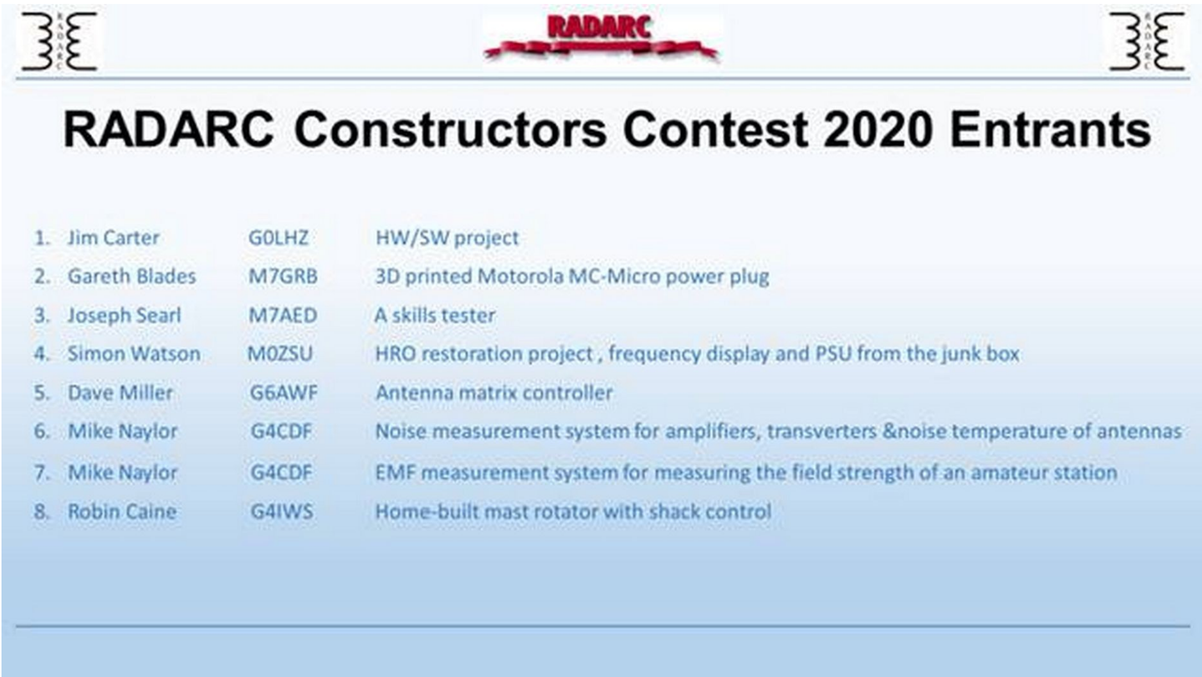
RADARC 2020 Construction Contest

The RADARC 2020 Construction Contest was a great event, thanks Loz G2DD for organising and running it last year. There were many very high quality entries, and a great display of ingenuity.
I found it hard to pick ‘winners’ and by rights all entrants deserve a prize.
Recorded here are the entries for posterity.

The winners in 2020 where Simon M0ZSU HRO restoration (1st construction cup) and Robin G4IWS Home built mast rotator with shack control. (2nd construction cup). As a keen constructor and having ran the construction contest for many years, Robin stated it was nice to win a cup!



Jim Carter G0LHZ – Software/Hardware Project

Functionality:

Mode 1 - Repeater

In this mode, it allows any two radios with the standard 6 Pin Micro DIN Data Port to be joined to act as a repeater. RH Radio is audio sent out on LH radio (big knobs control LH & RH volume). It turns out that the 9600 Data Audio is pretty much all the received audio and so can relay speech.

If you press the PPT key on the LH radio, then LH audio is transmitted by RH radio.

The clever bit is that there is an internal Morse Code generator that will superimpose your call sign at pre-defined intervals on the LH radio transmission – this allows you to run the system as a local repeater and still meet your licence obligations (call sign sent at least every 15 minutes). If a transmission is less than the predefined period, then it sends the call sign when the LH radio stops transmitting (i.e. when the RH Radio stops receiving).

Call Sign, Transmission Period and Morse speed can be changed by the user over an RS232 interface and are stored in internal EEPROM

This ***could*** be used to re-broadcast GB3RD or a 2M simplex channel (received via you proper shack antenna on your shack rig) on to say, 70 cms via another rig. You could then use a Hand held anywhere in the near locality (i.e. in garden) to listen to RD and reply to calls.

So, in my shack, the white stick antenna up on the chimney is connected to a Yaesu FT7800 Dual Band VHF rig. This is plugged into the RH socket. Plugged into the LH socket is a Yaesu FT817, this is set to TX on 70 cms and is fitted with a short stubby antenna. I am in the garden with my Baofeng UV 82 hand held tuned to 70 cms.

I can listen to GB3RD and reply to GB3RD if I want to. My call sign is automatically sent on the FT817 transmission periodically or at the end of a transmission to ensure the local re-broadcast meets the licence conditions.

You can make a local rebroadcast system with something like the Yaesu FT8900 (a full Dual Band Rig with an internal Diplexer), but this does not meet the licence conditions as it does not insert your call sign on the re-broadcast channel. So, your local rebroadcast does not comply with your radio licence conditions.

Mode 2 - Tone or PIP Beacon

In this mode the unit will transmit only the radio connected to the LH socket:

a. continuous Tone
b. A PIP tone (actually any morse character sent at 1 second intervals – so think single DIT (Morse ‘E’) or a DAH (Morse ‘T’) or DIT DIT (Morse ‘I’).

A predefined intervals, it will send a call sign and a locator (i.e. G0LHZ QTH IO91LM) thus meeting the licence conditions.

The Tone Frequency, PIP Tone Letter, Call Sign, QTH Data and Morse speed can all be set by the user over an RS232 interface and are stored in internal EEPROM.

Using FM it can be used to test out antennas etc.

By using CW rather than FM, this could be used in conjunction with the Reverse Beacon Network (RBN) to test out propagation and antennas.

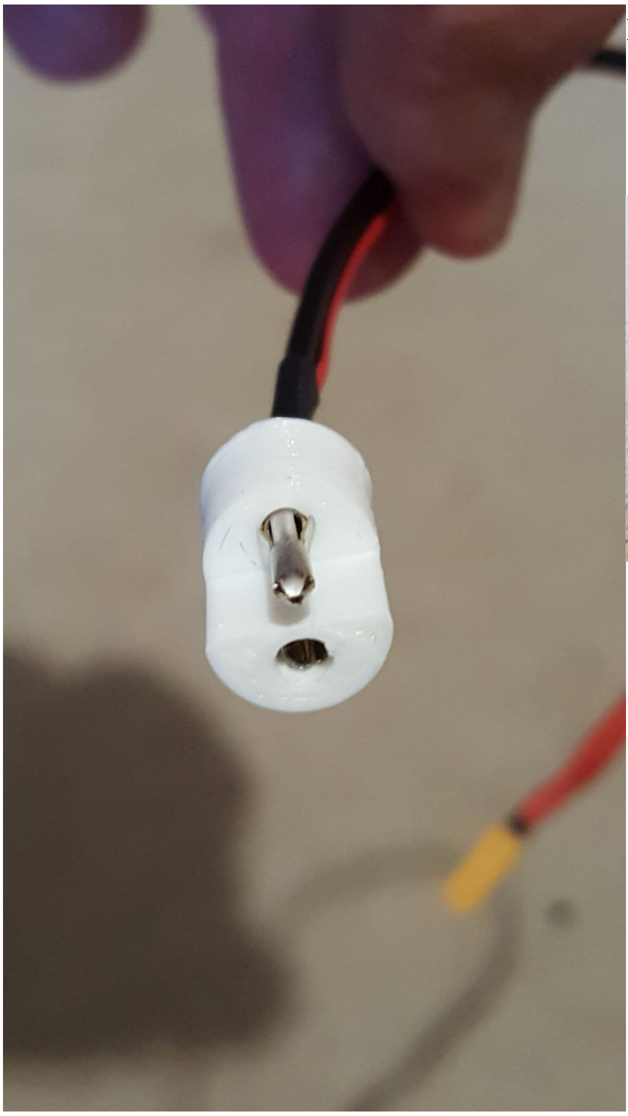
[Welcome! - Reverse Beacon Network]

RBN logs with signal strength, time and date morse code stations it receives. There are RBN SDR monitors all over the world.

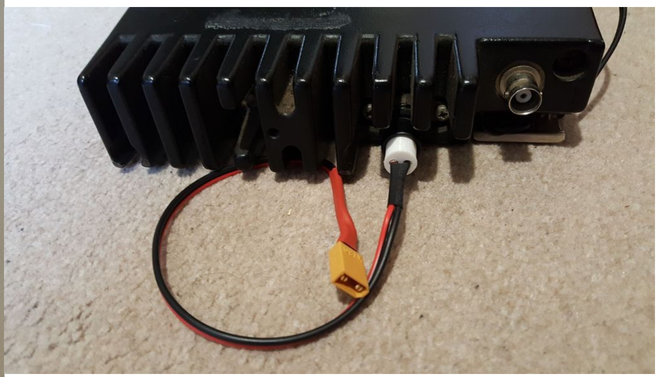
It is a bit like WSPR, but is more representative of ‘real QSO’ conditions. WSPR uses a lot of clever digital signal processing and error correction and works with very low signal levels, whereas this beacon is just morse code.

The electronics is based on a PIC18F46K22 processor, the code is written in ‘C’. The morse code generator is run under interrupts to ensure other tasks do not disturb the code being sent. The small knob sets the Morse Code Audio Level, the switch sets Mode 1 or Mode 2. The LEDs on the front show the TX and RX state of the LH and RH TXCR.

Gareth Blades M7GRB – 3D Printed Motorola MC Plug

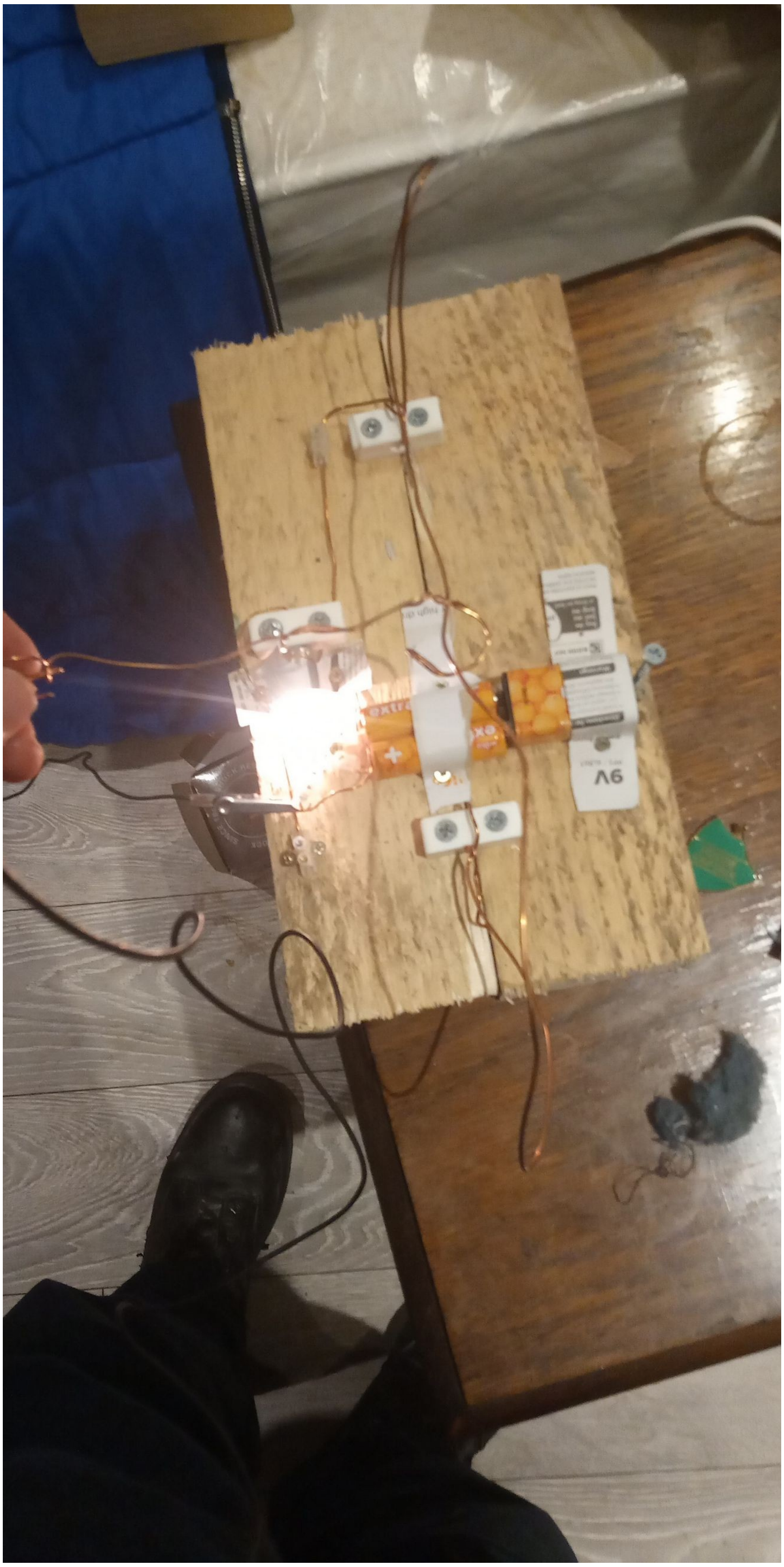


Gareth designed this perfect power plug for the MC Micro (now unobtainable) from scratch



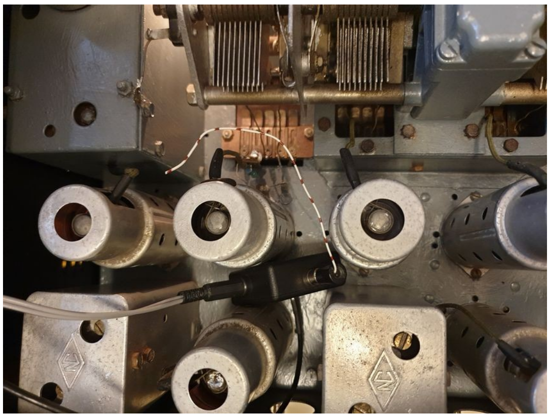
Joseph Searl M7AED – A skills tester

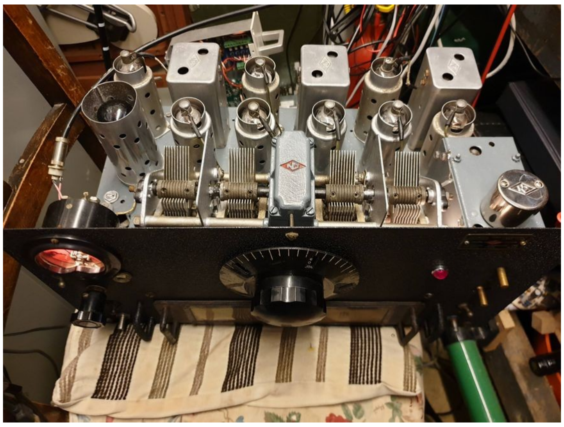
Joseph built this great test of steadiness from parts from local shops. A great display of ingenuity.



Simon Watson M0ZSU – HRO Restoration project, frequency display and a PSU from the junk box.

After seeing an HRO in action, Simon fell in love and wanted one! He found one in poor condition and made it a project to restore. He also constructed a VFO sniffer amplifier which connects to a frequency counter module for frequency readout, and created a power supply from the junk box. The chassis and case were rubbed down and re-painted. M0ZSU hasn't repainted the coil packs yet!





Dave Miller G6AWF – Antenna Matrix Controller

A clever antenna controller designed from scratch. There is an Arduino processor in the right hand box, and switch box is linked with a re-purposed VGA cable.

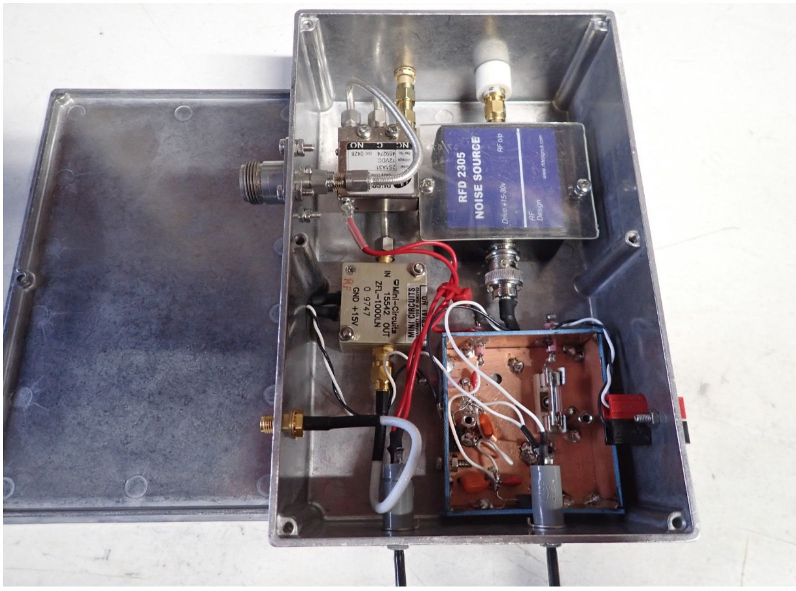
The box supports WSPR operation and switching to a dummy load.

Mike Naylor G4CDF Noise measurement system for amplifiers, transverters and noise temperature of antennas

Noise Measurement System Capabilities

- Measure the noise figure of amplifiers and transverters from 10 MHz to 3.4 GHz
- Measure the Noise level of antennas
- Calibrate a secondary noise source
- Specified Accuracy is ±0.25 dB.

Noise Measurement Meter



Noise Measurement Meter

- Calibrated Noise source
- SMA coaxial relay
- 20dB gain amplifier
- Power supply

- Output feeds into a Rigol 1.5 GHz spectrum Analyser

Noise Measurement Principles

Use a Noise source with calibrated Excess Noise Ratio (ENR) of approximately 5dB: calibrated from 10MHz to 3.4 GHz

- Noise source switched between hot (on) and cold (off)
- Y Factor is the measured noise power ratio between hot and cold noise levels

- Noise figure of a device is measured using the cascaded noise figure formula to compensate for the Spectrum Analyser noise figure

Noise Figure Spreadsheet (1.296 GHz LNA)

	A	B	C	D	E	F	G	H	I	J	K
6											
8	**NF Measurement System**						**NF DUT + NFMS**				
9	Temperature				15.6		Temperature				15.6
10	ENR compensated		dB		5.292		ENR compensat		dB		5.292
11											
12	N on		dBm/Hz		-144.8		N on		dBm/Hz		-113
13	N off		dBm/Hz		-147.3		N off		dBm/Hz		-118.9
14	Y		ratio		1.7783		Y		ratio		3.9355
15											
16	NF (cal)		dB		6.3806		NF (overall)		dB		0.6152
17			Ratio		4.3457				Ratio		1.1522
18											
20	**NF DUT**										
21	Gain DUT		Ratio		2591						
22	NF		dB		0.6089						
23			Ratio		1.1505						
24											
25											

Antenna Noise Measurement

- Receiver consists of spectrum analyser (SA) and low noise amplifier (LNA)
- Noise figure of SA and LNA is first measured using Y factor method
- The receiver is switched to the antenna
- Receiver Noise level is measured at desired azimuth points
- Enter points into a spreadsheet
- Spreadsheet displays actual noise levels and noise temperatures

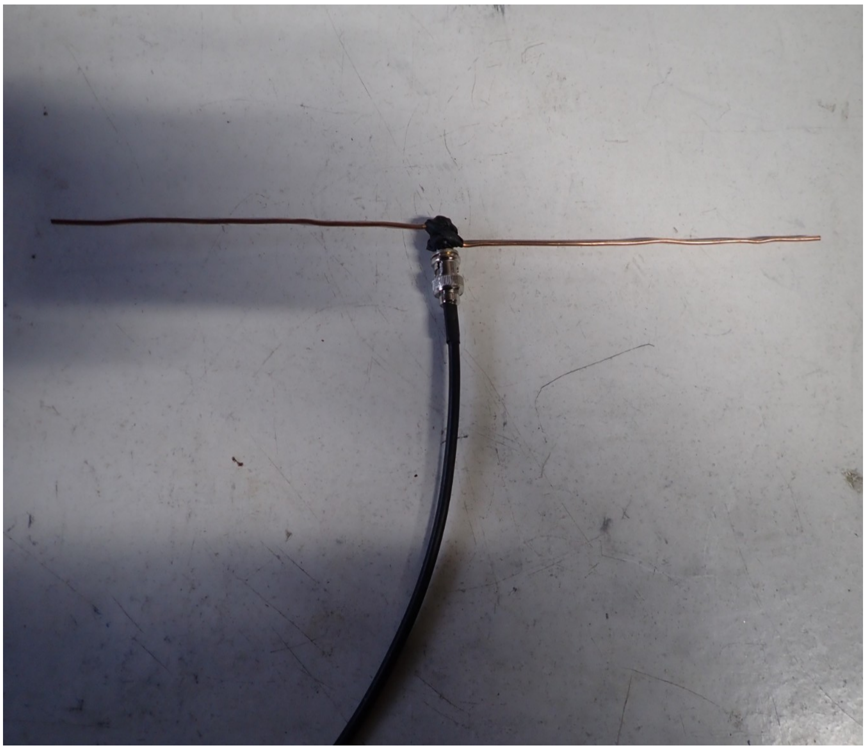
Mike Naylor G4CDF – EMF measurement system for meaduring the field strength of an amateur station.

Analysis versus Measurement?

- Ofcom are introducing a requirement for all licensed radio amateurs (and most other users) to demonstrate that they comply with the ICNIRP guidelines for Electromagnetic Fields
- Demonstration can use analysis or measurement or both
- Analysis can be used in many cases, but some stations are too difficult to analyse rigorously
- Doing some measurements adds confidence that any analyses are accurate
- This measures the field strength of an amateur station (currently only 70cm but being extended).
    - Uses one dipole antenna per band
    - Can be extended to HF with some additional work

Where is this useful?

- To provide additional evidence of compliance to support calculation or modelling
- Where modelling or calculation is not possible or easy such as:
- Through walls or roofs
- Antenna patterns are not known and detailed dimensions are not available
- Several antennas are interacting in an unknown manner
- There are structures around that are difficult to model



Calibration

- Calibration is required for the highest accuracy
- Only required periodically provided same items are used each time for measurement

Calibration system

- Two identical dipole antennas and feeders
- Two camera tripods or similar plus insulated antenna stub masts
- antennas are at >2 λ above ground to limit ground reflections
- Spectrum analyser with tracking generator
- Test range with enough space, preferably outdoors
- Far field > 2 λ ie 1.4 metres at 432 MHz
- Custom spreadsheet to derive calibration factor

Calibration Procedure

- Set Spectrum Analyser (SA) to centre frequency (432 MHz) and span to 20 MHz
- Link Tracking generator (TG) to SA input
- Perform normalisation
- Connect antennas and feeders to TG and SA
- Space antennas horizontally polarised by typically 2m, 3m and 4m (assuming 432 MHz) and enter measured path loss into spreadsheet.
- Calibration spreadsheet will calculate antenna factor and insert into Measurement spreadsheet

Calibration Spreadsheet

Dipole Calibration							
Frequency	MHz	432					
Wavelength	m	0.694444					
Distance	m			2.433	3.118	3.08	2.139
Free Space Path loss isotropic	dB			-32.8743	-35.029	-34.9225	-31.7557
Measured Loss	dB			-32.5	-33	-38	-37
Difference	dB			0.374289	2.028969	-3.07754	-5.24434
Mean difference = 2*Cal Factor	dB	-1.47965					
Dipole Gain	dB	2.15					
Feeder Loss	dB	-1.24					
Mismatch loss	dB	-0.177					
Expected cal factor	dB	0.733					

Measurement procedure

- Connect feeder of one antenna to SA
- Switch off TG
- Select frequency of transmission (eg 432.22MHz) on SA
- Set bandwidths to 100 kHz, Max hold trace
- Activate transmitter at max power CW or FM
- Move antenna at desired position in different orientations for maximum signal
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Calculate Results

- Entered measured signal to spreadsheet for each antenna position resetting trace each time (Clear/Write)
- Spreadsheet reports pass/fail and safety factor
- Compare with calculated values and allowable limits
- Define duty factor and amend safety factor appropriately
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Measurement Spreadsheet

Dipole Reference Antennas		
Frequency	MHz	432
Area	m2	0.038376481
Cal Antenna Gain	dBi	-0.739827137
SA Reading	dBm	-5.09
Power received	dBm	-4.350172863
Power received	W	0.000367268
Power Density	w/m2	0.009570124
Reference	w/m2	2.16
Safety Factor		225.7024063
dB	dB	23.53536189

Robin Caine G4IWS – Home built mast rotator

Again designed from scratch, including the mechanics and low level logic, this very sturdy rotator incorporates logic to control and direction display with UK map at the other end of a cable in the shack.