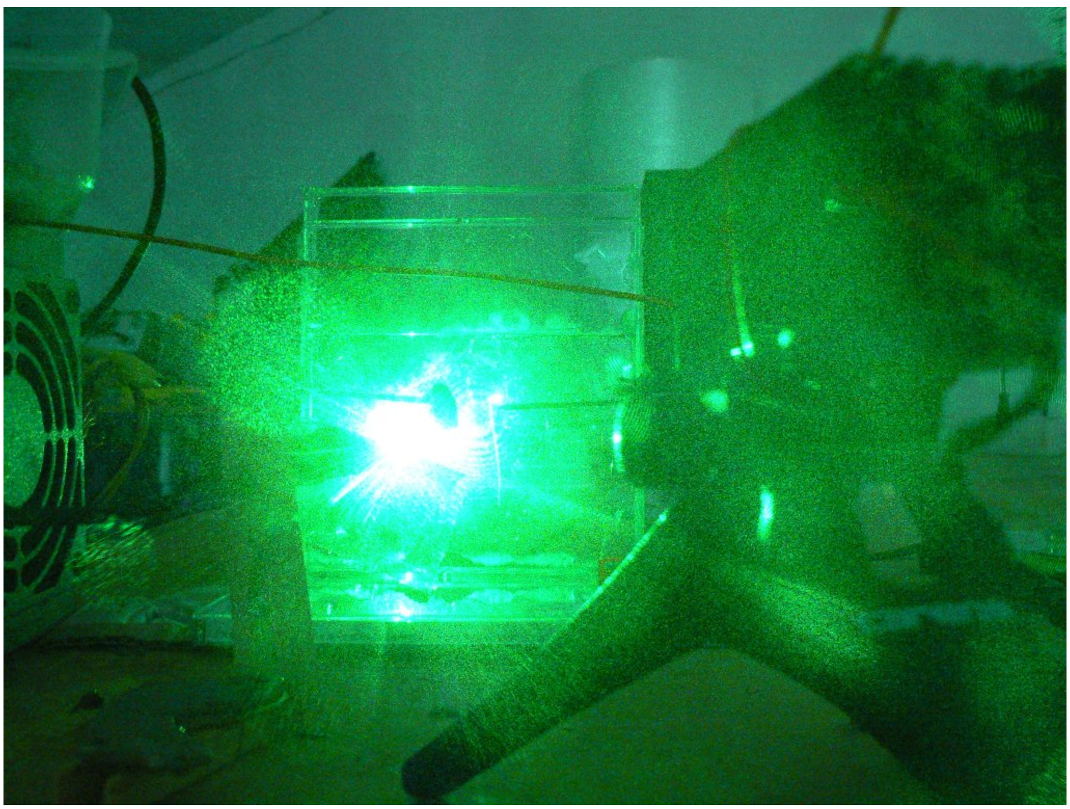
The Garage Log2 (August to October 2012)

Martin Howse

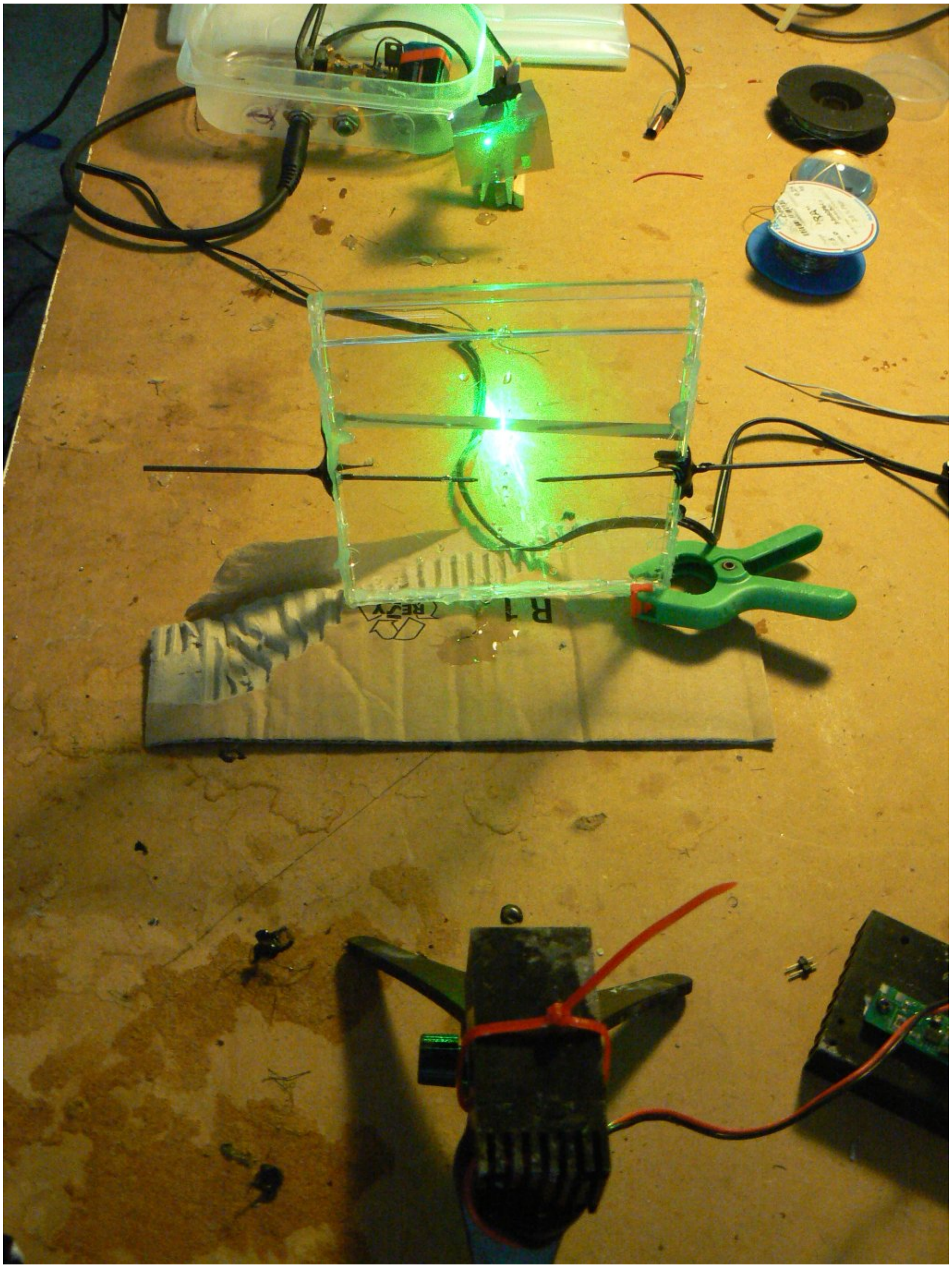
02 November 2012



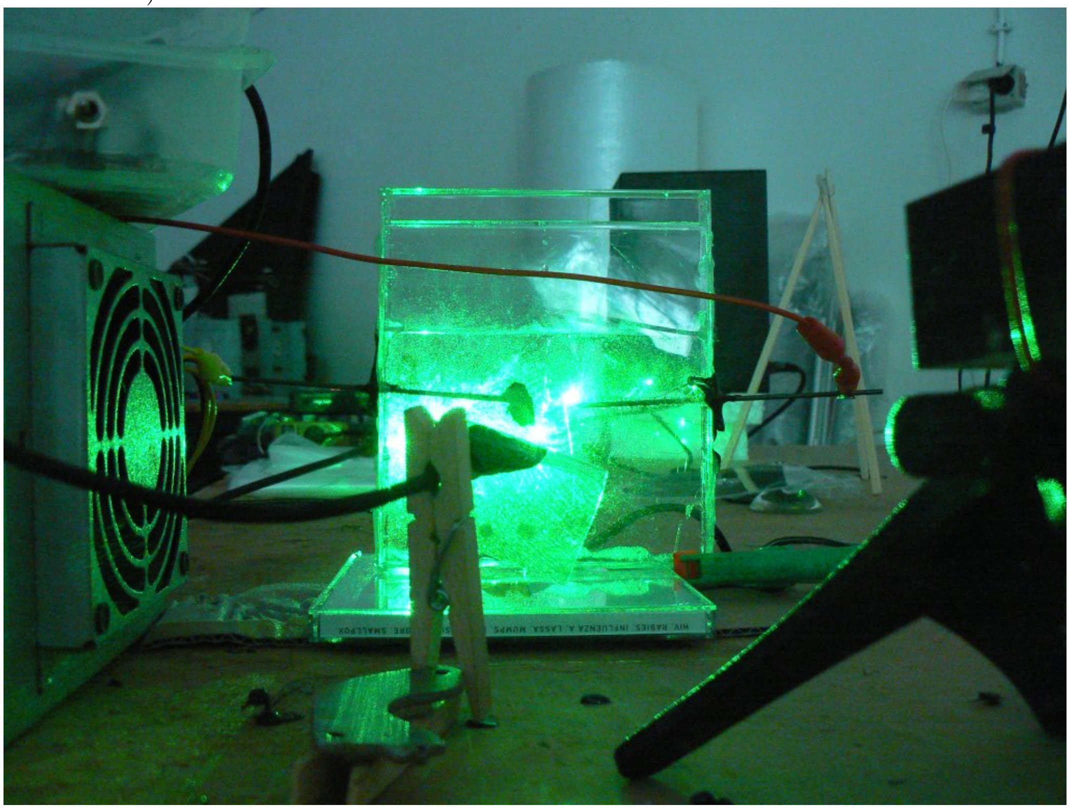
August 28 2012

Laser-based sonification of silver nitrate electrolysis (using graphite electrodes, refillable pencil leads).

track: 147



Laser straight through our SN container (hotglued CD case) with photodetector on the other side: bubbles ok, but not much from crystal formation. In any case, no direct light from laser should hit photodiode head (covered with translucent film).

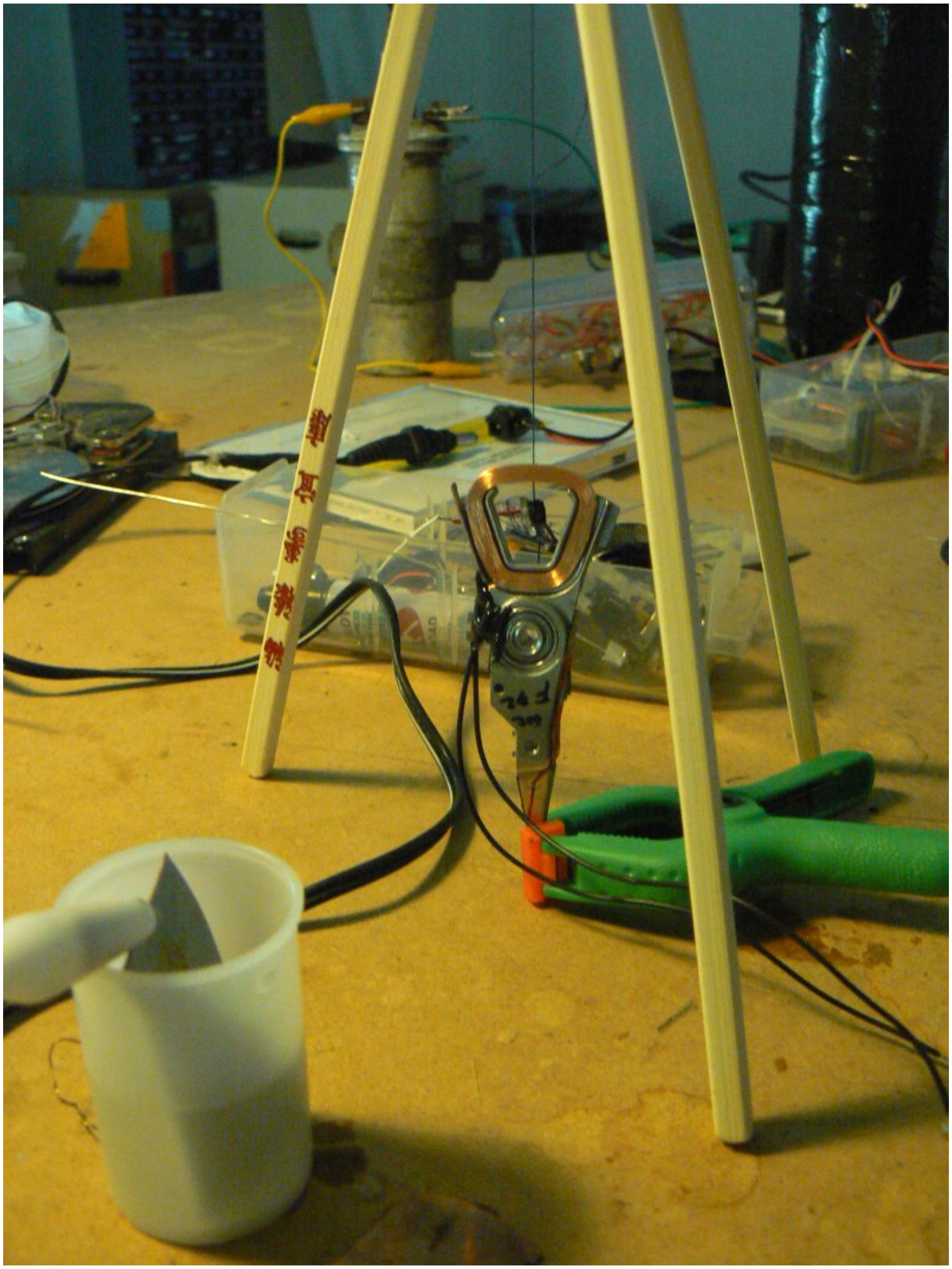


For crystals: 148.wav use reflection (very sensitive to any feedback/movements). Also added mirror on other side and galvanometer with copper/zinc vinegar electrolysis

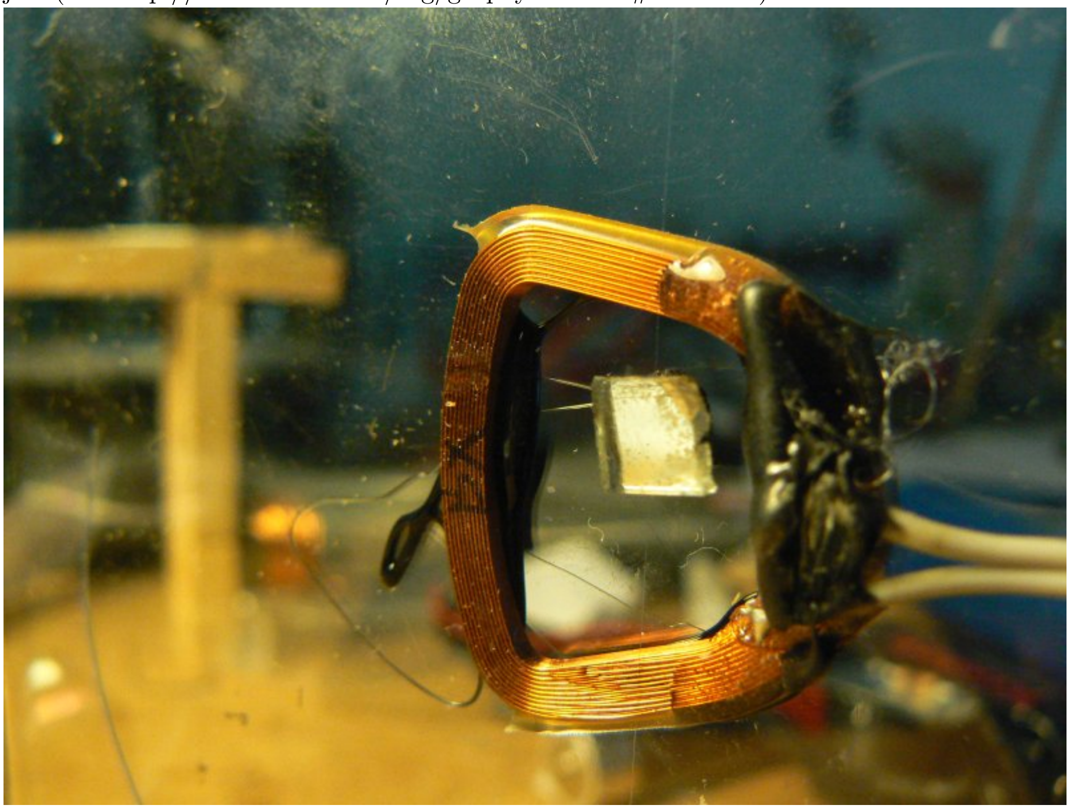
August 29-31 2012

Simple mirror galvanometer

With salvaged HD coil, chopstick tripod, 2 small neodym magnets, mirror. Magnets (with mirror glued to one side) sandwiched over thread hanging from the tripod. Coil is just held upright by a peg. Current passed through coil deflects mirror (laser bounce/amp).

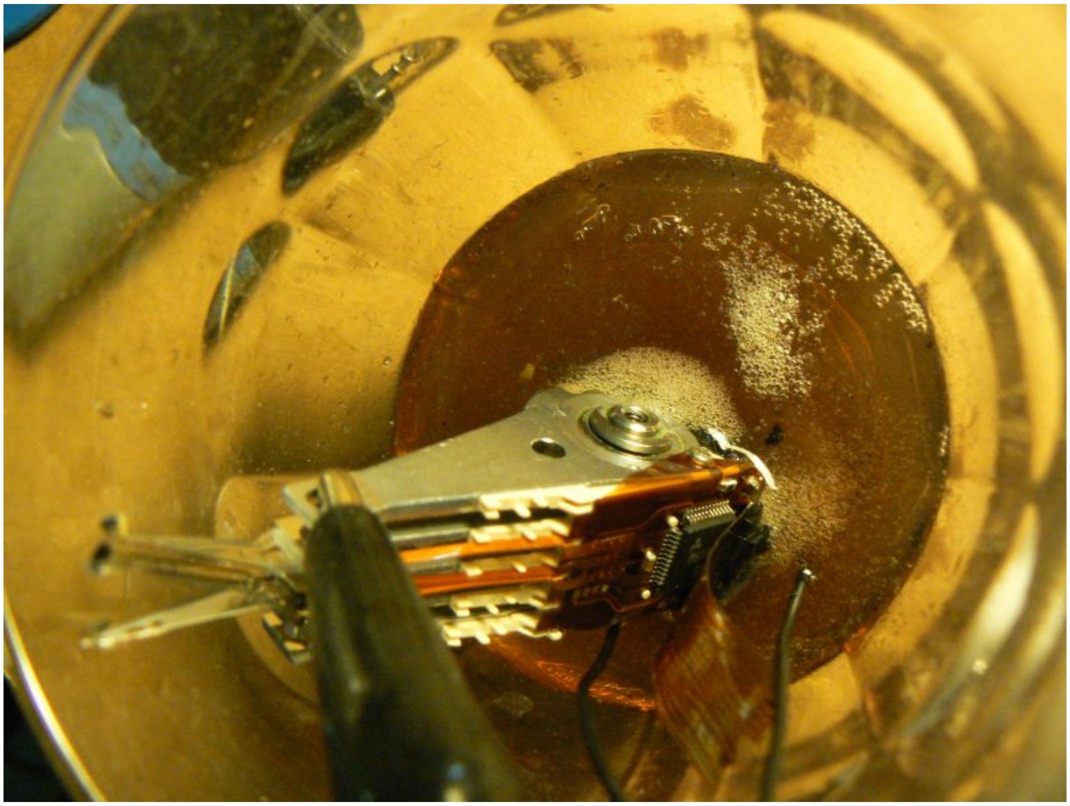


Thinking to combine this with CDROM/cassette box case magnetometer project (ref: http://www.1010.co.uk/org/geophysics.html#sec-2.1.1):



sulphuric acid electrolysis

Of piezos, hard drive coil/read head assemblies, copper and zinc.



Notes for performance:

electrolysis of piezo (in sulphuric)

- remember cap on piezo out, 12v power supply
- power to copper side, gnd to signal side (track 150)

-also using copper and zinc!! (track 153)

and of HD coil

- cap on signal from coil, other to gnd
- 12v power to silver/metal of coil holder and whole more or less immersed (track 155)

gstreamer and gst-launch

Webcam to audio. Using now bare ps3 eye without lens, and own homemade pinholes, lenses.

Some examples:

```
gst-launch-0.10 v4l2src device=/dev/video0 ! videoscale \
! video/x-raw-yuv,width=441,height=60,framerate=10/1 ! ffmpegcolorspace \
! video/x-raw-gray,bpp=8 ! ffmpegcolorspace ! audioparse ! audioconvert \
! audio/x-raw-int,rate=44100,channels=1,depth=16 ! alsasink -v
```

```
gst-launch-0.10 v4l2src device=/dev/video0 ! videoscale \
! video/x-raw-yuv,width=80,height=80,framerate=4/1 ! ffmpegcolorspace \
! audioparse ! audioconvert ! audio/x-raw-int,channels=1,width=16,depth=16,rate=44100 \
! alsasink
```

```
gst-launch-0.10 v4l2src device=/dev/video0 ! videoscale \
! video/x-raw-yuv,width=80,height=80,framerate=6/1 \
! ffmpegcolorspace ! video/x-raw-gray,bpp=8 ! ffmpegcolorspace \
! audioparse ! audioconvert ! audio/x-raw-int,channels=1,width=8,depth=8 ! alsasink -v
```

test webcam with:

```
gst-launch-0.10 v4l2src device=/dev/video0 ! xvimagesink)
```

September 2 2012

Luminous fungi for inter-species communication

Towards:

bioluminescence as a possible communications vector. Culturing bioluminescent fungi such as Panellus Stipticus - recording and analysis of photon detection over periods of time (analogue photographic materials/chemistry, photomultiplier/photodiode detection). Possibly some kind of human-bio-feedback loop established - strobe lights?

Using photomultiplier(below) and logging (dedicated scry with PSU)

Fungi are:

P.Stipticus and Moonlight Mushroom (Lampteromyces japonicus) from: http://mushroombox.co.uk/index.p

Cultivation/notes:

Jack O'Lantern mushroom (Omphalotus olearius):

http://www.mrcashop.org/mushroom_shop/omlphalotus-olearius-jack-olantern-mushroom-spawndowels-p-619.html

on logs

o ghost fungus (Omphalotus nidiformis)

see: http://springbrook.info/research/luminous_ghost_fungus.htm MYA

o Honey mushroom (armillariella mellea):

http://www.carolina.com/product/bioluminescent+fungus+kit.do?keyword=fungi&sortby=bestMatches

o Panellus stipticus:

http://www.mrcashop.org/mushroom_shop/panellus-stipticus-luminescent-panellus-p-448.html

and:

grow on woodchips: Panellus Stipticus - contact: http://www.glowfungi.com/
and:
http://sporeworks.com/Panellus-stipticus-Luminescent-Panellus-Culture-Syringe.html

The mycelium can be grown on a wide variety of wood, grains and agar formulas under a wide range of temperatures. Mushrooms grown on whole grains or grain flours typically do not develop normally and abort at a small size. Plug culture on logs or woodchip/sawdust blocks are recommended for observing normal fruiting.

The images below show Panellus fruits produced using the Wood Based MycoBag(TM). Decently formed fruits are easy to obtain when the substrate material is removed from the bag and placed in a humidity chamber or tent with increased air flow. Odds of fully developed fruits increases if you are able to keep colonized substrate block in outdoor environment without drying or exposure to excessively cool/hot temps.

o several species of Mycena

Refs:

"A substance called luciferin reacts with an enzyme, luciferase, causing the luciferin to oxidise, with the consequent emission of light. [...] The function in fungi is unknown. It has been suggested that it attracts insects which then disperse the spores."Luminous Fungi.

http://www.mykoweb.com/articles/BioluminescentFungi.html

Photomultiplier and logging setup

Also have: Hamamatsu r1477-07 with c6270-21 psu (gold connector (signal) and: black, black, red, white, orange):

red: +15vdc black: GND white: HV control (0 to 5v) other: vref?

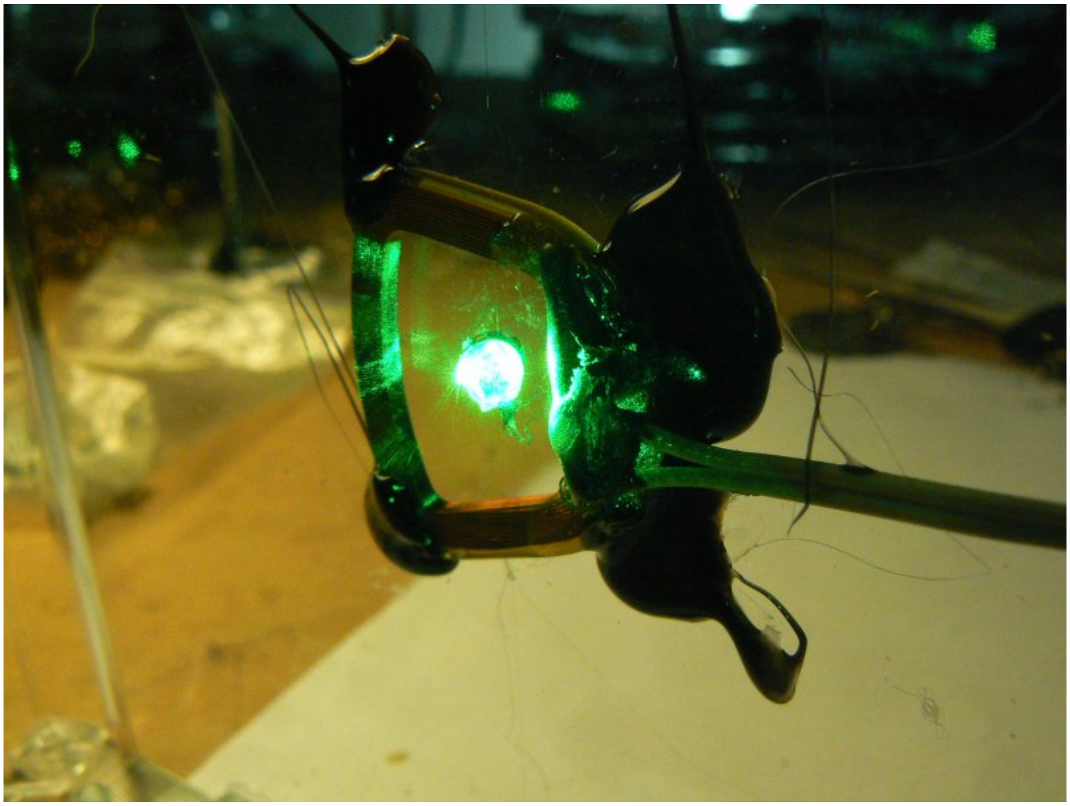
Notes for Burle 4526.

See: http://www.1010.co.uk/org/geophysics.html#sec-3.1
and:
http://1010.co.uk/org/wv2.html#sec-4.5

Questions for Burle:

- to find SHV/BNC cable?
- where is signal
- voltage divider for logging
- what kind of cable/adapter for Hamamatsu?

Simple mirror galvanometer/cd case mod



Following make/torsion balance mag:
http://www.1010.co.uk/org/geophysics.html#sec-2.1.1

Modified with salvaged hard drive coil. Sensitive to detect current flow when we hold zinc and copper electrodes.

September 4

track: 156

50% sulphuric, dash of 95%, hard drive coil electrolysis.

scanner audio

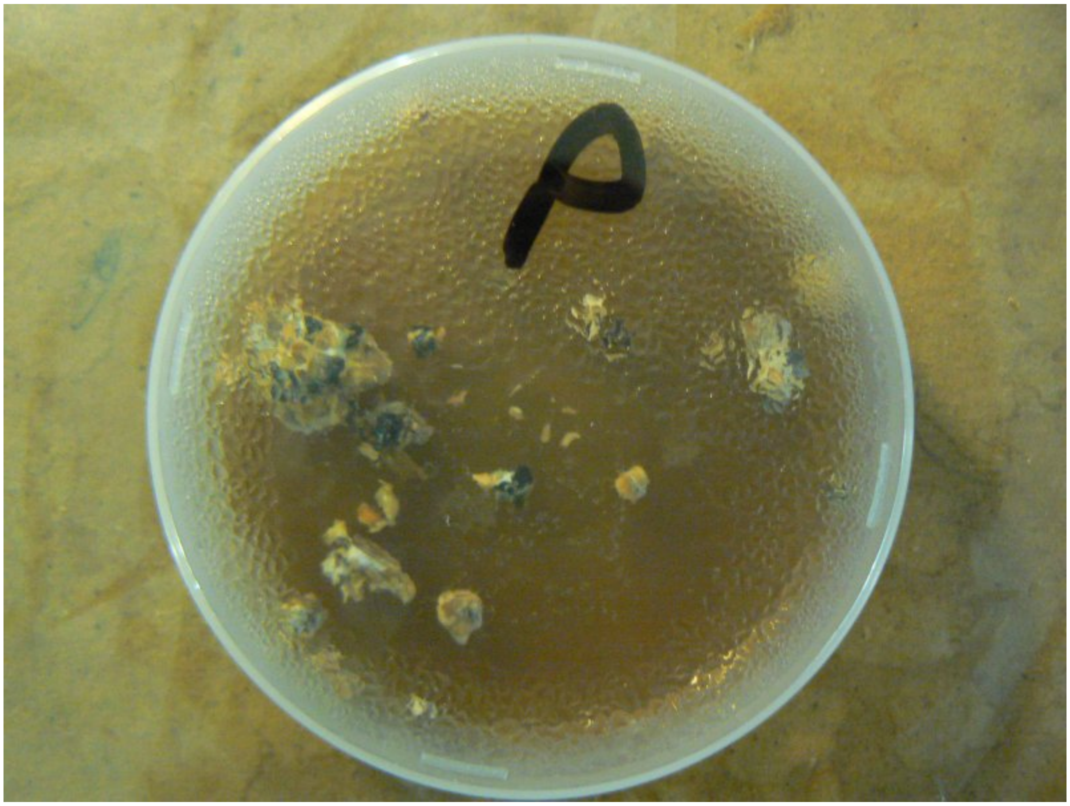
```
scanimage -x 215 -y 297 --mode Gray --depth 8 --resolution 125 > pipe
play -t raw -r 44100 -u -b -c 1 ~/pipe
```

September 5

Schopftintling/shaggy mane/Coprimus comatus

On straw pellets, soaked in boiling water - use of orignal bag (micropore?) and microwave/steam bags. (around 50/50 grain to pellets).

P.Stipticus and Moonlight Mushroom (Lampteromyces japonicus)



On MYA and on wood chips (soaked in boiling water). MYA in CD cases (sealed) and petri dishes. Wood chips in steam bags.

MYA recipe

12 gms (0.42 oz) agar 12 gms (0.42 oz) light malt powder 1 gm ((0.035 oz) nutritional yeast powder 1 litre water

(adjust for 500 ml)

September 14

Fungi update

Schopftintling/shaggy mane/Coprimus comatus

Growing through well in both cases.

P.Stipticus and Moonlight Mushroom (Lampteromyces japonicus)

On MYA both surrounded by blue mould, one of Moonlight has peculier orange goo-like protusion. No sign of luminescence in any case.

On woodchips both slowly growing through.

strange mould with orange fringe

Growing fast on discarded straw pellets. Sprayed today with silver nitrate.

Tabletop setup:

Composed of:

- earth (Johannisthal forest)
- Shaggy Mane mycelium
- sprays (silver nitrate solution and distilled water): using skoda wasch-pumpe (relay or irf640 activation)

Note that inlet is straight out of bottom and outlet is to one side (and GND is on same side as outlet!)

- shafts of light (what is controlling these, what are they - strobe??)
- concrete trays with various chemistry:

leached processors (in nitric acid

silver nitrate solution

rochelle salt

ferrous sulphate - from where? as moss killer or acetone/iron wool/sulphuric - see: http://www.crscientific.com/ferroussulfate.html

- HV pulses (again control or **in performance**)

potentially 2 or 3 relays

- metal electrodes/antennae

And activated in performance with:

- laser/interferometer setup on edges (light detection: solar, diode, webcam)

- hanging tripod magnetometer/plugged in galvos (above)
- other receivers/detektors (run through):
- other detectors:

  – coils
  – electrolytic/coil
  – seismometer
  – ultrasound
  – earthboot/micro-voltage
  – radio

Photomultiplier setup

Hamamatsu r1477-07 with c6270-21 psu wired as follows:

red to 15v, both shields to GND, white(control) and orange(VREF 5v) wired together

signal (chopped MMC connector) to op07 (question of positive and negative supply not resolved) as transimpedance amplifier -

+in to GND, 50 ohm input(? to -) to PMT signal, powered by regulated 5v. 1M or 100k feedback resistor

We get 4.3v in dim light, 1.31 in black bag on multimeter.

TODO: think on +- supply, scope, program logger and test.

September 17

photomultiplier

Biasing + input of op-amp to 2.5v (test results: ???)

Own scope is too slow for potential 10-100mV 5nS wide pulses from photons.

Note also oscilloscope probes (high impedance) provide load resistance.

earthboot/earthboot audio

(To program: hold middle two jumpered, jumper briefly edge 2 and release middle 2)

- earthboot audio version is in:

/root/collect2012/earth/earthcode/earthboot/LUFA_091223/Demos/Device/LowLevel/VirtualSerial

one in 2011 seems for earth measurement

- earthboot itself is in:

~/collect2011/psych/crystalworld/earthcode/earthboot/earthboot

For some reason we needed to “make clean” both versions to get them running.

ferrous sulphate

from link above:

- Degrease the steel wool by immersing it in acetone for half an hour. Remove it from the acetone and let it dry in a well-ventilated lab where nobody can disturb it.
- Place the degreased, dry steel wool in the glass beaker and pour in

enough 30-40% sulfuric acid to cover it completely. Don't use concentrated acid. If the steel wool is not fully submerged, carefully push it down with a glass rod. The sulfuric acid will begin to dissolve the steel, producing hydrogen gas. Over the course of several hours the steel wool will gradually disappear. Carefully add more steel wool. Repeat this a few times. Reddish-brown, insoluble ferric compounds will form if you add too much steel wool

irf640

Now on arduino uno pin 7

GDS in order from left. Gate by 1k to arduino pin. Drain is where we pull through power from pump, Source is GND (arduino and 12v PSU), 100k, gate to GND.

On pump power is nearest the exit pipe (which is the one on the side with straight pipe on end as inlet).

earth measurement device

Red of cable connecting boards is away from USB end.

Gain (on AD620 resistor between pins 1 and 8) is now 1k. Gain=50x

Should have switch no resistor(1x), 100ohm(500x) and 5k(10x) perhaps. DONE for 50x and 500x.

October 4

Commencing research relating to Gent lab/fieldtrip.

Persinger/God Helmet

What is the simple relationship between windings/thickness and resistance/inductance?

The simplest inductor is a single turn of stiff wire with air in the centre (air core). If a metal object is placed in the centre of the turn, the inductance is increased. If additional turns are added, the inductance is increased. If the diameter of the turn is increased, the inductance is DECREASED. If the turns are stretched apart, the inductance of the coil DECREASES.

Roughly.

L (inductance) of an air core cylinder coil =

(air permeability*number of turns*area of cross section)/length of coil

L for a multilayer coil with ferrite core =

air perm * ferrite perm * N(number of windings) squared * (area/length)

Resistance is roughly length/cross sectional area so thicker wires have less resistance.

See also: http://www.epanorama.net/documents/components/coils.html

What is the relationship between windings/thickness, inductance and magnetic field density/flux?

Faraday's laws?

Flux density= (inductance*current) / (number of windings * area/cross section)

(So if we have thicker wire we have less windings in the given area and so more flux… but what of inductance?)

Current(I)=V/R

Measuring the field?

Using our gaussmeter. Gauss is the unit of mag field (flux density). Relation of gauss to tesla:

1 tesla=10000 gauss 1 gauss=100 microTesla (uT)=0.0001 Tesla

We aim for around 1 uT=0.01 gauss = 10 milligauss (as in shakti)

Calculate the limiting resistor

If we pull 12v with the IRF640 through the coil.

Refs

http://xxn.org.uk/doku.php?id=brain_writing:calculations&s[]=wagner

http://forum.allaboutcircuits.com/archive/index.php/t-61749.html

http://books.google.de/books?id=YeKleGrKwC4C&pg=PA29&lpg=PA29&dq=tms+coil+wire+thickness
JyGQl&sig=MdPem9C1FY6EJPNGfKGQ4OaS5Ps&hl=en&sa=X&ei=FcVsULipLJOHswa6wYDACA&redir

http://brainmeta.com/forum/index.php?showtopic=13724&st=30

http://books.google.de/books?id=vOj_GZ2-1dEC&pg=PA177&lpg=PA177&dq=tms+coil+wire+thickness

http://www.physicsforums.com/showthread.php?t=358357

Plant/earth measurements

Resistance and impedance

- finger/earth resistance

  Test and distinguish which wires are which.

- GSR mod (op07 or opa336 smd)

  Could use psyche board with opa336 (also for ad5933).

- Wheatstone bridge and mirror galvanometer

  What could be test values on the bridge?

  If we have R1 and R2 as right and left at top and R4(variable) and Rx as same bottom:

  R1/R2=Rx/R4

  Rx=(R1xR4)/R2

  try R1 and R2 as 10K and R4 as 1M variable.

- AD5933

  Based on psyche board.

micro-voltage/differential measurement

Options are:

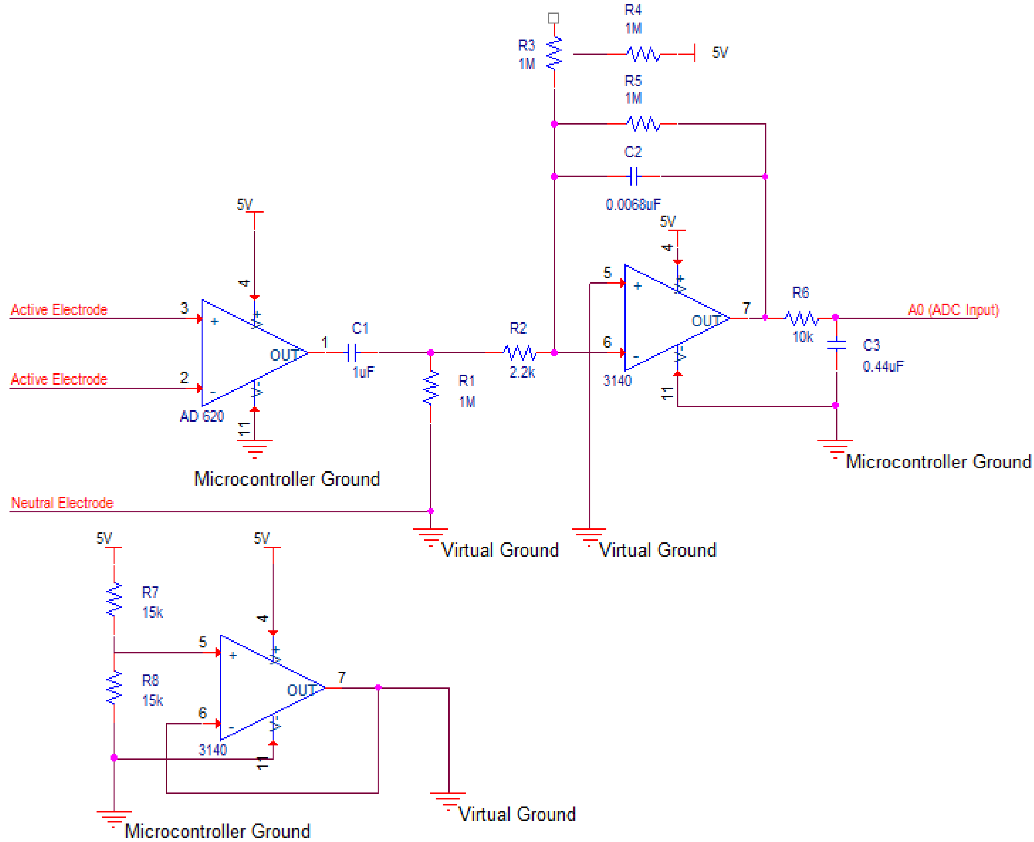
- latest earth device based on AD620 instrumentation amp

  Test again.

- further AD620 device

  With AGND and amp/filter as in:

  http://people.ece.cornell.edu/land/courses/ece4760/FinalProjects/s2012/cwm55/cwm55_mj294/index.ht



AD620:

- resistor between pins 1 and 8 sets gain: 1k=50x, 100R=500

- earthboot/mega32u4 and onboard diff. amp.

  Make a few more of these!

GPS/new skry

With GPS to left power is bottom left connector with red on right.

rendered audible

- laptop/software a la earthboot
- microcontroller and amplifier
- analogue VCO (741, 4046, 555)

Photomultiplier/bioluminescence

- not glowing (more oxygen, lower pH)
- where to source P. Stipticus/other biolums?

ordered log dowels (Jack O'Lantern mushroom (Omphalotus olearius)) from: http://www.mrcashop.org/mushroom_shop/panellus-stipticus-luminescent-panellus-p-448.html

but for this we need to find a log and:

Please use hardwood (most suitable: oak, beech). Let the log dry for approx. 4 5 weeks after felling. For inoculation with the dowels the log have been preperated: duck for 3 days in water (log should be complete coverd with water). After this let the log dry for approx. 2 days in the sun. We recommend to use logs (with bark!) diameter approx. 20 -35 cm length 50 bis 80 cm.

- correct operation of Hamamatsu?
- do we need stretch/count pulses? and if so how? (if we use digital scope I guess not)

what are designs for detect/stretch pulses?

see also: http://ugastro.berkeley.edu/ay122_fall12/PMT/index.html

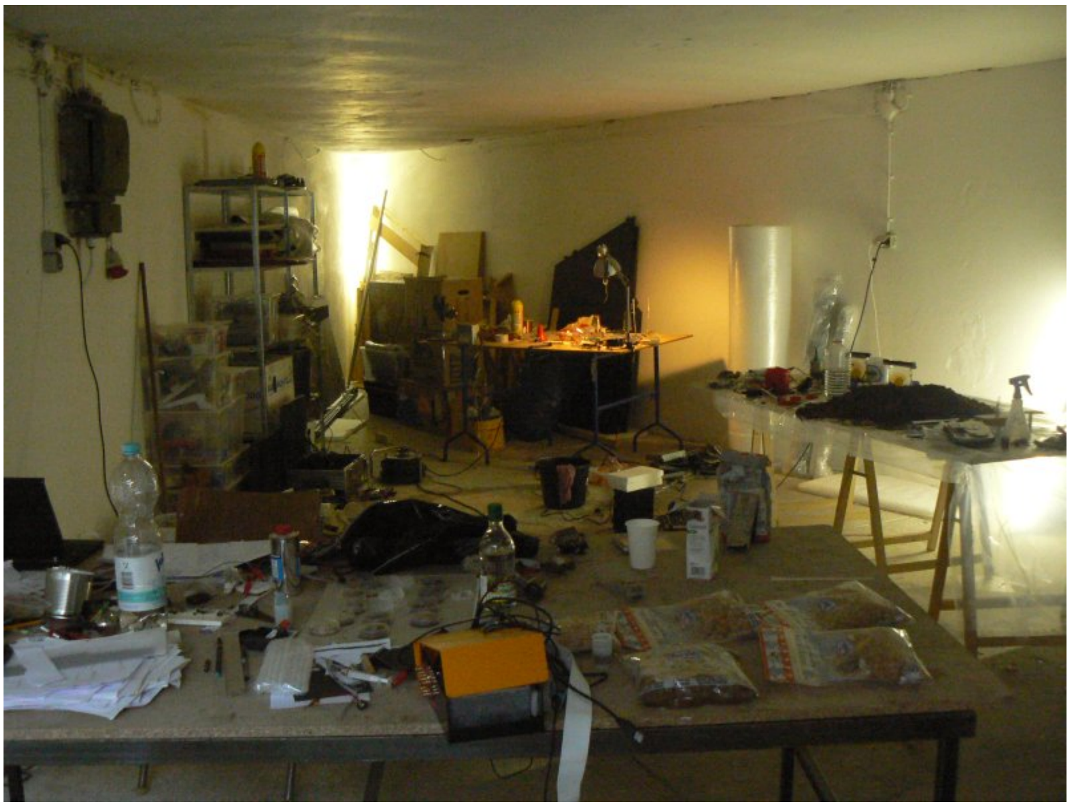
http://www.diyphysics.com/2012/02/02/home-built-radiac-radiation-detector-and-meter-for-a-surplus-dt-590apdr-56f-scintillation-probe/

- cable and test other tube with amp?
- photodiode?

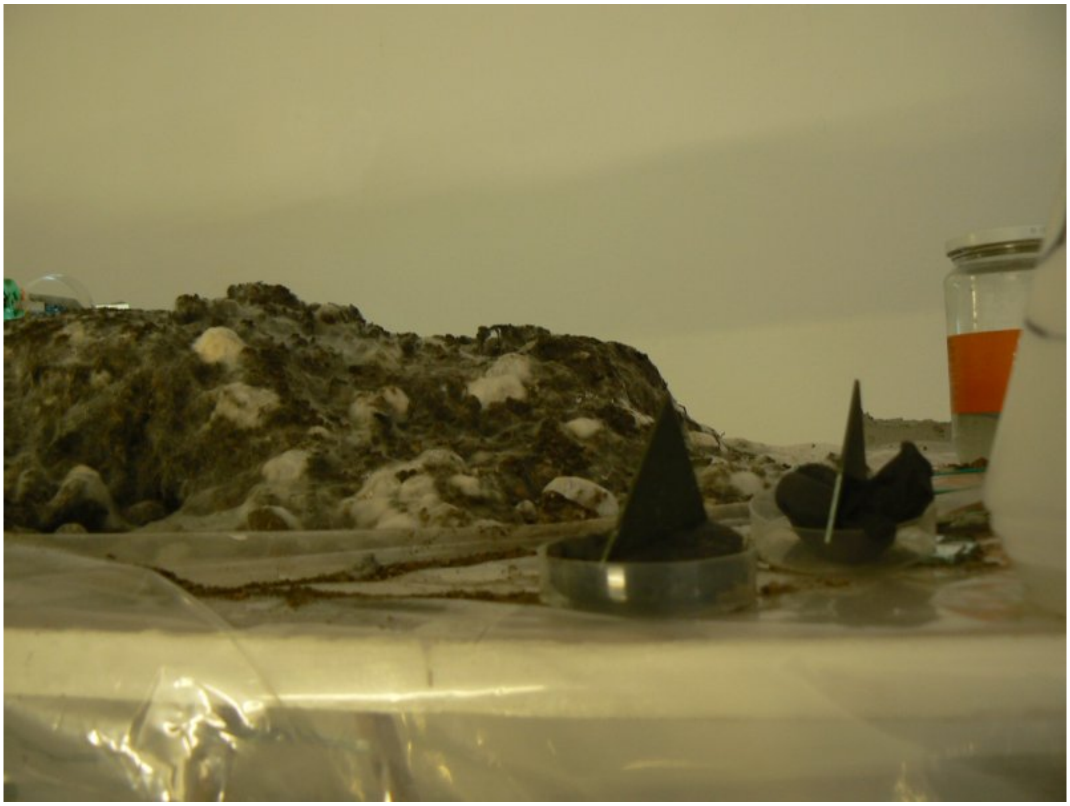
October 5

earthcoding documentation

Preparation for earthcode evening Sept 20



Post-earthcode

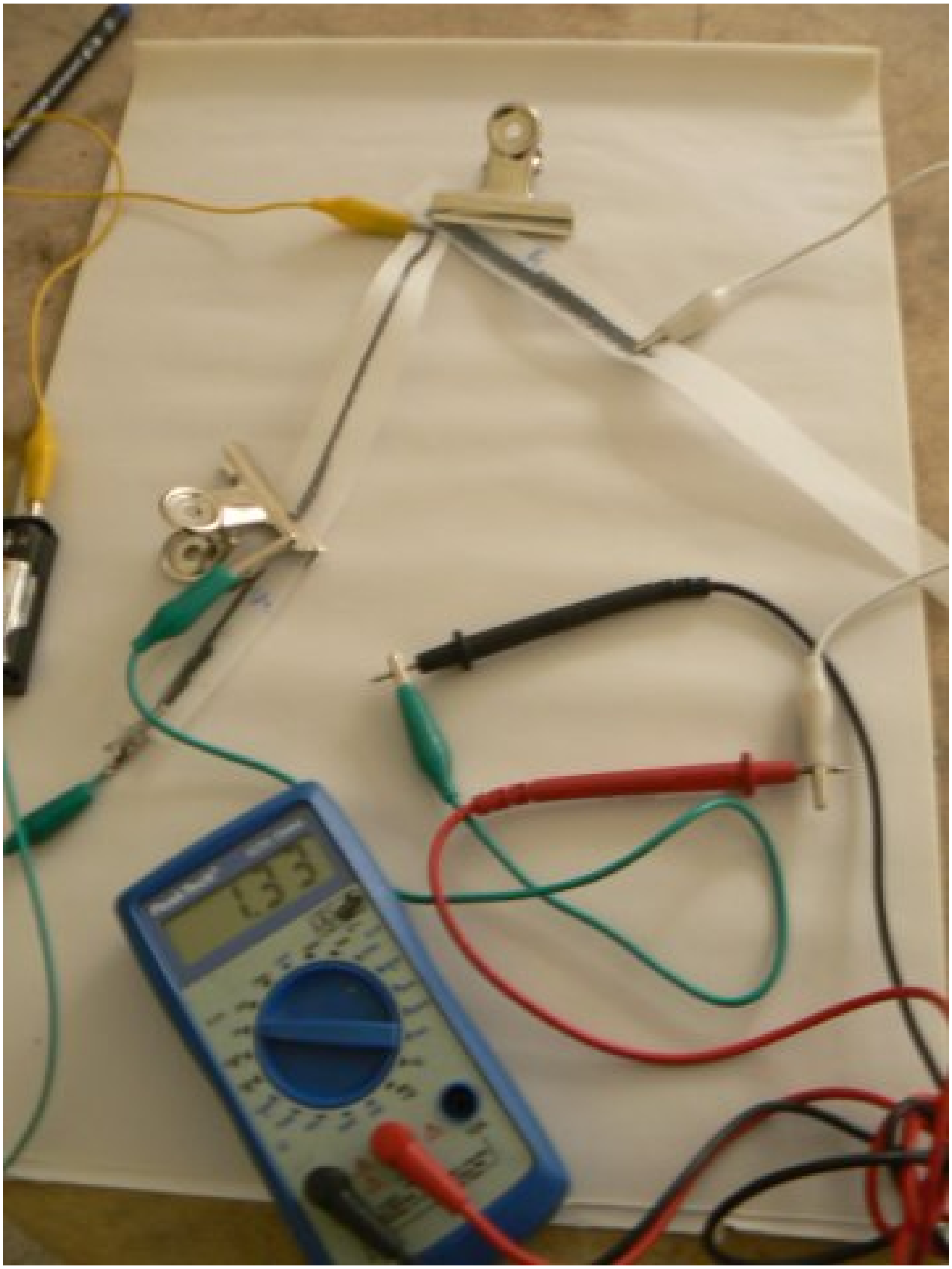


October 8

Mirror galvanometer

Rebuilt with bottle top, usual thread, 0.2mm copper wire windings.

Paper Wheatstone bridge



Working with multimeter and rough tests of finger resistance. But not much sign of any change with mirror galvo (although does shift the reflected laser beam when we adjust the nulling potentiometer on fixed resistance setup (top of bridge 1k and 1k, 100k poti). Could be that the resistance of galvo is not high enough (but if was higher we would lose current - test with smallish (say 100 ohm) series/shunt resistor.

ref:

http://archive.org/stream/methodsmeasurin00nortgoog#page/n19/mode/2up

http://electron9.phys.utk.edu/phys136d/distlab/lab7.htm

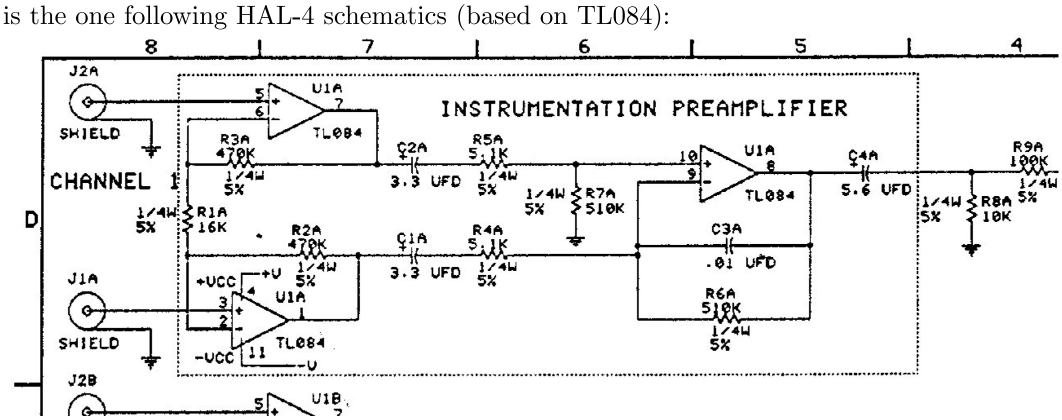
Reviving old plant/bio measurement box

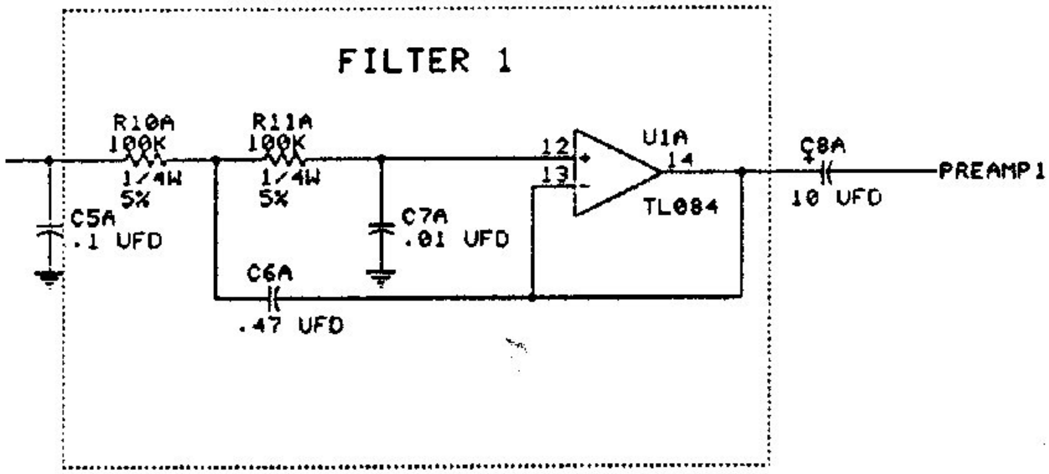
Includes:

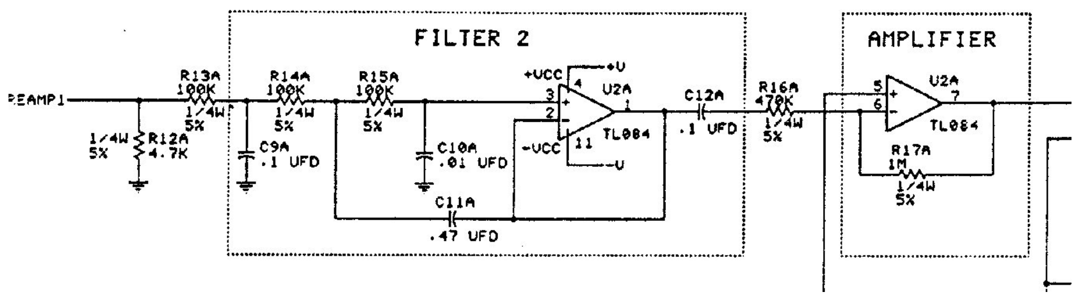
- HAL-4 one channel EEG, attached to HID (order of inputs=EEG, Wheatstone, differenz)
- Wheatstone bridge with amplifier
- Elektor CA3140 design - differenzverstaerker (Mai 1977)

Old EEG design

... is the one following HAL-4 schematics (based on TL084):







So we have one channel here (differential pair - 2 jack sockets with shielded cable, and one jack socket for common ground on ear).

- software used for first version of this

  (Now it is attached to HID/earlier BYRON) was in c and read from parallel port:
  file:~/collect2011/psych/technique/biologic/eeg/oldeegincvx.c
  see eegtool below

software to log HID

hidtool is in: root/collect2011/code_ref/c/hidclient/

```
hidtool read 5
```

Which reads analogue 10 bit values from channel 5 to STDOUT. [first rmmod usbhid to detach driver]
(5 is diff, 4 is wheat, 3 i guess is EEG)
Also included eegtool which appears to be version of oldeeg for HID!

data logging on SD from ADC

On pin 7 of top header (ADC7)

see (GSR example with averaging): /root/xxxxx_2/xxxxx/trunk/mini_skry/main.c

October 9

E-S-E

Details on earth-substrate-earth device. Green wires are electrodes with changing flow of current, purple as measurement.

See: Earth Resistivity Logger. John Becker. EPE. Everyday Practical Electronics. April/May 2003

Here:

electrically probing the soil in their search for minerals and oil deposits (since 1946 says Robert Beck), it has been found that there are better probing techniques than just using two probes. Some of these have been adopted by archaeologists.

Most of the favoured ones all use four probes – two for transmission (TX), and two for reception (RX). The righthand section of Fig.2 shows one way in which the second pair of probes can be used. Anthony Clark says that there are also some techniques that use five probes – with push-pull TX across two and the fifth becoming a grounded reference perhaps?

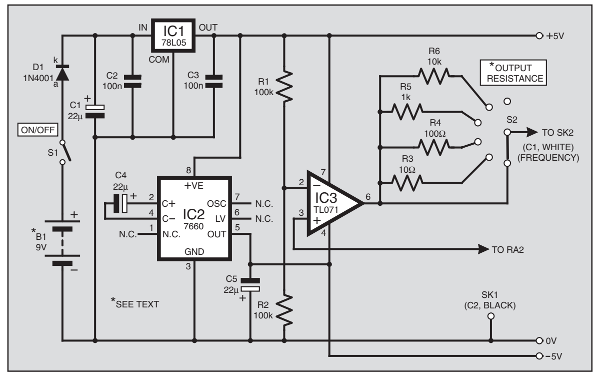


Fig.3. Power supply and transmission interface circuit for the Earth Resistivity Logger.

TWIN PROBES

There are several ways in which four probes are used in relation to each other, and each with its own merits. Their use is outlined later, but no quality judgement is offered here on their appropriateness to various survey situations – but it is worth noting that Clark considers the Twin-Probe technique to be the most favoured for archaeological surveying, although the Wenner technique is said to provide more detailed results. Nick in his extensive use of the prototype adopted the Twin-Probe technique.

The Twin-Probe and Wenner techniques were outlined in Robert Beck's article and were used in the author's garden tests with this Logger. They will be discussed in Part 2 in a bit more detail. Suffice to say for the moment, both involve placing in the soil a reference probe that is connected to the circuit's 0V line (common ground). This is regarded as one half of the TX probes pair.

To the other TX probe is fed the alternating voltage or current, evenly swinging as a square wave above and below the 0V reference value. The function of the TX probes is to set up a field of potential gradient in the soil, which is then sampled by the RX probes.

The RX probes are positioned at distances away from the TX probes as dictated by the probing technique being used. They are connected to the twin inputs of a differential amplifier, whose output signal amplitude is determined by the difference in the two input levels. It is this signal which is then monitored by the control circuit.

It is not even necessary to use special probes, any metal object that does not corrode and can be inserted into the soil with a wire attached will do. The probes don't even need to be inserted very far, just enough to penetrate the soil to make electrical contact with its moistness.

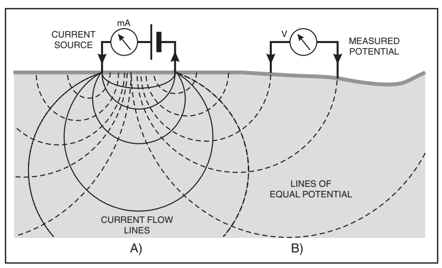


Fig.2. How current flowing between two probes is detected by a second pair.

It will be obvious, of course, that dry soil will be less capable of passing a current than moist soil. Keep in mind that the surface of the soil can dry out faster than that below it, and so a reasonable amount of penetration should be allowed. Robert Beck allows 200mm with his probe structures discussed in Part 2.

With some sites it may be necessary to evenly damp the soil with water before adequate probing can begin.

POWER SUPPLY

The PIC-controlled processing circuit is almost irrelevant to the main aspects of soil monitoring! So first let's look at the power supply requirements, and the simple transmission circuit, both illustrated in Fig.3.

As said in Table 1, the power can originate from any d.c. source (e.g. battery) ranging between about 9V and 15V. This is input via diode D1 to the +5V voltage regulator IC1. The diode prevents distress to the circuit in the event of the battery being connected with the wrong polarity.

The regulated +5V output from IC1 powers the main PIC-controlled circuit, which must not receive a supply significantly greater than +5V. It also provides the positive power to the TX and RX circuits. Both of these circuits additionally need an equivalent negative supply. This is generated from the +5V line by the voltage inverting chip IC2, which outputs a voltage of close to –5V.

TRANSMISSION OUTPUT

Op.amp IC3 is the device which feeds the 137Hz alternating signal to one TX probe (the "active" TX probe). As previously said, the other TX probe is connected to the 0V power line. IC3 is configured as a comparator whose inverting input (pin 2) is tied to the potential divider chain formed by equal-value resistors R1 and R2. The resistors are connected across the +5V and 0V lines and the voltage at their junction is thus 2·5V.

The non-inverting input (pin 3) of IC3 is connected to one of the PIC microcontroller's output pins (RA2) and is fed with a 137Hz square wave, generated by the software, and which alternates between +5V and 0V. As this square wave repeatedly crosses above and below the 2·5V reference voltage, IC3's comparator action takes place and its output (pin 6) alternates between the device's upper and lower voltage limits, i.e. swinging between about +4V and –4V.

Note that the op.amp to which the TX probes are connected (IC3) is short-circuit protected internally and is unlikely to suffer if the probes accidentally come into contact with each other while the power is switched on. However, do not sustain such contact since it could cause regulator IC1 to get hot, and it will shorten the battery charge life.

OUTPUT RESISTANCE

Depending on the probing technique used, experienced geophysicists can determine not only the subterranean density, but also its possible composition. This is apparently achieved by pre-setting the current which flows between the two TX probes.

Robert discussed this in the '97 text, referring to the technique as providing a "constant current". It would appear, though, that his circuit did not provide a *constant* current in the literal sense – same current flowing irrespective of resistive conditions – but rather it provided a *current limit*. It is the same *limiting* approach that has been taken in this Logger design.

The output from IC3 can be switched by S2 to the active TX probe via one of five paths. These comprise a direct unlimited path, and four limiting paths via resistors R3 to R6, in order of 10Ω, 100Ω, 1kΩ and 10kΩ.

Readers are referred to the publications listed in Part 2 for information on resistive path use. The field tests performed by

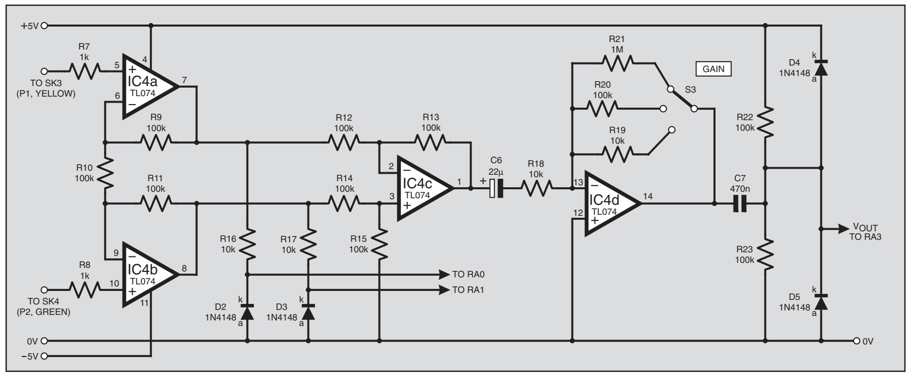


Fig.4. Differential amplifier that receives, amplifies and conditions the RX probes signal prior to sending to the ADC input of the PIC microcontroller.

the author and Nick Tile were carried out via the direct TX path (Nick says he has not found the switchable resistance facility to be useful). In this role, the signal amplitude across the TX probes is picked up by the RX probes simply as an alternating signal whose amplitude varies according to the soil density it has to pass through.

RECEIVING CIRCUIT

The receiving circuit is shown in Fig.4. The twin RX probes and their received d.c. coupled signals are connected via buffering resistors R7 and R8 to the respective inputs of the differential amplifier, formed initially around op.amps IC4a and IC4b and having a gain of three. The outputs from these op.amps are summed, still as d.c. signals, by op.amp IC4c, which provides unity gain.

The resulting signal represents the difference between the two input signal levels. It is now a.c. coupled via capacitor C6 to the amplifying stage around IC4d. Here the gain can be switched by S3 between ×1, ×10 and ×100. In the prototype's garden tests, the ×1 gain was satisfactory across the maximum probe separation distance that the dense garden flower beds would allow (11 metres)! Nick says he prefers the ×10 setting.

At this stage the signal is swinging above and below 0V. It has to be shifted so that it only swings between 0V and +5V at the maximum extremes, to suit the PIC microcontroller's limits. This is achieved by a.c. coupling the signal via capacitor C7 to the level-shifting potential divider formed by resistors R22 and R23. Diodes D4 and D5 limit the maximum voltage swing then fed to the PIC, preventing it from swinging above or below the PIC's limits of acceptance.

It will be seen that two additional signal paths are provided from the output of IC4a/b and consist of resistors R16 and R17 plus diodes D2 and D3. These are not part of the required analogue processing circuit but were included for use during software development. Their function will be described presently.

CONTROLLER CIRCUIT

The PIC-controlled processing circuit is shown in Fig.5. At its heart is a PIC16F876 microcontroller, IC5, manufactured by Microchip. It is run at 3·6864MHz, as set by crystal X1. The frequency may seem unusual, but crystals tuned to it are standard products. Its choice provides greater accuracy of the baud rate at which the logged data is output to the computer.

The software-generated 137Hz square wave pulse train is output via pin RA2, and fed to the TX op.amp IC3 in Fig.3.

Pin RA3 is the pin to which the level-shifted signal output from IC4d is input. The pin is configured by the software as an analogue-to-digital converter (ADC).

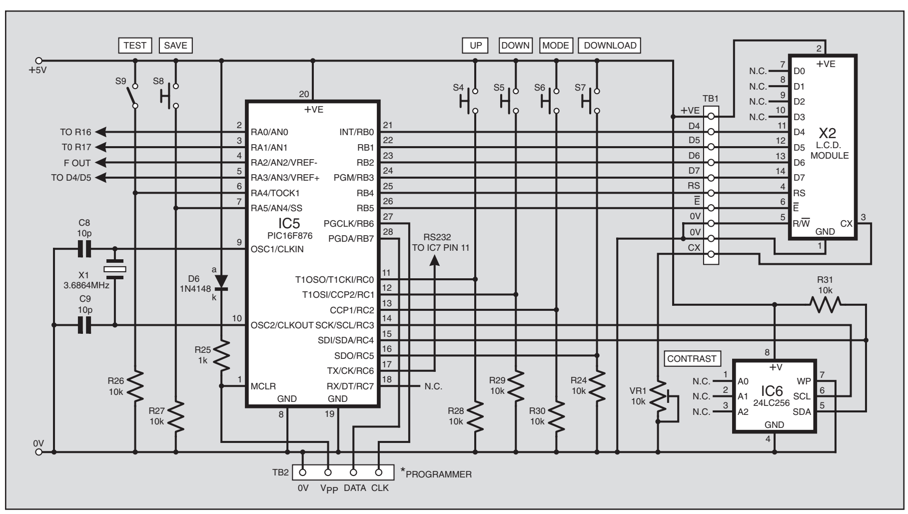


Fig.5. PIC-controlled processing, display and data storage circuit.

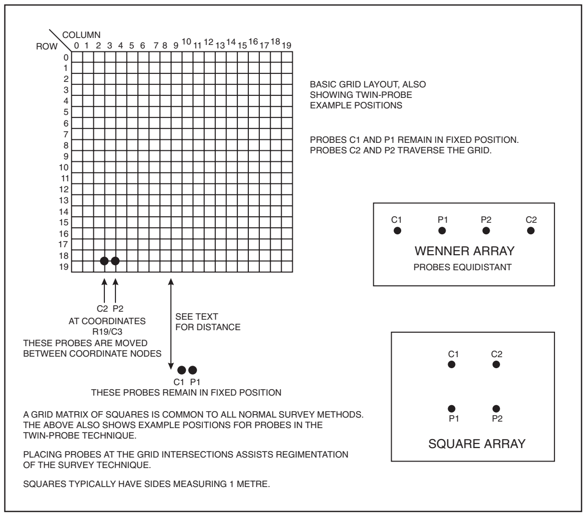


Fig.8. A 20 x 20 grid layout with Twin-Probe example positions, and the positioning of the probes in Wenner and Square arrays.

There are numerous archaeological web sites with bulletin boards and "chat-zones" on-line if you search through the excellent **www.google.com**, or other quality internet search engines. It is worth noting, though, that Anthony Clark considers the Twin-Probe technique to be that most suitable to archaeological work, and is the one used by Nick with his surveys.

With all techniques, the area to be surveyed is first marked out as a grid with tapes or similar, to form squares having sides of, say, one metre in length (this is a commonly quoted distance in this context), and probably forming a 20 × 20 matrixed area, see Fig.8.

Anthony Clark comments that plastic covered clothes line is also useful for setting out a grid matrix. He cautions, though, that it can be difficult to untangle and on one site he knows of, it had to be "guarded in the presence of sheep, by whom it was regarded as a rare delicacy"!

TWIN-PROBE

The Twin-Probe technique is apparently more suited to initial surveying of a site, establishing whether or not it is worth carrying out a more detailed survey.

With this method, the two probes C1 and P1 are inserted into the ground, sufficient to make electrical contact with it (see earlier), centrally to and somewhat outside the area to be surveyed. Anthony Clark discusses the best distance in his book.

Probe C1 is the transmitting probe connected to the comparator IC3, via switch S2. Probe P1 is one of the receiving probes, connected to the input of op.amp IC4a.

Probes C2 and P2 are inserted into the ground, to a similar depth, at the far corners of the first square to be monitored, say top left, coordinate R0/C0 (row 0, column 0). Probe C2 is the 0V reference probe, and P2 is connected to the input of op.amp IC4b. The respective leads from the Logger are then connected to the probes, using heavy duty crocodile clips seems the easiest method.

The Logger's storage coordinates are set to suit the square number, i.e. to R0/C0 in this case, and a reading saved to the Logger's serial EEPROM by pressing switch S8.

The C2/P2 probes are then moved to the top corners of the next square, to the right for example, to be monitored and its coordinates set into the Logger, in this case R0/C1. Again a reading is stored to the EEPROM.

The process continues fully across horizontally for the width of the marked survey area, e.g. R0/C19 (the final column of this row in a 20 × 20 grid). The probes are then moved down by one row, and the process repeated, to the left this time, back to R1/C0. And then down by another row, and so on for all 400 squares.

WELL ORDERED

Note that the relative order of all probe connections must be maintained during the survey. Differences in reading can result if the order is changed, hence the earlier recommendation that the plugs and crocodile clips should be colour-coded.

In practice, it does not matter in which direction you move the probes, or whether you start the survey from the top of the grid or the bottom. Note that the PC screen regards location 0,0 as being at top left of the screen.

"Be methodical and consistent" seems to be the key phrase, though – this helps you to establish a routine that becomes second nature, which the author soon found when starting his own mini surveys!

It was also soon found that it is not necessary to move both probes on each occasion. Since one is already at the corner of the next square, it is only necessary to move the probe from the corner now finished with, putting it in the next square's opposite top corner, and swap the probe leads to retain the correct order.

The author surveyed his garden several times in different ways during design development, and on each occasion became faster at doing so. On the final survey, on an 11 × 7 grid (77 samples) it took about an hour and half.

Of course, during the process of doing the test surveys, several methods for speeding it were imagined. For a solitary surveyor, perhaps the most efficient in terms of speed would be to insert separate probes at each corner of the matrix prior to taking readings. It would then only be required to repeatedly change the lead connections – a seemingly much faster "conveyor belt" system. No doubt, though, having an assistant would probably make the moving of just two probes a speedy alternative.

A perhaps less practical method was (bizarrely?) thought up too – using a motorised vehicle like a golf buggy with probes attached to the wheels in Boadicea fashion. This would then be driven back and forth across the grid, the probes automatically inserting themselves, and triggering the storing of each reading at the correct coordinates! (Well – a chap can dream, can't he?!)

WENNER PROBING

Another seemingly useful technique is known as the Wenner configuration. In this method the four probes are arranged in a straight line, equally spaced apart, say a metre between them. Fig.8b shows the order of arrangement.

This method is apparently better suited to doing a more detailed survey of the matrixed grid site. The principle is that the TX probes are the outer two. The RX probes are in line between them. The current flows across the TX pair and is picked up across the RX pair, the received signal value varying with the resistance in series with the probes in a more direct fashion than with the twin-probe technique.

A variant of this technique, the Schlumberger, in which the probes are not equally spaced, is discussed in Anthony Clark's book. But he regards it as not ideally suited to archaeological surveying.

SQUARE ARRAY

Another method is known as the Square Array in Anthony Clark's book. With this method, the TX and RX pairs are placed at the corners of the one metre squares, as shown in Fig.8c. The four probes are moved as a set from square to square.

The transmission signal flows between the TX pair as before. This time the RX pair pick up the radiated signal at the same distance from the TX probes. If the soil resistance between the TX and RX pairs is uniform, so too will be the amplitude of the signal received by both RX probes.

Tests showed that because the probes are connected to a differential amplifier, if the two input amplitudes are the same, they will cancel each other out at the final combining stage (IC4c).

If, on the other hand, the amplitudes are not the same, the difference between them is that which will be finally output from IC4c. In this case, what would be looked for is any difference values, indicating the edge of a subterranean feature.

It is evident, however, that balanced (zero) readings, when the two input values are equal, would only indicate the uniformity of the terrain in that grid. It would not indicate whether that uniformity was due to a highly resistive feature or a highly conductive one. Nonetheless, the detection of only outlines might in itself be a desirable situation.

A variant of this technique would be to place the two TX probes at one end of a column, and the RX pair at the other, taking a reading and moving both pairs to the next column, still at the top and bottom points. This could perhaps yield initial information about whether or not a site is worth examining more closely. Not being an archaeologist, though, the author cannot comment on the validity of this.

Anthony Clark discusses the above named probing techniques in more detail, and describes others.

PROBE CONSTRUCTION

During garden tests with the prototype Logger, individual metal rods measuring about one metre long by 5mm diameter, and with a right-angled bend at the top were used as the probes. These were purchased inexpensively from a garden centre, their intended use being to support plants.

A recently observed, but not tried, possibility was in the form of long inexpensive barbecue skewers – seen in a local supermarket.

If you wish to construct purpose-built probe structures of more durability, and perhaps greater ease of use, the probe assemblies described by Robert Beck should be considered. Schematics of the original figures illustrating these probes have been redrawn and are repeated here. Other than the following details, no additional information can be offered.

Robert's rigid frame assembly for two probes is shown in Fig.9. Details of his single probe are given in Fig.10.

His original text states that the Twin-Probe assembly was specially developed and that its top member is a wooden batten, 30mm × 50mm × 1050mm, the ends of which are bound with self-amalgamating tape to form hand grips.

An aluminium platform is attached to the centre of this batten to carry the case that holds the electronics, secured by rubber bands. The bottom member is a similar wooden batten, but this piece must have good insulating properties (to prevent current leakage between the probes). He suggests that you either dry and coat the batten with varnish, or devise insulating collars of Tuffnol or similar material, and fit them where the probes go through the batten.

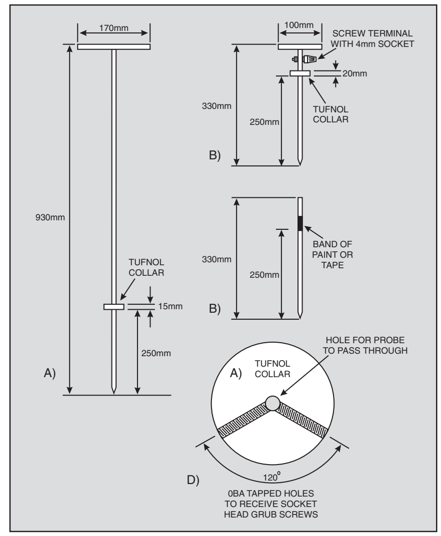


Fig.10. Construction details of Robert Beck's probes.

The top and bottom battens are held together by metal conduit pipes, threaded at each end and secured by lock-nuts.

In describing the construction of the other probes, he says that none of their dimensions are critical and may be dictated by what is to hand. In Fig.10a is shown a substantial probe made out of stainless steel tubing with a brazed on T-handle and tip which assist soil penetration. This probe is designed to be used by the operator in the standing position.

A smaller version of Fig.10a is shown in Fig.10b. This has a 4mm screw terminal added, an alternative method of wire connection.

Probes may be constructed of material other than stainless steel, which is expensive and a little difficult to obtain, he says (provided it is corrosion resistant of course).

An extremely simple probe is shown in Fig.10c and which may be constructed from 6mm diameter metal rod, i.e. brazing or uncoated welding rod, mild steel, silver steel, etc. A depth guide consisting of a band of paint or insulating tape is added and connections are made to the top using a crocodile clip.

The depth stop in Fig.10d is adjustable by means of an Allen key. The material need not be insulating, and could be of metal if desired.

SERIAL OCX

Since finalising the *Earth Resistivity Logger* Part One for publication last month, reader Joe Farr has provided *EPE* with a specially written SerialIO.OCX program that allows legal access to Visual Basic's own serial control I/O facilities.

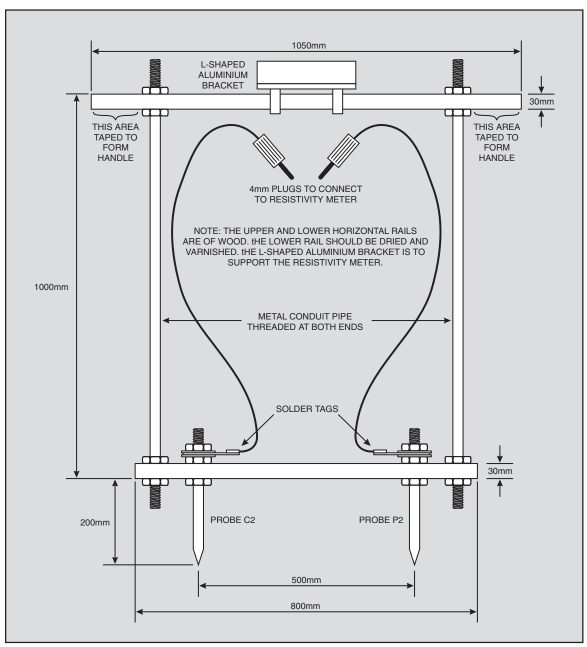
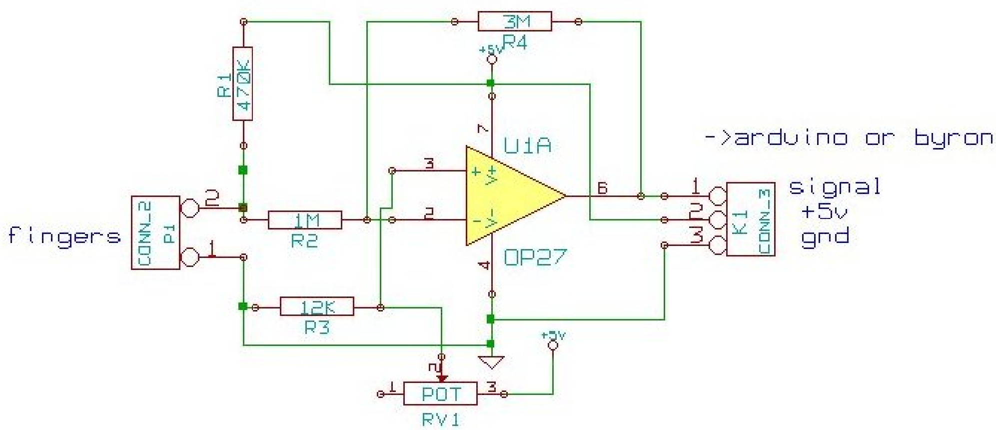


Fig.9. Support frame for the Twin Probe configuration used by Robert Beck.

GSR/plants



plot notes

live plotting with minicom/gnuplot

minicom is set to 9600 baud - set logging to file called test2

run looper as follows:

gnuplot¿ a=0 gnuplot¿ load "/root/collect2011/psych/fieldeffect/software/looper"

plotting with python

```
python wx_mpl_dynamic_graph.py
```

or use in plotmon dir:

```
python plotting_data_monitor.py
```

gnuplot notes

basic plot:

```
plot "201201171520.results.log" w lines
```

plotting only a section:

```
plot [:10][:300] "201201171520.results.log" w lines
```

set output to a png:

```
set term png size 1024,768
set output "/root/collect2011/psych/logimages/test.png"
```

and set title, set xlabel, set ylabel as further commands

for earthboot (mod to measure)

find mod somewhere in 2011

- earth measurement

  using plotting_data_monitor.py in

  `/root/collect2011/psych/walker/psychogeophysics-walker/software/plotmon/`

  (first remember to expand window of app)

- earthboot

  (program: hold middle two jumpered, jumper briefly edge 2 and release middle 2)

  - earthboot audio version is in:

  /root/collect2012/earth/earthcode/earthboot/LUFA_091223/Demos/Device/LowLevel/VirtualSerial

  pipe business

  one in 2011 seems for measurement

  - earthboot itself is in:

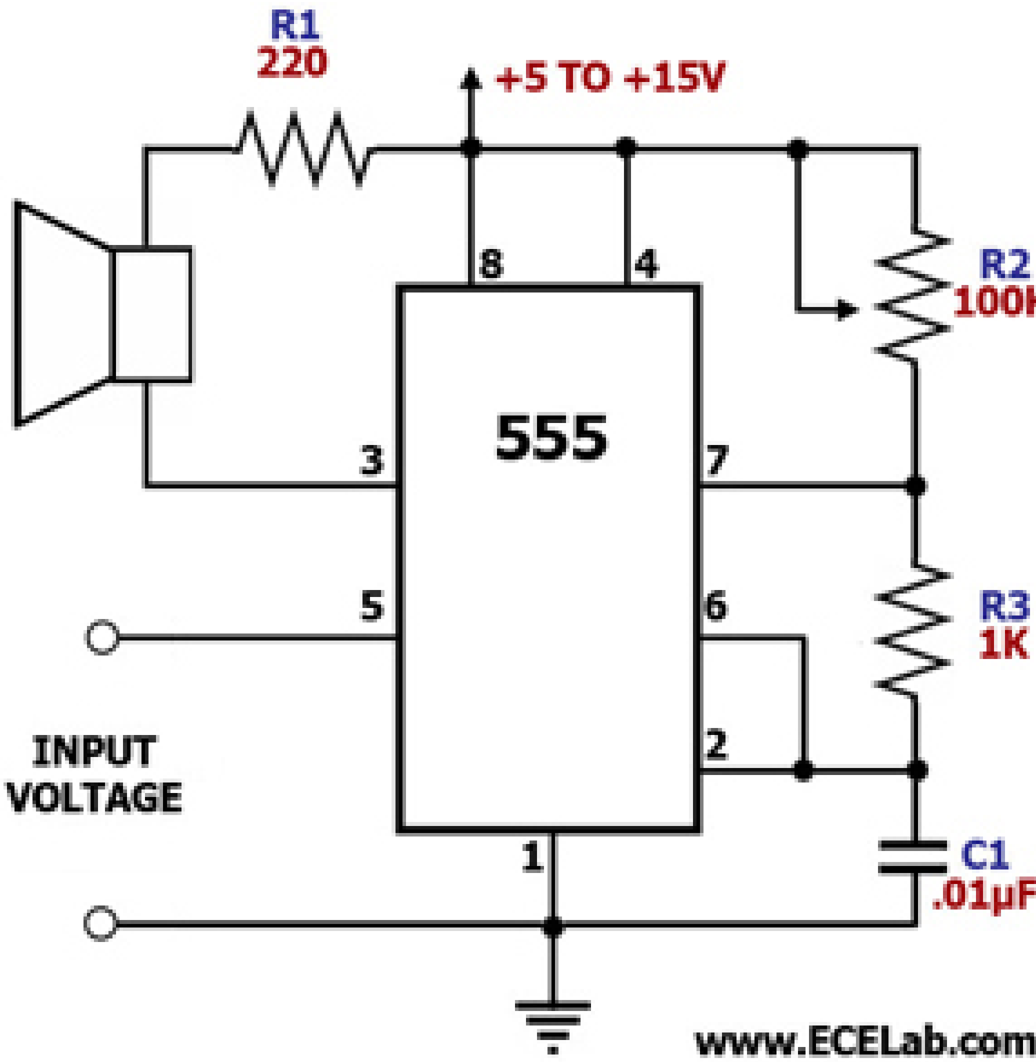
  ~/collect2011/psych/crystalworld/earthcode/earthboot/earthboot

for newskry plots

Newskry reads in order ad8313,lowfi,gsr, temp:
Process using:
file:~/collect2011/psych/studies/summit2011/software/gpsgsr.py

October 10

555 VCO



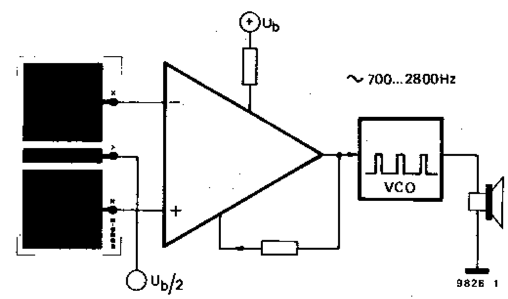
R2 as 1M for lower frequencies

741 VCO (from elektor elektroskop design mai 77):

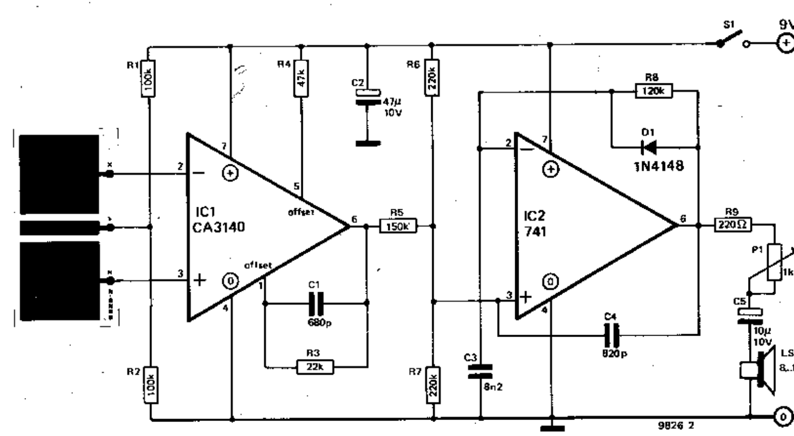
eine Spannung meßbar.
Als Meßelektroden werden, wie bereits erwähnt, bei dieser Schaltung zwei Kupferflächen verwendet; sie weisen quadratische Form auf und befinden sich auf einer gemeinsamen Platine. Die zwischen ihnen angebrachte schmale Kupferfläche dient zum Ausgleich eventueller statischer Aufladungen. Der Abstand zwischen den Meßelektroden beträgt 11 mm, bei diesem Wert ist das Verhältnis zwischen Feldstärke und Empfindlichkeit am günstigsten.

Differenzverstärker

Die Meßelektroden sind direkt mit dem invertierenden bzw. nicht-invertierenden Eingang des CA 3140, einem Operationsverstärker mit MOSFET-Eingangsstufe, verbunden. (Bild 2) Die Verstärkung des



2

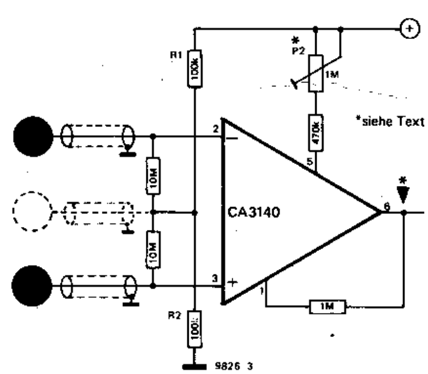


OpAmps liegt infolge der Rückkopplung zwischen Ausgang und Offseteingang relativ niedrig, der hohe Eingangswiderstand bleibt hierbei erhalten. Infolge statischer Aufladung der Meßelektroden kann der Ausgangsspannungsbereich des CA 3140 überschritten werden. Um dies zu vermeiden, entlädt man die Platten von Zeit zu Zeit durch gleichzeitiges Berühren der Meßelektroden und der auf halber Speisespannung liegenden dritten Elektrode.

VCO

Der VCO ist mit einem OpAmp vom Typ 741 aufgebaut; seine Frequenz hängt von der Ausgangsspannung des CA 3140 ab. Bei der im Schaltbild angegebenen Dimensionering von R9 und P1 eignen sich Lautsprecher mit einer Impedanz von 8 Ω bis 150 Ω zur akustischen Anzeige. Bei Anschluß eines 8 Ω-Lautsprechers muß der Gesamtwiderstand von R9 und P1 390 Ω betragen. Die Stromaufnahme liegt bei maximal 5 mA, so daß als Energiequelle eine 9 V-Kompaktbatterie ausreicht.

3



With 10n and 680n substitutions works well.

Wheatstone with transistor

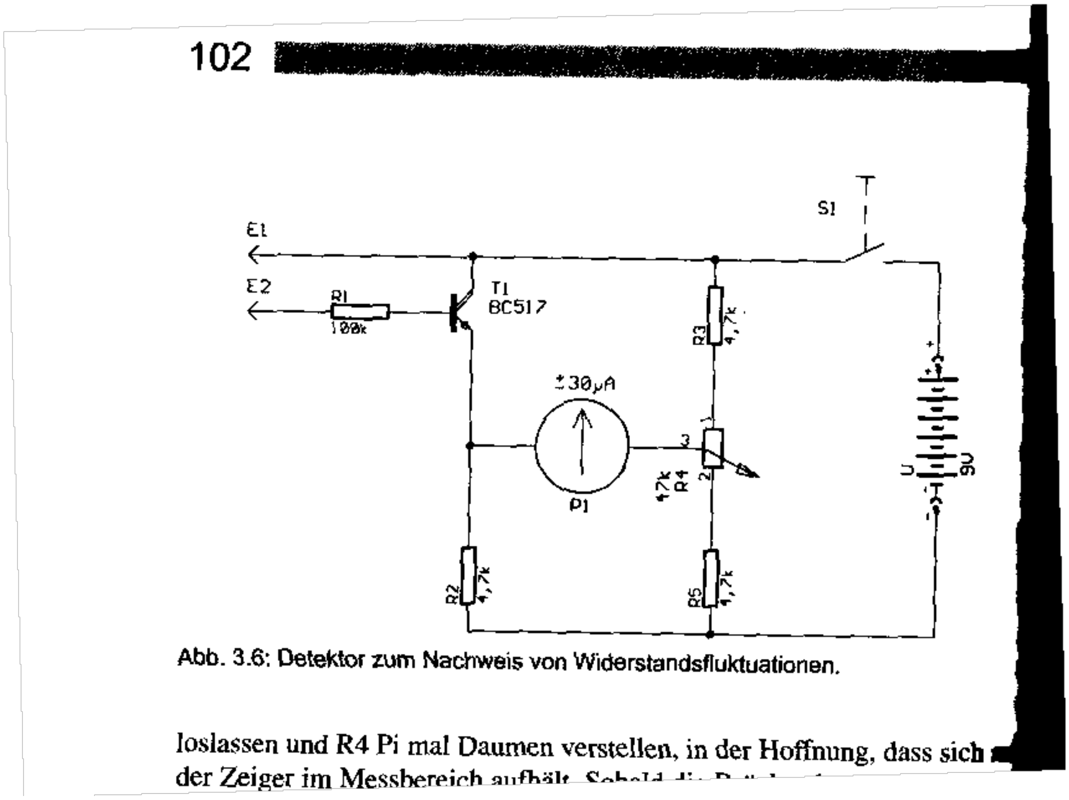


Abb. 3.6: Detektor zum Nachweis von Widerstandsfluktuationen.

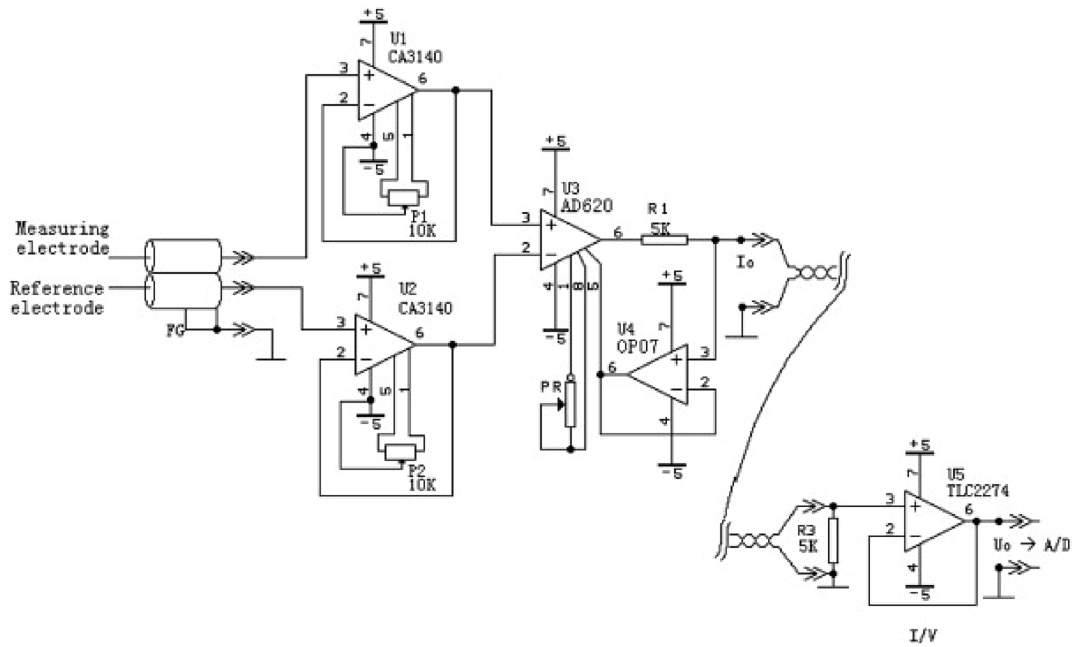
loslassen und R4 Pi mal Daumen verstellen, in der Hoffnung, dass sich
der Zeiger im Messbereich

Also works well with BC547b/c, 10K instead of 4.7K (and Followed by LM358 inverting op-amp [two 1K resistors into + / - in and 1M poti for feedback/gain). Can also have emitter of transistor into VCO (ignore bridge).

Question is if it can drive mirror galvanometer.

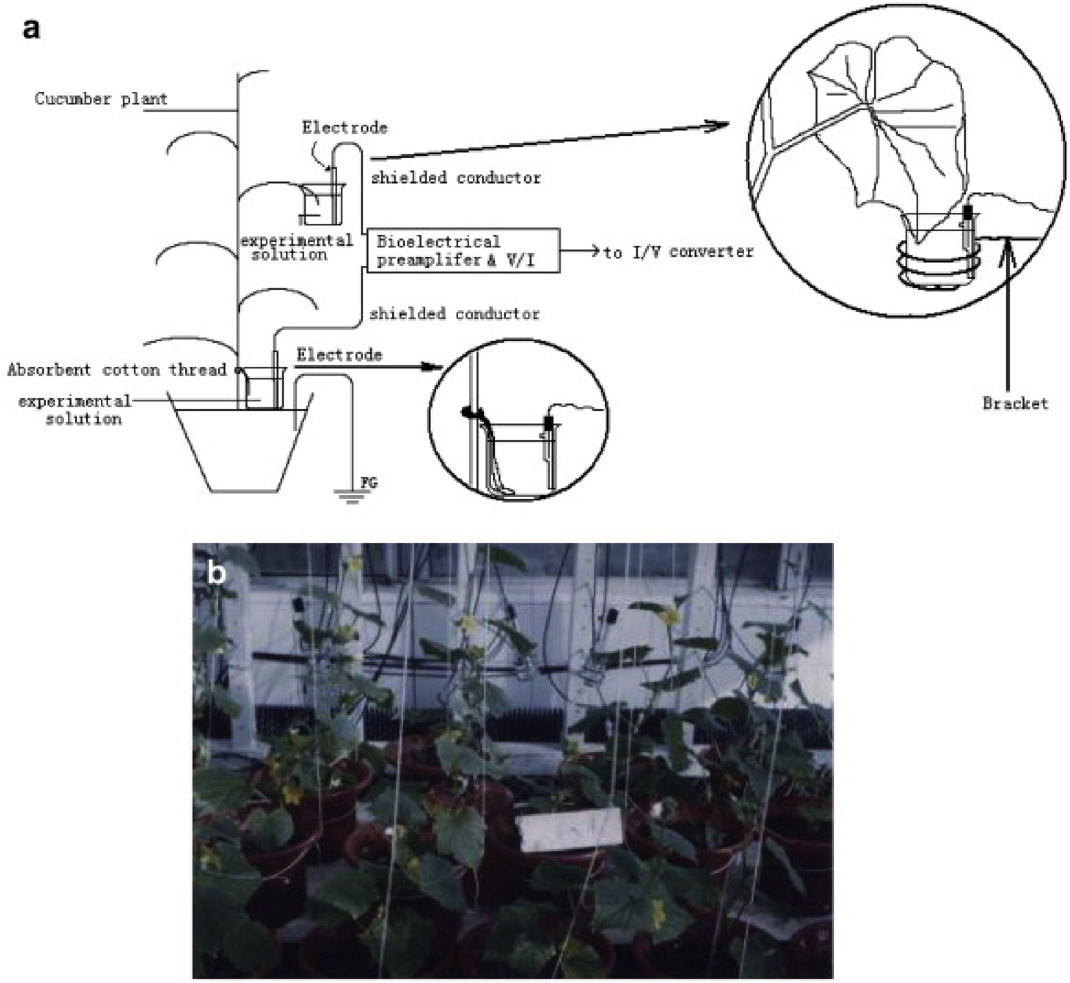
AD620

See also:



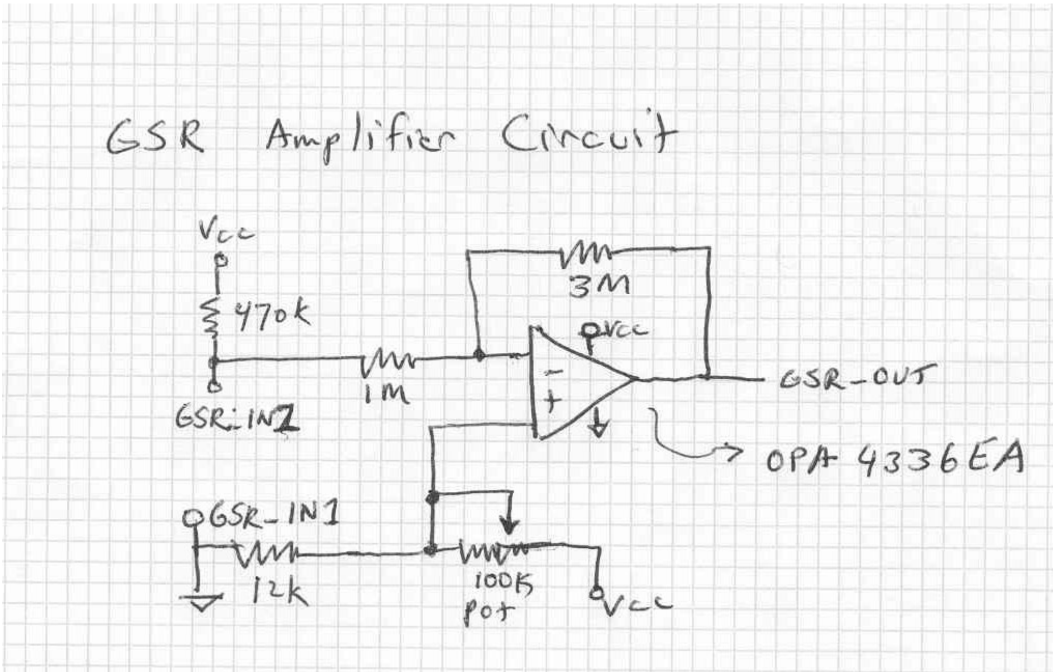
U1
CA3140
U2
CA3140
U3
AD620
U4
OP07
U5
TLC2274
P1
10K
P2
10K
R1
5K
R3
5K
PR
Measuring
electrode
Reference
electrode
FG
Io
Uo → A/D
I/V
+5
-5

and:

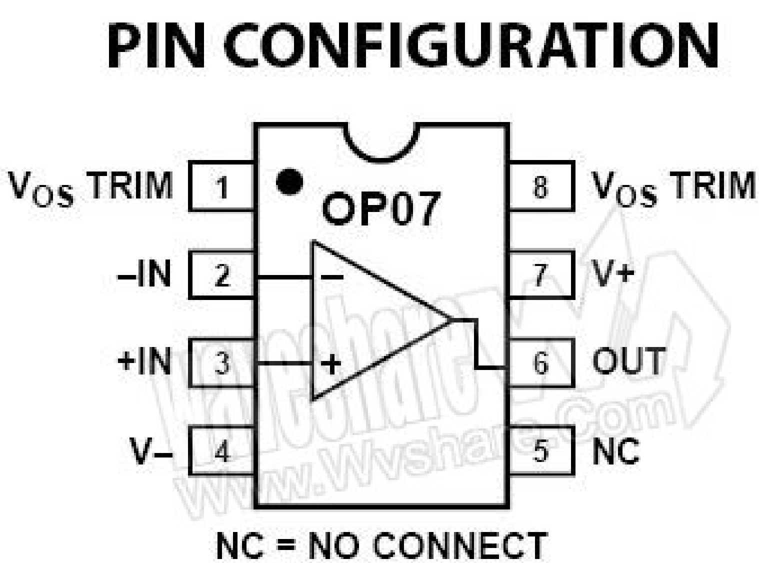


and maybe use +-5v

GSR



Modded for op07:



Again test with mirror galvo.

October 18

At foam… see all online libarynth notes:
http://lib.fo.am/silent_dialogues_notes
201210181504.results.log - first leaf test with no amplification
201210181530.results.log - 50x
616 and 557 with GND in earth
201210181741.results.log (with second set of wrapped electrodes)

2 earthboots/2 channels

```
play -t raw -r 44100 -u -b 8 -c 1 ~/pipel -t raw -r 44100 \\
-u -b 8 -c 1 ~/piper --channels 2 -M
```

metaphase typewriter

```
quantum.py
```

but what sort of data does it expect - numerical in relation to len(probb)