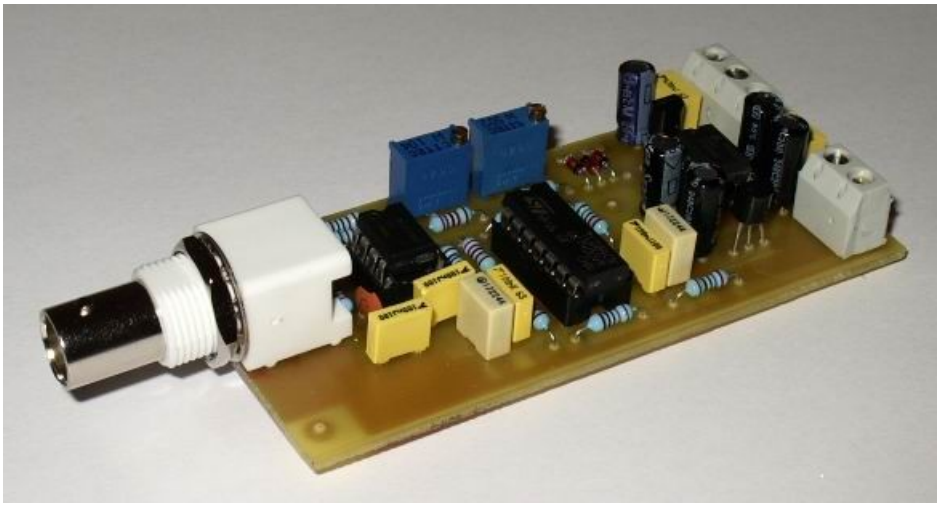
PH Probe for the PIC Temperature Controller

This is a ph probe amplifier designed to match any standard PIC micro analogue input port, as originally used on a PIC 16F and 18F Aquarium Temperature Controller I built some time ago.

It can accept any standard bnc ph probe and has proven to give good reliable result.

It requires manual calibration and does not have or need temperature compensation when used in the aquarium.

No programming code is given, as its very simple, but some guide notes are detailed later.



the ph amplifier pcb

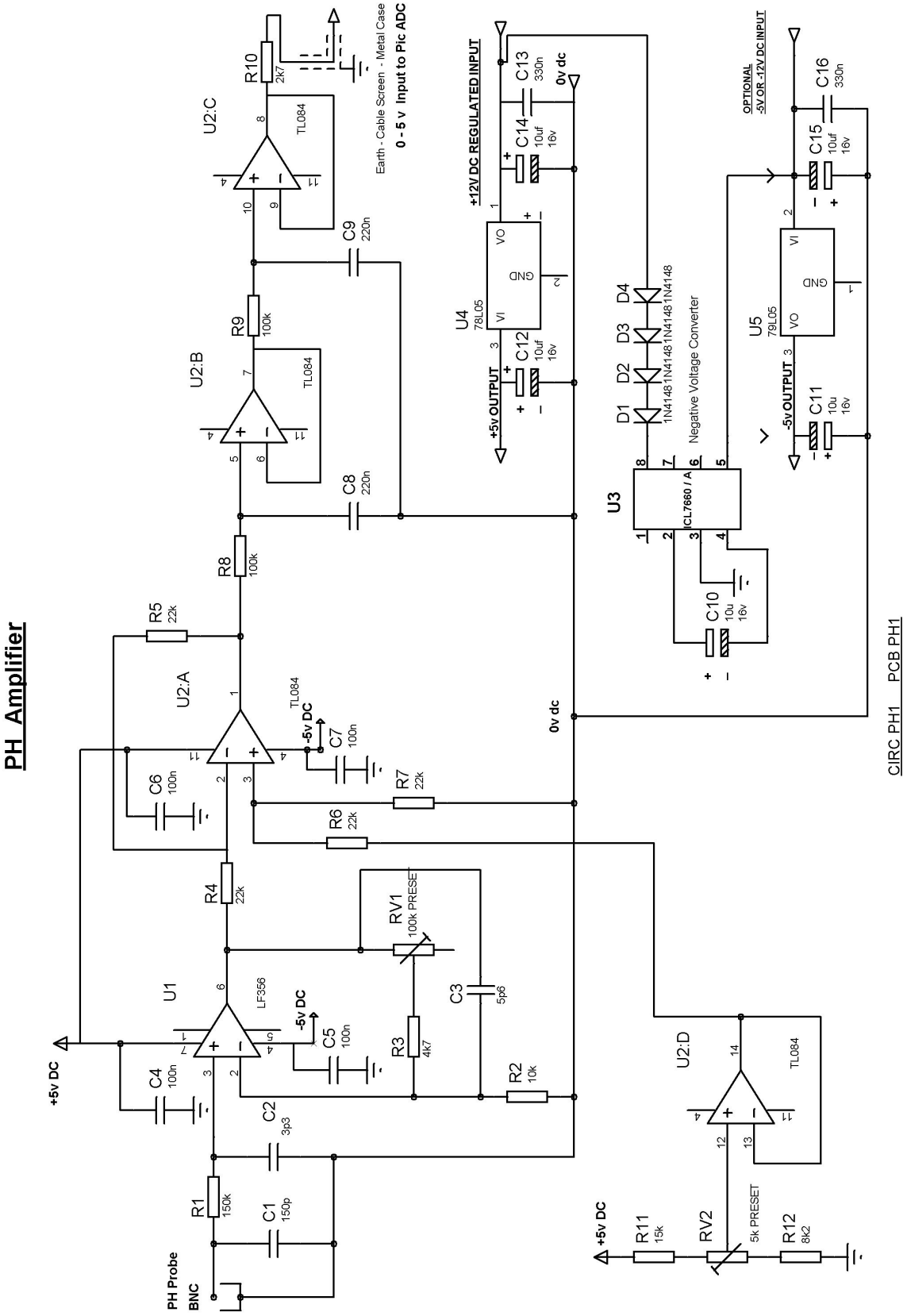
- low cost and easily obtained parts
- on board manual calibration for ph 7 and ph 4/10
- runs from a standard +12v dc regulated power source
- resolution and accuracy of 0.02ph

Program Control (this is how I programmed mine)

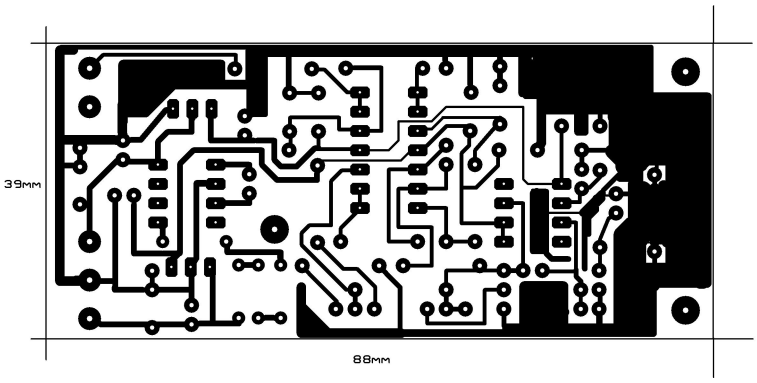
- automatic control of the ph dosing, upwards or downwards
- a selectable 24 hour timer
- a ph dosing on/off control

PART1 **2**

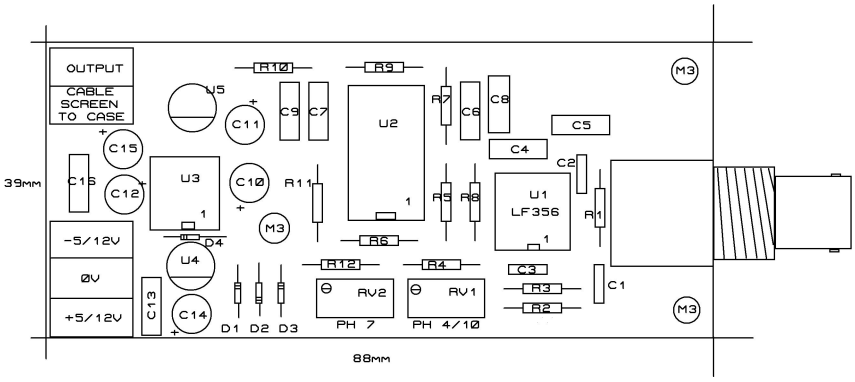
Circuit diagram



PH AMP TOP VIEW – LOOKING DOWN AT COPPER TRACKS THROUGH THE BOARD



SCREEN VIEWS MAY NOT BE TO SCALE



PH AMPLIFIER Parts List

BNC PCB SOCKET			1
R 10	2K7	All Resistors .25w or .4w or .6w	1
R 3	4k7	Metal Film 1% - if possible	1
R 12	8k2		1
R 2	10K		1
R 11	15 K		1
R 4,5,6,7	22k		4
R 8,9	100K		2
R 1	150k		1
RV1	100K Preset	18/22 turn cermet top trimmer	1
RV2	5K Preset	18/22 turn cermet top trimmer	1
C 2	3p3	Ceramic capacitor	1
C 3	5p6		1
C 1	150 p		1
C 4,5,6,7	100 nf	Polyester or similar capacitor	4
C 8,9	220 nf		2
C 13,16	330 nf	220nf or 470nf also ok	2
C 10,11,12,14,15	10 uf 16 or 25v	Electrolytic capacitor	5
IC1	LF356		1
IC2	TL084		1
IC3	ICL7660 or ICL7660A	Either version ok	1
IC4	78L05	100ma +5v Regulator	1
IC5	79L05	100ma -5v Regulator	1
D 1,2,3,4,	1N4148 or 1N914	Diode	4
IC SOCKET	14 PIN DIL		2
IC SOCKET	8 PIN DIL		1
PH PROBE	With BNC connector	Quality - see text	1
Optional Connectors			
CON1	3 way	5 mm pcb terminal	1
CON2	2 way	5 mm pcb terminal	1
Metal Case	To suit	Or housed in PCB07s metal case	1
PCB Lacquer		Or similar spray coating	1

Parts Buying

In North America the 5K pre-set RV2 seems not readily available - so use a 10K version and change R11 to 10k to compensate.

PH Probes

If, as I was, you are new to PH probes, an important point about probe Accuracy.

Most probes of whatever quality will calibrate at 7ph and 10 or 4 ph.
You would then expect that any reading in between these two calibrated points to be linear.
Well, this is where the Accuracy parameter of the probe comes in, a good quality probe with a specified accuracy of + - 0.01ph will give good results for reef keeping.

However some of the cheaper probes can have much poorer accuracy figures up to + - 0.2ph

There are many probes to choose from, but for your initial probe I would suggest you buy a good quality one like, for example, the PinPoint one, who on asking, stated an Accuracy of 0.01PH. http://www.americanmarineusa.com/ -accessories page

A generic probe from here- also gave good results:-
http://www.reefdreams.co.uk/acatalog/Replacement-Probes-Electrodes.html

The following link provides some helpful information about probes and calibrations.
http://www.reefkeeping.com/issues/2005-02/rhf/interindex

Construction and Testing

Construction should be straight forwards - once done, check the voltages before inserting the 3 ics.
First test for +12v and +5v from the U4 regulator.
Insert just the 7760 chip and check that you get -5v from the U5 regulator.

Insert the other chips and measure the current on the +12v input - this should be about 25ma + -3ma

To test the operation, set both trimmers to their midway position, connect the BNC Input to the 0v rail.
With a voltmeter on the output connector adjust RV2 , PH 7 , until you get a reading of 1.709 Volts. - approx.
This should give a reading of about 7.00 PH on the controllers lcd.

Being a very high impedance amplifier it is important you take reasonable steps to avoid problems -

Once you prove the board working, spray at least the copper side with a lacquer or conformal coating to prevent any slight shorts that can be caused by fingers/marks or the slightest moisture etc.
If you spray the component side, mask off the body of U3, U4 and U5 so they do not overheat

Use a screened lead for the output and ideally house the unit in its own earthed metal box to avoid any electrical interference.

Calibration

General guide - refer also to the notes from your ph probe and calibration solutions.

For a new probe, suggest you connect it to the powered amplifier and place the probe in the tank overnight.
If not, ensure they are powered and the probe in the water for at least 30 minutes.
Also check its calibration a couple of times during the first week

Enter the Calibration mode on the Temp Controller.

Using new PH 7 and 4 or 10 solutions, dependant on your requirements, calibrate the unit at PH7 first by adjusting with RV2, then check and adjust at PH 4 or 10 using RV1.

Repeat the sequence to get the exact settings.

Note in calibration mode the ph value may show some slight signs of jitter on the last digit - this is normal.

Try and keep the calibration fluids at the same temperature as the tank water – in a tray of warm water etc.

Allow at least 2 minutes in the solution before making the adjustment.

Rinse the probe in tepid RO or deionised water between each calibration fluid.

The keywords here are take your time and be patient

Programming notes

The amplifier was designed to run on a standard Pic 10 bit Analogue port using +5v dc.

This gives 1024 steps on 5v ,but with the ph amplifier, a standard ph probe will give 0 -14 ph in 0 - 3.148v

So your programming must work from, 0 – 3.148v as being 0 -14ph, over 700 steps = 0.02ph per step.
3.149 – 5.00 v, the last 324 steps simply not being used.

When reading and displaying you adc/ph value you will find that the results, if read off, one after another will vary slightly - to avoid this problem, simply run the adc result into a simple average routine over 16 or more readings, with a short delay, eg 100ms+ , between each reading.