

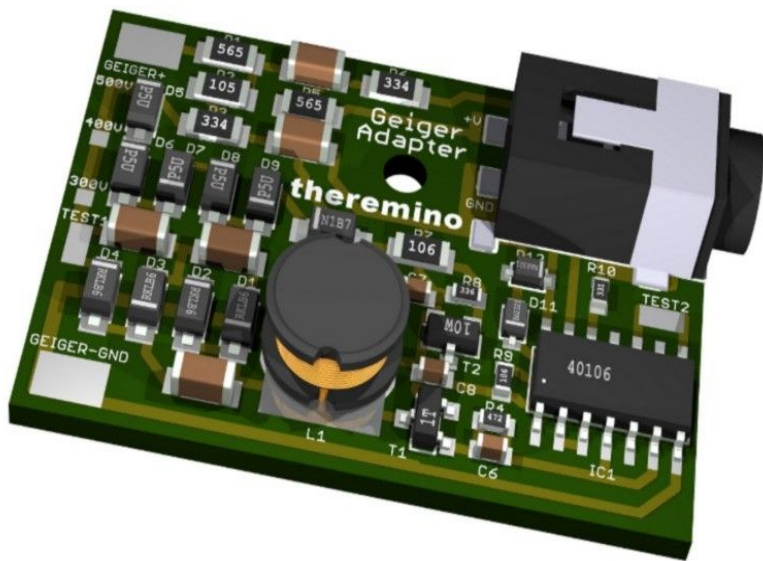
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System theremino

Geiger Adapter GA500

Data sheet

The Geiger Adapter - Description



The Geiger Adapter powers the Geiger tubes and adapt their signal to the Theremino System standard Pins.

To obtain the maximum efficiency and reliability the Geiger Adapter does not contain trimmers for adjusting the voltage and switches to the load resistors.

So each tube must be matched with a Adapter and permanently connected to it.

In this way it is possible to replace the probes quickly and ensure that each tube always work with the right voltage and impedance.

The output voltage is adjustable by means of jumpers on the printed circuit at 300, 400 or 500 volts. Any normal Geiger tube can work with these tensions.

Removing, or replacing the zeners D5, D6, D7, D8 and D9 can also get voltages from 50 to 600 V in steps of 50 volts (but it takes skill and proper tools are needed to handle and solder the SMD components)

The high voltage is constant to within +/-5% with supply voltages from 3.5 to 6 Volt, even with extreme weather conditions, with temperatures ranging from -30 to +90 degrees Celsius.

The Geiger Adapter are very efficient, consume a few uA and may be powered by a single lithium battery for many years.

The current limit is so effective that you can touch the high-voltage with the hands, without danger and without feeling sensations of discomfort.

The output signal is conditioned by a Schmitt trigger which isolates the pulses of the tube from the noise, provides a robust output signal and makes the stable operation, even in the presence of strong electromagnetic disturbances.

For Geiger tubes needing a load resistor of 10 Mega ohms (in practice the only LND712) a 4.7 Mega resistor can be added in series with the positive wire that goes to the tube.

To ensure a long life to the Geiger tube and does not degrade the character of Dead-Time is important to maintain a low capacitance on the anode of the tube (connection between the resistor and the positive pole of the tube) so do not use connectors or shielded wires, and the maximum length of the positive connection be few centimeters.

The Geiger Adapter - Electrical characteristics

Power supply voltage: from 3.5 to 6 Volt

Output voltage: from 100 to 600 Volt. +/-5% (Notes 1 and 2)

Output current: from 0 to 100uA

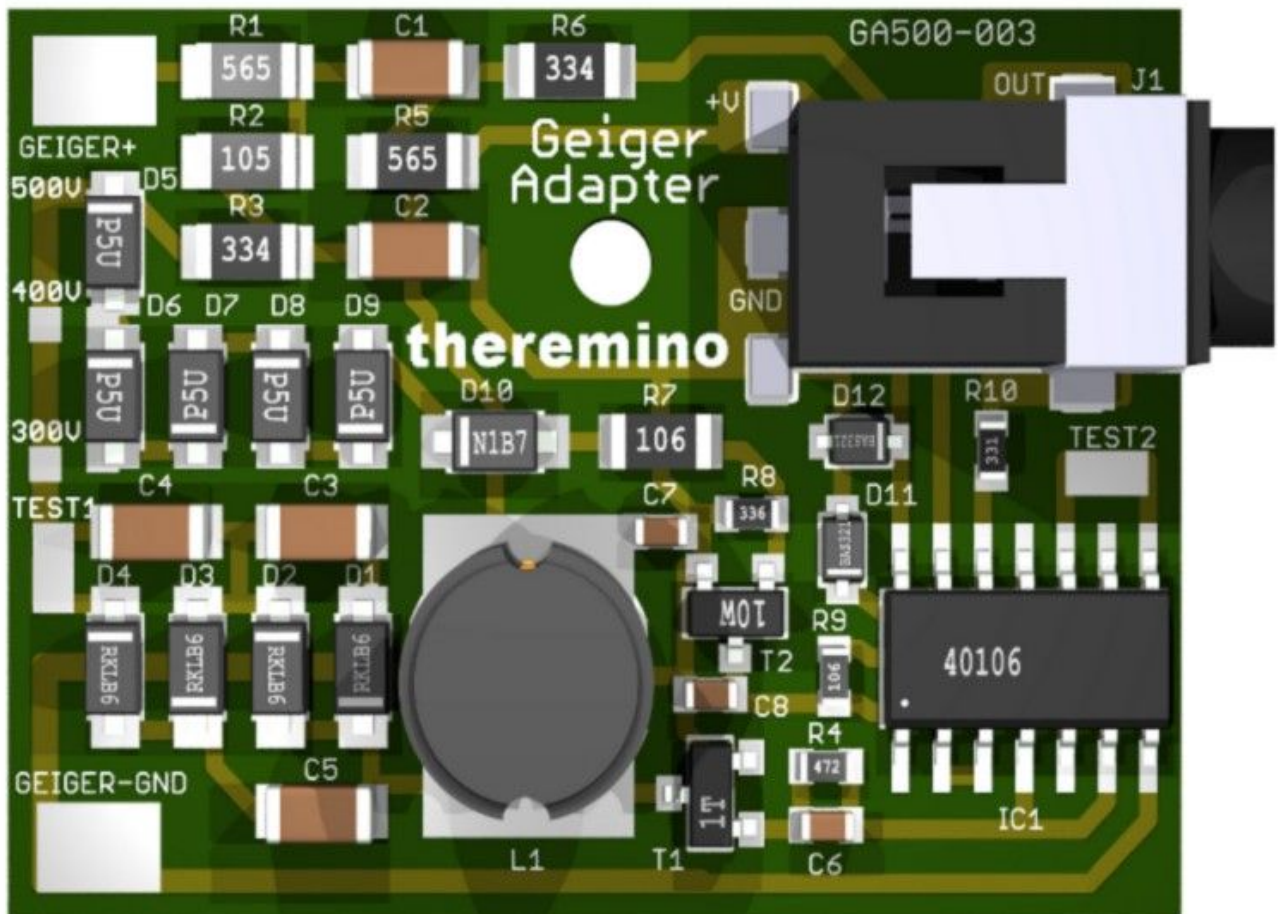
Performance: 60% up to output currents of 100uA.

Consumption: about 10uA (Note 3)

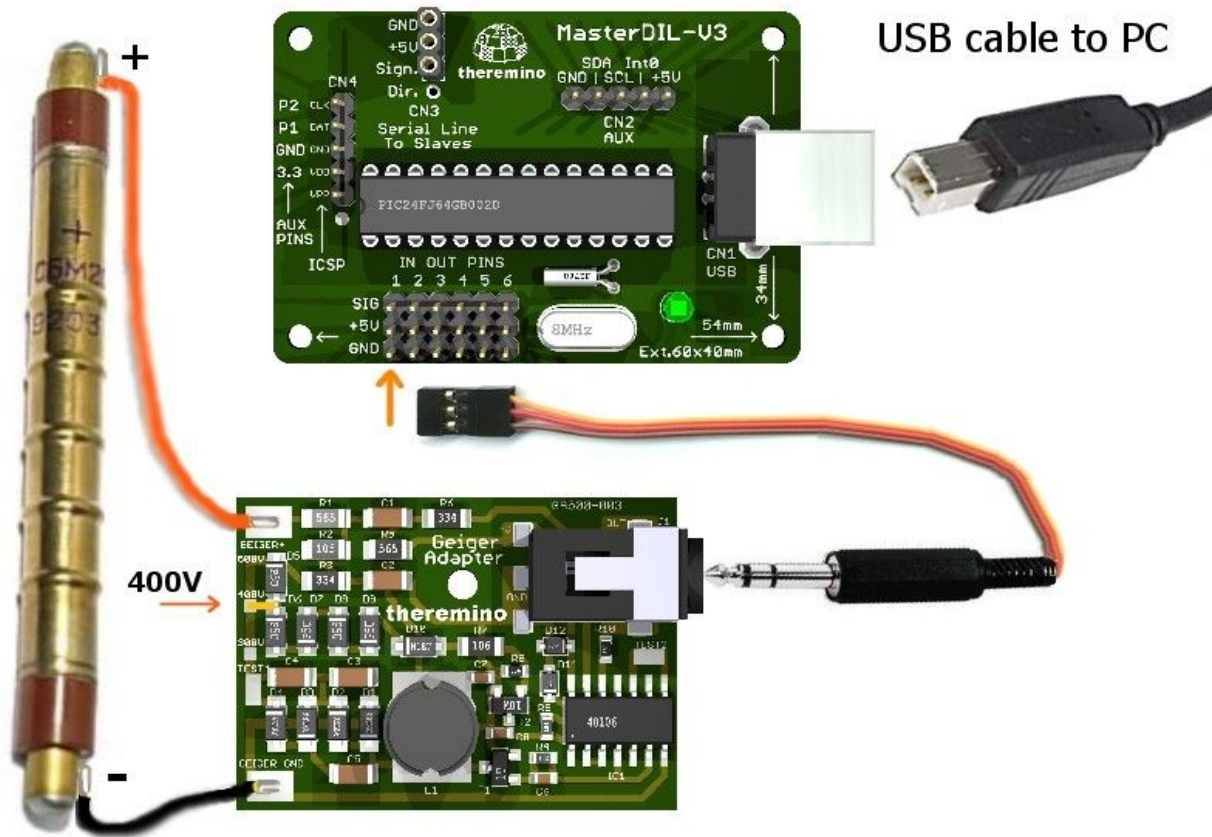
(Note 1) The standard voltages are 300, 400 and 500 Volt, for other voltages must be bridged diodes D7, D8, D9 and D10 with a soldering iron.

(Note 2) The presence of high voltages generates no health risks. The current is limited and capacitors are small. Touching the positive Geiger tube with your fingers can not feel anything, the voltage drops immediately to zero, as when the discharge tube, and you hear a counter "tick".

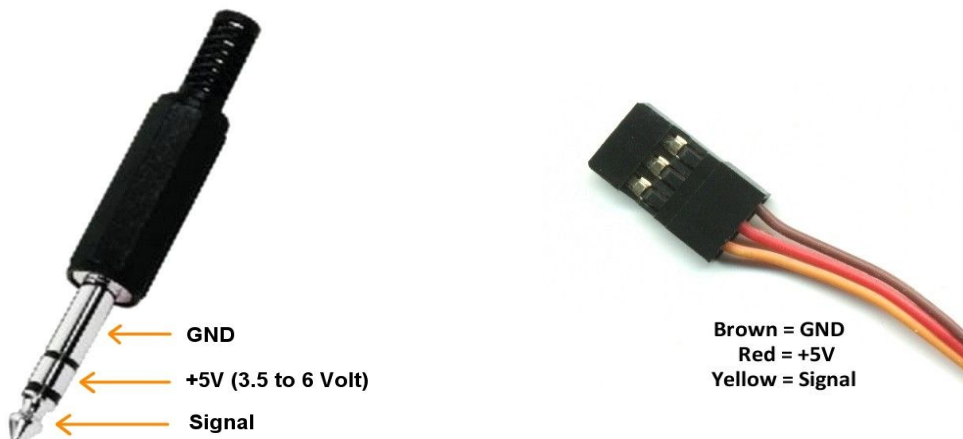
(Note 3) The consumption of 10uA is obtained only when the tube discharges with low frequency, in the presence of strong radiation, when the tube discharges with its maximum frequency, the consumption rises to some Milliampere.



Connect the Geiger Adapter



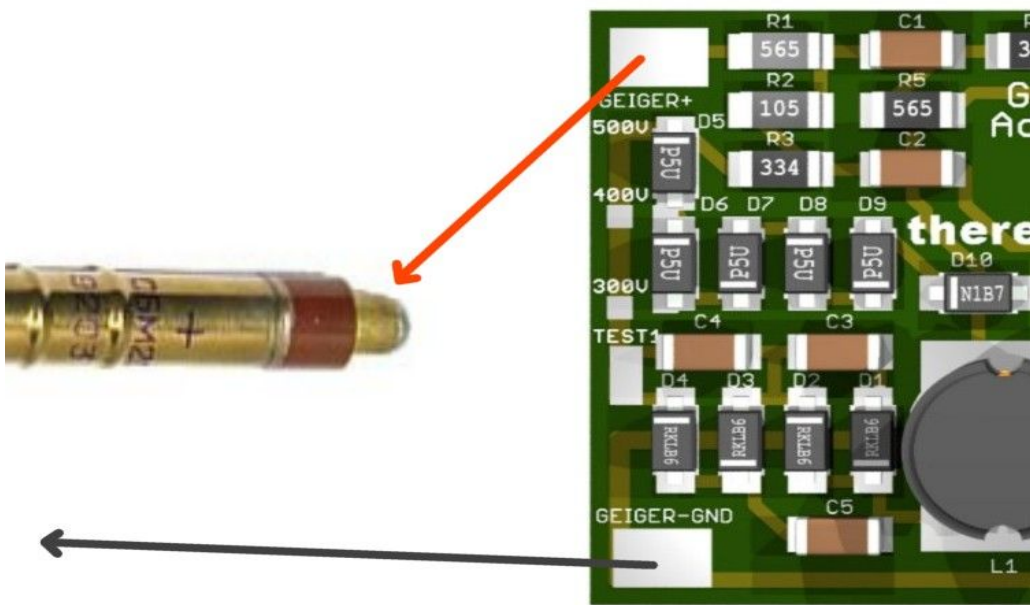
Connect the positive of the Geiger tube with a small, insulated, red wire.



Connect the Geiger tube

The wire of the positive should be kept short, at most a few centimeters. It is good to rotate the tube horizontally so that the positive is close to the Geiger Adapter.

The negative wire instead, can be very long and should move parallel to the tube and get to its negative pole which is located on the opposite side.



Pay attention to the positive of the Geiger tube, which sometimes may be difficult to notice, but should always be indicated with a "+"

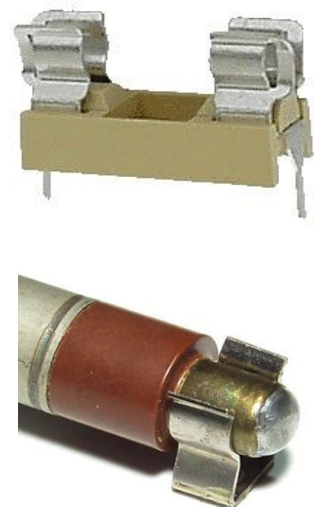
If you connect the tube to the contrary does not break but it does not work. It might seem OK because discharge is equally random, but does not increase the number of ticks in presence of radiation.

It is best do not solder the ends of the tubes STS-5 and SBM-20

You can get comfortable clips from fuse holders such as this. Remove all plastic and solder the clips on a vetronite coppery support, with the same length of the tube.

The copper must be isolated with a cutter so that there is no conduction between the positive and negative clips. Keep little copper on the side of positive clips.

Another way to create this connectors is to bend a strip of thin elastic plate. It should give you the approximate shape visible in this image.



Connect a Geiger tube with additional resistor

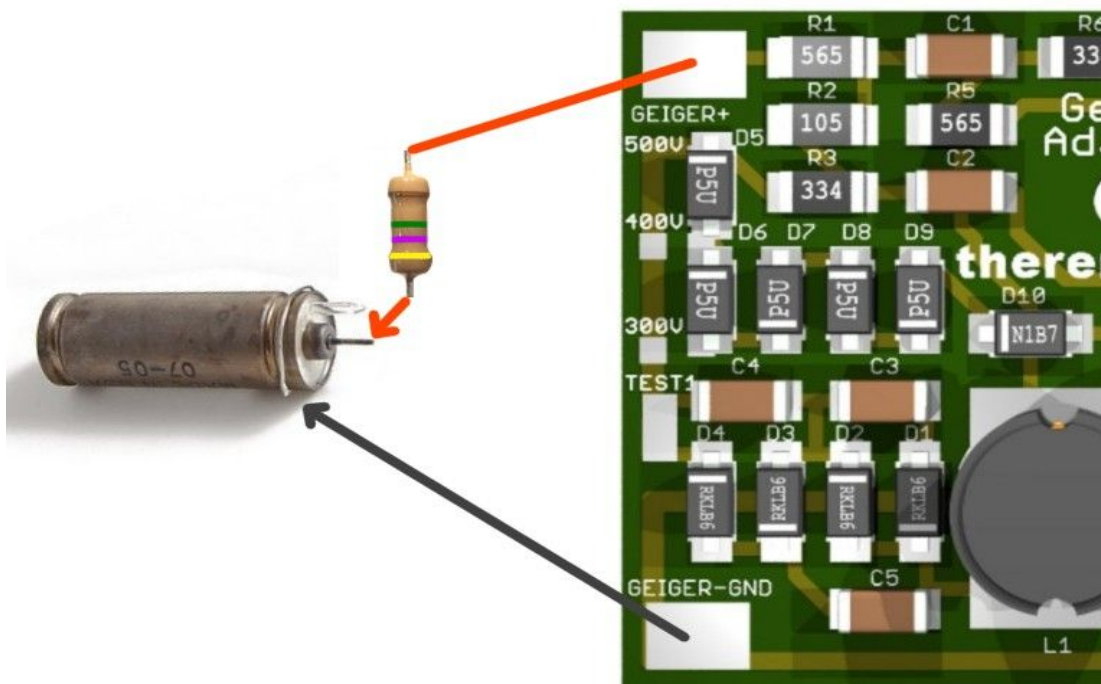
Virtually all tubes data-sheets say to use a 4.7 Mega ohm resistors, sometimes indicate that you can drop to 3.3 ohms and sometimes up to 5.6 Mega Ohm

The reason to use low values of resistance is to decrease the Deadtime but this leads to a higher discharge current and a lower tube life.

Since our electronics (better than the one imagined by the manufacturers of tubes) is made to work with low currents and that the program Theremino Geiger has the compensation of the Dead Time, we prefer to strain the little tubes and work with lower currents, and then resistors of greater value.

So we decided to use for all the tubes resistance "standard" 5.6 Mega Ohm (R1 on the printout)

Only for some tubes who want a resistance value even greater (in practice only the LND712 and GMT-01) it will add an external resistor of 4.7 ohms 1/4 Watt, on the positive wire, as visible in this image.



Some completed GeigerAdapter probes

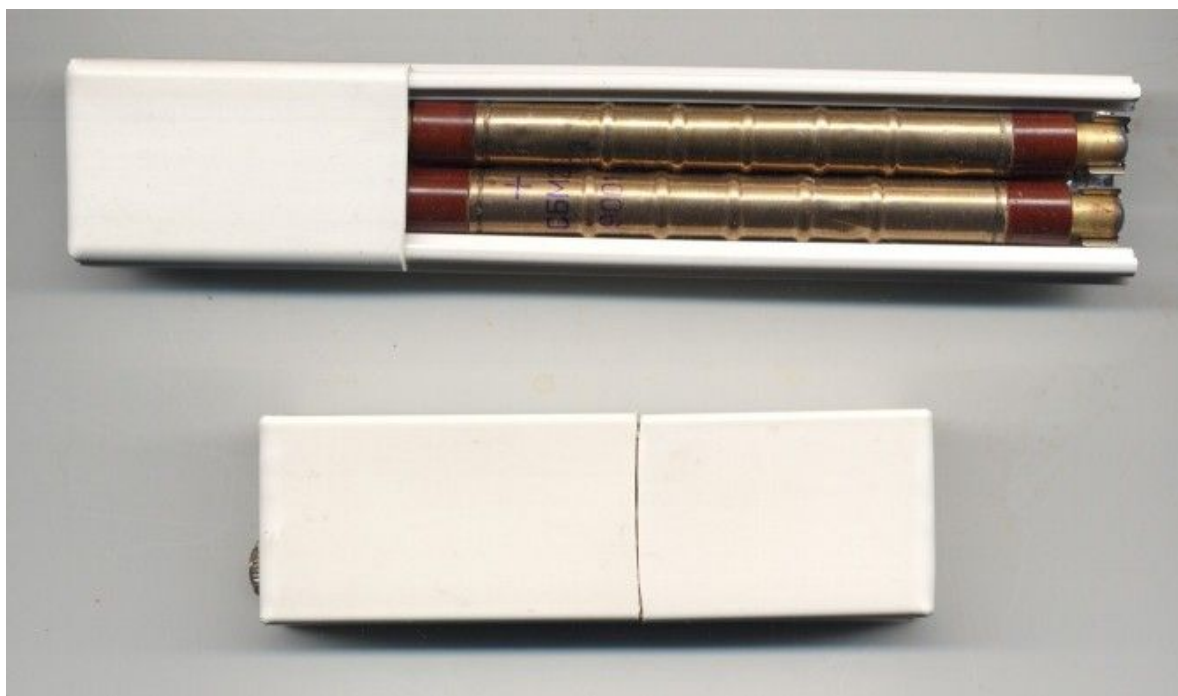
The Geiger tubes and the adapters are inserted into a piece of trunking electrical system. With the top of the raceway are obtained lids comfortable, easily removable, to protect the pipes when not in use.



A probe with two SBM20, without lids



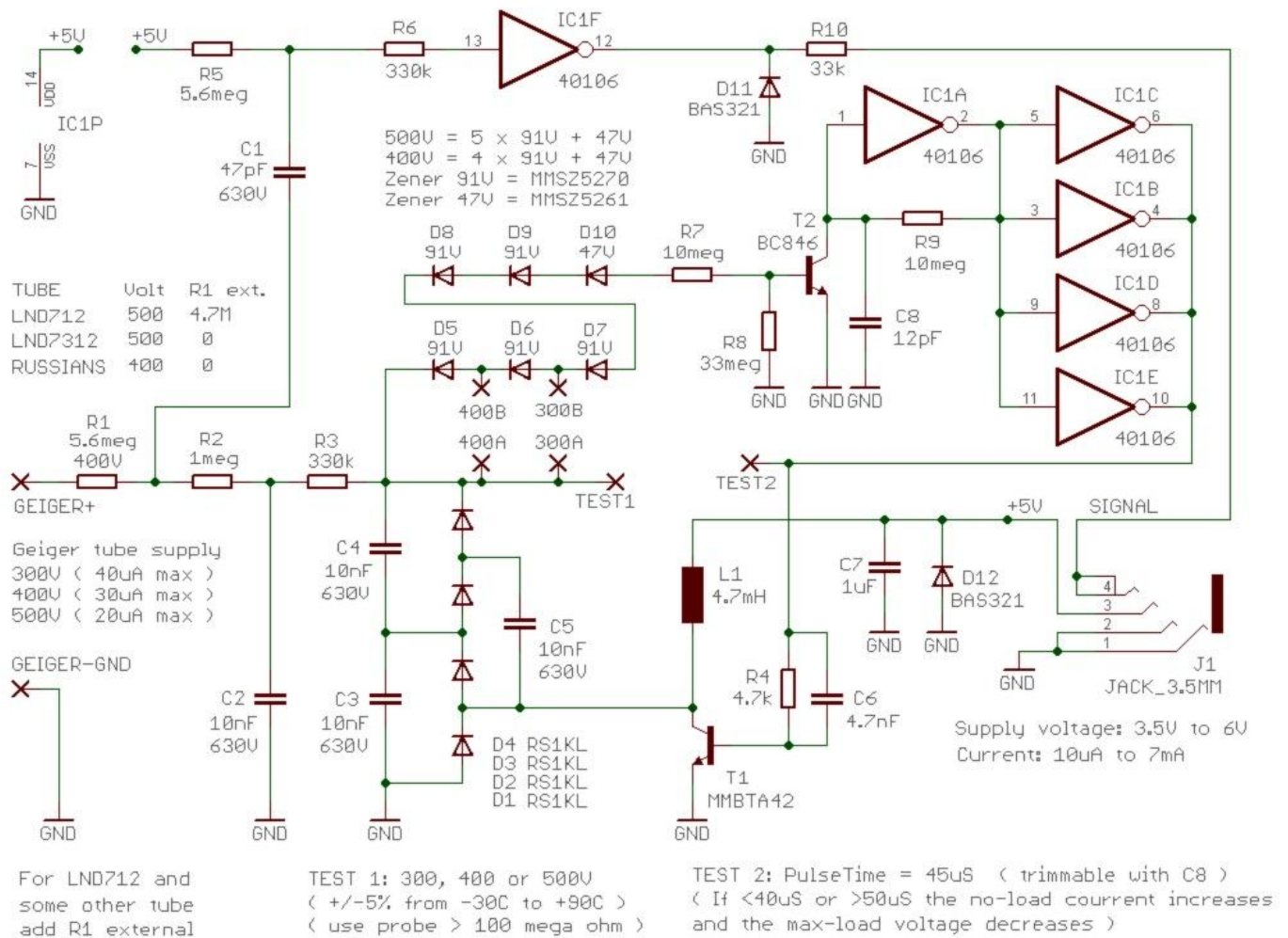
A probe with tube VA-Z-115.1 and one with the tube LND712 with the Geiger Adapter covered



The probe with two LND712 and the Geiger Adapter covered and the probe LND712 completely closed

The best raceway for STS-5 and the SBM-20 is "Scame WADO 30x15mm", see: www.scame.com
For LND712 is best to find a raceway slightly higher (about 18 mm in height)

Wiring diagram



The components in the lower left, R1, R2, R3 and C2 filter the high voltage and feeds the tube Geiger

The flyback circuit, composed by C3, C4, D1, D2, D3, D4, T1 and L1, produces a high voltage, variable from 50 volts to over 600 volts, depending on the driving ON and OFF times.

The measuring circuit composed of D5, D6, D7, D8, D9, D10, R7, R8 and T2, stabilizes the high voltage using only a few uA, in order not to reduce the total efficiency.

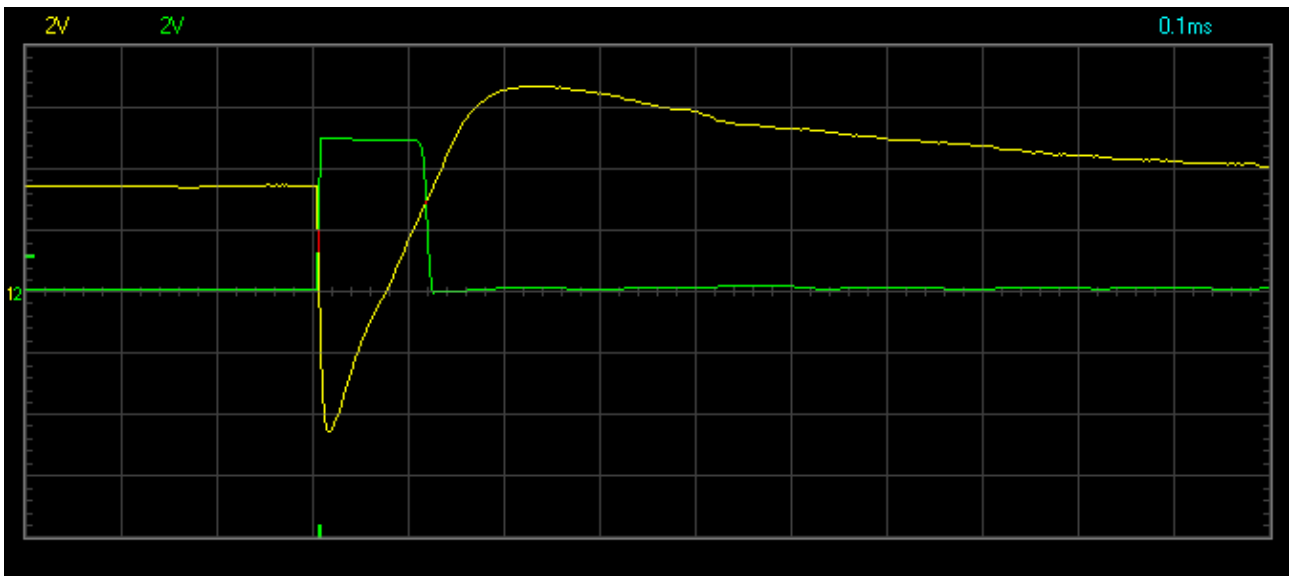
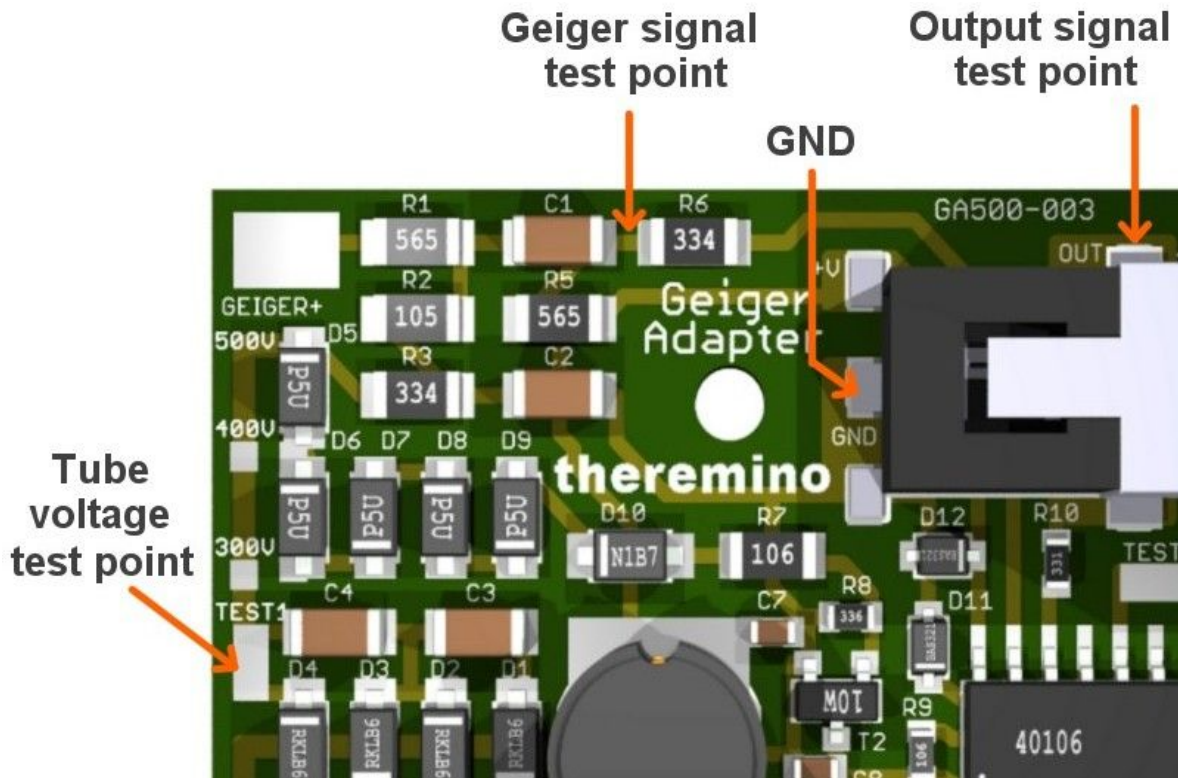
The oscillator circuit, consisting of C8, R9, and IC1A, produces an ON time fixed of about 45uS and an OFF time variable, depending on the current consumed by the Geiger tube, which may go from zero to about 40uA

The driving circuit, composed of IC1B, IC1C, IC1D, IC1E, R4 and C6, provides a strong instantaneous current to T1, to reduce the switching times to a minimum and ensuring the maximum efficiency.

The signal extraction and squaring circuit, composed of C1, R5, R6 and the Schmitt-Trigger IC1F, produces a sturdy and free of noise signal.

D11, D12, R10 and C7 have security features and limitations of the slew rate to avoid radiated interference when using long cables.

Test signals



In yellow the signal generated by the Geiger tube (junction point between R5, R6 and C1) in green the output signal.

The amplitude of the negative pulse, arriving from the tube, typically range from 4 to 10 volts. If it is too low (below 3 volts) you may lose count. The output signal is always 5 Volt and from 100 to 200us

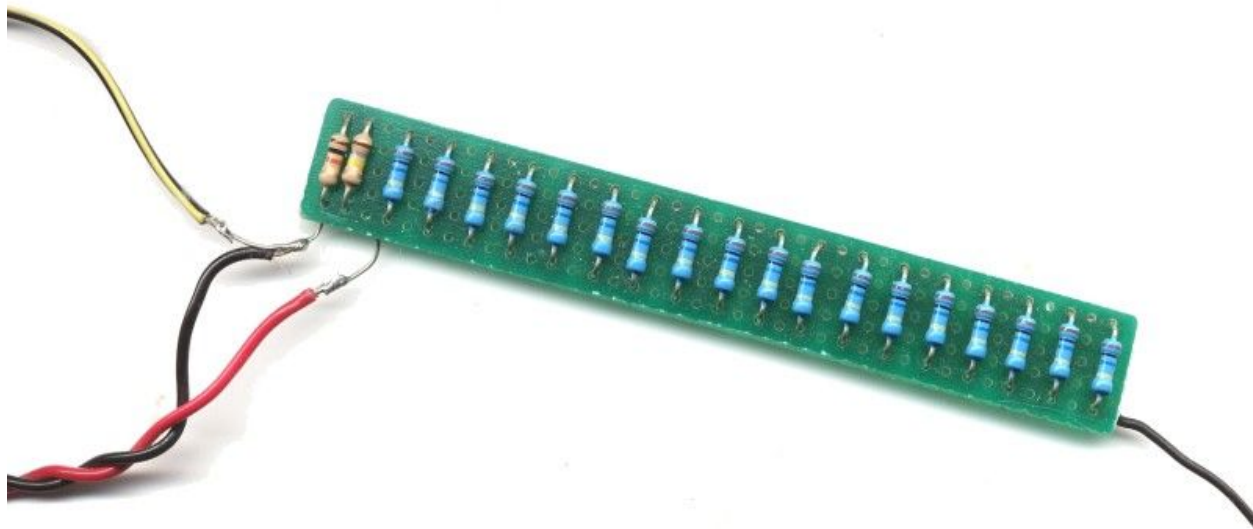
The rising and falling edges of the output signal are very steep (less than 1uS). In case of very long cables, the cable capacitance and the resistor R10 slow down the rising and falling edges to eliminate irradiated noises.

Measure the high voltage

No need to check the voltage of GeigerAdapters, they have been tested, their tension is definitely within +/- 5% (note 1) and, until now, no one has ever broken anyone.

Anyone wishing to measure the supply voltage should use a divider by at least 100 Mega Ohms or even greater (but normally not more than Gigaohm)

The voltage shall be measured between the GND and the point TP1 of the GeigerAdapter otherwise, because of the resistor that feeds the tube Geiger, will measure a wrong voltage, much lower than the real.



This adapter contains 18 resistors, 10 Mega for a total of 180 ohms, on the left you can see the resistors comparison that should be 180K (divide by 1000) but were increased slightly to compensate for about 10 ohms of the digital tester.

The tester is connected to the red and black wires, the yellow-black connects to negative voltage to be measured and the black wire on the right is connected to high voltage. If the tester measures, for example, 480 milli-volts, then the high voltage is 480 volts.

Tensions Medium, Low and High (Note 1) are:

With jumper on 500 Volt: Average = 480 Volt / 460 Volt = Minimum / Maximum = 500 Volt

With jumper on 400 Volt: Average = 385 Volt / 370 Volt = Minimum / Maximum = 400 Volt

With jumper on 300 Volt: Average = 295 Volt / 280 Volt = Minimum / Maximum = 305 Volt

Warning: tensions must be measured on TP1 - not on the Geiger tube.

(Note 1) To reduce the number of Background pulses, which make unstable measures at low radiation levels (and this effect is greater for the high voltage tubes), it is good to work the tubes in the first half of the plateau. Therefore, we prefer to feed the tubes with an average voltage slightly lower than the rated voltage.

Characteristics of the Geiger tubes

These are the most common Geiger tubes and their approximate prices.

STS-5 (15 Euro)



VA-Z-115.1 (25 Euro)



SBM-20 (20 Euro)



SI-29BG (30 Euro)



LND712 (60 Euro)



LND7312 (120 Euro)

The most common Geiger tubes, which are also the best, are collected in this list with their main characteristics.

Sensor	Sensitivity (cps/mR/h)	BKG (cps)	Dead Time (uS)	Operating voltage (Volt)	Limiting resistance (Mega)	Wall material density (mg/cm ²)	Active area length (mm)	Active area diam. (mm)	Active area (cm ²)	Length or depth / diameter (mm / mm)	Price approx. (Euro)
4xSBM20	116	0.80	190	400	4.7	40	90	---	36	---	80
SI-8B	111	1.00	160	400	4.7	---	---	---	30	20 / 80	85
LND7312	60	0.35	40	500	4.7	1.8	13	44	20	13 / 54	120
2xSBM20	58	0.40	190	400	4.7	40	90	---	18	---	40
VA-Z-115-1	32	0.06	150	450	4.7	35	27	---	---	52 / 13	25
SBM20	29	0.20	190	400	4.7	40	90	10	9	108 / 11	20
STS5	29	0.16	190	400	4.7	40	90	10	9	110 / 11	18
SI-29BG	18	0.07	95	400	4.7	---	---	---	---	55 / 11	20
LND712	18	0.10	90	500	10	1.8	38	9	3.5	49 / 15	70
GMT-01	18	0.10	90	500	10	1.8	38	9	3.5	49 / 15	70

All Geiger tubes have a very broad range of operating voltage, for example the LND712 can operate from 325 volts up to 650 volts and over.

Even a voltage much more high than the maximum voltage does not damage the tubes, provided that the current is limited by the resistor requested from the tube (or greater)

The absolute voltage is not so important, but it is very important to ensure a constant sensitivity with a supply voltage well stabilized.

Building the DIY version

The SMD version is not easily modifiable but the scheme is also valid for versions Thru-Hole and also with quite different features.

For example replacing T1 with a MJE13003 (the transistors that are found in fluorescent lamps from a few watts), C1, C2 with capacitors from 1500 Volt and C3, C4 and C5 with capacitors 800 volts could make it work up to 1400 volts (for very high voltages and depending on the current required some further modification to the values of some component may be necessary)

In a version not SMD, diodes D1, D2, D3 and D4 may be replaced with RGP02-20. In any case it must use zener with very low leakage current otherwise the voltage is not reached or falls when the ambient temperature increases.

If you do not have zener very low leakage current, then you can replace two resistors R7 and R8 with 1 Meg. With resistors from 1 Mega consumption rises from normal 10 uA to 150 uA but the leakage current of the diodes becomes tolerable.

Competing Power supplies

The Geiger tubes change their sensitivity by about 10% with a variation of voltage of 100 volts, therefore **it is not important to the absolute voltage, but once established a voltage, the power supply must be very stable, within a few volts more or less**, in order to reduce variations in sensitivity below one per cent.

A good Geiger power supply should not produce high frequency noise (above 100 Hz) with amplitudes greater than a few hundred millivolts that may cause false counts.

A good power supply must also maintain a **good performance over the whole range of current requests from the tube so as to minimize the battery consumption.**

These conditions must be maintained in a very broad temperature range and with a consumption of the tube Geiger variable in a ratio of one to ten thousand (from a few nanoamperes, when the tube makes one discharge per second, up to a few tens of microamperes, when the discharge tube with its maximum frequency)

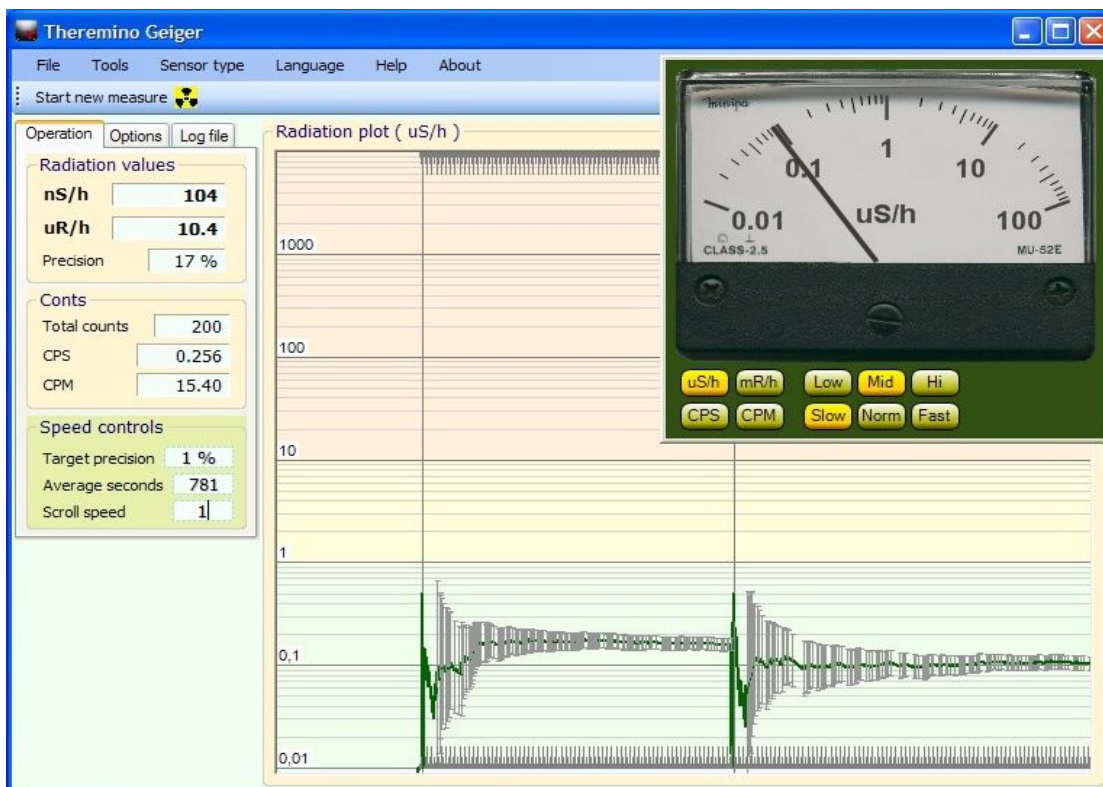
Simultaneously obtain these characteristics is quite difficult so many patents that have been written on the subject.

In practice among commercial products only the "Gamma Scout" consumes less than 100uA. The first versions consuming 10uA, but since they had problems of instability, the current versions have been modified and now consume, presumably, a hundred of microamps.

To achieve such a low power the "Gamma Scout" sacrifice stabilization, noise immunity and reliability but allows them to declare "10 years of operation" that are important for sales.

All other competitors claim, at most, autonomy of thousands of hours (months of operation) compatible with consumption by half milliampere to a dozen milliampere.

The measurement software



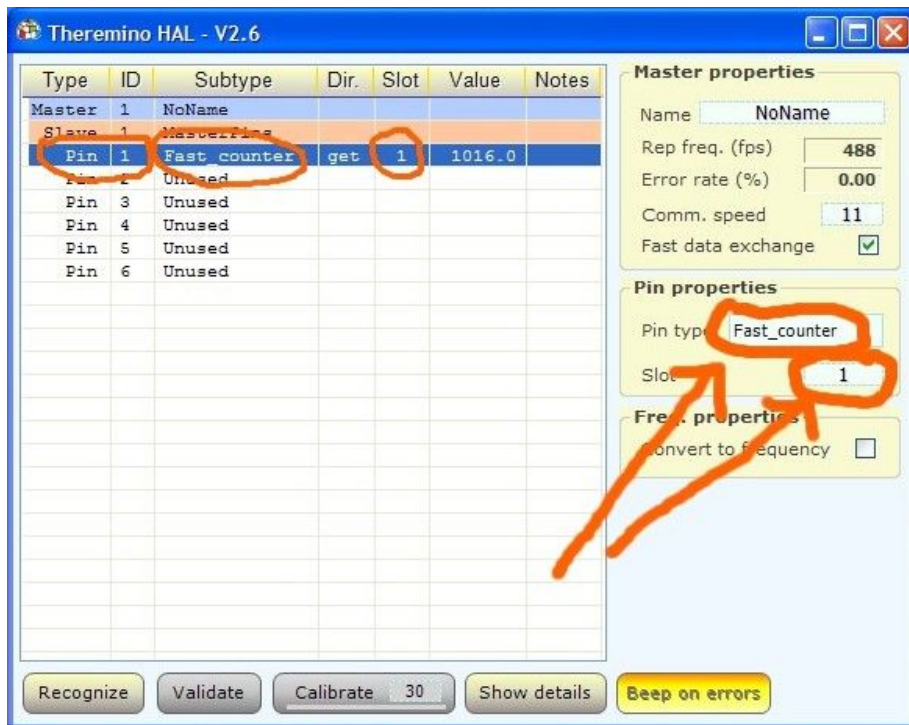
To read the incoming pulses from the Geiger Adapter we recommend to use the program Theremino Geiger.

In the documentation folder of Theremino Geiger (accessible from the Help menu) you can find all the information needed to use the program and the probes.

Download "Theremino Geiger" from here: www.theremino.com/downloads/radioactivity

Download the HAL (to access the hardware) from here: www.theremino.com/downloads/foundations

Start without reading the manual



Images showing how to set up applications Theremino HAL and Theremino Geiger to make them communicate with each other.

- 1) Connect the master to the USB
- 2) The master must blink fast
- 3) Download Theremino_HAL here: www.theremino.com/downloads/foundations
- 4) Launch Theremino_HAL
- 5) Select the line of the pin that is used as input (from 1 to 6)
- 6) In the "Pin properties" select "PinType = Fast counter" and "Slot = 1"
- 7) Minimize Theremino_HAL **but do not close it**
- 8) Download Theremino_Geiger from here: www.theremino.com/downloads/radioactivity
- 9) Launch Theremino_Geiger
- 10) In the "Tab" "Options" and select "Sensor type" = "Geiger tube used"
- 11) Also in the "Tab" "Options" select "Input = 1"
- 12) At this point should begin to hear the "clicks"
- 13) Close the analog meter, that in the laboratory is not needed (it is quick but not accurate)
- 14) In the tab "Action" select "Seconds FIR filter = 9999"
- 15) Place the sample and press "Start new measure"
- 16) Wait until the reading stabilizes
- 17) For each new measurement, press "Start new measure" and wait until the reading stabilizes.