Definitive Guide to mod “Bicron Surveyor 2000”

Original post KOFF reworked TOTO4G
http://tech.groups.yahoo.com/group/GeigerCounterEnthusiastsPAGE1/message/1205
Improvements to Bicron 2000 = Analyst 2000

Often overlooked, the Bicron Surveyor 2000 has some interesting features. Scaled for 0-2400 CPM and 0-2 mR/H, it has five multiplier ranges, X.1/X1/X10/X100/X1000. Naturally the X.1 range reduces the full scale to 240 CPM and .2 mR, very sensitive indeed. An internal GM tube is connected only in the X1000 range. Audio is from a piezo-sounder, similar to a small Sonalert, and can be disabled by a panel switch. Response is Fast/Slow, also selected by a panel switch.
GM Deadtime is supposedly handled by internal circuitry for net linear response on all ranges.

At 2400 CPM per 2 mR/H, that means the scale is calibrated to an external probe that will give 1200 CPM per 1 mR/H, or to put it in terms that are referred to in probe literature: 20 CPS/mR-H Co-60. A popular probe that uses the LND 725 tube is the Eberline HP-270. Most bare GM tubes are energy dependant, in other words the higher the energy of the radiation, the more they respond to a given field.
This is terribly confusing, as the count rate will vary for different isotopes of the same Ci level. In order to obviate this unwanted response curve, some probe's housings are made of a special material that works in the opposite direction of the tube's sensitivity curve, giving a net flat response to a wide variety of energy levels.

Illustration 1: DIALS

The HP-270 is of that variety, so mR/H can be read directly using this probe on this meter.

Inside the Bicron 2000 is a GM tube that works only on the X1000 range, where the other ranges use the external probe, via an MHV connector.

Illustration 2: MHV

Illustration 3: BNC

My first modification is the change the MHV to a BNC so that all my standard probe and cables are usable.

Next, add a new 2-position switch to the unit's front panel and rewire the internal/external portion of the range switch to this new switch, thereby allowing all ranges to be used with either the internal or external probe.

“TOTO4G” I preferred to put the switch within the instrument.

Alone this modification improves the 2000 beyond any other model in the Bicron line (all the other units are 3 or 4 step range controls, here we have a full 5!)

A few more added switches will transform this basic Geiger Counter to a crème-de-la-crème Analyzer.

First we must disable the built-in anti-saturation circuit so that scintillation detectors may be used. This is simply accomplished by pulling out U-1 and bending pin 14 back so that it does not make contact in the socket when the IC is re-inserted.
Another more complicated approach would be to cut the trace going to pin 14 of U1, and add a tiny on-off switch across the gap. The choice is yours, but either way, the circuit should be left disabled for home-lab* use.
All the other mods mentioned here will also work on the Bicron Surveyor M, but that unit already has the anti-sat switch included.
 *Never remove the anti-sat feature from a unit that may be used in commercial service, and tag all such changes in an obvious manner even in the home-lab unit.

“TOTO4G” I preferred cut and drill hole

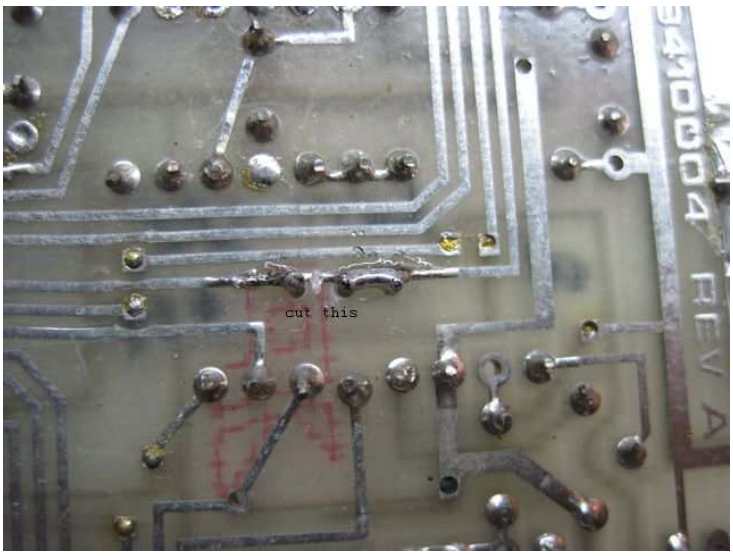

Illustration 4: anti-sat rear “cut trace”

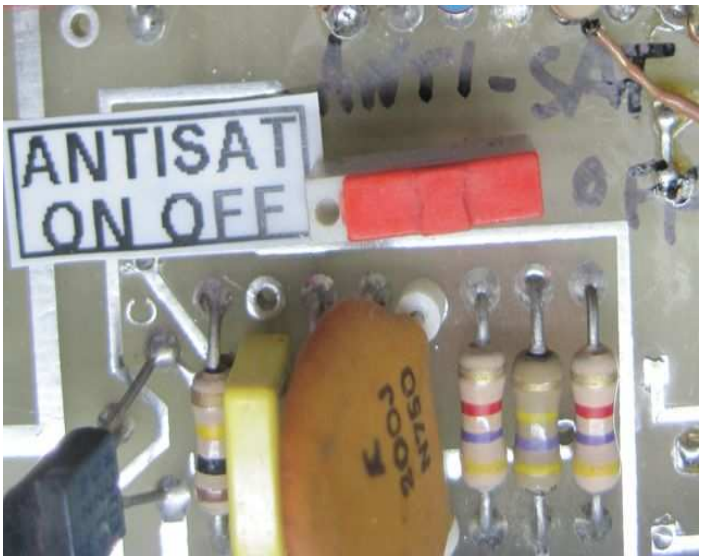

Illustration 5: anti-sat front

The unit can now be used with scintillation detector probes, but the basic input sensitivity is set so that only pulses above 1 Volt will register.
Ideally we want that sensitivity to be in the order of 10-50 milliVolts. The easiest way to accomplish this is to add a threshold (also called Lower Level Discriminator) control.
It sounds like a big deal, but in the Bicron, basically it's as simple as adding a variable resistor.
This is R2 in the Analyst schematic. While you're at it, change R3 from a 27K to a 10K resistor.

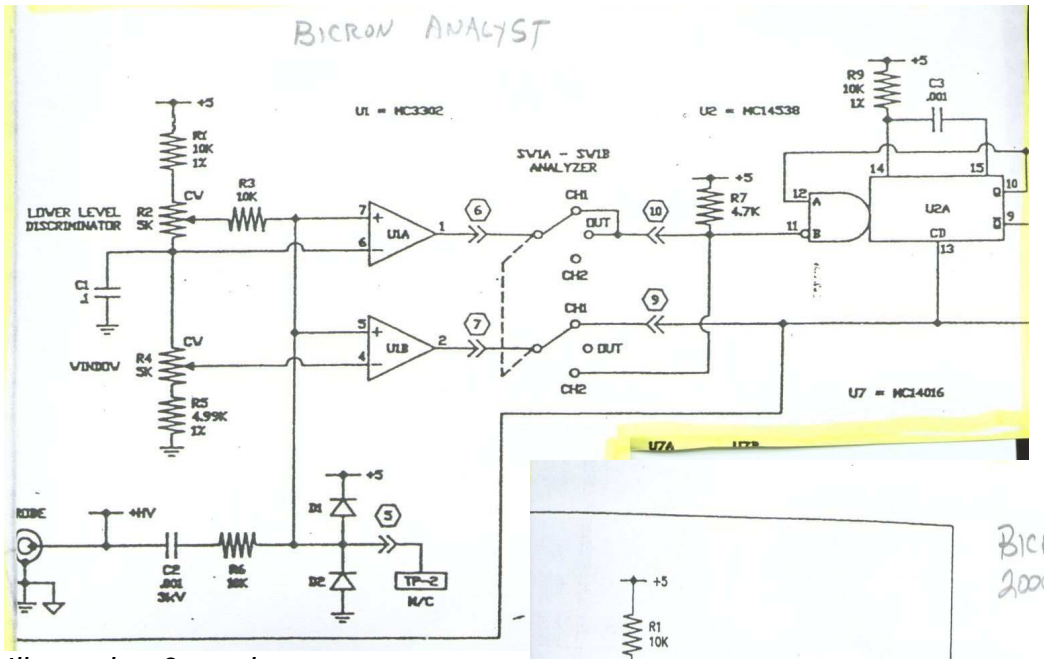

Illustration 6: analyst

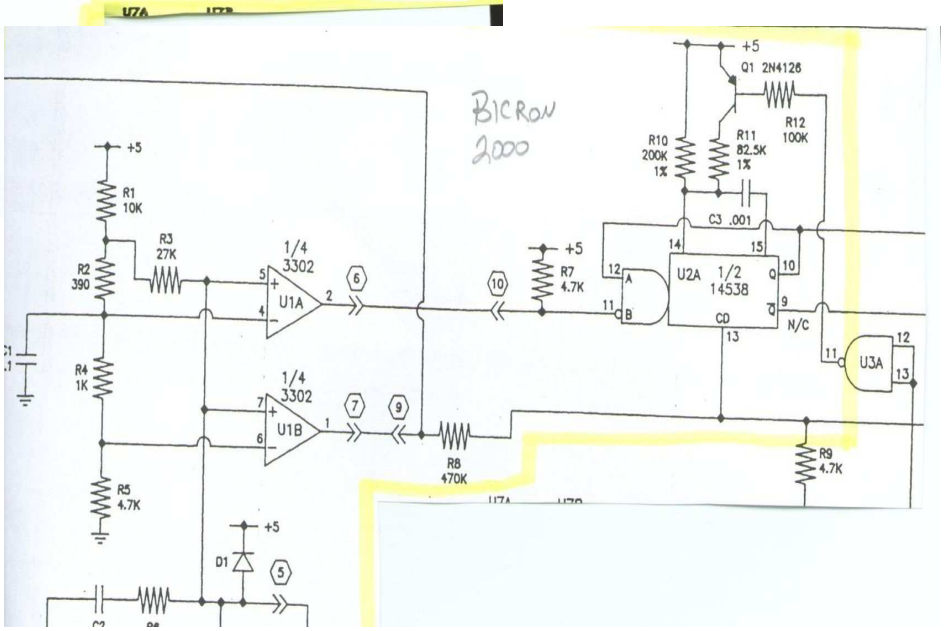

Illustration 7: surveyor

“TOTO4G” note the point 6-7 and 9-10 is the connection to front panel switch.

I raised the parts but without removing them, I soldered the wires to be connected to the trimmer.
the two wires brown and white are the control W, on the left.
the three white wires are the control LLD, on the right.
I recommend using the original scheme to find the correct position of the components.
adjust the LLD is very annoying but possible.

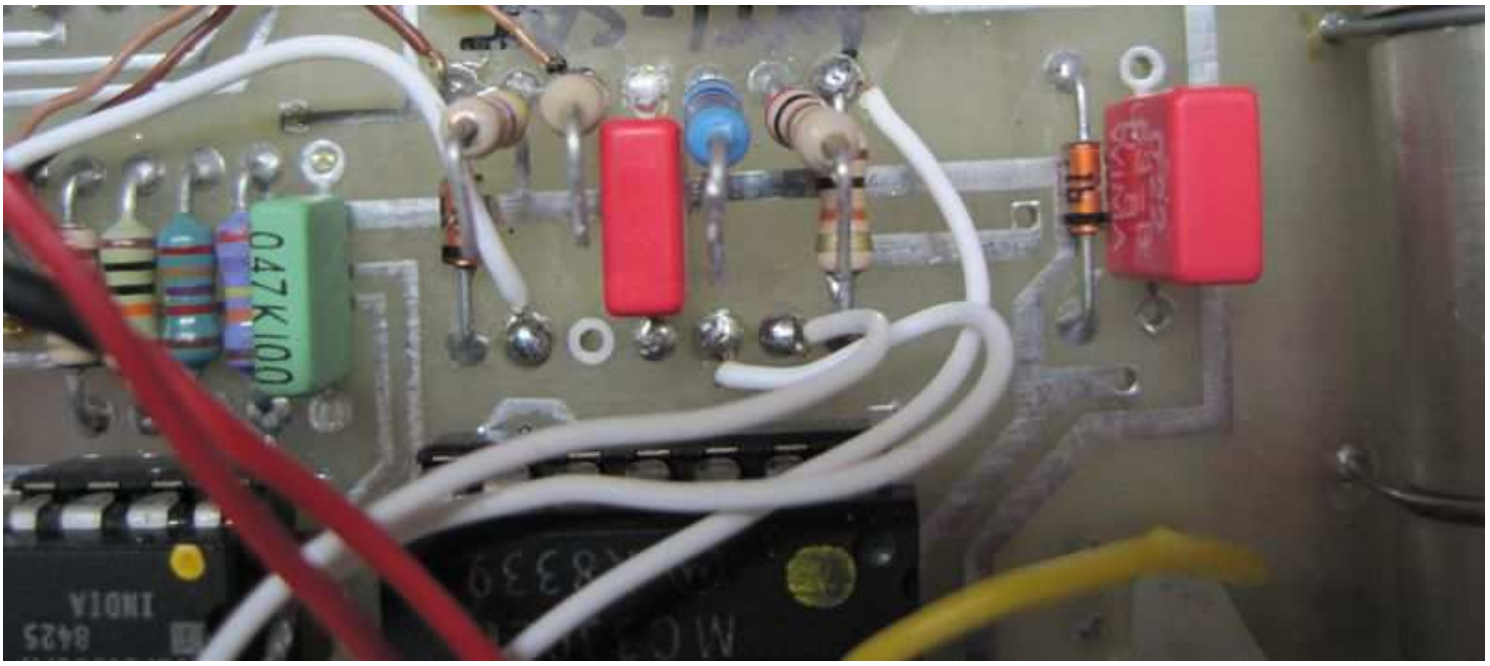

Illustration 8: LLD-W control

If the switch is not present "ch1-ch2-out" the control "W" is almost useless.

If you really want to go all the way, add the WINDOW control as well, and the ANALYZER Switch, as shown in the drawing.
There should be a place for the ANALYZER switch on the switch sub-board already, and a few jumpers are removed to accommodate the wiring changes.
An exact switch can be obtained for $7.00 USD from Digi-Key under the p/n RTA-P 30 206R SD M25S. This part is used for all the front panel rotary switch options, except the range switch.

Adding a RESET pushbutton makes sense, it goes between pin 2 and 6 of U4. It is wired to short out those pins when pushed.

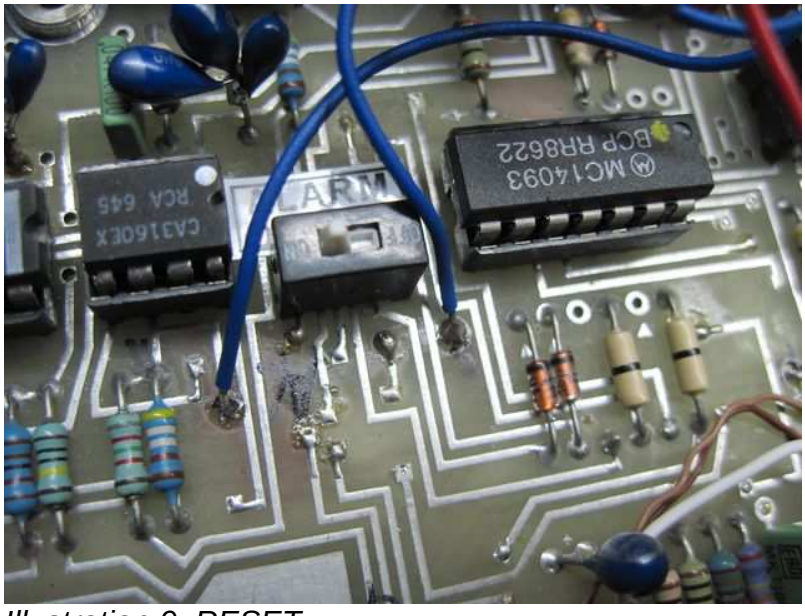

Illustration 9: RESET

“TOTO4G” the blue wire go to pushbutton

If desired, the HV set control can be brought out to the front panel, but actually I prefer to leave it inside where it won't be accidentally bumped. The sensitivity response of scintillation detectors are highly dependant on the HV, and a series of sample readings taken over a very long time period (like my 3 month field trips!) can be ruined by maladjustment.

“TOTO4G” I agree, the control "HV" must stay within

All the above are factory designed circuits, but for some reason they fail to bring them all together in one super-unit. To really put the set over the top, a digital scaler could be added. I have done this to Surveyor M units with great results.

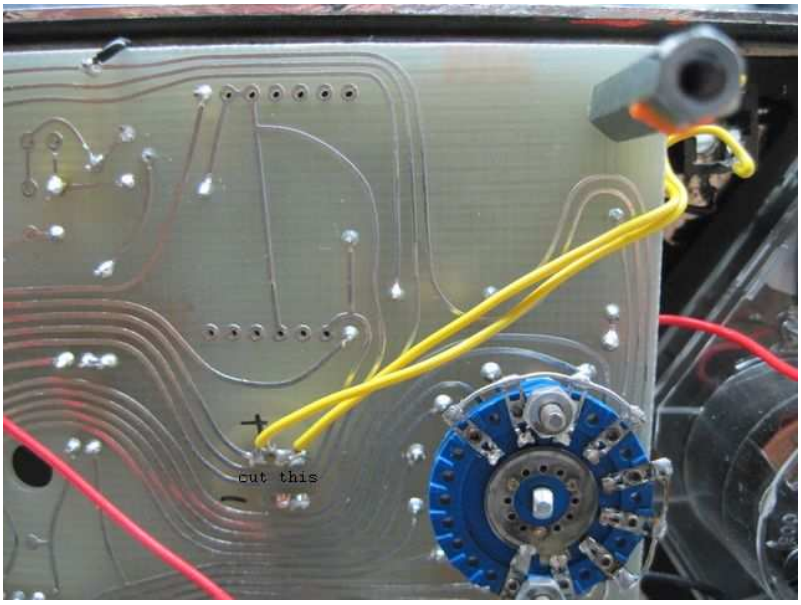

Illustration 10: earphone “cut trace”

Finally, easily added are earphone jack and meter light.

“TOTO4G” I have not added the light to save battery

OK all good until you can, if you make a mistake the instrument may become unusable.
It should make a change at a time and test it.
of course the responsibility is up to you to decide to do so.

Now a few tips on aligning the finished unit that may not be obvious from the manual. Good on all variations and generations of Bicron boards.

A) Place a digital Voltmeter between pin 15 (+) and pin 1(-) (ground) on the 24 pin inter-board connector. Adjust the ZERO control for 1 millivolt at that point.

B) With an external 1000 MegOhm HV meter (use adaptor from earlier article if need be), measure the HV at the probe jack.

Adjust it to an arbitrary 900 Volts using the HV pot. Now place the Bicron range meter into the HV position and note the meter reading on the unit. IF it is anything other than 900 Volts (or HV-OK on some scales) adjust the reading to the correct point using the SPAN pot.

C) Set the individual ranges with a pulser, using the cal pot for each. They do not interact. Depending on the dead-time of the GM tubes being used, the X1000 scale may or may not be set at 100%. I always set it at 100%, and usually use scintillation detectors in that range anyway.

If fully implemented, these modifications will allow all kinds of reading to be taken, impossible with other Geiger Counters. For example the Alpha-Beta dual phosphor scintillators can be put to their full range of uses. Scintillation detectors can be made to zoom in on a single- or group of energy levels of interest, making identifying, analyzing and assaying isotopes possible.

OPERATION of the ANALYZER -

THRESHOLD (LLD) pot sets the lower level. No pulses BELOW this setting will register. WINDOW control sets the UPPER LEVEL. No pulses ABOVE this level will register.

ANALYZER SWITCH -

Channel 1= Accepts pulses between LLD and WINDOW.....as set by the above controls.

Channel 2= Accepts signals ABOVE the window only

OUT- Accepts ALL signals above the lower level Discriminator setting.

Bicron units make a fascinating, light weight (2.2 pounds) handful of full featured diagnostic instrumentation.

The ANALYST 2000 that we have created, when teamed with an external HP-270 energy compensated side wall probe, a pancake probe and a 1" X 1" Gamma scintillation** detector will measure Gamma Rays from micro R to 2000 mR, and detect Alpha-Beta-Gamma over a wide dynamic range.
I doubt any commercially available single unit has all these features.

** These 1" x 1" scintillators give a response of 175 CPM per micro-R of Cs-137. A special micro-R scale can be made to correspond , and copied onto clear plastic, which in turn is overlaid on top of the existing meter face (on the surface), giving the resulting meter micro-R capability too! Likewise scales can be overlaid to correspond to the pancake tube's 55 CPS or the End-Widow's 35 CPS (per milli-R Cs-137).

Refurbishing UGLY units.

Many times the chrome plating deteriorates on the trim ring.
Remove the range plate from the front panel by the gentle addition of heat from a heat gun or hair dryer. A complete refurb would require going ahead and removing the thin transparent Mylar coating from the panel and replacing it with self-adhesive transparent plastic sheeting, as sold in office supply stores for self-laminating paper. Take the metal trim ring and remove all the chrome by sanding or sandblasting. Repaint using an epoxy paint or as I prefer, Hammertone paint fro WalMart.

Have Fun
George Dowell

Thanks George and good luck to all from TOTO4G