**Detection of Alpha Radiation with a PIN Diode Counter**
Bernd Laquai 6.6.12

There is a rumour saying that a PIN diode counter is not able to detect alpha radiation. Even though this rumour is not correct but its easy to understand why it came up. Therefore this article tries to clarify this issue.

First of all alpha radiation is associated with much more energy per disintegration compared to gamma radiation. Therefore the expectation is that a detector may be less sensitive to detect it. This can be proven, however there is another problem that arises. Alpha particles are slow enough and their mass is quite high (helium ions) so they react with all substances immediately and therefore are absorbed quickly and completely already by foils or sheets of a few mm thickness or even in air.

This means, that no sensitive detector is needed not even a PIN diode, a regular PN junction would be sufficient. A BPW21R from Vishay for example would do the job. However there must not be any obstruction in the way of the rays and the source must be closer than about 4 cm to the detector for the radiation to reach the detector. In such a case the strong pulses are easily visible with the same amplifier as used for beta and gamma rays.

It is not easy to meet these requirements since a diode (or a transistor) is required where the package can be opened such that a relatively large area PN-junction is exposed to the radiation with its naked surface. This PN junction must not be passivated in any way (except perhaps with a $SiO_2$ layer of few micrometers thickness). The easiest way to achieve this is to order a photo diode in a TO-5 package with a glass window. With a Dremel and a thin cutting wheel the package can be opened and the glass can be removed carefully. However be particularly careful with the electrical connection of the diode that on one side is typically a thin wire bonded to a small pad on the surface of the diode and the other one is the body of the package. Take care on this wire it is torn off easily and in such a case the diode is destroyed completely.

Having prepared the detector and having connected it to the amplifier best is to bring it into a completely shielded metal box also tight against light together with the radiation source. The output should be brought to the outside without giving any light a chance to enter the box. In the interior of the box the source should be brought as close as 1 ore 2 centimetres to the detector surface. As soon as the alpha radiation reaches the detector surface (this may happen quite abruptly) the amplifier suddenly reacts with a massive increase of pulse heights and an increasing counting rate. The measurement amplifier of the „Stuttgarter Geigerle“ may saturate completely for some samples whereas for a larger distance the typical pulse heights of less than 1V as a result of beta and gamma radiation (depending on the diode type) are obtained as usual.

A source that emits only alpha radiation may be advantageous but should not be shielded with a window (as in the case of an old watch). The Am-241 source of an old smoke detector generates almost solely alpha radiation and only a small amount of gamma radiation. Here the effect can be recognized very clearly. But care should be taken with such a sample to always maintain the integrity of the sample and not to incorporate any split off particles of it.

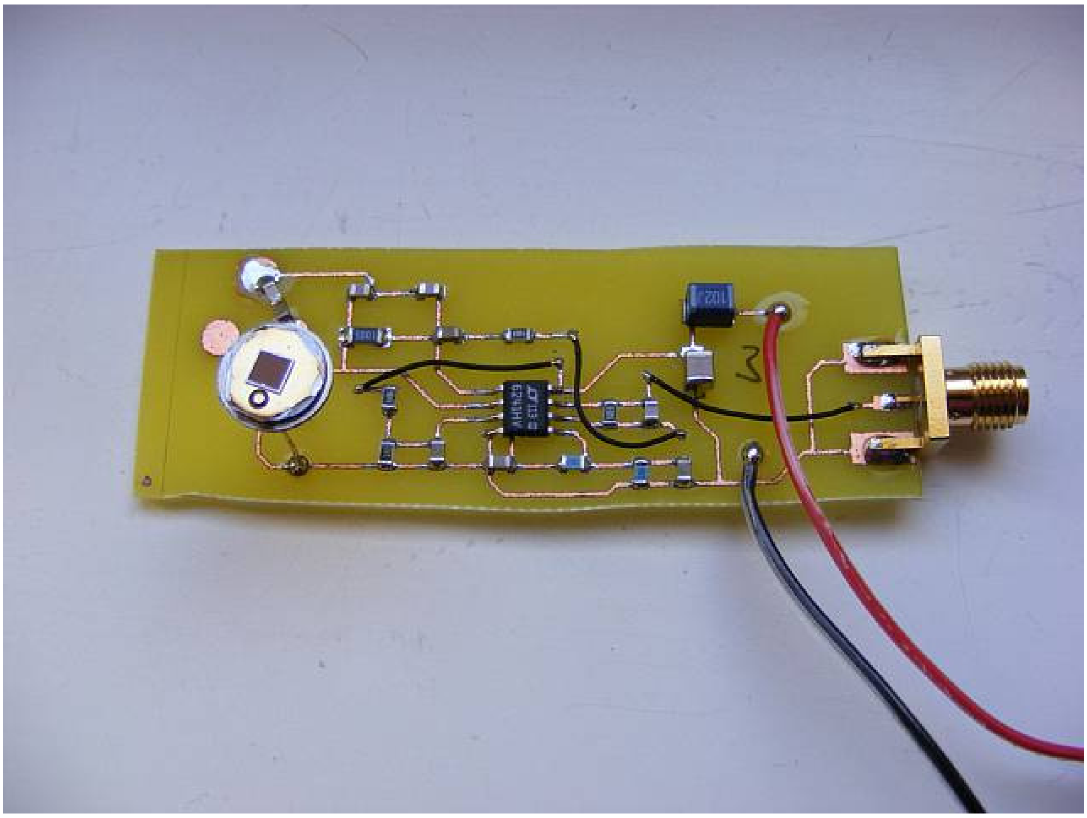

Fig. 1: Prototype PCB with amplifier (Geigerle circuit with LTC6241HV as OP) and BPW21R in an opened TO-5 Package (trimming capacitance replaced by a fixed value of 100pF

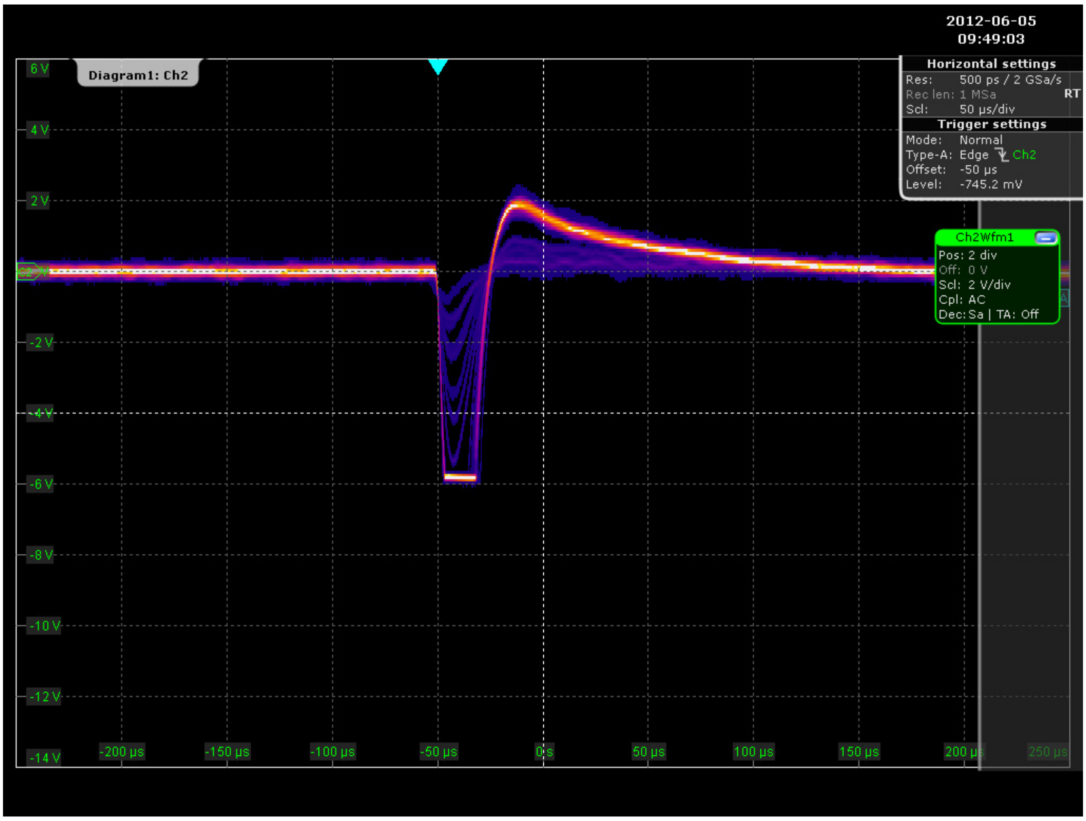

Fig. 2: Signal at the output of the amplifier when the opened photo diode is radiated with a Am-241 source of a smoke detector (AC coupled). Most of the pulses drive the amplifier into saturation at –6V (white colour).

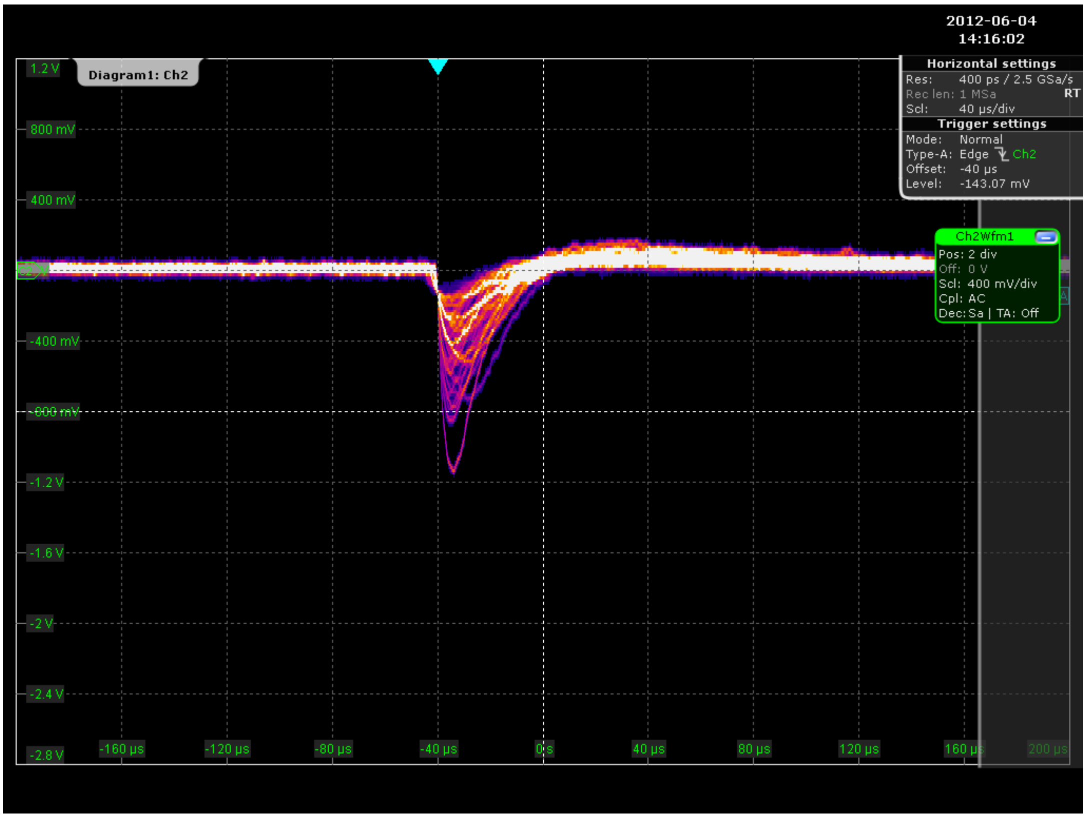

Fig. 3: Signal at the output of the same amplifier radiating the opened detector with a thorium containing mantle of a petroleum lantern enclosed in a paper envelope. See also the different scaling. The visibly smaller pulses can only be the result of beta or gamma radiation in the respective decay chain of thorium.