NANO-AMPERE AMMETER

RAJU BADDI

This instrument is useful while building, testing and experimenting with ultra low power circuits, especially those operating with batteries. It is built around the commonly available JFET input OPAmp TL081 and a few precision resistors. The instrument is designed to have a wide operating range from 0->10nA to 0->1uA in steps of multiplicative decades. If required the range can be easily extended to 10uA and 100uA by including additional range resistors of 100Ω and 10Ω respectively.

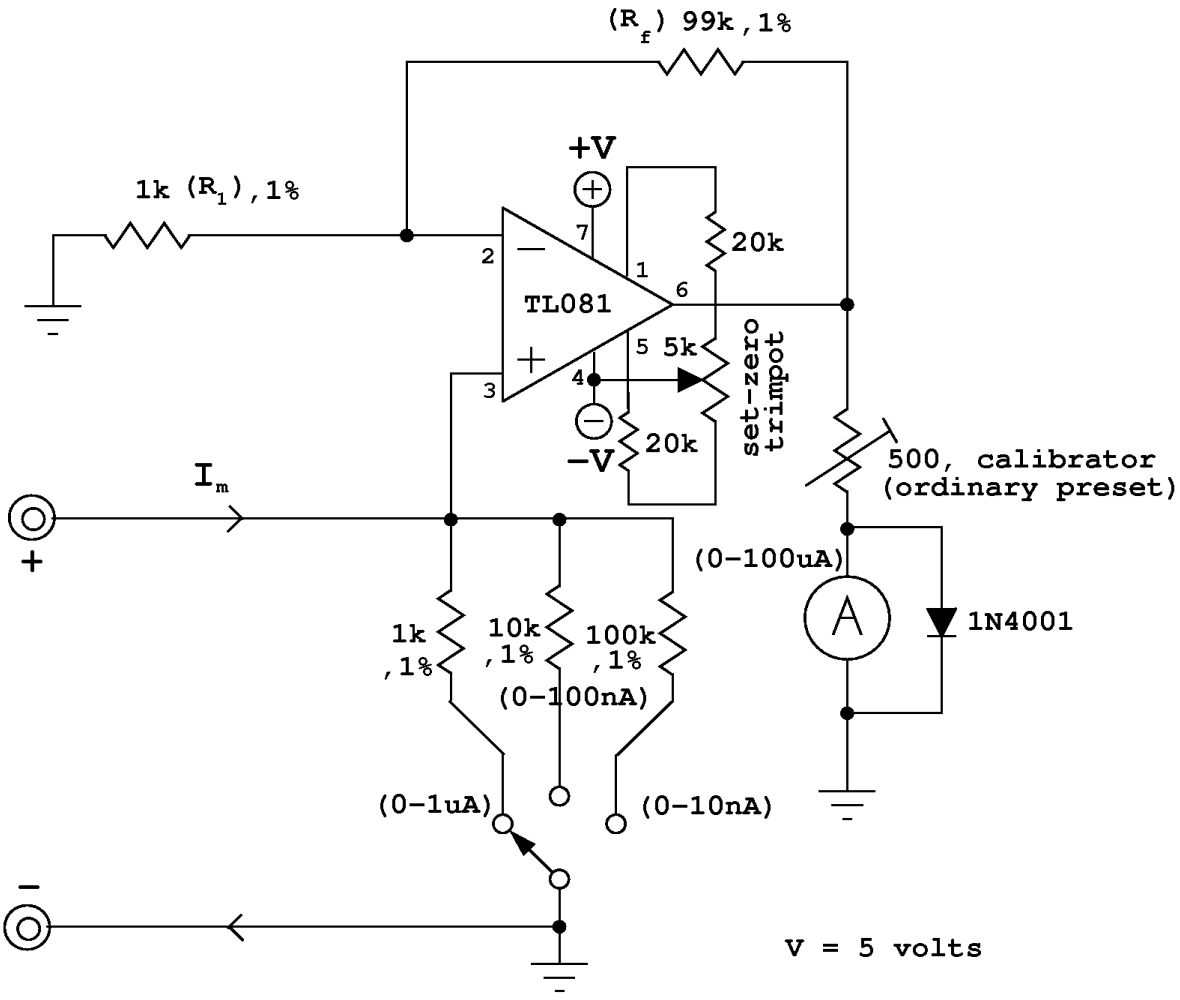

Fig 1: Schematic circuit diagram of Nano-ampere Ammeter.

TL081 has been wired as a high gain non-inverting DC amplifier with a gain of $(R_f/R_1+1)=100$. The current to be measured is passed through a fixed known resistance,

the voltage drop across this resistance is applied to the amplifier and is produced as 100 x I_m x R (where I_m is the current to be measured) at the output. The range can be controlled by selecting R(1kΩ,10kΩ,100kΩ) appropriately as has been done in the circuit diagram. Using a commonly available digital multimeter adjust the calibrator such that the resistance of the calibrator and 100uA meter(which has a typical resistance of 700Ω) in series is exactly 1kΩ. After this wire the entire circuit and adjust the set-zero trimpot to get a zero deflection on any range. Now the Nano ampere ammeter is ready for use. Any kind of meter can be used provided the gain of the DC amplifier is changed appropriately i,e a meter with FSD of 150uA would require a gain of 150 and viceversa. The diode in parallel with the meter protects it against high currents, which may occur due to improper range selection. Further the range resistances do not have any noticeable effect on the current to be measured, for instance to produce a current of 10nA from a 5V source it is necessary to include a 500MΩ resistance in the circuit. Since a 100kΩ is being used to sample this current it is very tiny compared to the gigantic 500MΩ. The ±5V supply can be obtained from the standard regulator chip 7805+7905.

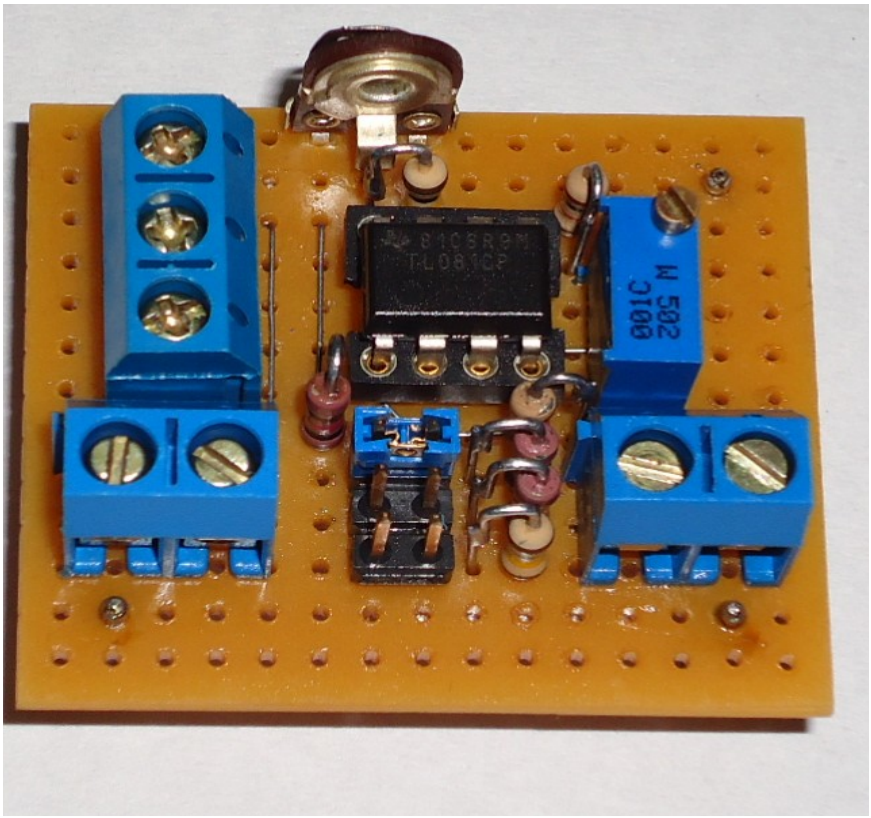

Fig 2: Photo of an actually built prototype. The plan for the connections are given in the next figure.

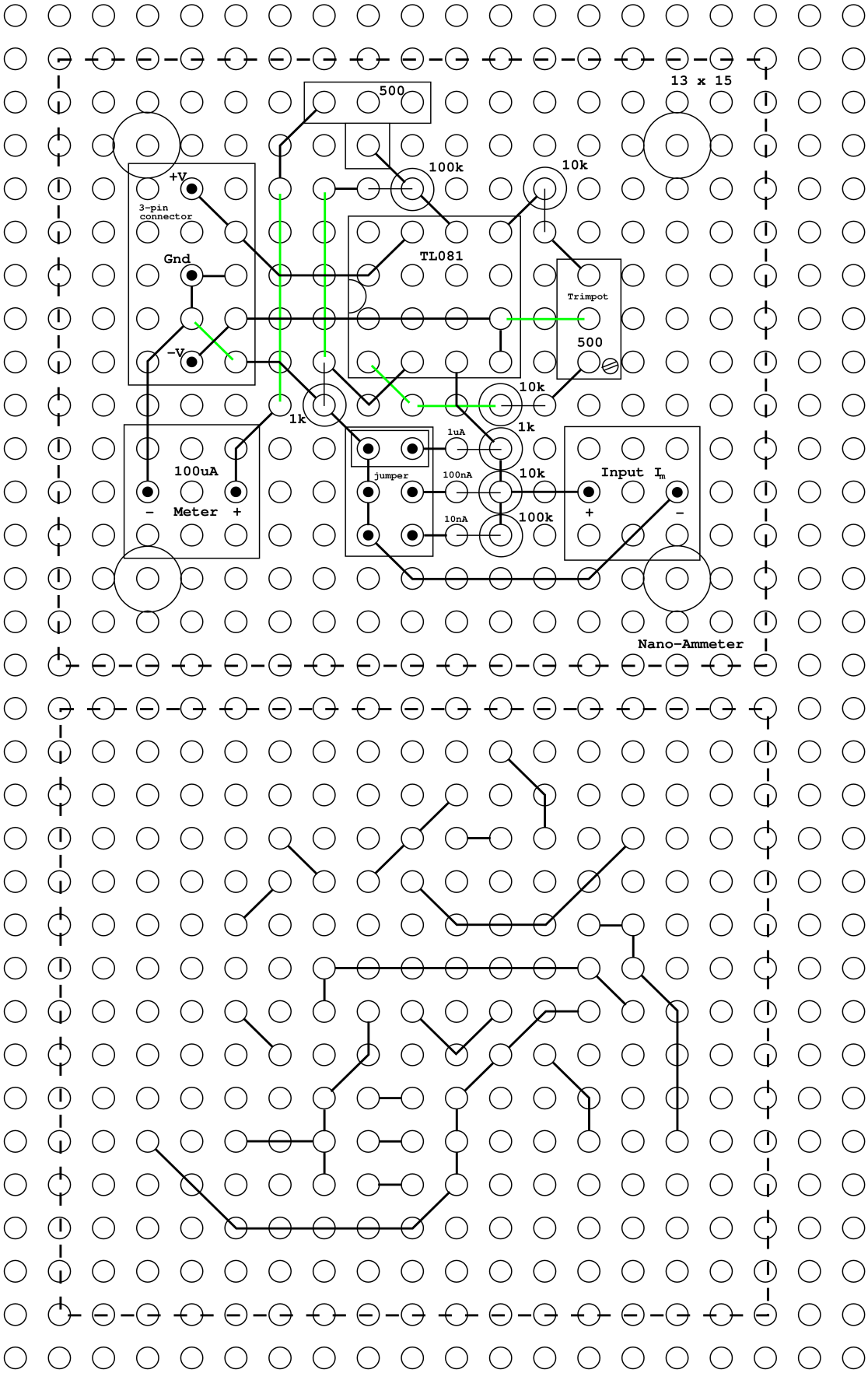

Fig 3: Plan to make the Nano-ampere Ammeter on a general purpose board. The bottom figure shows the mirrored connections for the under side of the board.