The „Stuttgarter-Geigerle“ in Through Hole Assembly Technology

Bernd Laquai 07.09.2012

It is not really a purely positive trend that the methods in modern technologies become more and more complex and sophisticated when looking at all the aficionados who loved this hobby without being professionals. In particular in the electronic manufacturing a dramatic change occurred a while ago making it more and more difficult to create electronic devices with reasonable effort at home and without professional education. The most disruptive change in this respect was the introduction of the surface mount technology (SMT) with electronic parts that no longer have connection wires for through hole assembly. Regarding the achievable signal quality, the clocking rates and maximum frequencies the SMT technology was definitely a significant breakthrough. In the meantime manufacturing with SMT is even often more cost efficient than with through hole assembly. But for the traditional electronics aficionado these parts are rather a nightmare. In addition, more recently, there is a trend that some of the parts no longer are available as through hole parts but only as SMT parts especially the semiconductors. Crowned is this trend even more modern leadless packages for ICs than not even have pins anymore just metalized pads at the package in a 0.5mm or less pitch and a so-called thermal pad at the bottom side. These parts only can be soldered in a special reflow machine. Furthermore passive parts such as resistors and capacitors come in 0402 and 0201 packages that manually can only be soldered with special equipment under a microscope. In this respect the industry should not wonder about the lack of qualified employees since young interested people do not have an option to enter this profession without particular help just by being motivated from a hobby.

Anyway, it often is possible to convert a circuit developed for SMT technology also into a version with through hole parts when some compromises are accepted. This is also true for the “Stuttgarter Geigerle” PIN diode counter circuit. The biggest challenge was to find a suitable operational amplifier in a DIP/DIL package with 8 through hole pins. Interestingly I was successful with a general purpose OP which in addition is really cheap. It is the TL072 from Texas Instruments. This device has an input stage with JFETs and really acceptable noise parameters. At least there is no big difference to its counterpart AD8666 from Analog Devices (this is valid for the SOIC package too). Beyond this it was not required to change the circuit architecture except for the inductor that is used for low pass filtering the power supply noise. Whereas the small SMT part already shows up with a high parasitic series resistance the through hole inductors come with very low series resistances such that an additional external resistor needs to be added to prevent oscillations. Other than this no changes were made with respect to the SMT version.

I also reshaped the PCB board a bit to better fit it into the housing and to ensure that a 9V block battery (9.6V NiMH rechargeable) finds enough space with the battery clip plugged on. In general the PCB can be easily manufactured with homemade photolithography and etching when only the bottom side is processed. The number of conductors on the top side is quite limited. These connections can be soldered later with additional individual wires.

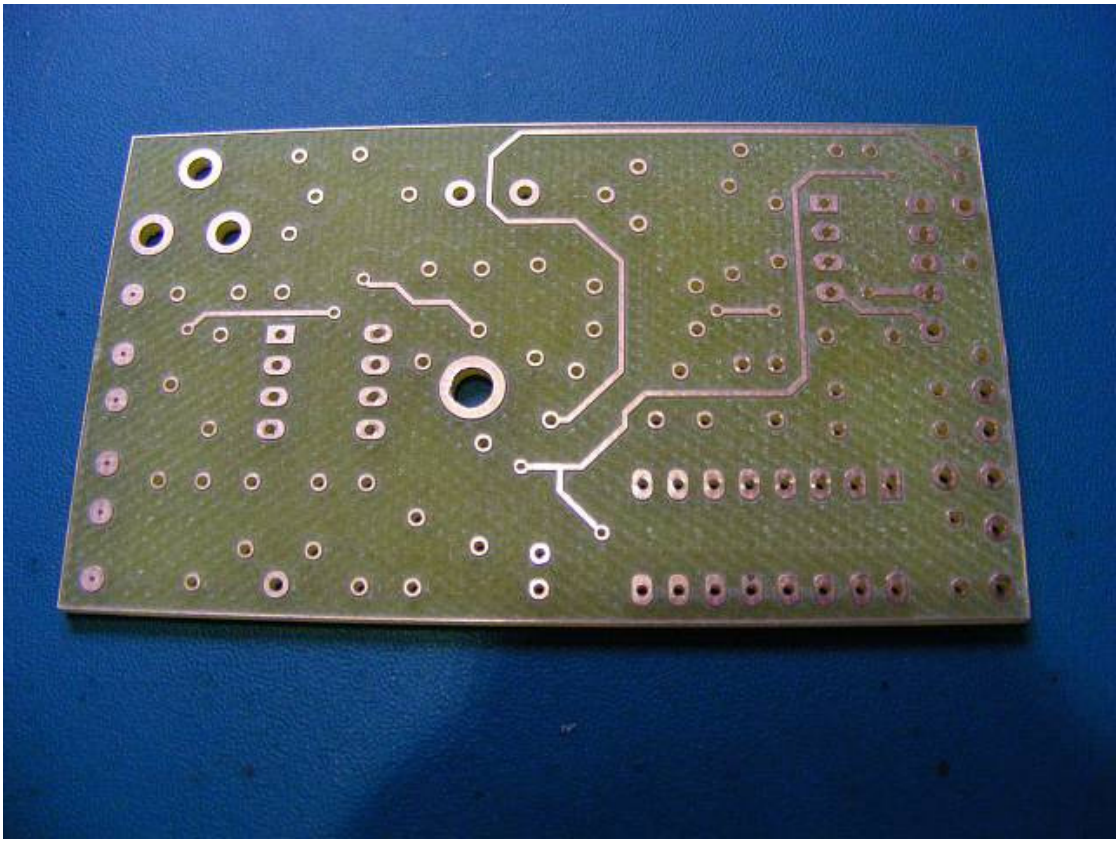

Fig. 1: Top side (assembly side) of the PCB

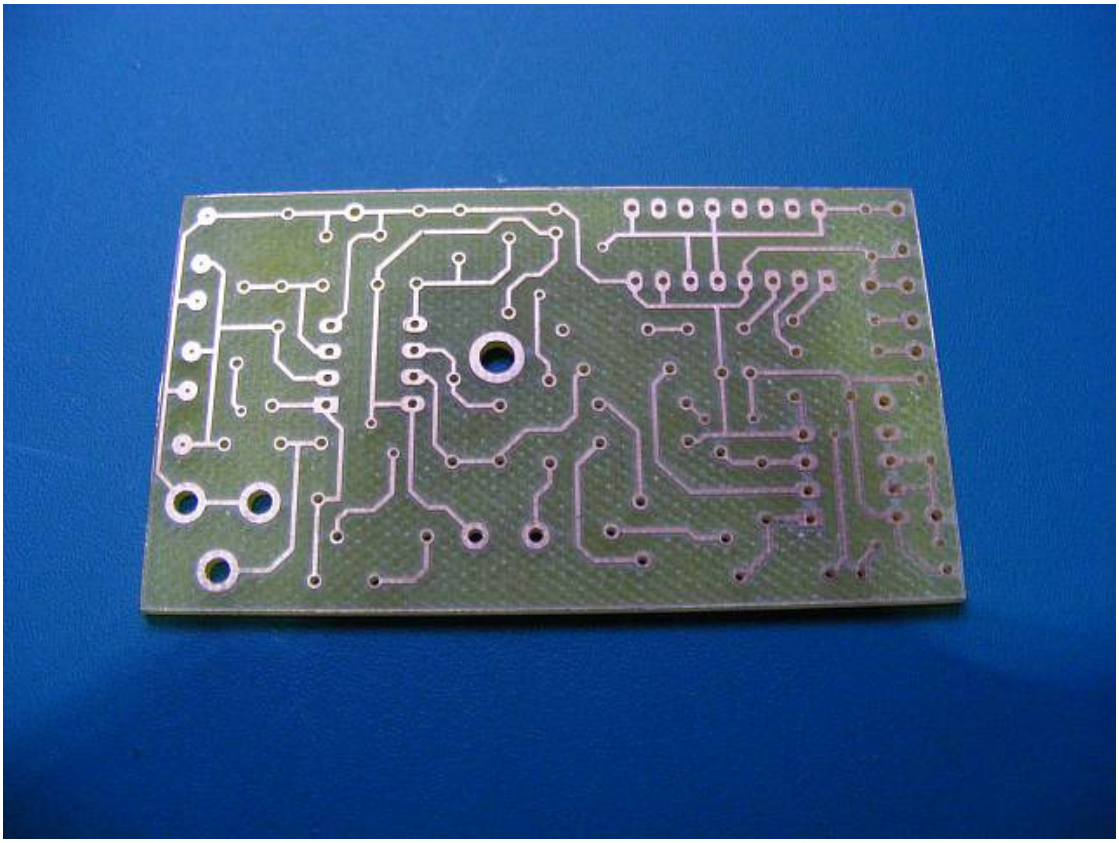

Fig. 2: Bottom side (soldering side) of the PCB

The signal quality is indeed not as excellent as with the SMT version due to the higher parasitic effects at the longer conductors of the parts (inductive and capacitive effects) and

the higher susceptibility for interfering fields mainly in the first stage of the amplifier. The analysis of the signals after the second stage (measurement amplifier output) however shows quite well conditioned pulses. The little more pronounced ringing has no impact on the comparator since the first ringing goes in positive direction whereas the threshold is set to trigger on the negative going primary pulse. The second ringing in negative direction is already damped sufficiently and does not generate a problem anymore. The comparator has a hold time of several 10msec a repeated triggering is therefore avoided anyway. At the output of the comparator finally no difference to the SMT version can be recognized.

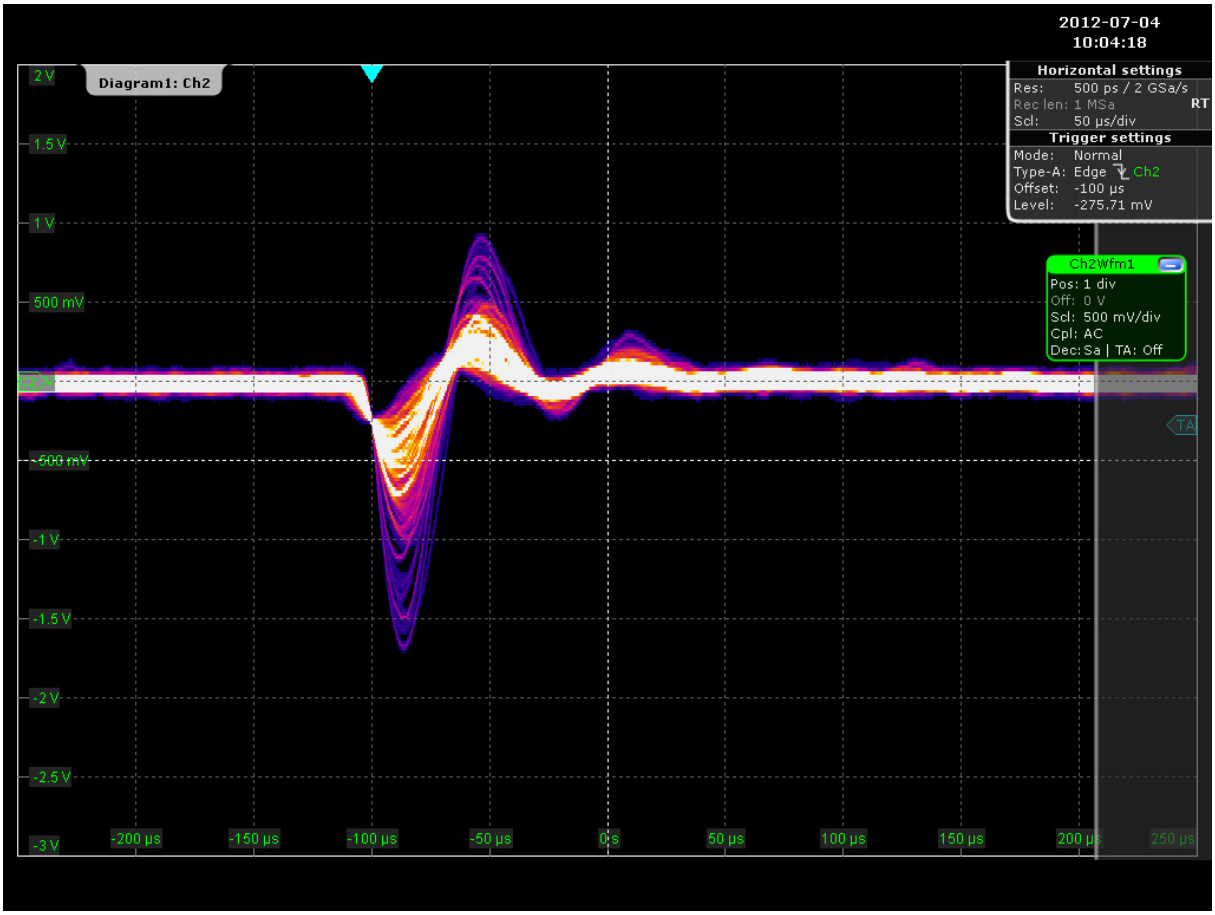

Fig. 3: Signal waveforms of the amplified current pulses at the output of the measurement amplifier using the TL072 OP in through hole assembly

Even though the PCB layout has a smaller dimension than the SMT version the integration into the housing is a bit more challenging, since the through hole parts are higher in size. Therefore the PCB must be first adjusted inside the housing and the mounting screw, the switch, the LED and the earphone jack must be marked precisely after they had been positioned in the remaining free space. Care has to be taken that a 3mm margin is left at the upper edge of the housing wall, because the cover has a special tightening which is of importance for shielding the light from the detectors. Important is also that the detector window is positioned with a minimum distance of 2mm to the bottom of the housing in order to provide enough area for the adhesive aluminium foil to be attached needed to cover the detector window from the outside.

Finally, it is required to position the PCB as low as possible in the housing to create enough space for the control elements but without creating a short cut at the housing bottom.

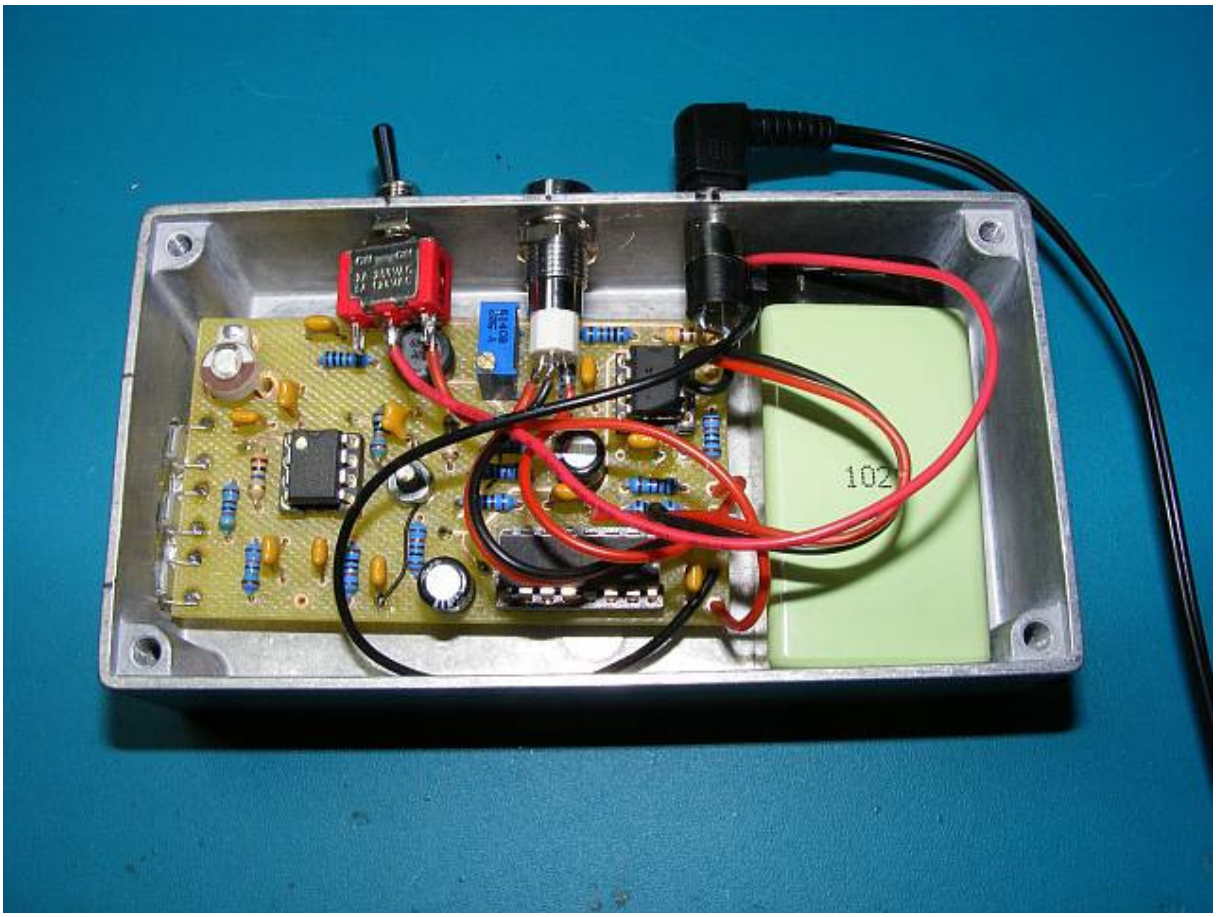

Fig. 4: Interior of the „Stuttgarter Geigerle“ with the PCB for through hole assembly and a 9.6V rechargeable NiMH block battery

I hope that I contributed with this design with not frightening by the complexity of today’s electronic manufacturing and thus to keep this hobby alive also for the „traditionally“ equipped aficionado and the interested youth.

Fig. 5 Circuit diagram of the „Stuttgarter Geigerle“ for through hole assembly