RF Current Meter Kit

When assembled, this kit provides you with a simple but effective means of measuring the current in antenna wires, and of looking for braid currents on coax feeders. The more current you can get flowing in an antenna, the more efficiently it will radiate your signal - so a means to monitor the current is a great aid when making adjustments and setting up antennas.

The circuit used is based on a design published by Ian White GM3SEK [1] and uses an idea broached by David Lauder, G0SNO, of the RSGB EMC Committee, in using a clamp-on EMC ferrite for the current transformer. Although these are intended for suppression of unwanted potential EMI components, they do make very good current transformers for measurement purposes up to 30MHz, and will continue to give useful relative indications well into the VHF region. Further information, beyond the construction and use notes here can be found on Ian's webpages.

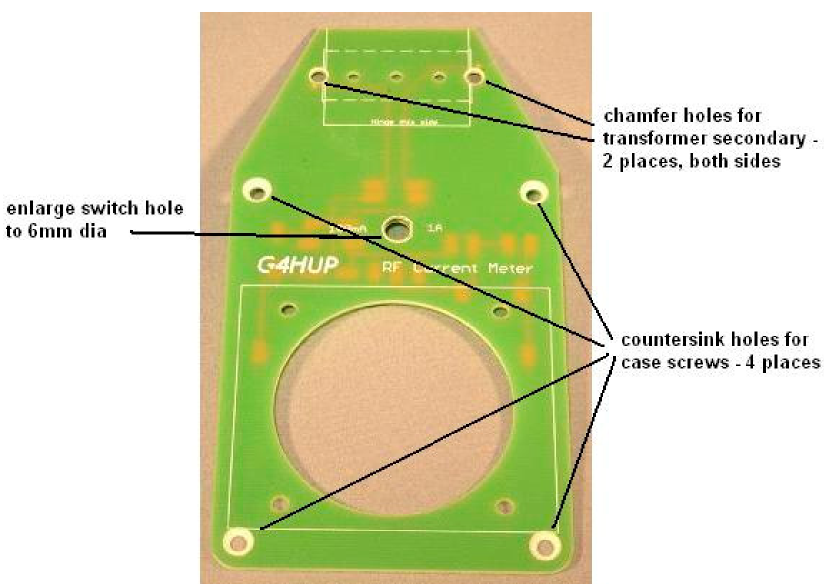
The completed meter is shown in Fig 1 - it is assembled 'pseudo-SMD' style on a single PCB, which also supports the ferrite clamp and the meter. A plastic housing is used to cover and protect the electronics and the rear of the meter movement. The ferrite clamp used is large enough to handle RG213/UR67 size feeders.

Fig 1 - Completed RF Current Meter

PCB Preparation

There is a small amount of PCB preparation required before the assembly starts. This is the countersinking of the case holes, enlarging the switch mounting hole, and relieving the sharp edges around the transformer secondary holes, as shown in Fig 2 below

Fig 2– PCB preparation details



Assembly Sequence

Most of the components are mounted on the rear side of the PCB, where there are large pads. All of the resistors, capacitors and diodes are prepared by trimming the leads and bending them slightly down, so that they can be soldered to the pad surface as shown in Fig 3, which shows the prepared component, and an example of a component as received. Try to keep the leads as short as possible - the component body should be almost touching the PCB. Take care when preparing the diodes that you do not bend the leads right against body, or you risk fracturing the glass encapsulation.

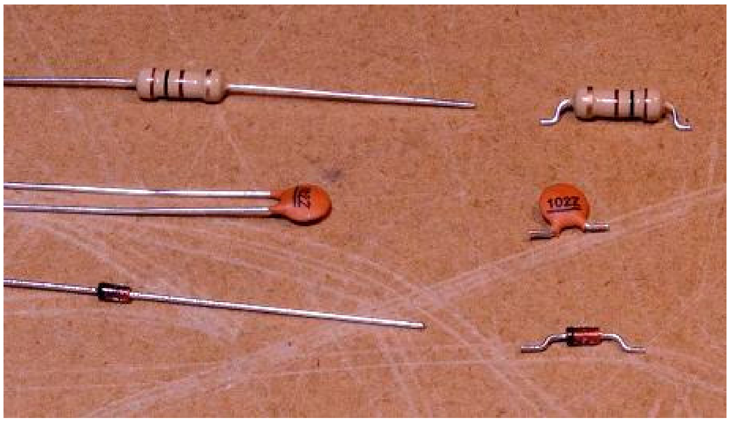


Fig 3 - Component preparation and placement

Now place the two resistors, then the capacitors, and finally the diodes (observing correct polarity).

For each of the trimmer potentiometers bend the tips of the pins so that the body of the pot is about 5 to 8mm above the surface of the PCB - and solder them in place.

Next mount the switch - two wires are needed to link the switch contacts to the PCB - the lead ends that you cut from the resistors or capacitors will do fine here.

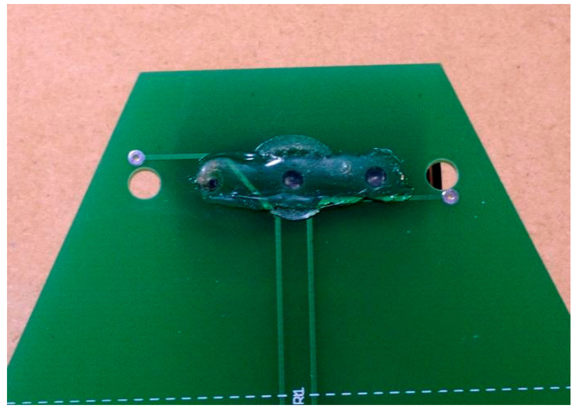
Note that some kits include an extra resistor – R3. This is because the 100k trim pots used are a nominal 20% tolerance; however the circuit requires a minimum of approx 96k into to achieve the correct calibration point. R3, 47k, is included in all new kits and any old kits that do not have R3 provided do have pots that meet the required spec. Where R3 is not provided, use a spare piece of wire, cut from a resistor or capacitor to bridge the R3 pads on the PCB.

Transformer mounting and winding

There are two methods of winding the transformer – one requires the ferrite to be mounted to the PCB before winding the secondary, the other afterwards – so read the following and make your choice now!

The ferrite clamp mounts on the upper side of the PCB, at the opposite end to the meter. The hinge side of the clamp must be towards the meter, and the clamp is best secured with a hot melt glue gun. When you attach the clamp (either method) make sure that the glue penetrates the three holes under the clamp, then run some glue across on the underside, as in Fig 4.

Fig 4 - Mounting of Ferrite Clamp



Method 1 – clamp secured first

Once the glue is set, you can wind the secondary of the transformer. Take the length of 30SWG Enamelled Copper Wire (ECW) and place one end through the small hole to the left of the ferrite. Using a hot iron (circa 400C) solder the wire to the pad - it is self-fluxing wire, so no scraping or stripping is needed, but try not to inhale the fumes.

Now take the wire across the top of the half-ferrite, and pass the free end of the wire through the large hole at the opposite end of the ferrite, and bring it across under the board, laying over the flattened glue mounds. Make sure that the wire is pulled tight through the ferrite core, and then bring it up through the large hole to the left of the ferrite ready to wind the second turn. Continue until 10 turns have been wound, then pass the end of the wire through the small hole on the right of the clamp and solder to the pad. Note that each pass down the centre of the core counts as 1 turn.

Fig 5 shows the stages of winding the transformer secondary - with care, the 10 turns can be wound to lay flat in the bottom of the curve of the ferrite clamp. A further layer of glue can be added over the windings on the underside of the PCB to protect them, and you may find it a good idea to put a thin layer of epoxy (eg Araldite or similar) over the windings inside the core, and to run some hot melt glue up over the secondary wire at each end (outside the core!) to protect it.

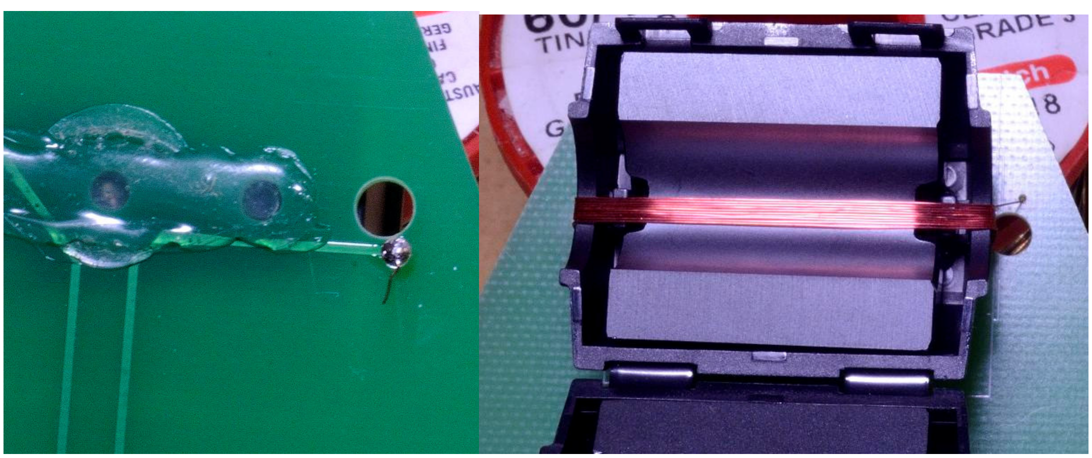


Fig 5 - Transformer winding stages - method 1

Method 2 – secondary wound first - Recommended

For this method you need to remove the lower half-core from the clamp – do this by pushing the plastic clip that holds it in place towards the end face of the housing. DO NOT lever against the ferrite core as you are liable to fracture it.

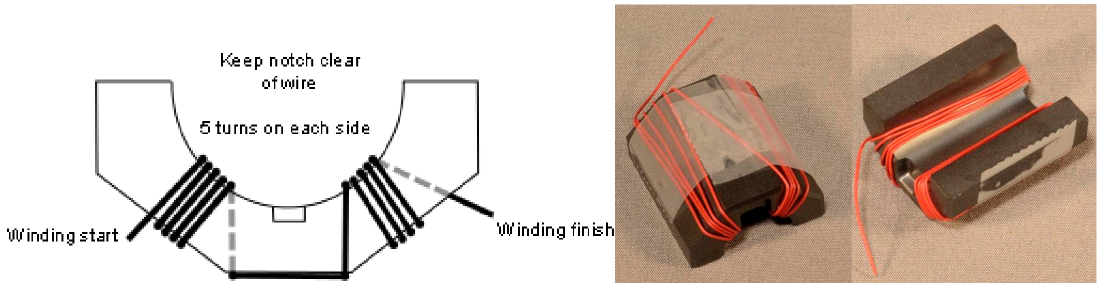


Fig 6 – Transformer winding – method 2

Wind 5 turns of thin wire round one side of the core as shown in Fig 6 above, then cross over on the underside of the core and wind another 5 turns on the other side. Leave the two tails free, and use some tape to hold the windings in place as shown. Make sure that no tape will get between the core faces when the transformer is assembled.

Place the core half back into the housing, and make sure that it is fully clipped into place – Fig 7. Now the whole transformer can be attached to the PCB as per the directions above. Allow the glue to set, then connect the transformer wires to the pads, and apply some glue to each end to protect the wires – Fig 8

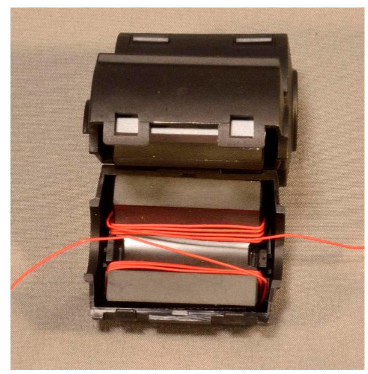


Fig 7 – completed winding

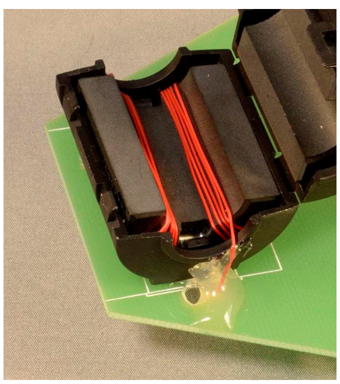


Fig 8 – Assembly mounted on PCB

This second method is preferred, although a little more complex to perform. The recommendation is based on the rather simpler process for replacing the ferrite core. At some point, due to usage, the plastic hinge on the core will fail. Replacement core kits are available from G4HUP. If you have used method one, you have no option but to cut the transformer windings, then remove the core from the PCB. After replacing the core, you will need to wind a new transformer secondary.

By using the second method, just unsolder the two secondary joints and then the transformer and core can be removed from the PCB. Remove the lower core ferrite carefully from the old housing, and place it into the new housing. Glue the complete new core to the board and reconnect the old winding.

The replacement core kits do include enough wire to wind a new secondary for the transformer.

Final Assembly

Once the transformer is complete, the meter can be mounted in place using the small washers and nuts provided. Connect the meter to the circuit pads using short lengths of wire. Fig 9 shows a view of the fully assembled meter PCB.

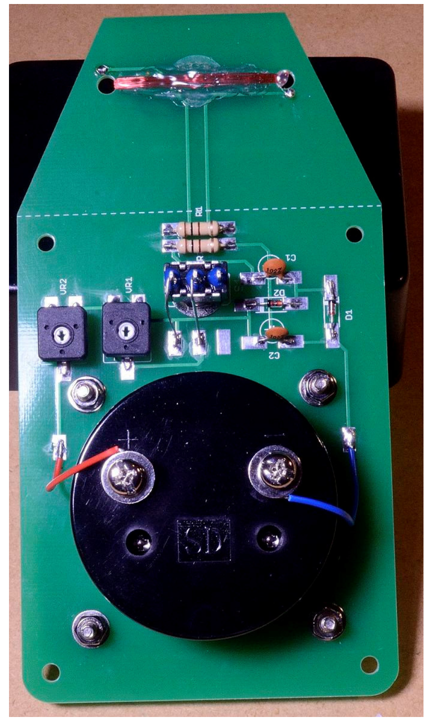


Fig 9 - Fully Assembled RF Current Meter PCB

Meter Calibration

The only calibration required is to set the two trimmer pots to give the correct deflection of the meter.

Set VR2 so that the total resistance of the trim pot and the meter is 6k8Ω. Now set the switch into the 1A position, and adjust VR1 to give a total resistance from the switch to the meter negative terminal of 104k - do not re-adjust VR2 at this stage!

Calibration is complete! The plastic case housing can now be put in place and secured with four screws.

Test Cable

It is useful to have a test cable around to confirm the meter behaviour. A test cable can easily be made from a UR67 or RG58 patch lead. The test cable needs to have the outer diverted so that the ferrite of the meter can be clamped around the inner of the cable alone.

Remove about 100mm of the outer sheath from the cable - the position along the cable does not matter. With a sharp cutter, cut through the braid all round at the midpoint of the exposed braid. Now unplait each half of the exposed braid back to the end of the sheath. Once this is done, twist the braid up tightly on each half. Tin the end of each spur and solder them together - you may find this easiest by taking a length of solder and wrapping it round the two overlapped spurs. This will help to hold them together as they get soldered - see Fig 6

Fig 6 - Test Cable for the RF Current Meter

Once the solder is cool, your test cable is complete.

To check the operation of the meter, connect one end of the cable to your rig, and terminate the other in a dummy load (use a load of at least 50W rating). If you have a power meter you could connect it in-line also. Clip the ferrite clamp around the cable inner, making sure that both clips are fully fastened - the two faces of the cores must be in full contact for correct readings. Switch the meter to the 1A range.

Set the rig to CW Tx, and starting at low power, increase the Tx power and note the needle deflection - on all the HF bands, you should find that the meter reaches full scale deflection at between 40 and 50W. Typical readings obtained different samples are given on the website, at http:g4hup.com/RFC/RFC.htm

If you remove the clamp from the inner of the coax, and clip it around the bypassed braid, you should read exactly the same current levels as in the inner.

You can also calibrate the ranges on a per band basis, by this method. 5W will drive the 100mA range to FSD easily, so for most antenna measurements and investigations, quite low power will be good enough for working with, and should create no RF safety issues. It is still sensible to remove the RF power source whilst adjustments are actually being made, of course.

You can open the clamp by gently lifting each of the two fastening tabs.

Usage notes

The 1A range is designed to cope with power levels up to 50W in the RF cable or wire. It is not advisable to be in close proximity for any length of time with that amount of RF power being applied! Work at lower power levels whenever possible, and keep RF exposure of yourself and others to a minimum. Testing has shown that the meter will give 1A full scale deflection on between 40 and 50W across all the HF bands. 5W will give approx 20% deflection across the range.

At all HF frequencies, 5W is more than enough power to cause full scale deflection on the 100mA range. Due to the non-linear nature of diodes, the lower part of the 100mA scale is non-linear, and its accuracy cannot be relied on when the indications are below about 30% FSD.

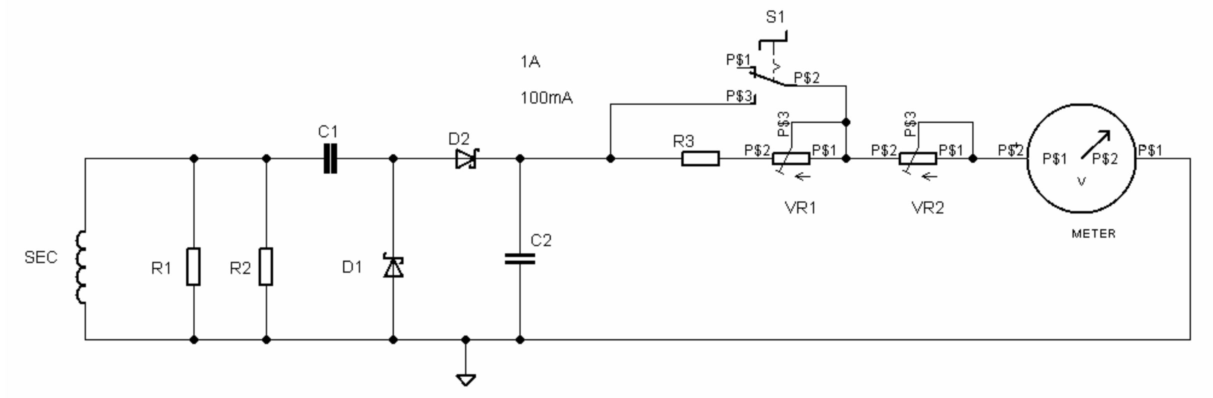
When experimenting with antennas at the Low Frequency end of the spectrum (136kHz and 472kHz bands) the RF Current meter can be a much more useful indicator than Standing Wave Ratio meters, since the current transformer action is more efficient in this design.

Maintenance

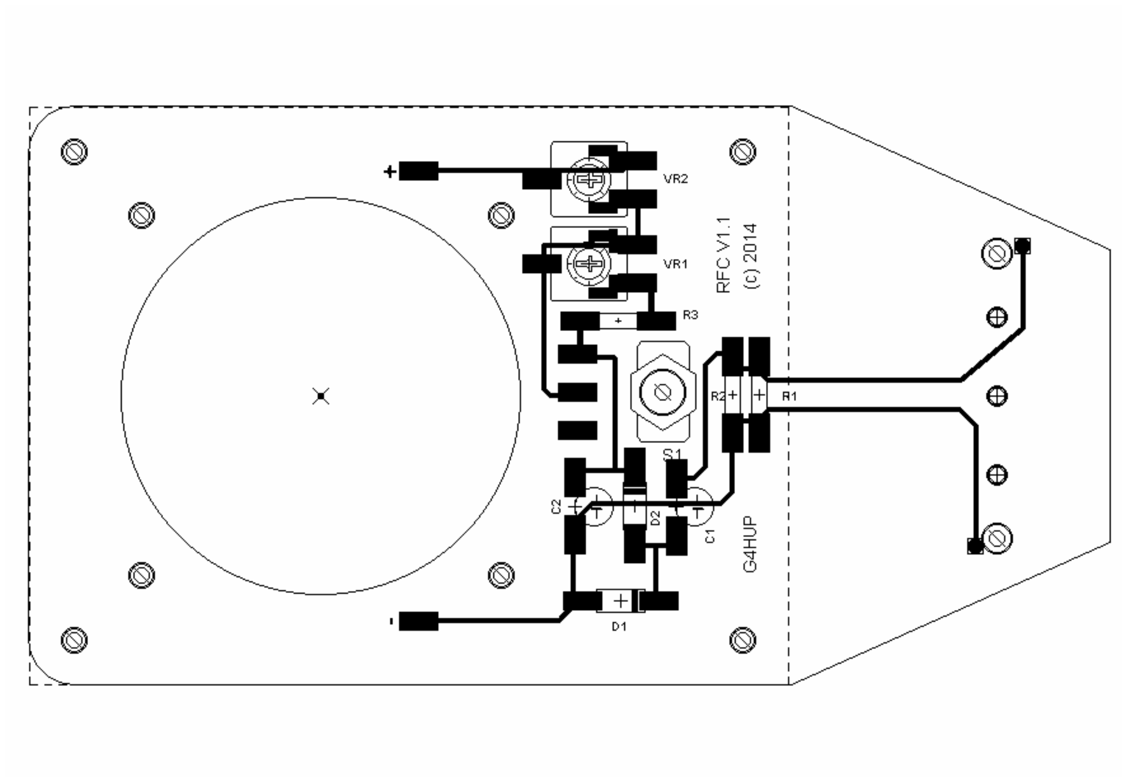
Eventually, the plastic hinge of the ferrite clamp may fail - they are not really designed for long-term repeated opening and closing. A replacement clamp and transformer wire set is available when this happens.

[1] White, Ian GM3SEK http://www.ifwtech.co.uk/g3sek/clamp-on/clamp-on.htm

Appendix 1 – Circuit detail, Layout and Component Values



RF Current meter Circuit Diagram



RF Current Meter – PCB Bottom Side view

R1,2	100R 0.5W	C1,2	1nF disc C	D1,2	BAT42
R3	47k 0.25W	VR1	100k	VR2	10k
S1	DPST	M1	100uA		