Introduction to ICNIRP and EMF

Version 1.1

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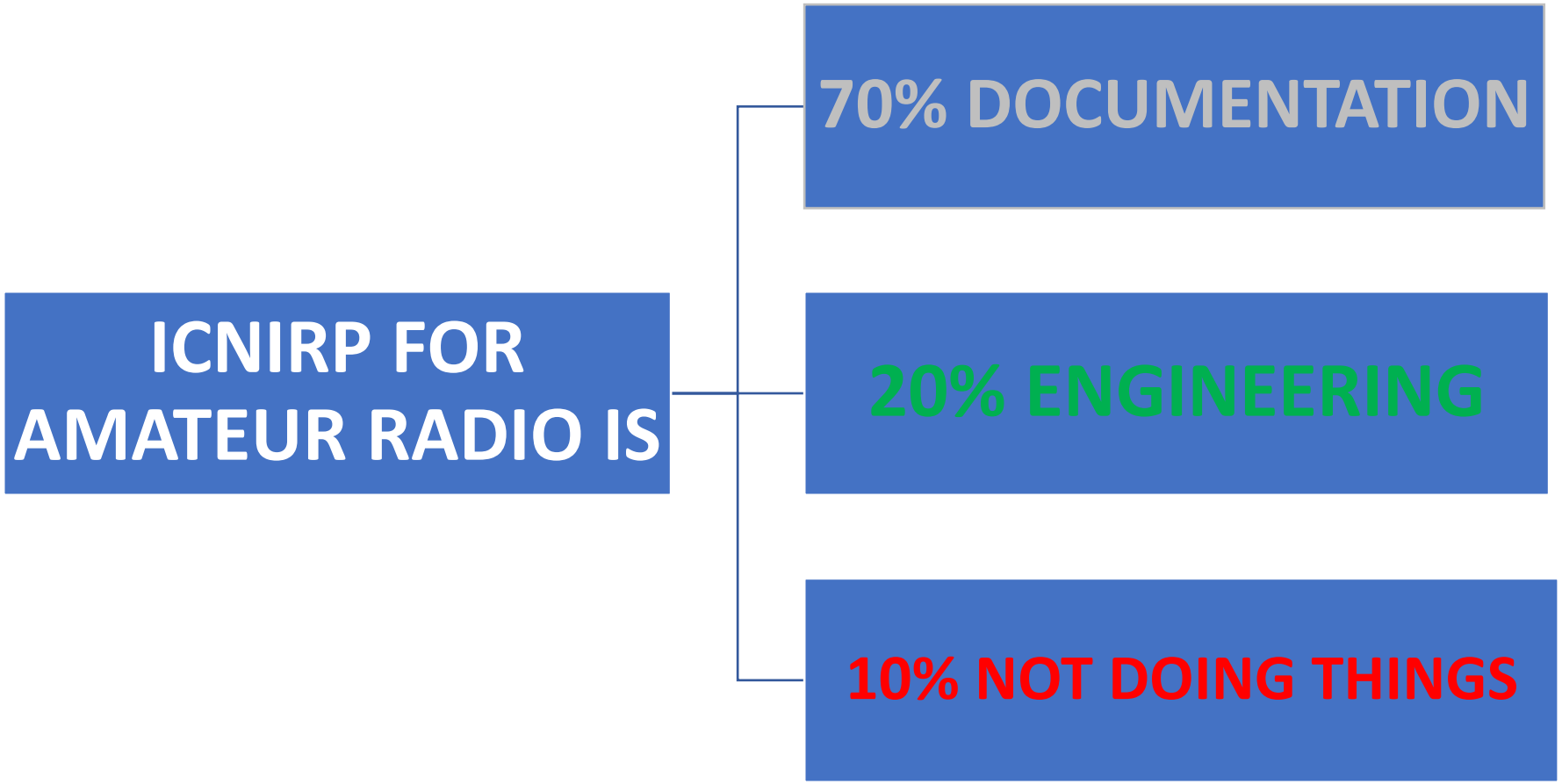
DISCLAIMER

This presentation represents the author's best current understanding of the evolving requirements for EMF assessment and recording and the tools available for doing so by radio amateurs in the UK as of early March 2022.

This has been prepared in a private capacity and does not represent the views of and is not endorsed by the author's employer, the RSGB, any radio club or RAYNET-UK.

Please follow the RSGB, ARRL and OFCOM links for the latest information !


ICNIRP FOR AMATEUR RADIO IS
70% DOCUMENTATION
20% ENGINEERING
10% NOT DOING THINGS

Contents

What are Electro magnetic Fields?

What are they ?

What are their effects on people ?

What is ICNIRP?

Where does it come from ?

What are the limits ?

What are the new OFCOM requirements?

The new license condition

The guidance and how it applies to Radio Amateurs

What tools are available to demonstrate compliance?

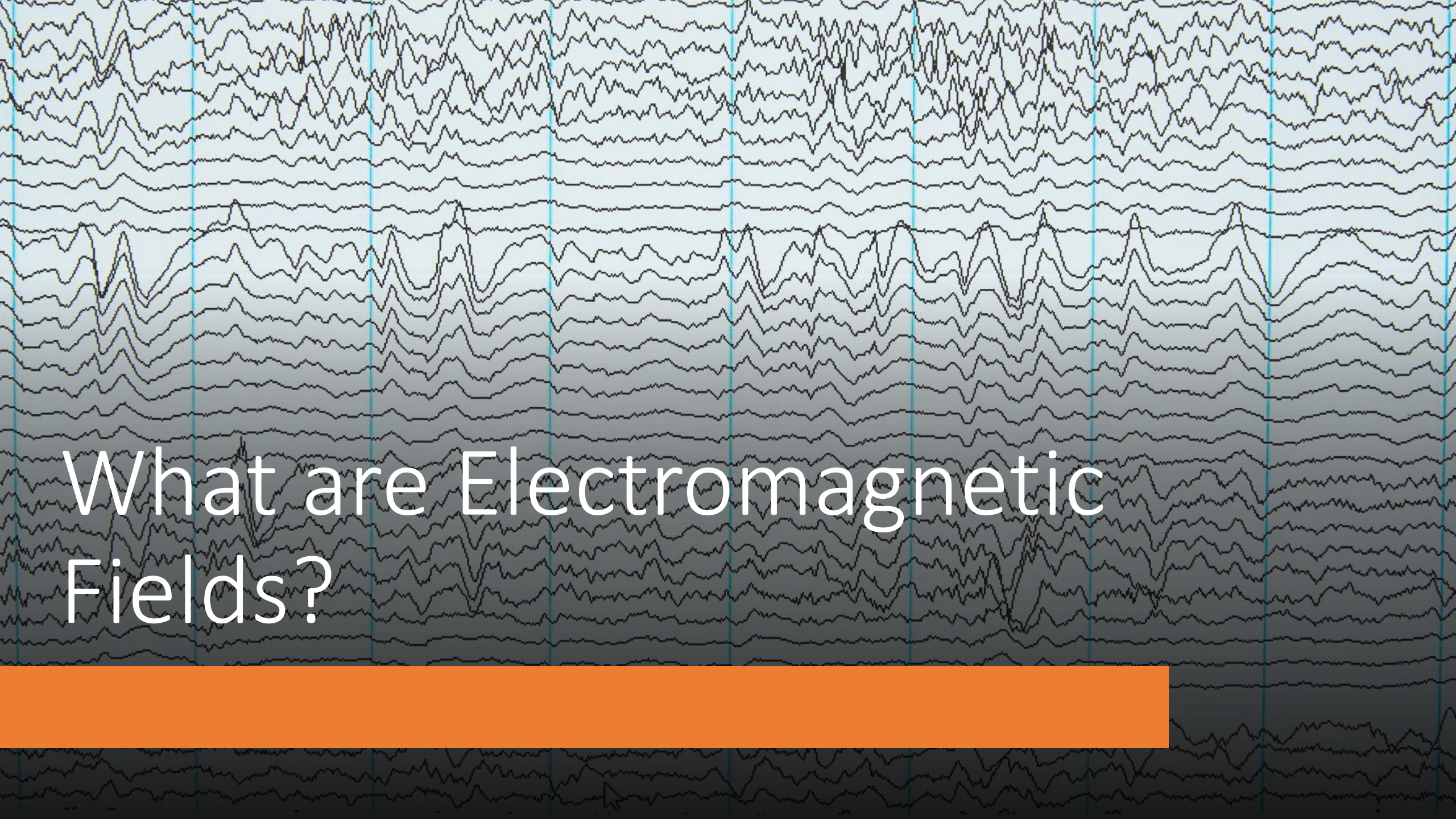
Published charts and tables

The OFCOM and RSGB calculators

RSGB Pre Assessed Configurations and the ARRL book of standard antenna tables

Electromagnetic Modelling Software

What to do if your station cannot comply?



What are Electromagnetic Fields?

What are Electromagnetic Fields ?

An electric field is produced by an electric charge or voltage in a wire

- It is measured in volts per meter (Vm^{-1} or V/m)

A magnetic field is produced by magnets or a current in a wire

- It is measured in amps per metre (Am^{-1} or A/m)

Radio waves consist of linked electric and magnetic fields

- Propagating at right angles to each other and the direction of propagation
- Carrying power which spreads out (leading to the inverse square law)
- Power density is measured in Watts per Square Metre (Wm^{-2} or W/m^2)

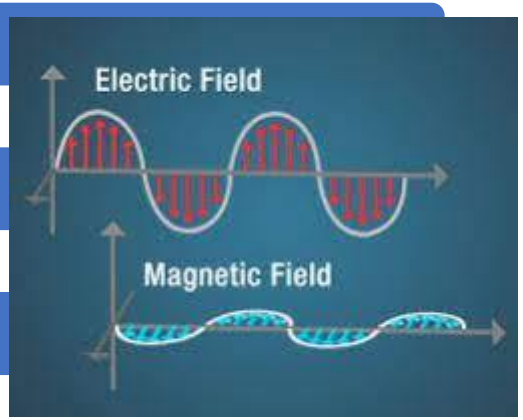
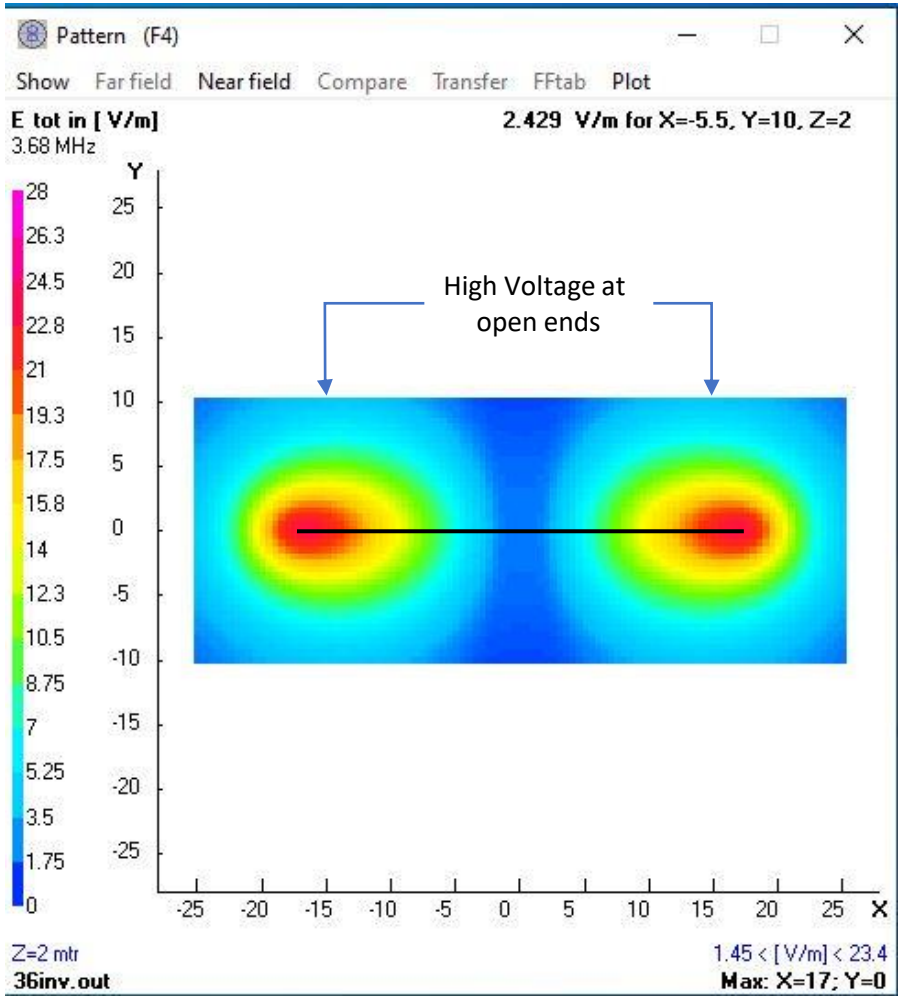


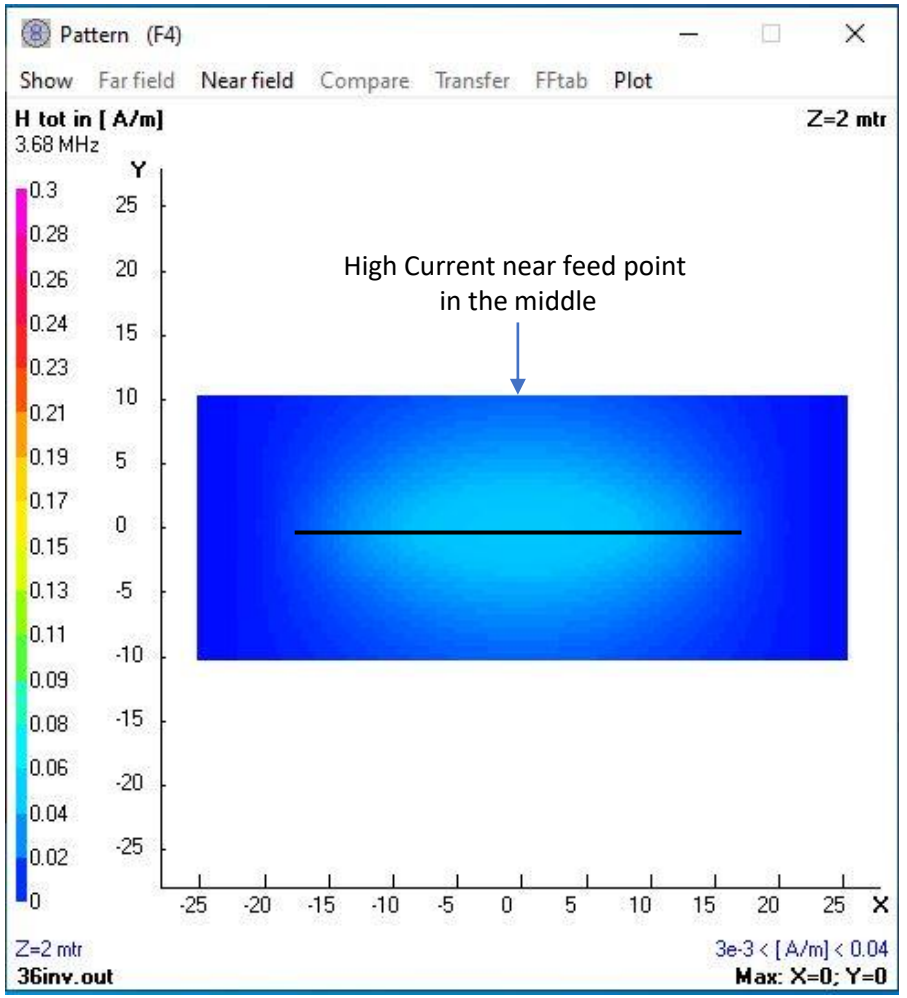
Image © NASA

Antennas create radio waves using a system of conductors

- The electric and magnetic fields combine at a distance to create a radio wave
  - This is the **FAR FIELD**
- Close to the antenna they need to be measured or plotted separately
  - This is the **NEAR FIELD**
- The antenna can be considered as a point source if you are far enough away to be in the far field
- Contributions of individual elements need to be added up at each location nearer to the antenna

Near Field Plots of an inverted V Dipole



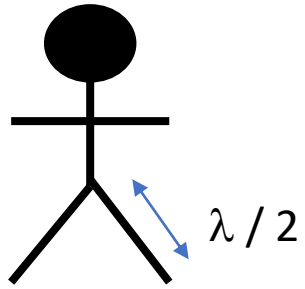


Maximum E Field is at open ends – maximum current is near feed point in the centre – nothing like far field !

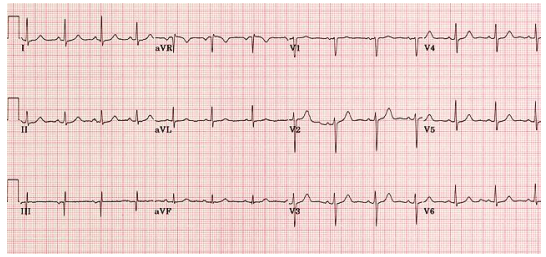
Biological Effects of Electromagnetic Fields

- Heating – much existing use e.g.
  - Microwave Cooking – 2.4GHz 500-1000W
  - Industrial RF Heating – 27MHz many KW
  - Medical RF Heating – various ISM bands

- Induced Currents
  - Arms and legs as antennas



- Nerve Stimulation
  - Our nervous system is electrochemical



What is ICNIRP ?

What is ICNIRP?

Guidelines for protection of the public from electromagnetic fields

- https://www.icnirp.org/en/publications/index.html
- https://www.icnirp.org/en/publications/article/rf-guidelines-2020.html

Published in the journal "Health Physics" by an international committee covering effects due to

- Gradual and Rapid Heating (the main emphasis)
- Changes to cell membranes
- Electrostimulation of nerves below 10MHz

What does ICNIRP do ?

Provides separate limits for General Public and Occupational exposure

- In general occupational levels are double the public levels

Limits are stated in terms of

- E fields (volts per metre) and H fields (amps per metre) at low frequencies below 30MHz
- Power density (watts per square metre) at above 30MHz (equivalent E and H available)

Three versions – progressively **less** severe in **most** respects

- 1998
- 2010
- 2020

ICNRP Limits in each version

Separate Electric and Magnetic Field limits must be used below 10MHz

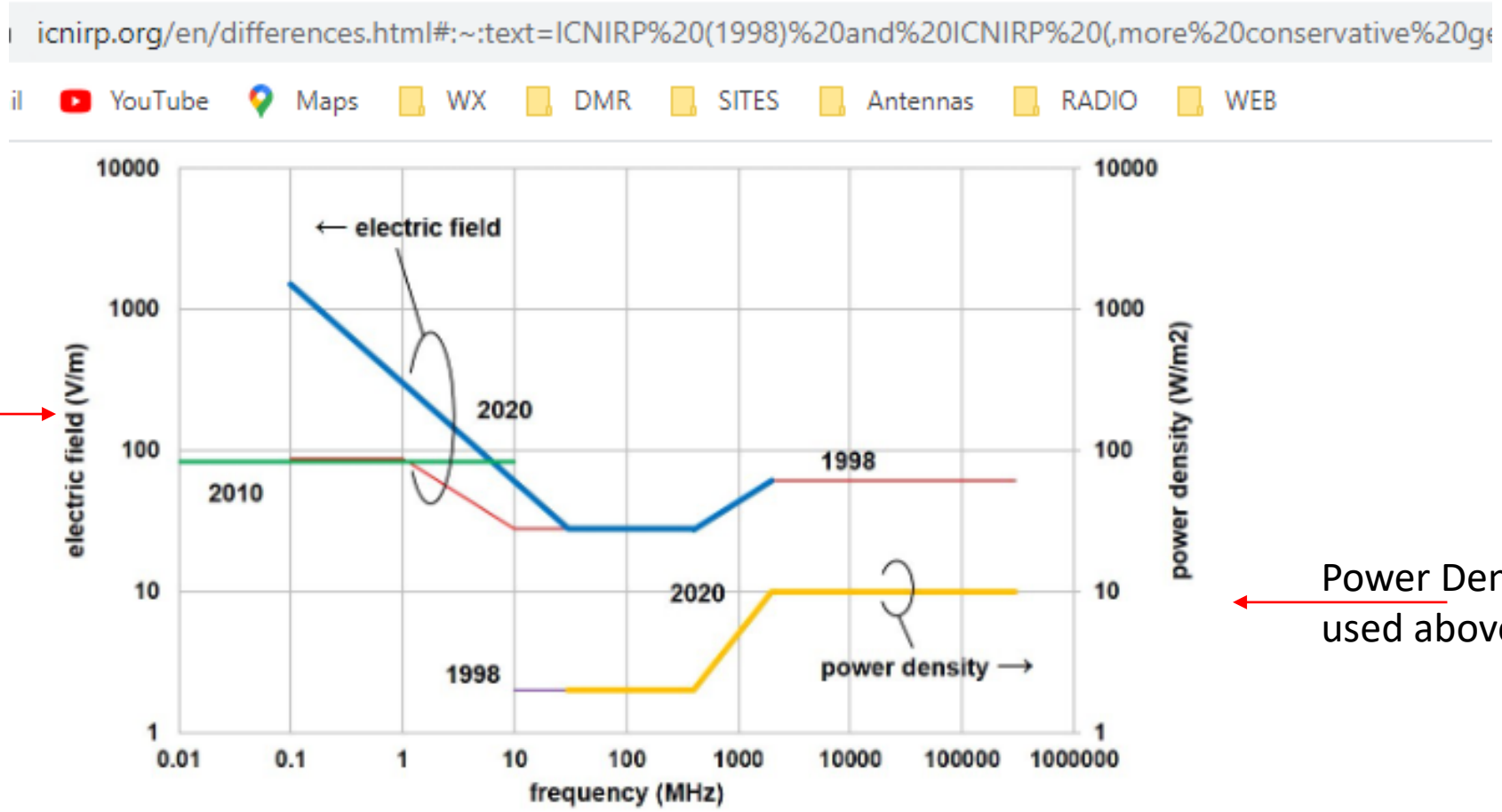


Figure 1. Whole body average reference levels for the general public for the ICNIRP (1998), ICNIRP (2010) and ICNIRP (2020) guidelines, for the 100 kHz to 300 GHz frequency range. Note that the units of the two y-axes (i.e. electric field and power density) are independent of each other.

Power Density can be used above 10MHz

ICNIRP 2020 levels calculated per band

ICNIRP 2020 limits by band

G0OZS 2021-03-15

BAND	Freq MHz	E (V/M)	H (A/M)	Source (Where 2 options, use lower)
160m	1.9	83	2.58	E from ICNIRP Table 8, H table 6 - general public levels
80m	3.65	83	1.34	E from ICNIRP Table 8, H table 6 - general public levels
60m	5.5	83	0.89	E from ICNIRP Table 8, H table 6 - general public levels
40m	7.1	83	0.69	E from ICNIRP Table 8, H table 6 - general public levels
30m	10	83	0.49	ICNIRP Table 6 - general public levels - below 30MHz
20m	14.2	104.74	0.35	ICNIRP Table 6 - general public levels - below 30MHz
15m	21.2	79.12	0.23	ICNIRP Table 6 - general public levels - below 30MHz
10m	29	63.54	0.17	ICNIRP Table 6 - general public levels - below 30MHz
6m	51	62.00	0.16	ICNIRP Table 6 - general public levels - 30-400MHz
4m	70	62.00	0.16	ICNIRP Table 6 - general public levels - 30-400MHz
2m	145	62.00	0.16	ICNIRP Table 6 - general public levels - 30-400MHz
70cm	432	64.15	0.17	ICNIRP Table 6 - general public levels - 400-2000MHz

ICNIRP Power Limits are Averages above 10MHz

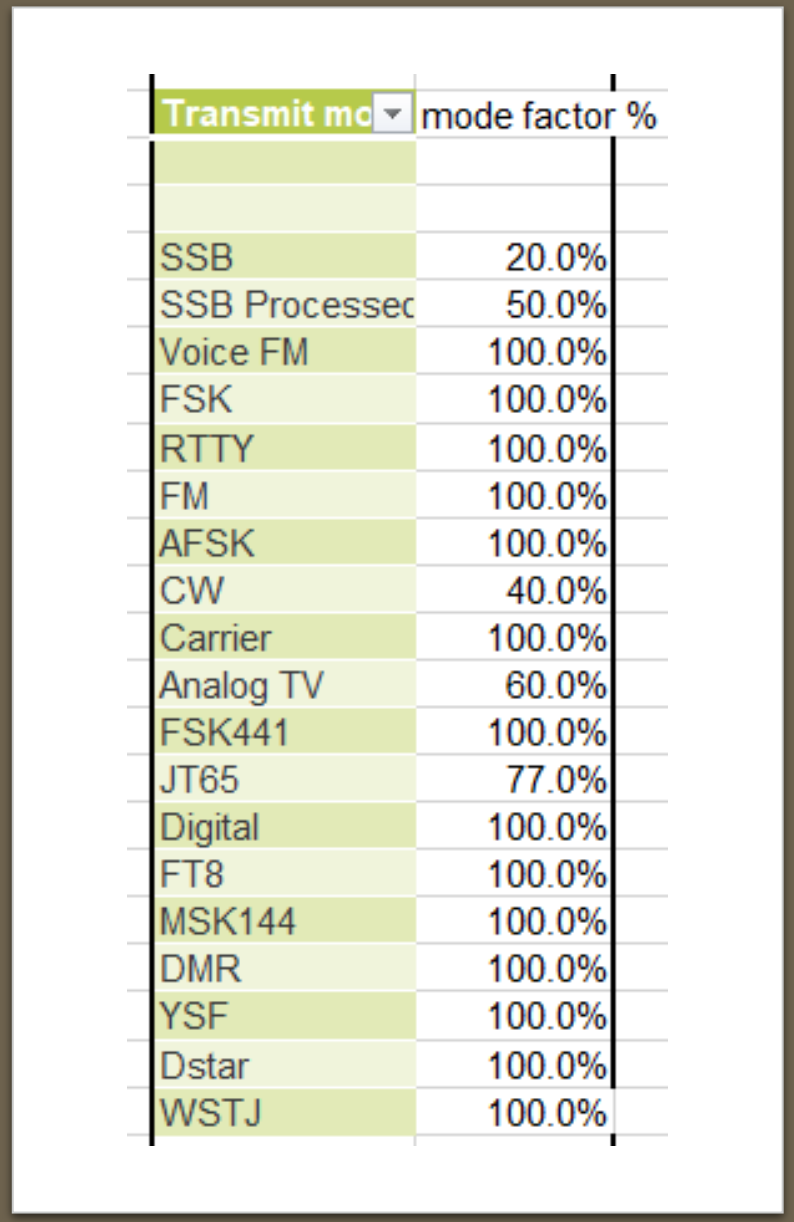
Below 10 MHz peak E-Field matters

- Therefore use PEP
- Regardless of mode or TX/RX ratio

Above 10 MHz limits are 6 minute average rather than peak so we can

- Consider TX/RX ratio
- Within TX/RX periods consider average power for the mode in use

The RSGB calculator does this for you



Transmit mo	mode factor %
SSB	20.0%
SSB Processed	50.0%
Voice FM	100.0%
FSK	100.0%
RTTY	100.0%
FM	100.0%
AFSK	100.0%
CW	40.0%
Carrier	100.0%
Analog TV	60.0%
FSK441	100.0%
JT65	77.0%
Digital	100.0%
FT8	100.0%
MSK144	100.0%
DMR	100.0%
YSF	100.0%
Dstar	100.0%
WSTJ	100.0%

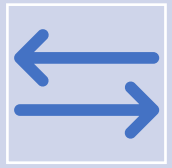
Don’t overestimate the TX/RX ratio & mode factor

- Only net control stations or 1:1 QSOs are near 1:1 (50%)
  - If overs are short divide power by number of stations in the net
  - If overs are longer use percentage of 6 minutes taken by each over
- Only FM and data modes have 100% transmitted power throughout an over
- CW 40%
- SSB 20-50% depending on compression and gaps in speech
- Average power = electrical power x TX/RX ratio x mode factor
- In net operation TX/RX ratio can be very low e.g.
  in a 80m SSB net with 5 stations and processed SSB
  average PEP = 20% of 40% = 8% of metered PEP

Effect of Antennas on Power

ICNIRP uses EIRP (Effective Isotropically Radiated Power)

EIRP is affected by antenna gain



Bear in mind that gain is directional

So peak power is where antenna is pointing

Power (and fields) are less in other directions

OFCOM calculators give the separation in the direction of maximum gain

Other calculators do correct for this !

Antenna Gain

Antenna gain and radiated power is expressed in dBi or dBd

- dBi and EIRP are relative to a spherical radiator (e.g. the sun or a light bulb)
- dBd and ERP are relative to a dipole which radiates mostly sideways
- There is a fixed ratio of 10/6 = 2.15dB between dBi and dBd
- dBi = dBd + 2.15 and dBd = dBi – 2.15

Dealers generally specify antenna gains in dBi

- Be sure to start from ERP if dBd or EIRP if dBi
- The maths underlying the OFCOM calculator use average EIRP

Power to EIRP conversion chart

https://g0ozs.co.uk/mdwiki/emf/g0ozs-power-gain-eirp-lookup.png

	Gain dBi	0	1	2	2.15	3	4	5	6	7	8	9	10
	Gain dBd	-2.15	-1.15	-0.15	0	0.85	1.85	2.85	3.85	4.85	5.85	6.85	7.85
POWER (W)	1	1.0	1.3	1.6	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0
	2	2.0	2.5	3.2	3.3	4.0	5.0	6.3	8.0	10.0	12.6	15.9	20.0
	3	3.0	3.8	4.8	4.9	6.0	7.5	9.5	11.9	15.0	18.9	23.8	30.0
	4	4.0	5.0	6.3	6.6	8.0	10.0	12.6	15.9	20.0	25.2	31.8	40.0
	5	5.0	6.3	7.9	8.2	10.0	12.6	15.8	19.9	25.1	31.5	39.7	50.0
	6	6.0	7.6	9.5	9.8	12.0	15.1	19.0	23.9	30.1	37.9	47.7	60.0
	6.1	6.1	7.7	9.7	10.0	12.2	15.3	19.3	24.3	30.6	38.5	48.5	61.0
	7	7.0	8.8	11.1	11.5	14.0	17.6	22.1	27.9	35.1	44.2	55.6	70.0
	8	8.0	10.1	12.7	13.1	16.0	20.1	25.3	31.8	40.1	50.5	63.5	80.0
	9	9.0	11.3	14.3	14.8	18.0	22.6	28.5	35.8	45.1	56.8	71.5	90.0
	10	10.0	12.6	15.8	16.4	20.0	25.1	31.6	39.8	50.1	63.1	79.4	100.0
	12	12.0	15.1	19.0	19.7	23.9	30.1	37.9	47.8	60.1	75.7	95.3	120.0
	15	15.0	18.9	23.8	24.6	29.9	37.7	47.4	59.7	75.2	94.6	119.1	150.0
	20	20.0	25.2	31.7	32.8	39.9	50.2	63.2	79.6	100.2	126.2	158.9	200.0
	25	25.0	31.5	39.6	41.0	49.9	62.8	79.1	99.5	125.3	157.7	198.6	250.0
	30	30.0	37.8	47.5	49.2	59.9	75.4	94.9	119.4	150.4	189.3	238.3	300.0
	35	35.0	44.1	55.5	57.4	69.8	87.9	110.7	139.3	175.4	220.8	278.0	350.0
	40	40.0	50.4	63.4	65.6	79.8	100.5	126.5	159.2	200.5	252.4	317.7	400.0
	45	45.0	56.7	71.3	73.8	89.8	113.0	142.3	179.1	225.5	283.9	357.4	450.0
	50	50.0	62.9	79.2	82.0	99.8	125.6	158.1	199.1	250.6	315.5	397.2	500.0
	60	60.0	75.5	95.1	98.4	119.7	150.7	189.7	238.9	300.7	378.6	476.6	600.0
	70	70.0	88.1	110.9	114.8	139.7	175.8	221.4	278.7	350.8	441.7	556.0	700.0
	80	80.0	100.7	126.8	131.2	159.6	201.0	253.0	318.5	400.9	504.8	635.5	800.0
	90	90.0	113.3	142.6	147.7	179.6	226.1	284.6	358.3	451.1	567.9	714.9	900.0
	100	100.0	125.9	158.5	164.1	199.5	251.2	316.2	398.1	501.2	631.0	794.3	1000.0

The new OFCOM condition

And guidelines specifically relevant to Amateur Radio

The new OFCOM condition

https://www.ofcom.org.uk/manage-your-licence/emf
https://www.ofcom.org.uk/__data/assets/pdf_file/0028/220798/emf-licence-condition-what-you-need-to-know-amateur-radio.pdf
https://www.ofcom.org.uk/manage-your-licence/emf/compliance-and-enforcement-guidance

7(1) The Licensee shall ensure that:

(a) the emitted frequency of the apparatus comprised in the Radio Equipment is as stable and as free from Unwanted Emissions as the state of technical development for amateur radio apparatus reasonably permits; ~~and~~

(b) whatever class of emission is in use, the bandwidth occupied by the emission is such that not more than 1% of the mean power of the transmission falls outside the nominal modulated carrier bandwidth[3] ~~.~~; *and*

(c) the establishment, installation, modification or use of the Radio Equipment is carried out in accordance with the restrictions set out in Schedule 3 of this Licence in relation to electromagnetic field (EMF) exposure.

7(2) Where this Licence is a Foundation Licence, the Licensee shall only use commercially available Radio Equipment which satisfies IR 2028. Foundation Licence holders may also use Radio Equipment constructed using commercially available kits which satisfy IR 2028.

7(3) Notwithstanding any other terms of this Licence, the Licensee shall ensure that the Radio Equipment is designed, constructed, maintained and used so that its use does not cause any Undue Interference to any wireless telegraphy.

(Change highlighting provided by OFCOM)

OFCOM Licence Changes

OFCOM added a new clause 7.1c and schedule 3

Schedule 3 specifies ICNIRP 1998 table 7 or 2020 tables 5 to 9

- Most calculators are still based on 1998 limits

Schedule 3 clause 7 incorporates the OFCOM guidance by reference

- So guidance has the same force as the license proper

Requires ***local*** records to be available for inspection by Ofcom

- But does ***not*** prescribe the form or contents of these records in detail

OFCOM Guidance

- Exempts transmitters below 10.1w EIRP (i.e. after antenna gain)
- Includes family members guests and lodgers as general public
- Exempts amateur licensees working together e.g. at a field day
- Exempts shared sites below a total power of 100W from extra rules otherwise applied to multi-transmitter installations
- Defines and excludes areas where the public can be presumed not to be present
- Lists methods of demonstrating and recording compliance
- Lists methods of mitigating the risk including distance, locked gates and signage
- Confirms that OFCOM accept operator settings and average power as mitigation

OFCOM RESOURCES

OFCOM have provided resources to help licensees assess compliance

The Spreadsheet Calculator

- https://www.ofcom.org.uk/manage-your-licence/emf/calculator

The Guidance for Radio Amateurs

- https://www.ofcom.org.uk/__data/assets/pdf_file/0028/220798/emf-licence-condition-what-you-need-to-know-amateur-radio.pdf
- There is a flowchart on page 3
- There is a table of pre-calculated distances by power and band on page 10

The Pre Calculated OFCOM table

BAND/EIRP	10W	50W	100W	200W	300W	400W	1KW
10MHz	4.8m	4.8m	4.8m	*4.8m*	*5.6m*	6.4m	10.1m
14MHz	3.8m	3.8m	3.8m	*4.6m*	*5.6m*	6.4m	10.1m
21MHz	*2.3m*	*2.3m*	*3.2m*	*4.6m*	*5.6m*	*6.4m*	*10.1m*
28MHz	1.8m	2.3m	3.2m	*4.6m*	*5.6m*	6.4m	10.1m
50MHz	1.1m	2.3m	3.2m	*4.6m*	*5.6m*	6.4m	10.1m
70MHz	*1.1m*	*2.3m*	*3.2m*	*4.6m*	*5.6m*	*6.4m*	*10.1m*
144MHz	1.1m	2.3m	3.2m	*4.6m*	*5.6m*	6.4m	10.1m
432Mhz	1.0m	2.2m	3.8m	*4.4m*	*5.4m*	6.2m	9.8m

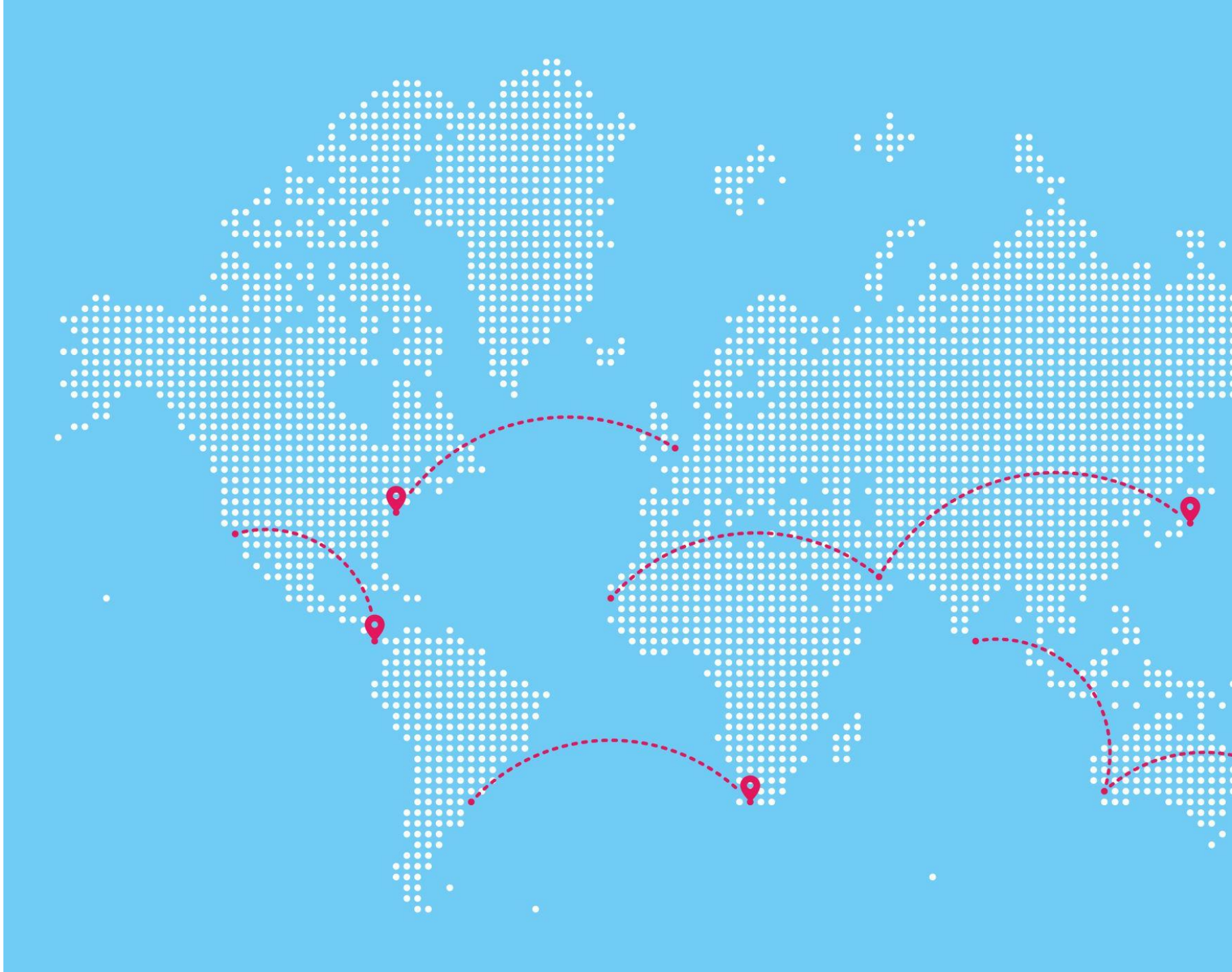
This is a re-creation of the OFCOM power / separation table now removed from the guidance document.
This lists the limits by band with *extra rows* for 21MHz and 70MHz and extra columns for 200W and 300W EIRP.

OFCOM implementation Schedule

You need to have done this by the following dates:

- **18 November 2021** for frequencies you are using at or above 110 MHz;
- **18 May 2022** for frequencies you are using above 10 MHz but below 110 MHz;
- **18 November 2022** for frequencies you are using at or below 10 MHz.

Demonstrating Compliance



Methods of demonstrating compliance

In order of increasing difficulty:

- Use of low power and low gain antennas
- Avoiding the general public
- Use of OFCOM’s calculator or one derived from it
- Use of published tables or pre-assessed configurations

Simplifications

The following will always be true and can save work:

- If I calculate an antenna separation for the highest power I can use, it will be more than enough for any lower power into the same antenna.
- If there is enough clearance at a given power, frequency and height then any additional height will be an improvement.
- For simple antennas (dipole and ¼ wave) OFCOM gives a slightly greater separation distance at 2m than 70cm for equal gain. So a 2m calculation will cover 70cm.
- For HF wire antenna below 10MHz the E-field limit determines the distance

Demonstrating Compliance through low power

Demonstrating compliance due to low power

OFCOM exempt stations with EIRP less than 10W from assessment and separation distance requirements in guideline 6.5(a). This can be achieved by

- Choosing a radio and antenna so as to make it physically impossible to exceed 10W EIRP
- Set up and/or installation of the radio and antenna to operate below 10W EIRP
- Above 10MHz, Operating restrictions to bring the 6 minute average power below 10W EIRP

Demonstrating this can be achieved by, for example:

- Programming a code plug to allow only compliant output power with your antenna
  - Buying a radio and antenna incapable of exceeding the power limit (guideline 6.5a)
  - Noting in the log that the power switch was set to low or medium (guideline 6.8)
  - Calculating Power x antenna gain x modulation factor to be less than 10W (guideline 6.5a)
  - Keeping a low transmit / receive ratio (guideline 6.8) by use of TOT or short overs

I have prepared a summary sheet showing how all my radios can be used without an antenna assessment under guideline 6.5(a) either by design or with power and duty cycle limits

G0OZS RADIO LOW POWER STATEMENT

The following transmitters or transceivers used under this license are incapable of more than 6 watts of electrical power output or can be set to achieve an average power less than 6 watts, so, when used with a dipole or an antenna of lesser gain including but not limited to a quarter wave or shorter whip or a helical whip antenna, are incapable of radiating more than 10.1W EIRP so are assessed to comply with OFCOM license condition 7.1 (c) due to a 6 minute average EIRP of 10 watts or less according to guideline 6.5 (a). Where necessary, the power settings and duty cycle limits required to reduce the average power to 6 Watts or less according to guideline 6.8 are listed. Use of these settings will ensure a 6 minute average EIRP below 10 Watts:

Make	Model	Band(s)	Power/Mode	Special Conditions for compliance under guideline 6.8
Kenwood	TH-D7E	2m/70cm	5 Watts FM/APRS	NONE
Lanch	HG-UV98	2m/70cm	5 Watts FM	NONE
TYT	MD-390	70cm	5 Watts DMR/FM	NONE
Motorola	Astro Spectra	2m	8/25 Watts FM	1:1 TX/RX ratio on 8W and 1:4 TX/RX ratio on 25W max over 1 minute
ICOM	IC-F1010	2m	5/25 Watts FM	None on 5W 1:4 TX/RX ratio on 25W
ICOM	IC-F610	70cm	5/25 Watts FM	None on 5W 1:4 TX/RX ratio on 25W
ICOM	IC-F3G and S	2m	6 Watts FM	1:1 TX/RX ratio and original antenna
ICOM	IC-F4G and S	70cm	5 Watts FM	NONE
ICOM	IC-2E	2m	1.5 Watts FM	NONE
Alinco	DR-599	2m/70cm	5/15/35 Watts FM	Low or Medium Power Only – 1:2 TX/RX ratio on Medium
Kenwood	TM-D710	2m/70cm	5/15/45 Watts FM/APRS	None on 5W 1:3 TX/RX on 15W and 10:1 APRS only on 45W
Plessey	UK/PRC-320	1.5-30MHz	5/30 Watts SSB/CW	None on Low Power, HP only above 10MHz 1:1 Max TX/RX ratio * %
M.E.L. (Thales)	UK/PRC-319	1.5-30MHz	6/40 Watts SSB/CW/FSK	None on Low Power, HP SSB 1:2 FSK 1:8 max ratio only above 10MHz * %
M.E.L. (Thales)	UK/PRC-321	1.5-30MHz	5/45 Watts SSB	None on Low Power Mode. HP only above 10MHz 1:2 Max TX/RX ratio * %
Marconi	UK/VRC-353	4m/6m	0.25/1/15/30 Watts	NONE on 0.1 and 1W, 1:2 TX/RX ratio on 15W, assess for 50W
RACAL	P25 (PRC8894)	2m	5 Watts FM/P25	NONE
RACAL	Cougar	2m and 4m	2 Watts FM	NONE
RACAL	Cougar SMT	2m and 4m	18 Watts	1:4 TX/RX ratio maximum
RACAL	VRM5080	2m and 4m	0.1/15/60 Watts FM	Low or Medium Power Only – 1:2 TX/RX ratio on Medium, assess 60W
Tadiran	PRC-77	4m/6m	4 Watts FM	NONE
Telefunken	SEM35	10m/6m	2 Watts FM	NONE
Voronzeh	R-107T	10m/6m	1.5 Watts FM	NONE
Voronzeh	R-126	6m	0.25 Watts FM	NONE
REME	SR-128	40m/80m	1 Watt CW	NONE
Skanti	TRP8255	10-30MHz	20/60/120W CW/SSB	1:1 TX/RX ratio on low power, 1:3 TX/RX ratio on medium, assess for high %

* Because ICNIRP 2020 table 8 specifies peak power below 10MHz averaging under guideline 6.8 cannot be used to achieve compliance with clause 7.1(c)

% Using 40% modulation factor for Processed SSB and CW as in RSGB Calculator version 9d of March 2021

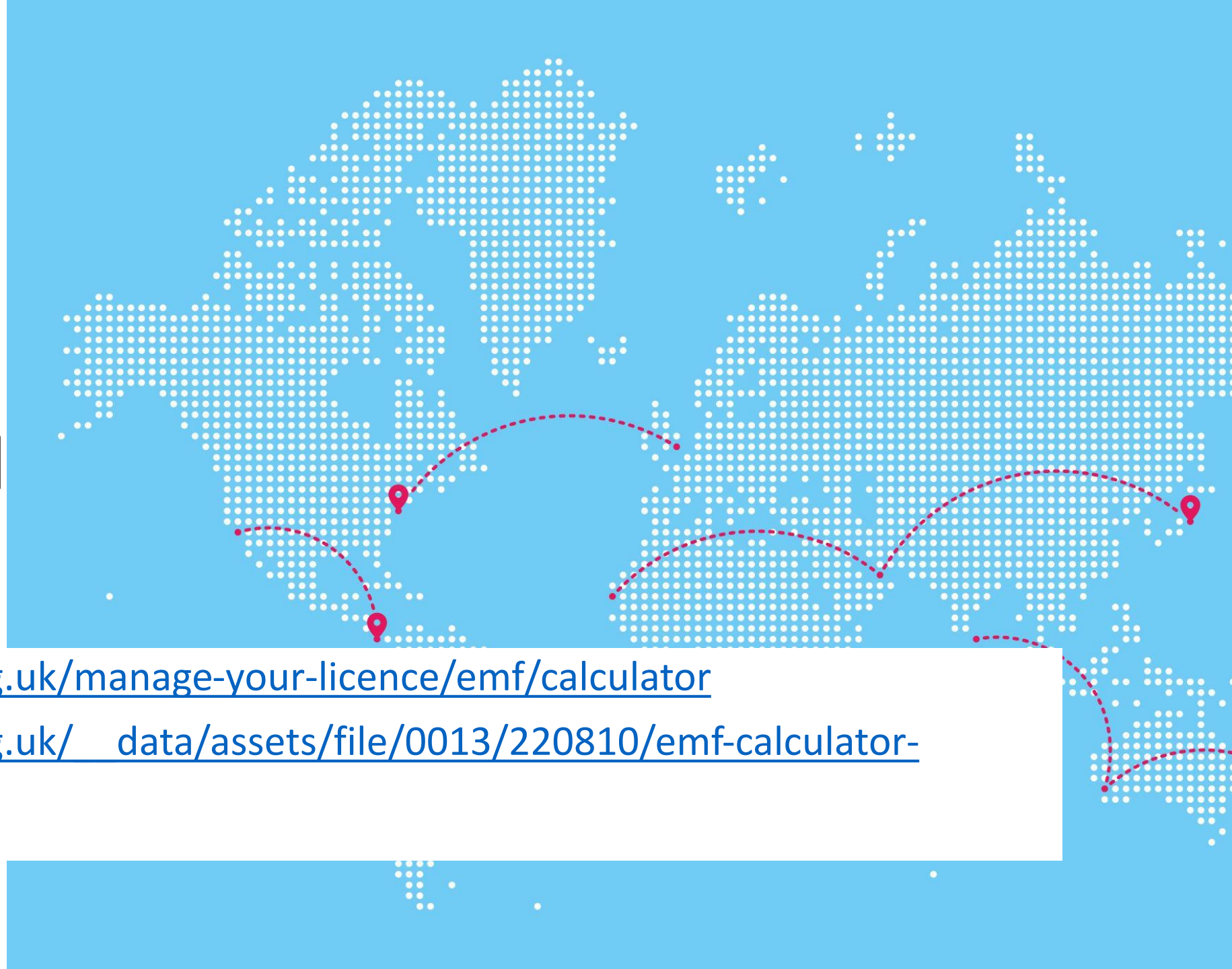
Maximum transmit time for 10W average

It is possible to calculate the maximum percentage of transmit time in 6 minutes to keep under 10W average EIRP for a given antenna gain and RF power output, when operating above 10MHz:
https://g0ozs.co.uk/mdwiki/emf/g0ozs-power-gain-exempt-duty-cycle.png

FM TX:RX ratio needed to achieve 10 Watts EIRP

	Antenna Gain (dBi) - add 2.14 and round up if found in dBd										
RF POWER	0	1	2	3	4	5	6	7	8	9	10
1	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	100%
2	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	100%	79%	63%	50%
3	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	84%	67%	53%	42%	33%
4	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	79%	63%	50%	40%	31%	25%
5	NO LIMIT	NO LIMIT	NO LIMIT	NO LIMIT	80%	63%	50%	40%	32%	25%	20%
6	NO LIMIT	NO LIMIT	NO LIMIT	84%	66%	53%	42%	33%	26%	21%	17%
7	NO LIMIT	NO LIMIT	90%	72%	57%	45%	36%	29%	23%	18%	14%
8	NO LIMIT	NO LIMIT	79%	63%	50%	40%	31%	25%	20%	16%	13%
9	NO LIMIT	88%	70%	56%	44%	35%	28%	22%	18%	14%	11%
10	NO LIMIT	79%	63%	50%	40%	32%	25%	20%	16%	13%	10%
12	83%	66%	53%	42%	33%	26%	21%	17%	13%	10%	8%
15	67%	53%	42%	33%	27%	21%	17%	13%	11%	8%	7%
20	50%	40%	32%	25%	20%	16%	13%	10%	8%	6%	5%
25	40%	32%	25%	20%	16%	13%	10%	8%	6%	5%	4%
30	33%	26%	21%	17%	13%	11%	8%	7%	5%	4%	3%
40	25%	20%	16%	13%	10%	8%	6%	5%	4%	3%	3%
50	20%	16%	13%	10%	8%	6%	5%	4%	3%	3%	2%

The OFCOM Calculator

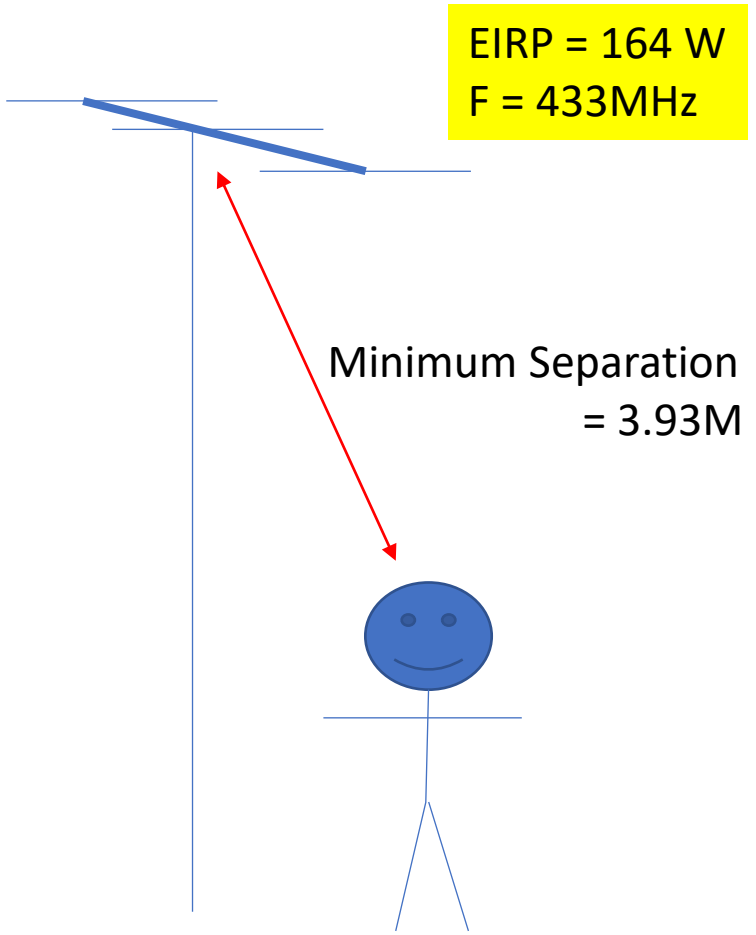


https://www.ofcom.org.uk/manage-your-licence/emf/calculator

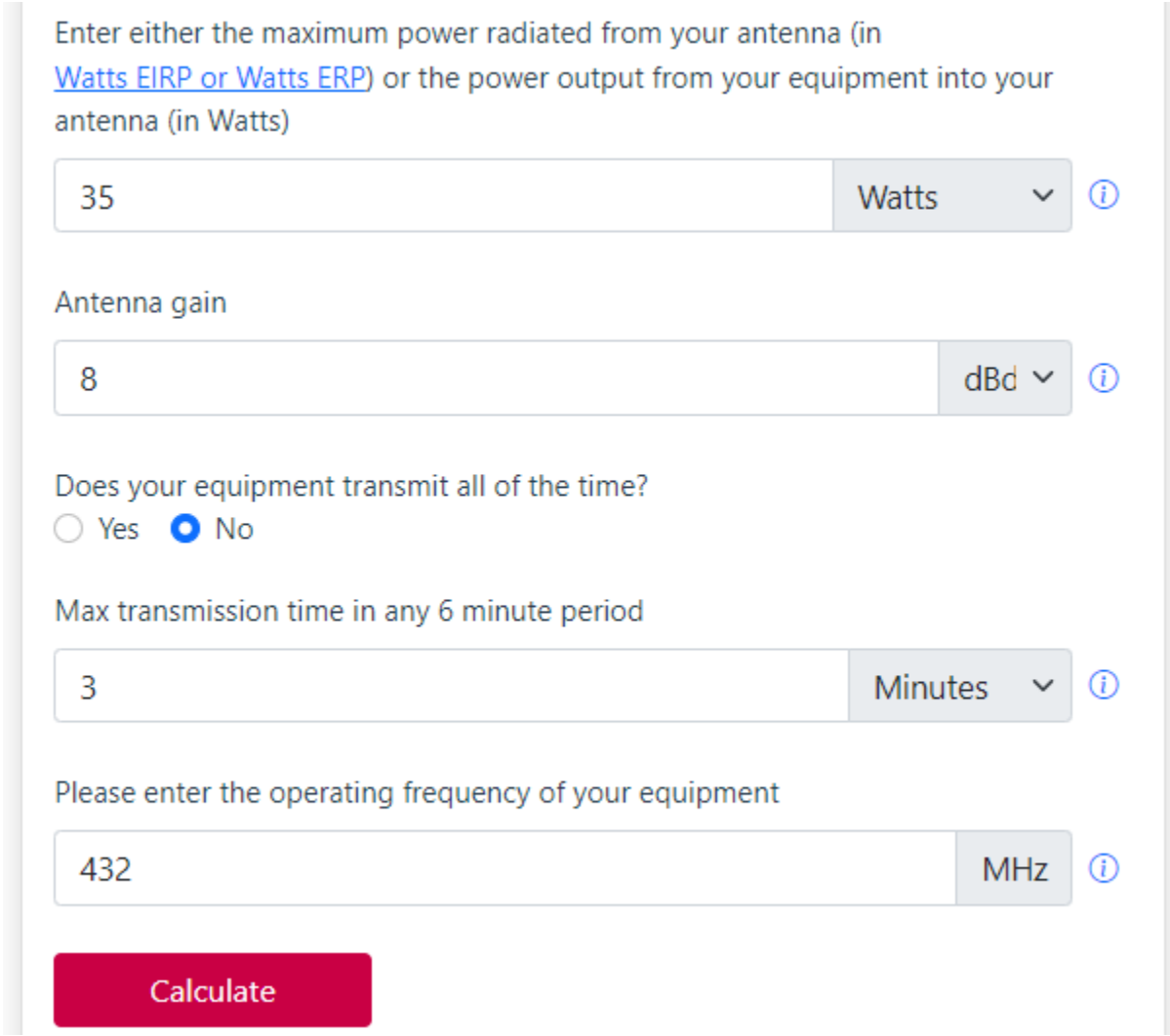
https://www.ofcom.org.uk/__data/assets/file/0013/220810/emf-calculator-v1.0.xlsx

The OFCOM calculator

- Originally provided as an Excel sheet (still there)
  - Reputed to run in Google Docs and OpenOffice
- Now available as an online form
- Treats antenna as a point source
- Takes EIRP, duty cycle and Frequency as input
- Uses ICNIRP 1998 formulae
- No results below 10MHz
- Separation distance is straight line to the antenna
- Good for VHF if you know your EIRP – use with care if the “Reactive Near Field” distance gets close to the Separation Distance.



OFCOM Data Input



Br

OFCOM Results

Compliance Distance Calculation Result

Input parameters

Power input	35	(Watts)
Antenna gain	8	(dBd)
Max transmission time in any 6 minute period	3	Minutes
Operating frequency of equipment	432	(MHz)

Calculated result

The result of the calculation is a compliance distance in metres that you need to maintain between the antenna and members of the general public

Compliance Distance (R)	4.13	(m)

For information only, intermediate parameters used in calculation are provided below

Percentage of transmission time in any 6 minute period	50.00%	
Average radiated power EIRP	181.08	(Watts)
Wavelength	0.69	(m)
Reactive near-field boundary	0.11	(m) ⓘ
Reference level for power density (from ICNIRP 1998 Guidelines)	2.16	(W/m2)

Print Re-Calculate

Tabulated OFCOM Results

It is possible to prepare a table of separation vs frequency and power using the OFCOM calculator
https://g0ozs.co.uk/mdwiki/emf/g0ozs-band-eirp-separation-lookup.png

BAND/EIRP	10W	50W	100W	200W	300W	400W	1KW
10MHz	4.8m	4.8m	4.8m	4.8m	5.6m	6.4m	10.1m
14MHz	3.8m	3.8m	3.8m	4.6m	5.6m	6.4m	10.1m
21MHz	2.3m	2.3m	3.2m	4.6m	5.6m	6.4m	10.1m
28MHz	1.8m	2.3m	3.2m	4.6m	5.6m	6.4m	10.1m
50MHz	1.1m	2.3m	3.2m	4.6m	5.6m	6.4m	10.1m
70MHz	1.1m	2.3m	3.2m	4.6m	5.6m	6.4m	10.1m
144MHz	1.1m	2.3m	3.2m	4.6m	5.6m	6.4m	10.1m
432Mhz	1.0m	2.2m	3.8m	4.4m	5.4m	6.2m	9.8m

Tabulated EIRP Results

It is possible to prepare a table of power and antenna gain to EIRP from first principles or using the OFCOM page https://g0ozs.co.uk/mdwiki/emf/g0ozs-power-gain-eirp-lookup.png

	Gain dBi	0	1	2	2.15	3	4	5	6	7	8	9	10
	Gain dBd	-2.15	-1.15	-0.15	0	0.85	1.85	2.85	3.85	4.85	5.85	6.85	7.85
POWER (W)	1	1.0	1.3	1.6	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0
	2	2.0	2.5	3.2	3.3	4.0	5.0	6.3	8.0	10.0	12.6	15.9	20.0
	3	3.0	3.8	4.8	4.9	6.0	7.5	9.5	11.9	15.0	18.9	23.8	30.0
	4	4.0	5.0	6.3	6.6	8.0	10.0	12.6	15.9	20.0	25.2	31.8	40.0
	5	5.0	6.3	7.9	8.2	10.0	12.6	15.8	19.9	25.1	31.5	39.7	50.0
	6	6.0	7.6	9.5	9.8	12.0	15.1	19.0	23.9	30.1	37.9	47.7	60.0
	6.1	6.1	7.7	9.7	10.0	12.2	15.3	19.3	24.3	30.6	38.5	48.5	61.0
	7	7.0	8.8	11.1	11.5	14.0	17.6	22.1	27.9	35.1	44.2	55.6	70.0
	8	8.0	10.1	12.7	13.1	16.0	20.1	25.3	31.8	40.1	50.5	63.5	80.0
	9	9.0	11.3	14.3	14.8	18.0	22.6	28.5	35.8	45.1	56.8	71.5	90.0
	10	10.0	12.6	15.8	16.4	20.0	25.1	31.6	39.8	50.1	63.1	79.4	100.0
	12	12.0	15.1	19.0	19.7	23.9	30.1	37.9	47.8	60.1	75.7	95.3	120.0
	15	15.0	18.9	23.8	24.6	29.9	37.7	47.4	59.7	75.2	94.6	119.1	150.0
	20	20.0	25.2	31.7	32.8	39.9	50.2	63.2	79.6	100.2	126.2	158.9	200.0
	25	25.0	31.5	39.6	41.0	49.9	62.8	79.1	99.5	125.3	157.7	198.6	250.0
	30	30.0	37.8	47.5	49.2	59.9	75.4	94.9	119.4	150.4	189.3	238.3	300.0
	35	35.0	44.1	55.5	57.4	69.8	87.9	110.7	139.3	175.4	220.8	278.0	350.0
	40	40.0	50.4	63.4	65.6	79.8	100.5	126.5	159.2	200.5	252.4	317.7	400.0
	45	45.0	56.7	71.3	73.8	89.8	113.0	142.3	179.1	225.5	283.9	357.4	450.0
	50	50.0	62.9	79.2	82.0	99.8	125.6	158.1	199.1	250.6	315.5	397.2	500.0
	60	60.0	75.5	95.1	98.4	119.7	150.7	189.7	238.9	300.7	378.6	476.6	600.0
	70	70.0	88.1	110.9	114.8	139.7	175.8	221.4	278.7	350.8	441.7	556.0	700.0
	80	80.0	100.7	126.8	131.2	159.6	201.0	253.0	318.5	400.9	504.8	635.5	800.0
	90	90.0	113.3	142.6	147.7	179.6	226.1	284.6	358.3	451.1	567.9	714.9	900.0
	100	100.0	125.9	158.5	164.1	199.5	251.2	316.2	398.1	501.2	631.0	794.3	1000.0

The RSGB Calculator

https://rsgb.org/main/technical/emc/emf-exposure/

https://rsgb.services/public/software/emccalculator/

https://rsgb.services/public/publications/emc/emf-calculator-v0.1.2-rsgb11d.xlsx

The RSGB Calculator

- Shares the same core calculation and limitations with OFCOM but
  - Adds antenna, feeder and average power calculations
  - Converts OFCOM distance to horizontal and vertical separations
  - Understands that antennas don't have the same gain downwards as outwards
  - Provides standard cable, antenna and transmission mode values
- Available as both
  - A web form and
  - An Excel spreadsheet
- Is designed to be printed and kept as a compliance record
- As it is based on the same maths as OFCOM it is also pessimistic at HF
  - More so as you go lower in frequency

RSGB Calculator Example – VHF Base 130W FM

Configurations | Backup | Save PDF | Interactive Info Buttons | Edit user details Iain Moffat G0OZS

Configuration name: G0OZS-VHF-QRO

Notes:
No uncontrolled public access within 5 metres at ground level.
Highest output power is RM LA-250 with 6W drive giving 130W out.
50% duty cycle for normal QSO operation - see separate report for GB2RS.
Calculated for FM as worst case - other modes have lower duty cycle.
Minimum mast height is 6m when in use.

Radio

Band	2m	
Mid-band frequency	145.5MHz	
Transmit mode	Voice FM	
Mode factor	100% (0dB)	
Transmitter power (W)	130	(21.1dBW)
Transmit % in 6 minutes	50	(-3dB)
Average power from transmitter	65W (18.1dBW)	
Peak power from transmitter	130W (21.1dBW)	

Feeder

Cable type	Ecoflex 10
Loss per 100m	-4.8dB
Cable length (m)	15
Feeder loss	-0.7dB
Second feeder losses (-dB)	0
Other losses (-dB)	0
Average power into antenna	55W (17.4dBW)
Peak power into antenna	110W (20.4dBW)

Antenna

Antenna type	5 Element Yagi	
Antenna gain	12.6 (11dBi)	
Mainlobe EIRP	692.3W (28.4dBW)	
Antenna polarization	Vertical	
Height of antenna (m)	5	
Directivity factor (-dB)	6	(-6dB)
Average EIRP	173.9W (22.4dBW)	
Peak EIRP	347.8W (25.4dBW)	

Key improvement Over OFCOM !

Further assessment required (average power >10W or peak power >100W EIRP)
Please use one of the methods below

Ofcom
ITU-T K.52 ICNIRP 1998 limits- Note: Calculator Limitations

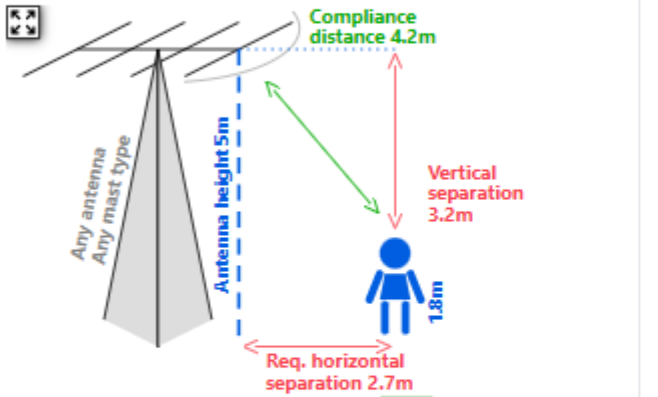
RSGB Calculator Example – Results

Further assessment required (average power >10W or peak power >100W EIRP)

Please use one of the methods below

Ofcom

ITU-T K.52 ICNIRP 1998 limits- Note: Calculator Limitations



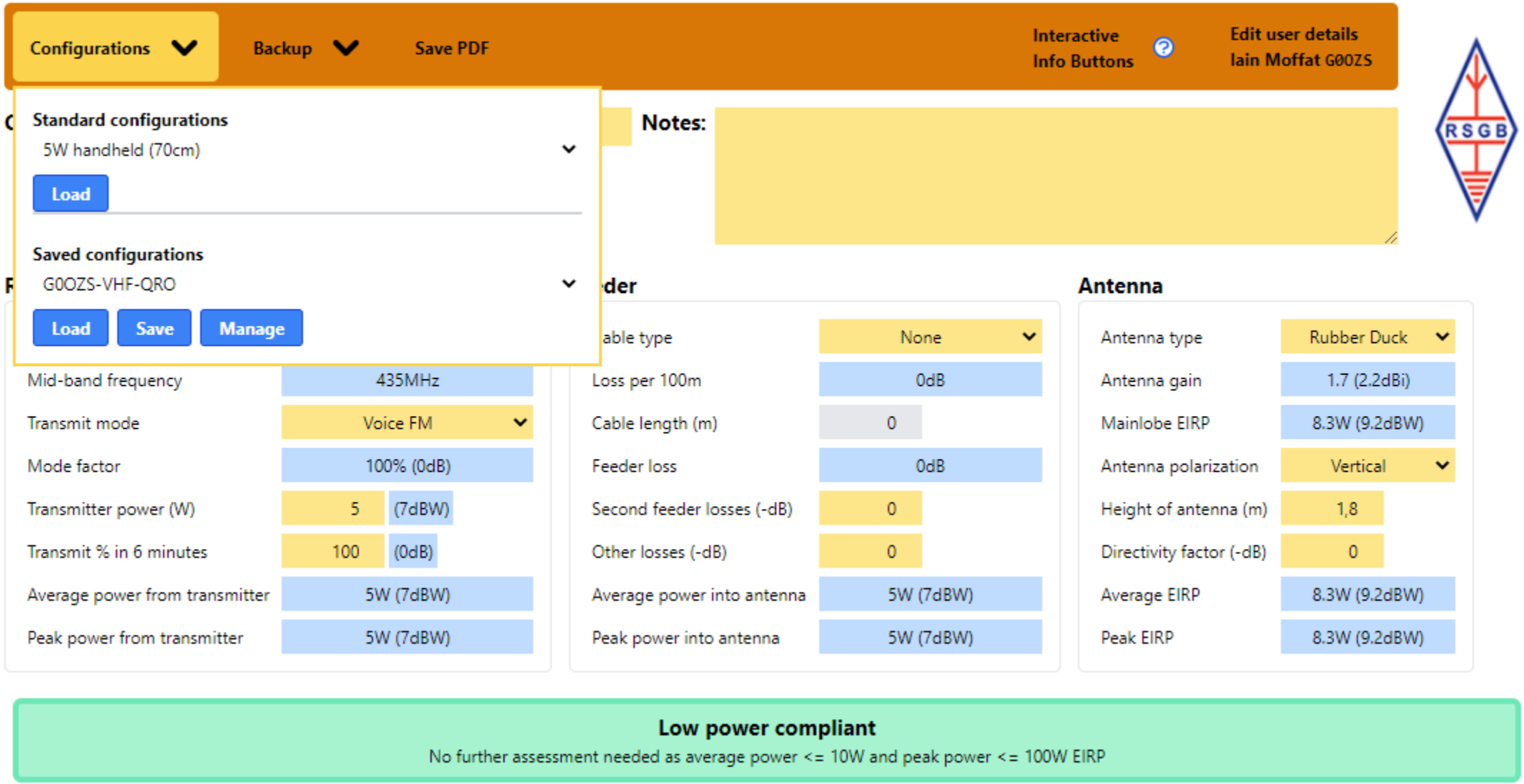
Ofcom compliance distance	**4.2m**
Vertical separation	3.2m
Required horizontal separation	2.7m
Reactive near field zone	0.3m

By Oli Sturm MM0YOS, based on work by Ofcom, John Rogers M0JAV, Peter Zollman G4DSE and Ian White GM3SEK

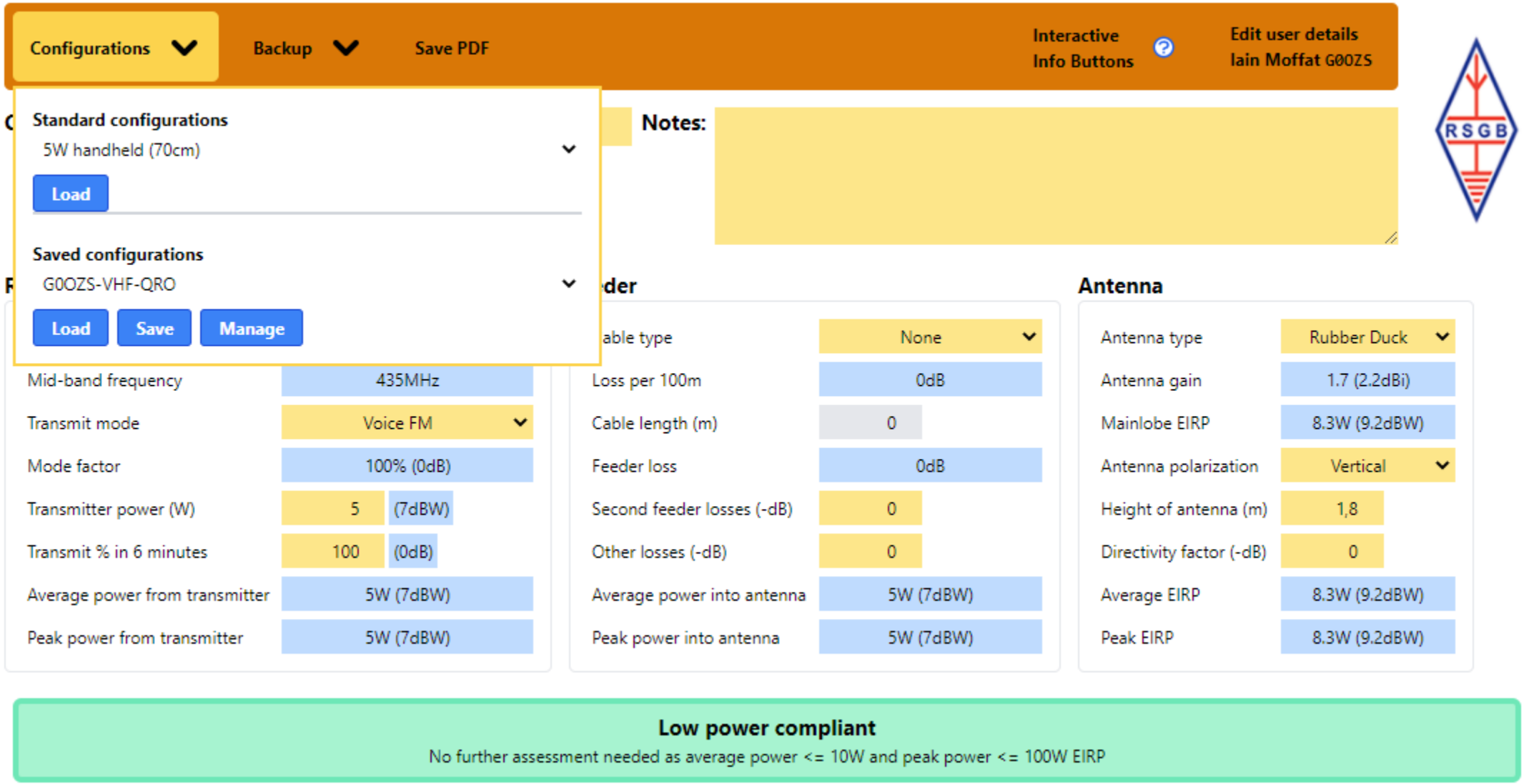
Version 1.0.19-beta2-11d

Legal notes

RSGB Calculator Built In – UHF Handheld 5W FM



RSGB Calculator Built In – UHF Handheld 5W FM



RSGB Calculator – VHF Mobile

Radio

Band	2m
Mid-band frequency	145.5MHz
Transmit mode	Voice FM
Mode factor	100% (0dB)
Transmitter power (W)	45 (16.5dBW)
Transmit % in 6 minutes	50 (-3dB)
Average power from transmitter	22.5W (13.5dBW)
Peak power from transmitter	45W (16.5dBW)

Feeder

Cable type	RG58A
Loss per 100m	-18.1dB
Cable length (m)	5
Feeder loss	-0.9dB
Second feeder losses (-dB)	0
Other losses (-dB)	0
Average power into antenna	18.3W (12.6dBW)
Peak power into antenna	36.5W (15.6dBW)

Antenna

Antenna type	Custom
Custom gain (dBi)	2,4 (1.74)
Mainlobe EIRP	31.7W (15dBW)
Antenna polarization	Vertical
Height of antenna (m)	1,6
Directivity factor (-dB)	0
Average EIRP	31.7W (15dBW)
Peak EIRP	63.5W (18dBW)

Further assessment required (average power >10W or peak power >100W EIRP)

Please use one of the methods below

Ofcom

ITU-T K.52 ICNIRP 1998 limits- Note: Calculator Limitations

Ofcom compliance distance	**1.8m**
Vertical separation	0m
Required horizontal separation	1.8m
Reactive near field zone	0.3m

RSGB Calculator – UHF Mobile

Radio

Band	70cm
Mid-band frequency	435MHz
Transmit mode	Voice FM
Mode factor	100% (0dB)
Transmitter power (W)	45 (16.5dBW)
Transmit % in 6 minutes	50 (-3dB)
Average power from transmitter	22.5W (13.5dBW)
Peak power from transmitter	45W (16.5dBW)

Feeder

Cable type	RG58A
Loss per 100m	-34.6dB
Cable length (m)	5
Feeder loss	-1.7dB
Second feeder losses (-dB)	0
Other losses (-dB)	0
Average power into antenna	15.1W (11.8dBW)
Peak power into antenna	30.2W (14.8dBW)

Antenna

Antenna type	Custom
Custom gain (dBi)	2,4 (1.74)
Mainlobe EIRP	26.3W (14.2dBW)
Antenna polarization	Vertical
Height of antenna (m)	1,6
Directivity factor (-dB)	0
Average EIRP	26.3W (14.2dBW)
Peak EIRP	52.5W (17.2dBW)

Further assessment required (average power >10W or peak power >100W EIRP)

Please use one of the methods below

Ofcom

ITU-T K.52 ICNIRP 1998 limits- Note: Calculator Limitations

Ofcom compliance distance	**1.6m**
Vertical separation	0m
Required horizontal separation	1.6m
Reactive near field zone	0.1m

RSGB Calculator – HF Intermediate SSB

Configurations | Backup | Save PDF | Info Buttons | Iain Moffat G0OZS

Configuration name: Intermediate SSB

Notes:

Radio

Band	20m	
Mid-band frequency	14.2MHz	
Transmit mode	SSB	
Mode factor	20% (-7dB)	
Transmitter power (W)	50	(17dBW)
Transmit % in 6 minutes	50	(-3dB)
Average power from transmitter	5W (7dBW)	
Peak power from transmitter	50W (17dBW)	

Feeder

Cable type	RG213
Loss per 100m	-2.4dB
Cable length (m)	15
Feeder loss	-0.4dB
Second feeder losses (-dB)	0
Other losses (-dB)	0
Average power into antenna	4.6W (6.6dBW)
Peak power into antenna	45.9W (16.6dBW)

Antenna

Antenna type	Half wave dipole
Antenna gain	1.6 (2.2dBi)
Mainlobe EIRP	7.5W (8.8dBW)
Antenna polarization	Horizontal
Height of antenna (m)	6
Directivity factor (-dB)	0
Average EIRP	7.5W (8.8dBW)
Peak EIRP	75.4W (18.8dBW)

Low power compliant

No further assessment needed as average power <= 10W and peak power <= 100W EIRP

RSGB Calculator – HF Intermediate SSB Processed

Radio

Band	20m
Mid-band frequency	14.2MHz
Transmit mode	SSB Processed
Mode factor	50% (-3dB)
Transmitter power (W)	50 (17dBW)
Transmit % in 6 minutes	50 (-3dB)
Average power from transmitter	12.5W (11dBW)
Peak power from transmitter	50W (17dBW)

Feeder

Cable type	RG213
Loss per 100m	-2.4dB
Cable length (m)	15
Feeder loss	-0.4dB
Second feeder losses (-dB)	0
Other losses (-dB)	0
Average power into antenna	11.5W (10.6dBW)
Peak power into antenna	45.9W (16.6dBW)

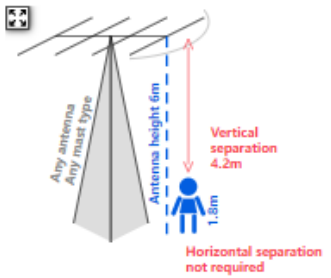
Antenna

Antenna type	Half wave dipole
Antenna gain	1.6 (2.2dBi)
Mainlobe EIRP	18.8W (12.8dBW)
Antenna polarization	Horizontal
Height of antenna (m)	6
Directivity factor (-dB)	0
Average EIRP	18.8W (12.8dBW)
Peak EIRP	75.4W (18.8dBW)

Further assessment required (average power >10W or peak power >100W EIRP)
Please use one of the methods below

Ofcom

ITU-T K.52 ICNIRP 1998 limits- Note: Calculator Limitations



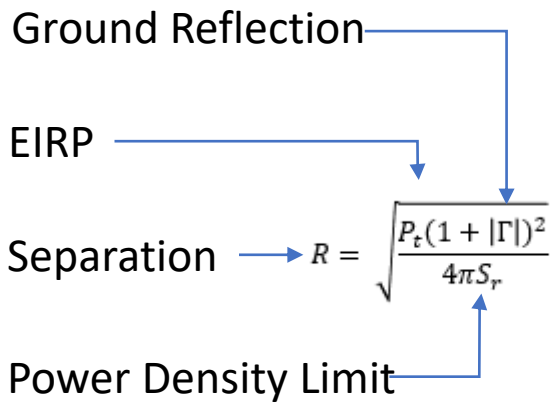
Ofcom compliance distance	**3.4m**
Vertical separation	4.2m
Required horizontal separation	0m
Reactive near field zone	3.4m

$$\text{Same} = \frac{\lambda}{2\pi}$$

Advanced Tools for HF and QRO

Limitations of simple calculators

- OFCOM, RSGB and IARU R1 ICNIRPCALC use a simple formula



  - This treats the antenna as a point source
  - It is not valid in the inner “reactive” near field zone close to the antenna – OFCOM use $\lambda /2\pi$ or approximately 1/6 wavelength for this.
  - They tell you the reactive near field distance if it is greater than the formula result
  - If the safety distance is less than the near field distance then other methods must be used to map the fields inside this zone

OFCOM acceptable alternatives

OFCOM recognise the limits of their calculator and in section 6.24 of https://www.ofcom.org.uk/__data/assets/pdf_file/0025/214459/guidance-emf-compliance-enforcement.pdf they list the following methods of assessment (summarised to fit the slide)

a) Manufacturer's Instructions
b) OFCOM's EMF Calculator
c) Other EMF calculators that **the user** is confident produce sufficiently accurate results
d) Measurements done in accordance with **methods in OFCOM's list of recognised standards**
e) Pre-assessed configurations provided by OFCOM **or developed and shared by reputable organisations** such as for example the RSGB
f) Instructions from a third party expert (such as a radiocommunications industry professional) **who has the technical expertise to ensure** that the equipment is installed and operated in compliance with the General Public EMF limits

Electromagnetic Modelling Software

Produces a map of near field strength in 3 dimensions

Can model nearby objects as well as the antenna

Can model interactions between antennas

Electromagnetic models can be used by

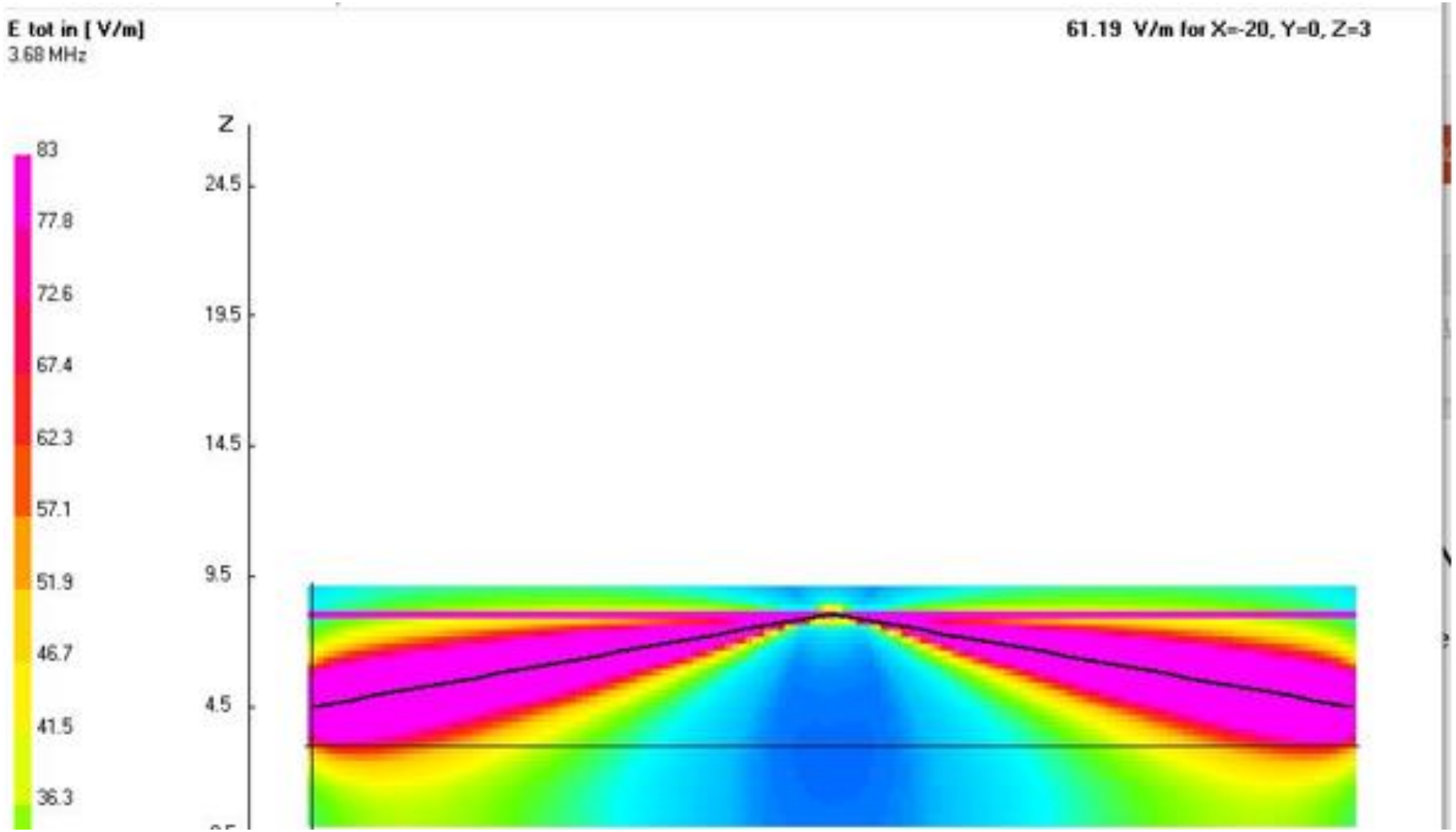
- Looking at pre-calculated models such as the RSGB PAC or the ARRL book
- Running the software yourself

NEC2 the Numerical Electromagnetics Code

- is the “gold standard” of free electromagnetic modelling software
- NEC was developed by Lawrence Livermore National Laboratory in the USA
- It has been around for over 40 years
- Many “user friendly” derivatives and work-alikes exist
- NEC4 is paid and much better especially at modelling real ground

The RSGB PACs and the ARRL book are based on NEC calculations

NEC model of inverted-V dipole E-Field

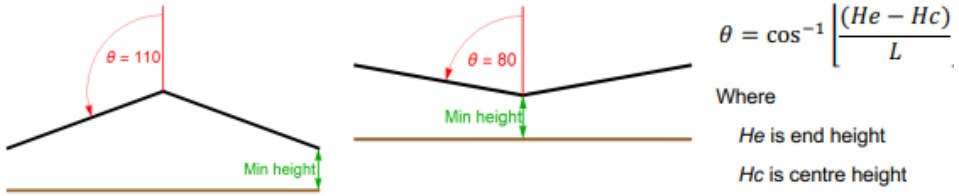


RSGB Pre Assessed Configurations

http://rsgb.org/main/files/2021/04/PAC-1-HW-Dipole-160to40m-v1.0.pdf

https://rsgb.services/public/publications/emc/PAEC-2_VHF-UHF_Beams_V1p0_2021-09-22.pdf

RSGB Pre-Assessed Dipoles



$$\theta = \cos^{-1}\left[\frac{(He - Hc)}{L}\right]$$

Where

He is end height

Hc is centre height

L is length of one leg

Figure 1 – Defining the V angle *θ* and minimum height

Table 2 – Minimum height for pre-assessed configuration cases

Configuration Description			Transmit power	Minimum height AGL for radiating structure			
#	Ground	V angle		160m	80m	60m	40m
1	Any excluding Sea	Any		160m	80m	60m	40m
			<= 10 W	2.3m	2.3m	2.3m	2.3m
			<= 50 W	3.2m	3.0m	2.9m	2.8m
			<= 100 W	3.7m	3.6m	3.4m	3.3m
			<= 400 W	6.4m	5.3m	N/A	4.3m
2	Any excluding Sea, Rich Soil	Any		160m	80m	60m	40m
			<= 10 W	2.2m	2.2m	2.2m	2.2m
			<= 50 W	2.7m	2.6m	2.6m	2.6m
			<= 100 W	3.1m	3.0m	3.0m	2.9m
			<= 400 W	4.8m	4.4m	N/A	4.0m

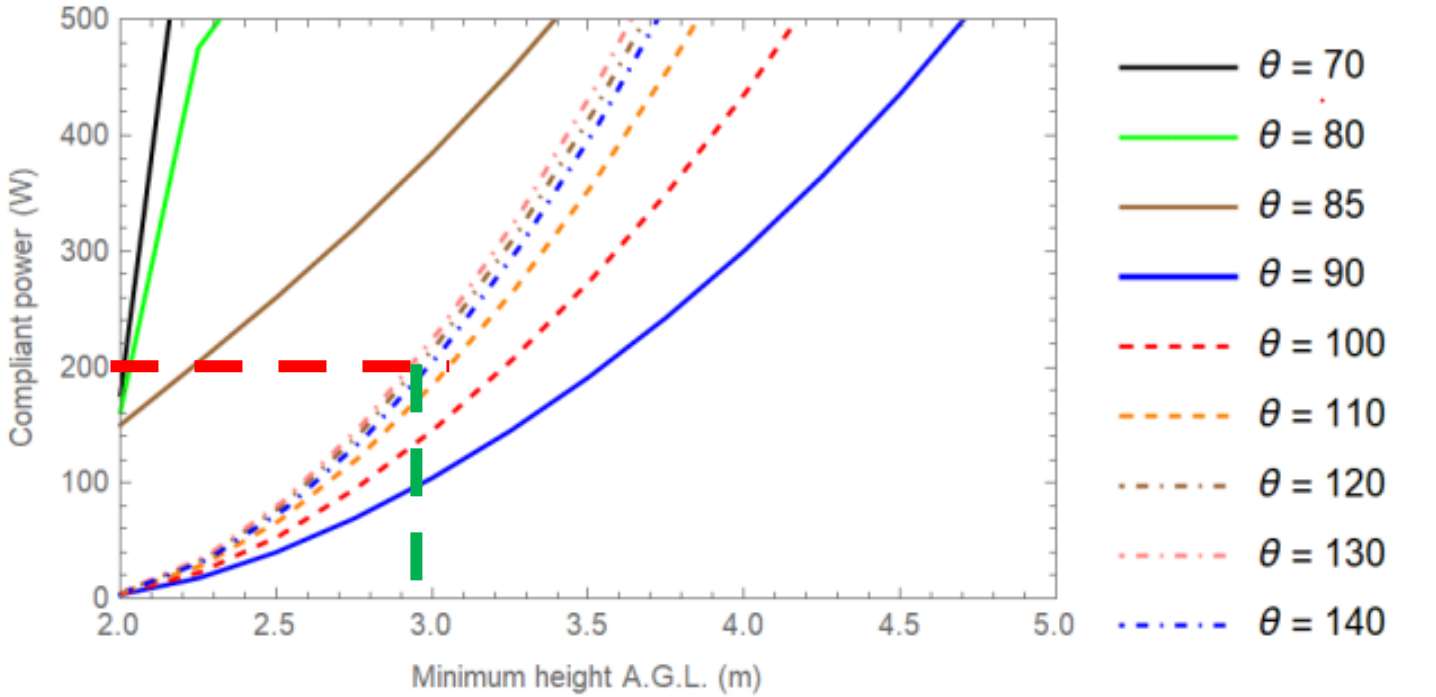
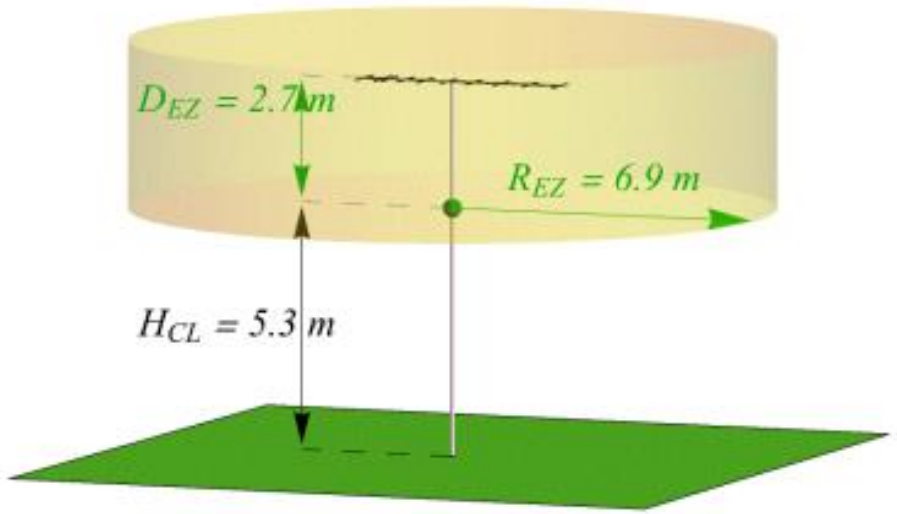


Figure C.2: Compliant power v minimum height for different V angle *θ* deg for 80m half-wave dipole antenna – "Clay ground"

1. Read across from power level to curve for your ground type
2. Minimum height is below where power level crosses curve

RSGB Pre-Assessed VHF/UHF Beams



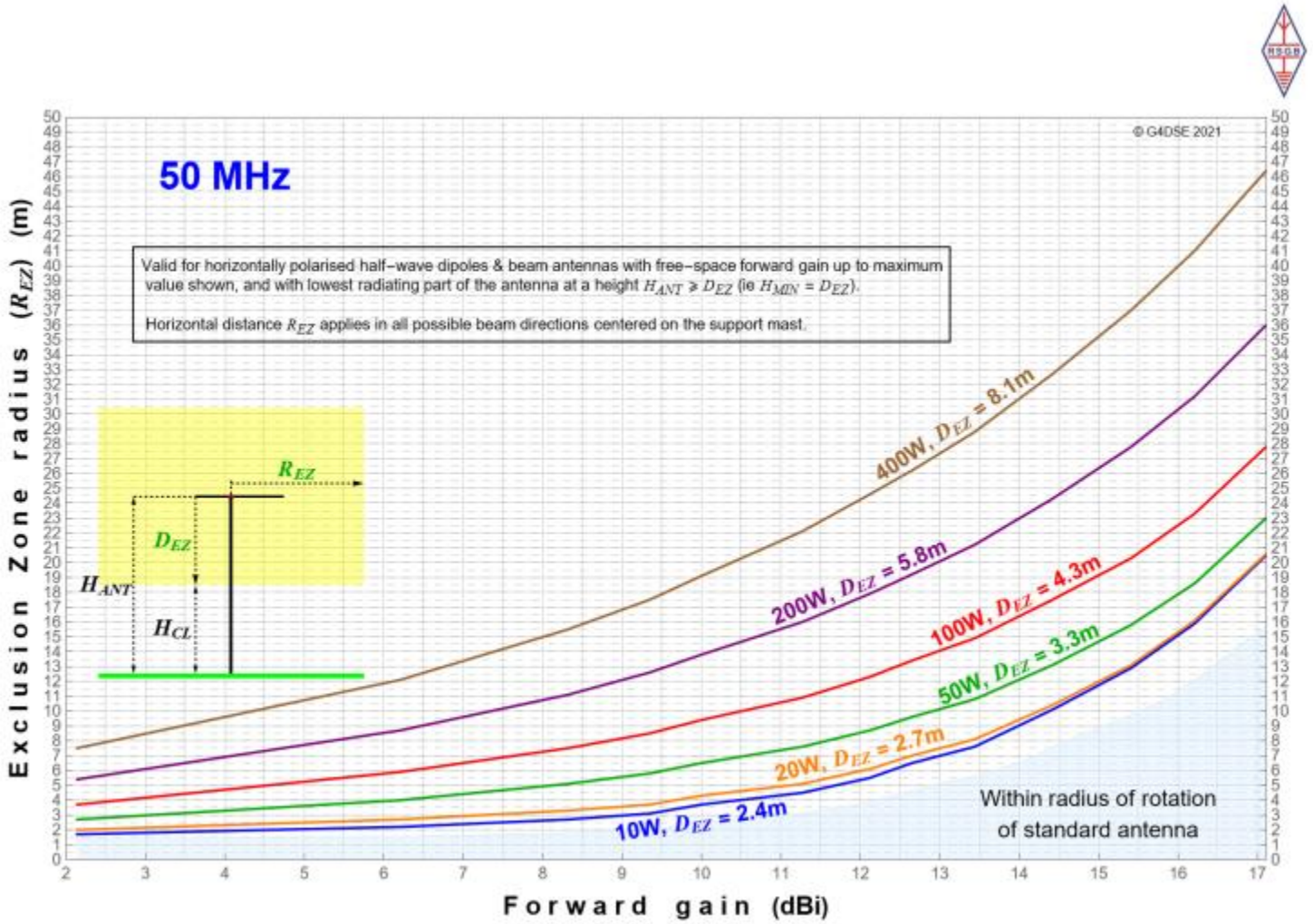


Figure 3A–Exclusion Zone for antennas mounted higher than $H_{MIN} = D_{EZ}$ (50 MHz)

The ARRL Book

http://www.arrl.org/files/file/Technology/RFsafetyCommittee/RF%20Exposure%20and%20You.pdf

The ARRL Book

Titled “RF Exposure and You” by Ed Hare W1RFI

Based on ICNIRP 1998 and published in 2003

Calculated using software from Lawrence Livermore National Laboratory

“Uncontrolled” is equivalent to OFCOM’s “general public” limit

Chapter 8 contains tables of safe distance for common antennas

- Verticals
- Dipoles and G5RV/Windom
- Yagis
- Long Wires
- Dimensions are in feet (1 metre = 3.25 feet)
- Download at: http://www.arrl.org/files/file/Technology/RFsafetyCommittee/RF%20Exposure%20and%20You.pdf

Example Table

40-meter band horizontal, half-wave dipole, Frequency = 7.3 MHz, Height above ground = 20 feet

Horizontal distance (feet) from any part of the antenna for compliance with occupational/controlled or general population/uncontrolled exposure limits*

Power**	Height above ground (feet) where exposure occurs							
	6 feet		12 feet		20 feet		30 feet	
(watts)	con.	unc.	con.	unc.	con.	unc.	con.	unc.
10	0	0	0	0	.5	1	0	0
25	0	0	0	0	1	1.5	0	0
50	0	0	0	0	1	2	0	0
100	0	0	0	0	1.5	2.5	0	0
200	0	0	0	0	2	3.5	0	0
250	0	0	0	0	2	4	0	0
300	0	0	0	0	2	4	0	0
400	0	0	0	0	2.5	5	0	0
500	0	0	0	0	3	5.5	0	0
600	0	0	0	0	3	6	0	0
750	0	0	0	0	3.5	6.5	0	0
1000	0	0	0	1.5	3.5	7.5	0	0
1250	0	0	0	4.5	4	8	0	0
1500	0	0	0	6	4	9	0	0

This means the public can walk under any part of this antenna

30-meter band horizontal, half-wave dipole, Frequency = 10.15 MHz, Height above ground = 10 feet

Note a Zero clearance distance means no clearance required at that height above ground

How to improve EMF compliance?

There are alternatives to technical compliance

If the most accurate calculations still show that the general public could access locations where the EMF field levels exceed the ICNIRP limits you may be able to modify your station or operating habits to address the issue.

It is not necessary to stop operating !

What can I do to improve ICNIRP Compliance

Reduce the power required to establish communication

- Use modes that need less power (e.g. FT8)
- Limit transmit/receive ratio (set a Time out)

Modify the Antenna

- Use a taller mast (which makes up for reduced power !)
- Prevent a beam antenna from pointing at public areas
- Use a higher gain antenna to reduce downward radiation

Operate when the “public” are not there

- Wait until the family are out
- Use CCTV or motion sensors to alert you when someone is in the exclusion zone

Put up warning signs or barriers

Effect of raising the antenna

The inverse square law applies to separation distance in far field

- A large increase in power requires a smaller increase in separation
- Conversely a small increase in separation allows much more power
- The easiest way to increase separation is upwards
- 5 metres is enough for any reasonable portable VHF setup used for RAYNET etc
- It is easy to construct simple unguyed masts to get a VHF antenna 5m high

Antennas have gain in the vertical plane

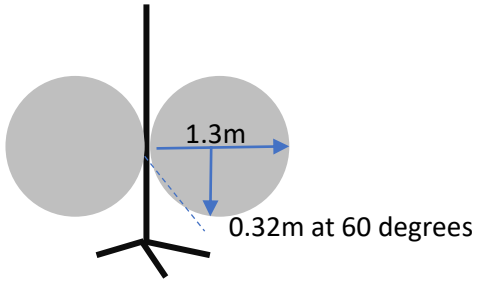
- So raising the main beam above head height helps
- OFCOM only give separation in the direction of maximum antenna gain
- Use the RSGB calculator and look up the directivity factor in antenna books or makers data

Higher antennas give longer range

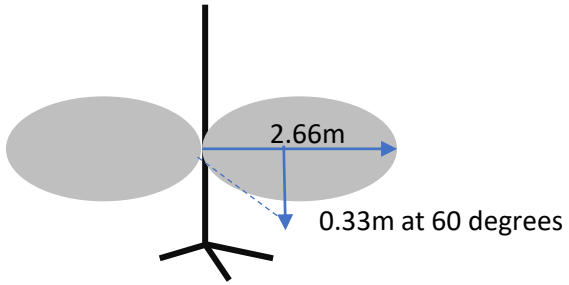
- This offsets the effect of reduced power so is a win/win

Avoiding pointing antennas at the public

- Directional antennas need more separation in direction of max gain
- Less separation is needed in other directions
  - OFCOM only give separation in maximum gain direction
  - RSGB PAEC 2 covers beam antennas in detail
- Take account of vertical radiation pattern for omnidirectional antennas
  - High Gain vertically polarised antennas have flat patterns
  - This can considerably reduce separation or height required
  - The RSGB calculator needs you to find the correction for your antenna yourself
  - IARU R1 IcnirpCalc.exe has pattern data for many commercial antennas
    http://www.iaru-r1.org/wp-content/uploads/2019/08/icnirp.zip



Diamond X30 (3dBi on 2m)
100 W FM



Diamond X700H (9.3dBi on 2m)
100 W FM

Non Technical Solutions

Operate high power only when family are out and door is locked

- This is particularly relevant to loft antennas

Use fences and gates with locks or alarms to exclude or warn of people

- This is applicable to larger gardens accessible to young people

Operate /p when you can see public approaching and stop transmitting

- This is applicable to SOTA and similar open outdoor sites
- Many RAYNET events may also be covered

Park where people cant get near you safely due to traffic or vegetation

Use signs to discourage long exposure of passing pedestrians

- This is applicable to “static mobile” use

The MoD Approach

Do not loiter within 2m of any antenna

THE END

ICNIRP 2020 table 6 – reference levels

Table 6. Reference levels for local exposure, averaged over 6 min, to electromagnetic fields from 100 kHz to 300 GHz (unperturbed rms values).[a]

Exposure scenario	Frequency range	Incident E-field strength; E_{inc} (V m^{-1})	Incident H-field strength; H_{inc} (A m^{-1})	Incident power density; S_{inc} (W m^{-2})
Occupational	0.1 – 30 MHz	$1504/f_M^{0.7}$	$10.8/f_M$	NA
	>30 – 400 MHz	139	0.36	50
	>400 – 2000 MHz	$10.58f_M^{0.43}$	$0.0274f_M^{0.43}$	$0.29f_M^{0.86}$
	>2 – 6 GHz	NA	NA	200
	>6 – <300 GHz	NA	NA	$275/f_G^{0.177}$
	300 GHz	NA	NA	100
General public	0.1 – 30 MHz	$671/f_M^{0.7}$	$4.9/f_M$	NA
	>30 – 400 MHz	62	0.163	10
	>400 – 2000 MHz	$4.72f_M^{0.43}$	$0.0123f_M^{0.43}$	$0.058f_M^{0.86}$
	>2 – 6 GHz	NA	NA	40
	>6 – 300 GHz	NA	NA	$55/f_G^{0.177}$
	300 GHz	NA	NA	20

[a] Note:

4. For frequencies of 100 kHz to 30 MHz, regardless of the far-field/near-field zone distinctions, compliance is demonstrated if neither E_{inc} or H_{inc} exceeds the above reference level values.

5. For frequencies of >30 MHz to 2 GHz: (a) within the far-field zone: compliance is demonstrated if either S_{inc}, E_{inc} or H_{inc}, does not exceed the above reference level values (only one is required); S_{eq} may be substituted for S_{inc}; (b) within the radiative near-field zone, compliance is demonstrated if either S_{inc}, or both E_{inc} and H_{inc}, does not exceed the above reference level values; and (c) within the reactive near-field zone: compliance is demonstrated if both E_{inc} and H_{inc} do not exceed the above reference level values; S_{inc} cannot be used to demonstrate compliance, and so basic restrictions must be assessed.

NOTE: Table 5 gives 30 minute VHF/UHF levels at 44% of 6 minute levels which apply to GB2RS readers and repeaters !

ICNIRP 2020 E-Field limits below 10MHz

Table 8. Reference levels for local exposure to electromagnetic fields from 100 kHz to 10 MHz (unperturbed rms values), for peak values.[a]

Exposure scenario	Frequency range	Incident E-field strength; E_{inc} (V m^{-1})	Incident H-field strength; H_{inc} (A m^{-1})
Occupational	100 kHz – 10 MHz	170	80
General public	100 kHz – 10 MHz	83	21

[a]Note:

1. Regardless of the far-field/near-field zone distinction, compliance is demonstrated if neither peak spatial E_{inc} or peak spatial H_{inc}, over the projected whole-body space, exceeds the above reference level values.

In general Table 6 gives lower H-Field and higher E-Field limits below 10MHz than Table 8 so lower HF bands E-Field limit is 83V/m but H must be calculated