

Notes for the PIC based altimeter by Richard Ottosen.

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The documentaion lies about what comparator (U2) is used. Note that there is no amplification from the sensor bridge to the comparator. This means that a foot of altitude change is represented by just a few microvolts! Obviously, the comparator performance is very critical and needed some playing with to get best performance. The "comparator" used is really an operational amplifier made by Texas Instruments number TLC277CP. Since the op-amp is not open collector like the LM393, the pullups (R12 and R13) are not needed.

The timing cap (C5) value was chosen from some I had in my stock. This value had to be large partly because of the relatively low input impedance of the original LM393 comparator. With the TLC277CP used as a comparator, the timing cap can probably be made smaller and the timing resistance (R7 and R9) made larger. Make sure that the timing cap is a mylar or similar quality cap. Do NOT use a ceramic cap.

Another modification I did to the original circuit is to add temperature compensation to the pressure sensor bridge (X1). This entails breaking the connection to pin 3 of the sensor and putting 3 series diodes (1N4148) across the break with the cathodes facing the sensor. The timing cap was increased to .33uF to allow for the smaller signal caused by the lower voltage exciting the bridge.

The hysteresis resistors shown on the schematic as R10 and R11 were not needed in the boards that I actually built. I left them out with no noticable problems.

Note that the A/D capacitor is charged non-linearly. This causes the displayed pressures to be somewhat inaccurate. However, the exponential charge curve does linearize the altimeter measurement. I have some notes on a better circuit to make both measurements accurate.

I have also worked on a version of the code for a PIC16C84 that stores the gain and offset settings in the internal EEPROM. Also I at the same time, I have been working on a version that accepts the high level signal from a conditioned transducer. More to follow when I get a chance...

Other possible changes:

Do data logging into RAM of a PIC with more RAM or into the EEPROM of the PIC16C84.

Get rid of the push button since the serial LCD terminal now sends codes for button presses.

One final confession. There is an oops in the Baud rate in the code that is distributed. The 9600 Baud setting is really 4800 Baud. This is caused by my not dividing by 8 properly in my head. The code can do 9600 baud with a trivial modification to the program.

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I also have some raw drawings for a printed circuit layout that I did for through hole components. These drawings are better than starting from nothing.

I used a Sensym pressure transducer in the original design. Digi-Key (phone: 1-800-344-4539) now has a transducer (part number 11025) that may work. It is a surface mount device which makes it harder to work with. An all surface board would make a really nice, compact package.

Some thoughts on how to calibrate the altimeter:

Note that the calibration procedure on the schematic is using absolute pressures. Obtaining this large vacuum (as much as 10 PSI) may not be easy. It is easy, however, to obtain a small vacuum with a syringe if the volume of the tubing and chamber are small enough..

Therefore, I suggest using a small plastic bottle which is just big enough to hold the altimeter. This is your "bell jar". To reduce the volume to be evacuated, fill the empty space in the jar with plastic beads from a hobby store. Install a fitting into the lid for the reference pressure gauge and the syringe. Glue a connector for the power and serial signals into the bottle.

Use a large syringe to create the vacuum. When the jar is properly sealed, pulling out on the syringe is just like pulling against a spring. You should be able to hold the syringe for several seconds and when you release it, the plunger should go back to its original position.

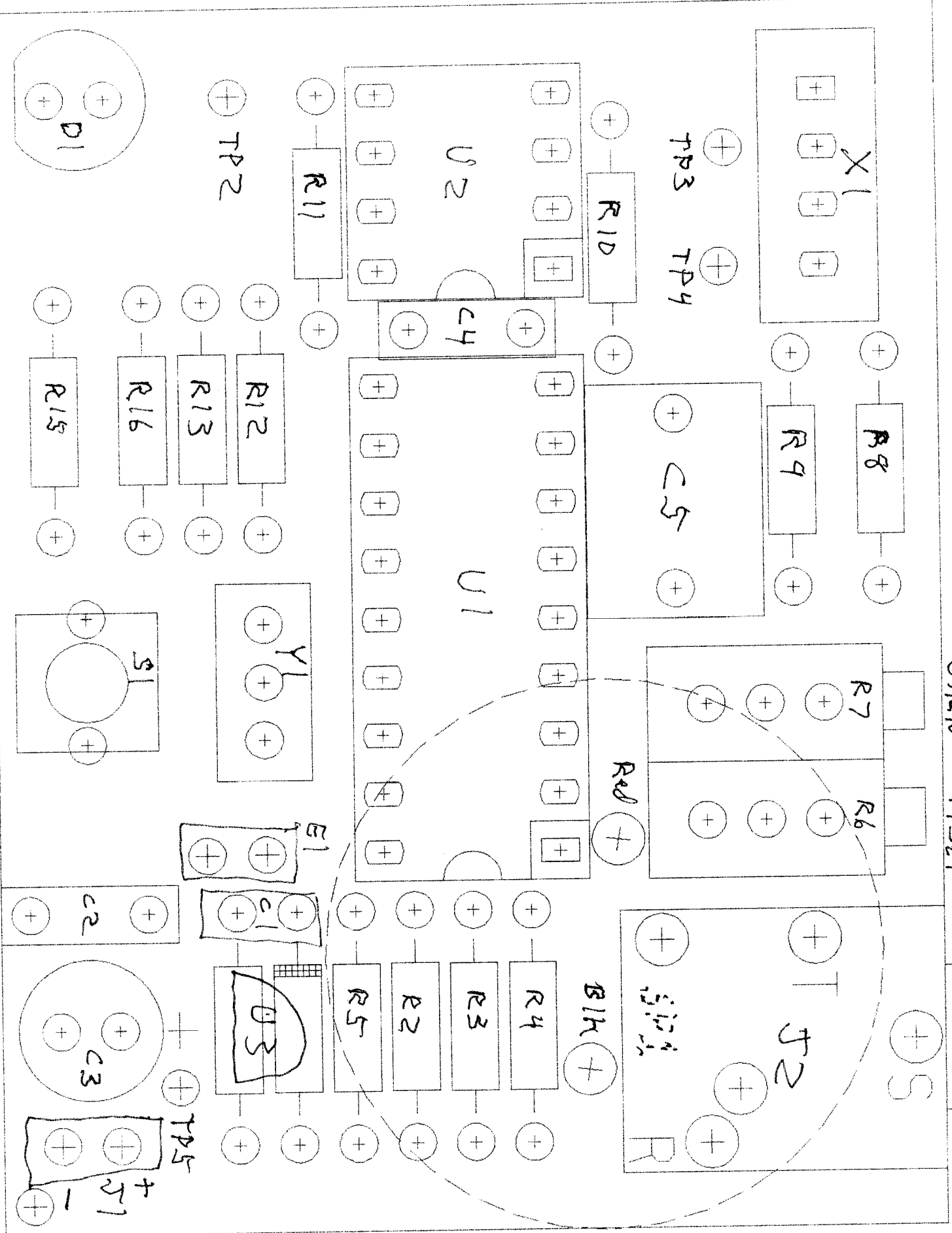
Warning!! Even a small vacuum can cause a huge pressure on the jar.

Do the calibration at only 1 or 2 pounds below ambient air pressure. This is safer and also easier to do with the syringe.

Another way to get data into and out of the bell jar, is to use infrared LED's and phototransistors. The TxD line from both the PIC and the RS-232 port can directly drive an LED. The photo transistor will need a resistor from the emitter to ground and about +9 volts to the collector. The output from the emitter is noninverting as required by the PIC software. Use a clear bottle that is big enough to hold the altimeter and its battery.



GAIN OFFSET



TP1



Item	Qty	Part	Description	Ref desig
0	0	12630	ASSY, ALTIMETER	-
1	1	12631	BOARD, ALTIMETER	-
2	1	11220	BATTERY, ALKALINE, 9V, 500MAH	B1
3	3	11112	CAP, MONO, .1UF, 50V	C1,2,4
4	1	12635	CAP, FILM, .27UF, 50V, 5%	C5
5	1	12315	CAP, ELECT, 220UF, 10V	C3
6	1	11221	CONN, BATTERY CLIP, 9V	J1
7	1	12629	CONN, HEADER, 2 PIN, SINGLE, STRAIGHT	E1
8	1	12450	CONN, JUMPER, SHORTING	(E1)
9	1	12585	CONN, PHONE, JACK, 3.5MM, STEREO, PC	J2
10	1	11181	DIODE, LED, RED, SMALL	D1
11	1	12636	ENCLOSURE, PLAST, 3.75X2.31X1, W/BAT	-
12	1	12259	IC, INTERFACE, LM393	U2
13	1	12617	IC, MICRO, PIC16C54, XTAL, OTP	U1
14	1	12632	IC, REGULATOR, LM2931AZ-5.0, TO-92	U3
15	1	11426	RES, 330 OHM, 1/4W, 5%	R4
16	1	11218	RES, 2.2K, 1/4W, 5%	R16
17	2	11515	RES, 22K, 1/4W, 5%	R12,13
18	1	11518	RES, 33K, 1/4W, 5%	R2
19	3	11683	RES, 100K, 1/4W, 5%	R5,8,15
20	1	11687	RES, 180K, 1/4W, 5%	R3
21	1	11690	RES, 270K, 1/4W, 5%	R9
22	2	11786	RES, 10M, 1/4W, 5%	R10,11
23	2	12633	RES, VARIABLE, 500K, TOP	R6,7
24	1	11198	SOCKET, DIP, 8 PIN	(U2)
25	1	11300	SOCKET, DIP, 18 PIN	(U1)
26	1	11178	SWITCH, PUSH BUTTON, N.O., PC, RUBBER	S1
27	1	12168	SWITCH, TOGGLE, SPDT, PC, HORIZ, R.A.	S2
28	1	11377	TAPE, DOUBLE STICKY, FOAM, 1/2" WIDE	(SP1)
29	5	11348	TERMINAL, TEST POINT	TP1-5
30	1	12634	TRANSDUCER, PRESSURE, 15PSI, ABS	X1
31	1	12004	TRANSDUCER, BEEPER, PZT, 4KHZ	SP1
32	1	12236	XTAL, CERAMIC RESONATOR, 4MHZ	Y1

Item	Qty	Part	Description	Manufact	Manu part num
0	0	12630	ASSY, ALTIMETER	Rho Ent.	12630
1	1	12631	BOARD, ALTIMETER	Rho Ent.	12631
2	1	11220	BATTERY, ALKALINE, 9V, 500MAH	Panasonic	6AM6X
3	3	11112	CAP, MONO, .1UF, 50V	Kemet	C323 C104M5R5CA
4	1	12635	CAP, FILM, .27UF, 50V, 5%	Panasonic	ECQ-V1H274JL
5	1	12315	CAP, ELECT, 220UF, 10V	Panasonic	ECE-A1AU221
6	1	11221	CONN, BATTERY CLIP, 9V	Radio Shack	270-325
7	1	12629	CONN, HEADER, 2 PIN, SINGLE, STRAIGHT	Digi-key, Sullin	S1012-2-ND
8	1	12450	CONN, JUMPER, SHORTING	3m	929955-06
9	1	12585	CONN, PHONE, JACK, 3.5MM, STEREO, PC	Mouser	161-3501
10	1	11181	DIODE, LED, RED, SMALL	Panasonic	LN28RP
11	1	12636	ENCLOSURE, PLAST, 3.75X2.31X1, W/BAT	Radio Shack	270-293
12	1	12259	IC, INTERFACE, LM393	National Semi.	LM393N
13	1	12617	IC, MICRO, PIC16C54, XTAL, OTP	Microchip	PIC16C54-XT/P
14	1	12632	IC, REGULATOR, LM2931AZ-5.0, TO-92	National Semi.	LM2931AZ-5.0
15	1	11426	RES, 330 OHM, 1/4W, 5%	R-ohm	R25J 330
16	1	11218	RES, 2.2K, 1/4W, 5%	R-ohm	R25J 2.2K
17	2	11515	RES, 22K, 1/4W, 5%	R-ohm	R25J 22K
18	1	11518	RES, 33K, 1/4W, 5%	R-ohm	R25J 33K
19	3	11683	RES, 100K, 1/4W, 5%	R-ohm	R25J 100K
20	1	11687	RES, 180K, 1/4W, 5%	R-ohm	R25J 180K
21	1	11690	RES, 270K, 1/4W, 5%	R-ohm	R25J 270K
22	2	11786	RES, 10M, 1/4W, 5%	R-ohm	R25J 10M
23	2	12633	RES, VARIABLE, 500K, TOP	???	???
24	1	11198	SOCKET, DIP, 8 PIN	Augat	208-AG29D2
25	1	11300	SOCKET, DIP, 18 PIN	Augat	218-AG29D2
26	1	11178	SWITCH, PUSH BUTTON, N.O., PC, RUBBER	Alps	KEF 10902
27	1	12168	SWITCH, TOGGLE, SPDT, PC, HORIZ, R.A.	???	???
28	1	11377	TAPE, DOUBLE STICKY, FOAM, 1/2" WIDE	3m	110
29	5	11348	TERMINAL, TEST POINT	Mouser	ME151-201
30	1	12634	TRANSDUCER, PRESSURE, 15PSI, ABS	Sensym	SX15A
31	1	12004	TRANSDUCER, BEEPER, PZT, 4KHZ	Murata	PKM35-4AO
32	1	12236	XTAL, CERAMIC RESONATOR, 4MHZ	Panasonic	EFO-GC4004A4

Item	Qty	Part	Description	Each	Total
0	0	12630	ASSY, ALTIMETER	50.00	0.00
1	1	12631	BOARD, ALTIMETER	3.00	3.00
2	1	11220	BATTERY, ALKALINE, 9V, 500MAH	3.18	3.18
3	3	11112	CAP, MONO, .1UF, 50V	0.22	0.66
4	1	12635	CAP, FILM, .27UF, 50V, 5%	0.27	0.27
5	1	12315	CAP, ELECT, 220UF, 10V	0.22	0.22
6	1	11221	CONN, BATTERY CLIP, 9V	0.25	0.25
7	1	12629	CONN, HEADER, 2 PIN, SINGLE, STRAIGHT	0.52	0.52
8	1	12450	CONN, JUMPER, SHORTING	0.30	0.30
9	1	12585	CONN, PHONE, JACK, 3.5MM, STEREO, PC	1.00	1.00
10	1	11181	DIODE, LED, RED, SMALL	0.20	0.20
11	1	12636	ENCLOSURE, PLAST, 3.75X2.31X1, W/BAT	3.99	3.99
12	1	12259	IC, INTERFACE, LM393	0.51	0.51
13	1	12617	IC, MICRO, PIC16C54, XTAL, OTP	3.20	3.20
14	1	12632	IC, REGULATOR, LM2931AZ-5.0, TO-92	1.05	1.05
15	1	11426	RES, 330 OHM, 1/4W, 5%	0.05	0.05
16	1	11218	RES, 2.2K, 1/4W, 5%	0.05	0.05
17	2	11515	RES, 22K, 1/4W, 5%	0.05	0.10
18	1	11518	RES, 33K, 1/4W, 5%	0.05	0.05
19	3	11683	RES, 100K, 1/4W, 5%	0.05	0.15
20	1	11687	RES, 180K, 1/4W, 5%	0.05	0.05
21	1	11690	RES, 270K, 1/4W, 5%	0.05	0.05
22	2	11786	RES, 10M, 1/4W, 5%	0.05	0.10
23	2	12633	RES, VARIABLE, 500K, TOP	0.95	1.90
24	1	11198	SOCKET, DIP, 8 PIN	0.15	0.15
25	1	11300	SOCKET, DIP, 18 PIN	0.24	0.24
26	1	11178	SWITCH, PUSH BUTTON, N.O., PC, RUBBER	0.25	0.25
27	1	12168	SWITCH, TOGGLE, SPDT, PC, HORIZ, R.A.	5.00	5.00
28	1	11377	TAPE, DOUBLE STICKY, FOAM, 1/2" WIDE	0.03	0.03
29	5	11348	TERMINAL, TEST POINT	0.15	0.75
30	1	12634	TRANSDUCER, PRESSURE, 15PSI, ABS	20.00	20.00
31	1	12004	TRANSDUCER, BEEPER, PZT, 4KHZ	1.42	1.42
32	1	12236	XTAL, CERAMIC RESONATOR, 4MHZ	0.92	0.92
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