Five Band Indoor Magnetic Loop Aerial.

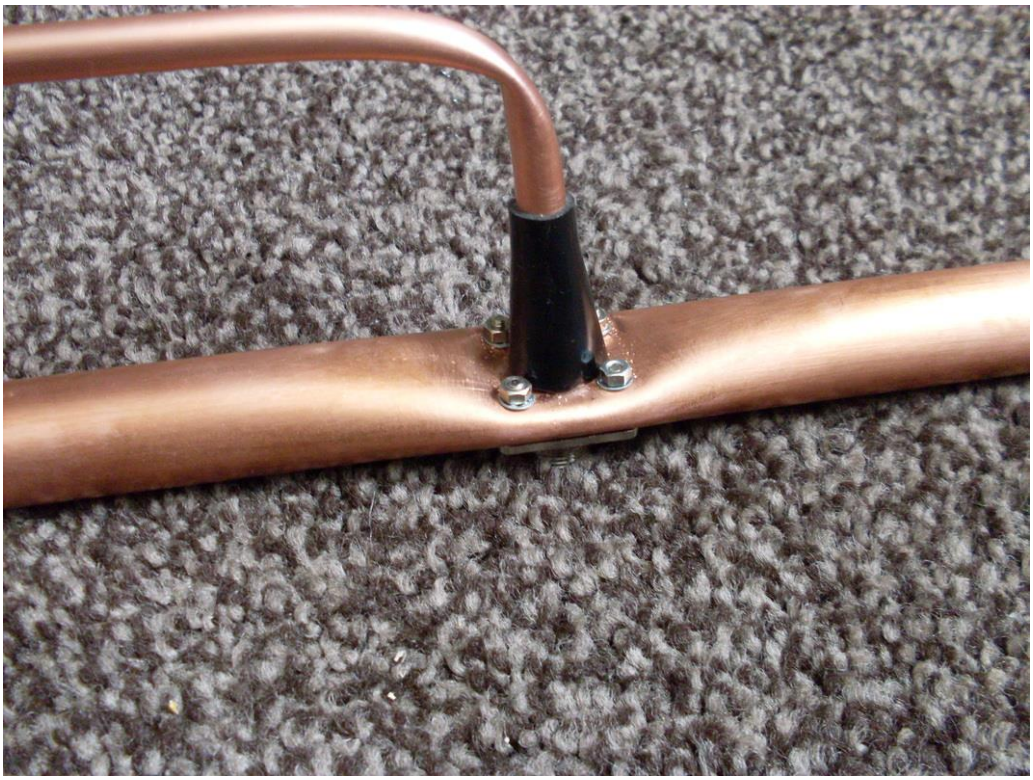
By G4IZH

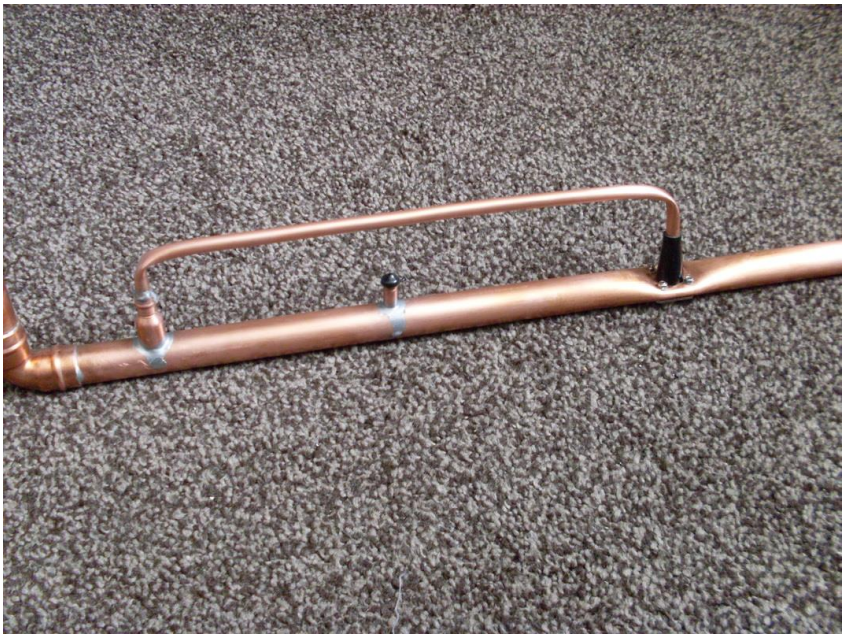
This aerial covers the 20, 17, 15, 12 and 10 metre bands and is made from a single 3 metre length of 22 mm copper tube cut into 4 pieces of equal length and joined in the corners with 90 degree elbows. Some plumbing skills are required here as you will need to use a blow torch with plumbers solder paste and solder so do not attempt this part if you do not have the required confidence and equipment. The pictures below show the full story at each stage of construction.
The wide spaced tuning capacitor being used is a very old 200pF + 200pF type but the fixed vanes are connected in series, the moving vanes will not be connected at all therefore the capacitance can can be varied from about 7pF min to 100pF max. The minimum capacitance is important as it is this that determines the highest frequency that the loop can be resonated at. The tube at the opposite side to the gamma match is marked in the middle and then the tuning capacitor positioned and an equal amount cut off to exactly accomodate the tuning capacitor used so that direct connections can be made. The dimensions of the gamma match are quite critical in order to achieve a good match on each of the bands covered, it is made from 8mm micro bore heating pipe. The tuning capacitor is driven by a geared down motor which produces 2 rpm at 12 volts. There is a wire wound 10k ohm pot employed which is inserted between the motor and the tuning capacitor isolating coupler which sends the required information back to the shack to drive a moving coil meter which can be calibrated in frequency. The loop covers from 14 to 29.7Mc/s and presents a one to one swr throughout.
I believe MFJ are the only commercial manufacturers of these but they are VERY expensive!
The main problem with mag loops is that they are very high Q and need to be re tuned even for a relatively small change in frequency so a motorised tuning capacitor arrangement is most definately required.
The big advantages are that they can be used indoors, are small in size and it is possible to cover quite a few bands with the same loop, they also tend to pick up less locally generated noise. The loop does have directional properties and can be used in the vertical or horizontal mode.
This mag loop will of course work well outside but quite a bit of thought will need to be put into its weather proofing.

These are the 4 pices of tube and 90deg elbows ready to be soldered together. The SO239 socket is fitted in the centre of one of the tubes, you will notice that the tube needs to be "crushed" enough to accommodate the socket.

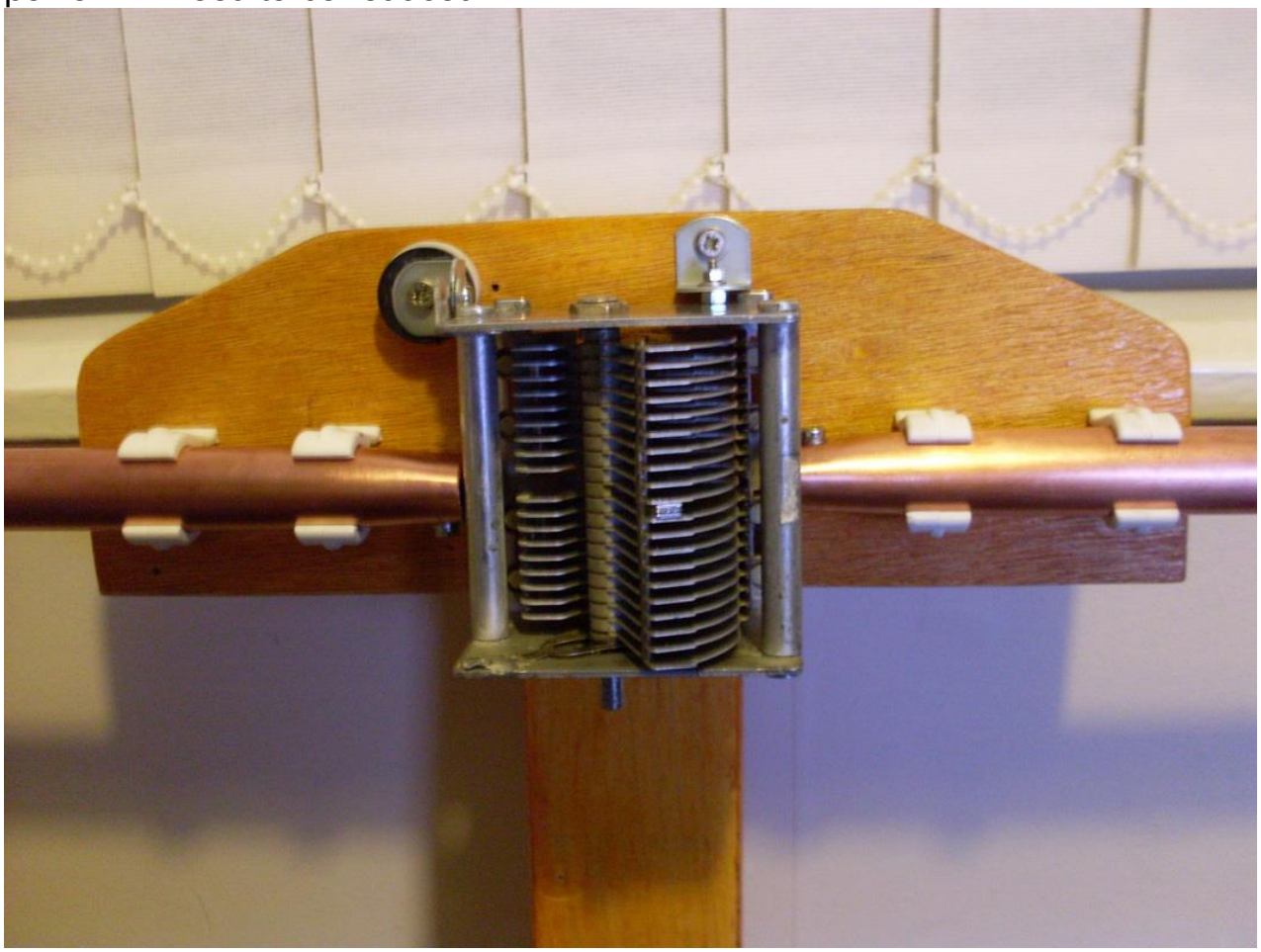
This is the loop soldered together.

Here is the finished feed arrangement showing the SO239 socket and the gamma match the dimensions of which are 300mm long (horizontal portion) with a spacing from the 22mm tube of 55mm, the gamma match tube is 8 or 10mm micro bore pipe.

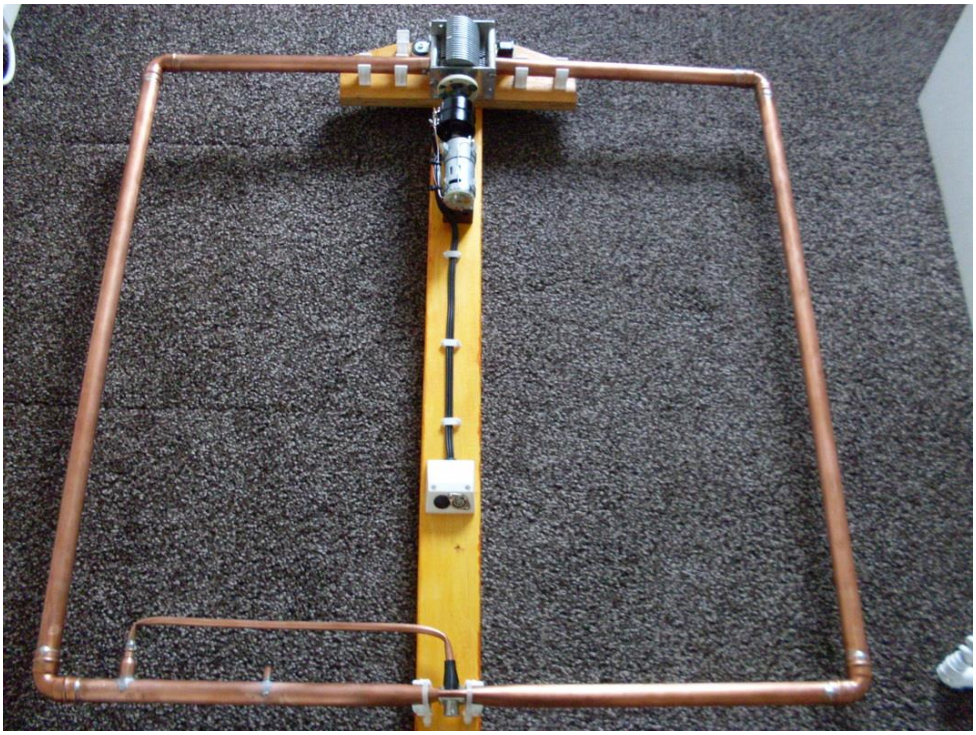




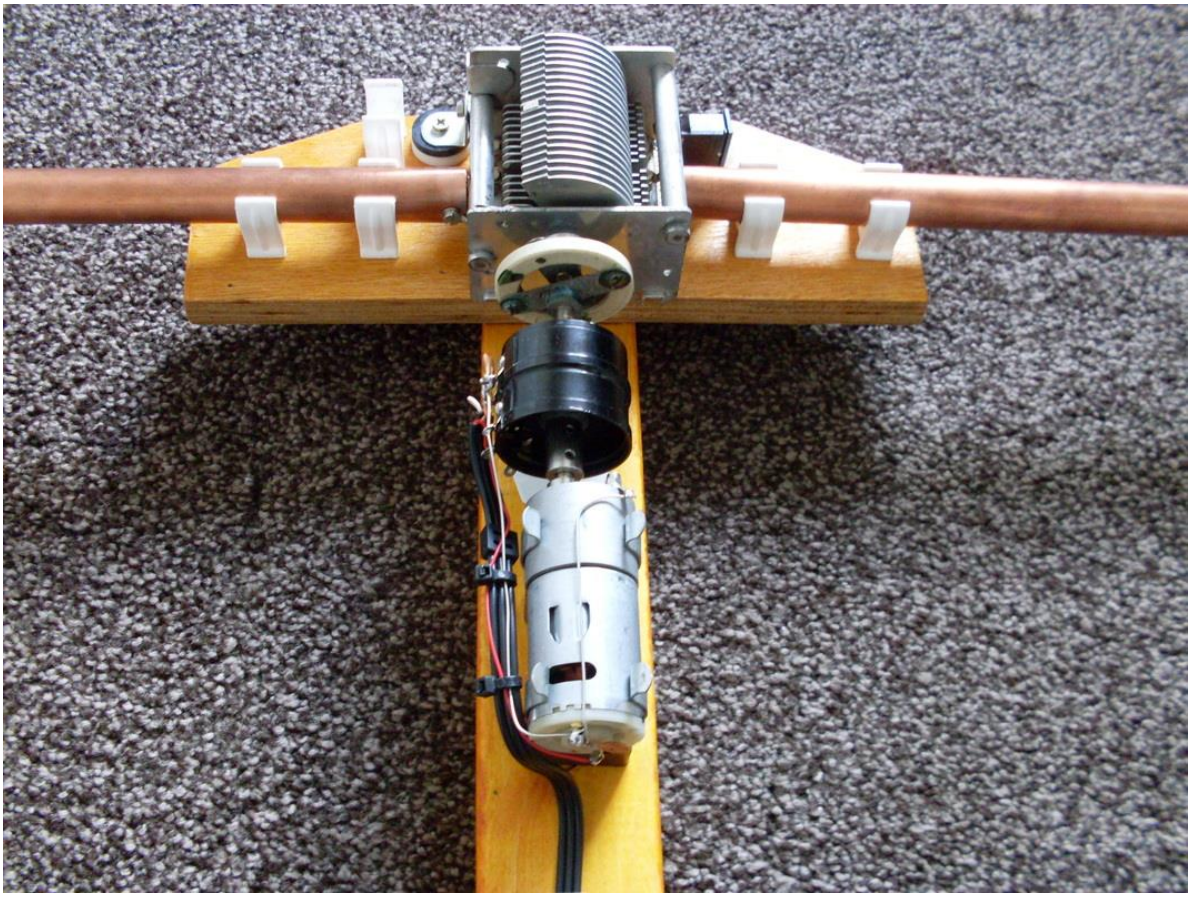
This is the wide spaced tuning capacitor shown fitted snugly between the pipes. A closer spaced tuning capacitor can be used but the maximum power will need to be reduced.



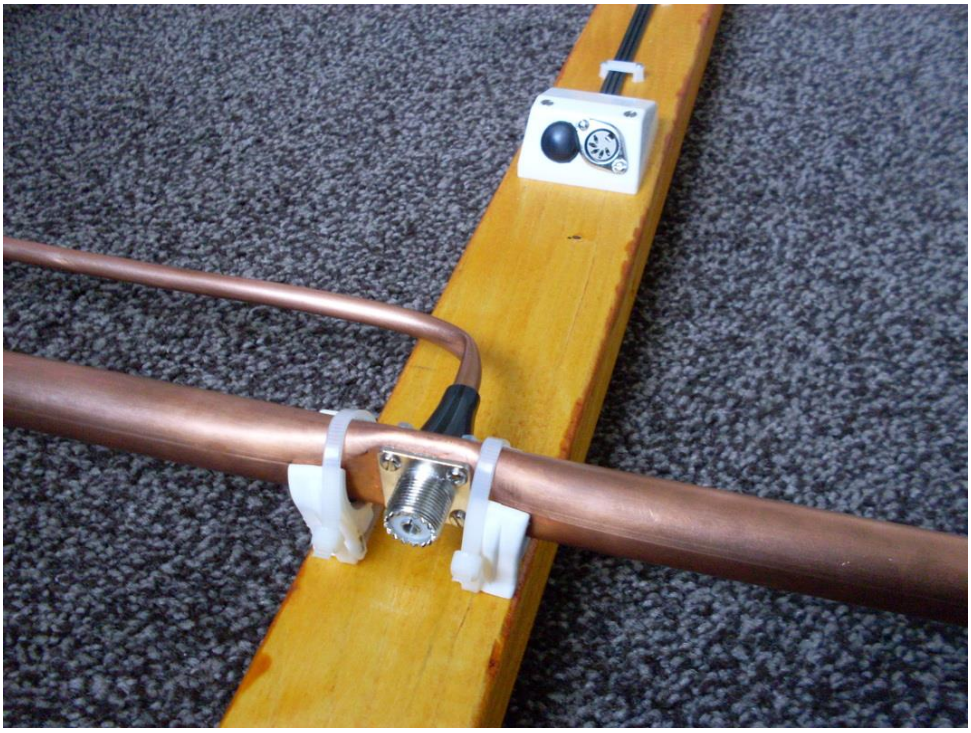
Here are the completed pictures showing the tuning capacitor, its slow motion drive motor with low loss isolating coupler and the junction box with 5 pin Din socket for the remote control.



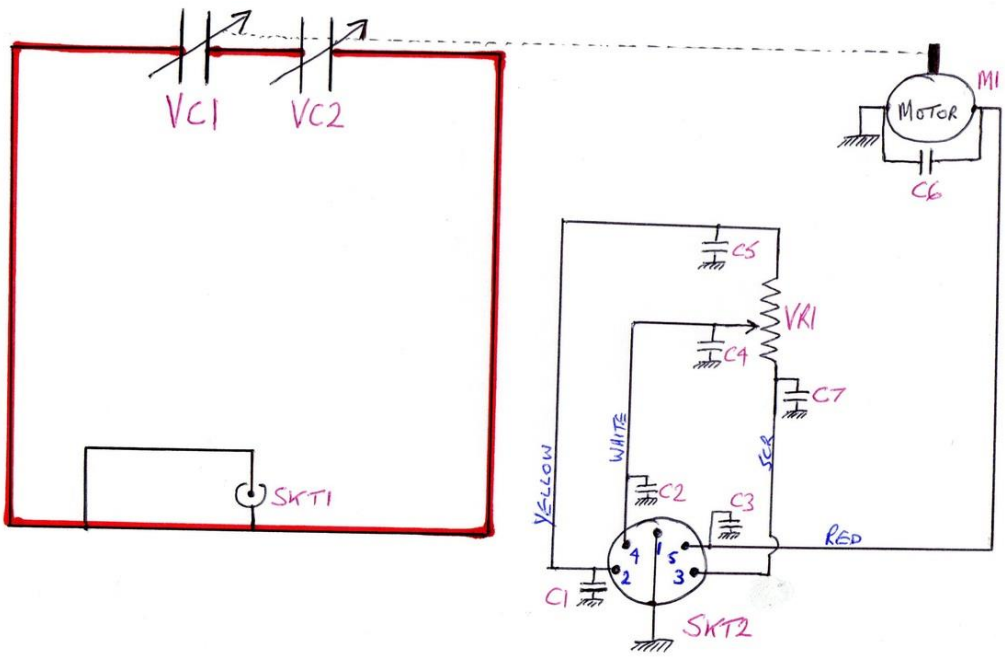
This is what the completed assembly looks like.



In this picture from top to bottom can be seen the TUNING CAPACITOR, CERAMIC ISOLATING COUPLER, 10k OHM POTENTIOMETER and lastly the 2 RPM MOTOR.



This is the remote control junction box showing the 5 pin Din socket.



Loop Schematic.

Parts List

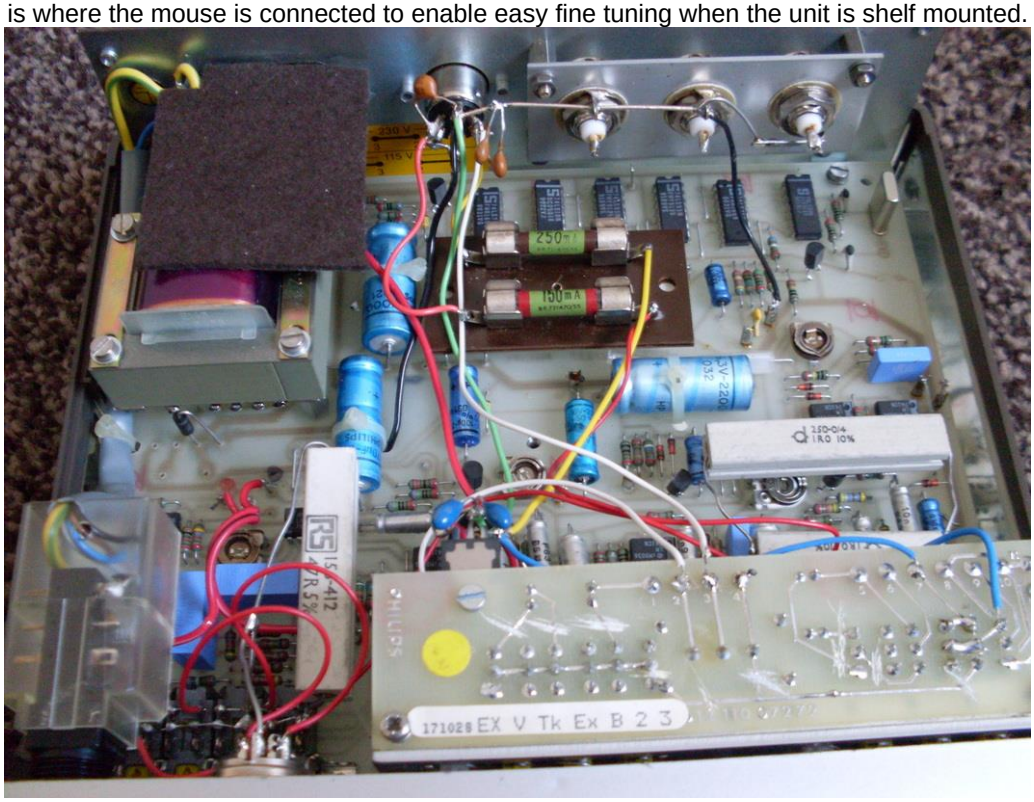
VC1/VC2	20	0 + 200pF Wide spaced tuning capacitor
	C1 to C7	1n 1kv wkg disc ceramic
SKT1		SO239 Socket
SKT2		5 pin DIN 180deg socket
VR1		10kohm linear w/w pot
M1		2 rpm at 12v motor (From China)

See text for loop and gamma match details. The motor as obtained from a Chinese supplier on E Bay and was under £10 including delivery. The motor produces very high torque with no backlash and is Ideal for this purpose. Just as an illustration here are the motor parameters at 3 and 6 volts.
Minimum to Maximum tuning time at 6v is 30 seconds @33mA
Minimum to Maximum tuning time at 3v is 65 seconds @30mA
When the motor is stalled, ie Min or Max travel the current increases to 48mA at 6v and 40mA at 3v

This is the simple remote control without any frequency indicator. The UP/DOWN buttons can be seen below their associated LED indicators. The batteries for the motor are enclosed within the control.

The mains operated control unit is shown below.

This is the control unit front panel view. The centre zero meter on the left reads motor current and the one on the right is for tuning capacitor position which with the aid of a small conversion chart indicates frequency. The four buttons to the right of the meters are for fast and slow tuning and the DIN socket below is where the mouse is connected to enable easy fine tuning when the unit is shelf mounted.

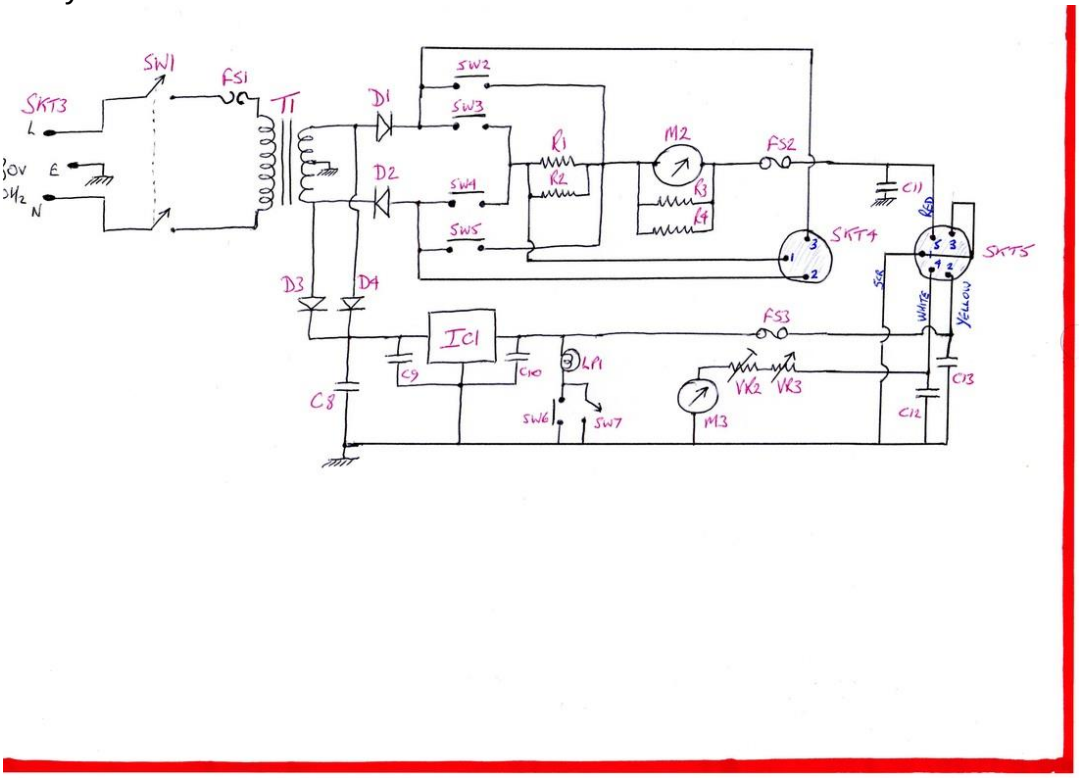


Inside view, the box was originally a wow and flutter meter made by Philips so most of the original circuitry was left in situ and not used. The modifications were then carried out accordingly.

Here are the connecting leads required from left to right, mouse with 5 pin Din plug fitted, IEC mains lead and 5 metre long Din lead.

This is the schematic diagram of the control unit. Note that the values of the M2

meter shunt resistors R3 and R4 are determined by the type of meter being used. Ensure that the pre set pot VR2 is initially set to MAXIMUM resistance or you will end up with a bent pointer. A digital voltmeter can be used in place of M3,VR2 and VR3 and this will provide a more accurate positional guide for the operating frequency.



Control Unit Parts List

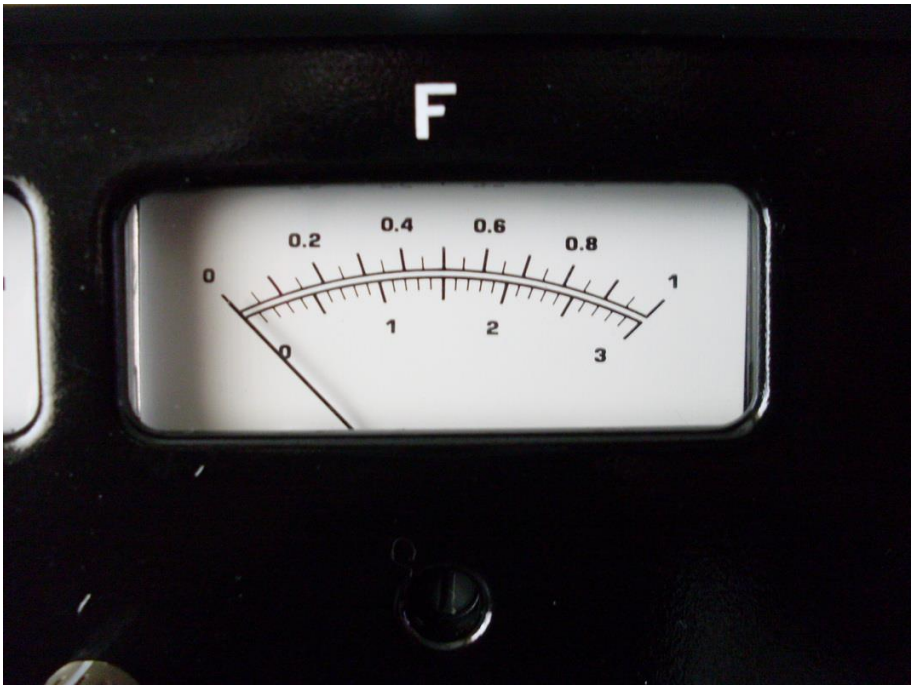
T1	Mains transformer, pri 230v 50Hz, sec 15-0-15v at 500mA
LP1	16v tube lamp (meter illumination)
SKT3	IEC chassis mounting mains plug.
SKT4	3 pin 180 deg Din socket (mouse socket)
SKT5	5 pin 180 deg Din socket (control lead socket)
SW1	2 pole push button power mains switch
SW2	Mom push switch (FAST c/w)
SW3	Mom push switch (SLOW c/w)
SW4	Mom push switch (SLOW c/cw)
SW5	Mom push switch (FAST c/cw)
SW6	Mom push switch (meter lamp)
SW7	Latch push switch (meter lamp)
FS1	Thermal fuse (part of T1)
FS2	250 mA fuse a/s
FS3	250 mA fuse a/s
D1	1N4001 diode
D2	1N4001 diode
D3	1N4001 diode
D4	1N4001 diode
M2	Centre zero m/c meter (approx 1mA fsd)
M3	m/c meter (approx 1mA fsd)
R1	47 ohm 5 watt w/w
R2	220 ohm 5 watt w/w
R3	1 ohm * (sot for meter type being used)
R4	1 ohm * (sot for meter type being used)
VR2	500kohm lin pre set pot (meter sensitivity)
VR3	10kohm lin pot (fsd calibration)

C8	1000 micro farad elec cap 35v wkg
C9	4.7 micro farad elec cap 35v wkg
C10	4.7 micro farad elec cap 16v wkg
C11	1n disc cer cap 1kV wkg
C12	1n disc cer cap 1kV wkg
C13	1n disc cer cap 1kV wkg
IC1	UA7812 regulator ic (no h/s req)

5 pin Din to 5 pin Din control connecting lead at required length.
IEC mains power lead (fused at 2 amps max).
PL259 to PL259 coax aerial connecting lead at required length.

Control unit Specifications.

As can be seen from the schematic diagram the control unit is mains operated. The front panel contains four momentary push buttons to the right side of the meters, these are for tuning HF and LF at two speeds, the fast mode is for changing band rapidly and the slow mode is for precise tuning. In the fast mode it only takes 10 seconds to move from 14 to 29.7Mc/s, or vice versa of course. Additionally the slow mode is available using the external mouse which sits on your operating desk, this plugs into the Din socket on the front panel which makes quick QSY very easy. The left meter reads motor current and is therefore a centre zero type. The meter on the right is calibrated 0 to 100 and with the use of a simple conversion chart reads frequency, the meter can of course be calibrated to read frequency directly, the meter is reference calibrated at 14Mc/s ("50" on my meter) using the small pot (VR3) seen between the meters.



This is a close up of the meter which indicates the position of the tuning capacitor and with the conversion chart shown below gives frequency.

Below is the Mag Loops final resting place, in the loft, it is supported by just two plastic clips.

The loop can be made to operate well on the 30,40 and 60 metre bands also by fitting an additional capacitor across the VC1/VC2 combination, the value of this capacitor needs to be about 140pF for 40 metres which of course must be removed when using the 20 to 10 metre bands. Because the voltage is very high at this point even when running only about 10 watts I found that the use of a coaxial capacitor to be the simplest option. No problems were found running 100 watts which is all I have ever used on the HF bands. The coaxial capacitor is simply a 56 inch length of UR67 coax cable with suitable tails and crocodile clips to fit across the variable tuning capacitor, at the other end of the cable the outer screen should be cut back about an inch to prevent any flash over. Don't be tempted to wrap this coax into a coil because that would of course introduce inductance and would affect the overall loop efficiency and increase the swr. Fine tuning on 30,40 and 60 metres is performed by tuning VC1/VC2 in the same manner as for the other bands, a one to one swr was obtained.

If the value of VC1/VC2 was increased to say 500 + 500pF then the 30 and 40 metre bands would be covered without any additional capacitor. The problems with this are, a) its physical size of the capacitor would be very large and much more difficult to accommodate, b) it would be even more expensive and c) the fine tuning on each band would be much more critical which is not at all desirable.
I have now modified the loop to also operate on the 30,40 and 60 metre bands using a solenoid controlled swinging arm which brings in the additional tuning capacitors. It may seem odd having to use a swinging arm in this manner but switches and relays can not be used here as the additional capacitance would upset the 10 to 20 metre operation. Its overall efficiency is of course reduced on the three lower frequency bands but at least it is now a 9 band loop. I am not going to show the detailed constructional details as this is down to the builders preferences but below are two pictures which show how the additional capacitors are introduced to the loop by the swinging arm arrangement.
There are of course many changes that could be made to the shape of this loop, it can be given eight sides instead of four or it could be formed into a circle which

should increase its efficiency by about 10%.
Best of luck building this loop but don't forget that VERY high voltages exist in the area of the tuning capacitor even when only running a few watts so take great care in the loops positioning keeping it away from humans and pets.

This picture shows the "MF adaption" disengaged.

This is with the "MF adaption" engaged.