBug console, verifying both the chip and the serial interface. It then runs the LCD display through four quick tests before moving on to display the temperature, and to verify the operation of the Timer1 oscillator and the operation of the potentiometer/ADC combination. If the Timer1 oscillator is working correctly, the middle number on the display will increment every second. The LED also blinks every second. As the potentiometer is turned from full CCW to full CW, the right-hand number changes from 00 to FE or FF. Turning the RPG turns on individual segments of the LCD, verifying that no adjacent pins of the display are shorted together. Turning the RPG clockwise or counterclockwise also increments/decrements a number sent to the QwikBug console. The LED is turned on in response to the pressing of the RPG's pushbutton. The current draw of the board while running this program (with the LED jumper removed and the LCD switched off) is about 20 μA.