ICOM-UK

EMF Compliance for the General Public

Based on ICNIRP1998 Power Density Exposure Levels

Marine MF/HF Fixed Installation On Vessels
10MHz to 30MHz

Frequencies between 1.6MHz to 10MHz are not covered in this document
The document will be updated when guidance is available.

EMF Compliance Dates

18th May 2022 for frequencies between 10MHz and 30MHz

18th November 2022 for frequencies below 10MHz

Marine VHF/UHF Fixed Installations On Vessels
156MHz to 163MHz
457MHz to 467MHz – Onboard Communications

EMF Compliance Dates

18th November 2021

Contents

EMF Compliance

ICNIRP 1998 Power density limit for the General Public is 2W/m^2 measured over a six-minute period. (10MHz ~ 400MHz) For frequencies greater than 400MHz the Power Density Limit for the General Public increases up to a maximum of 10W/m^2 > 2000MHz (2GHz) to 300000MHz(300GHz)

Power Density Limit W/m^2 is calculated from the formula *frequency(MHz)/200* between 400MHz and 2000MHz

Table 7 of ICNIRP 1998 Guidelines available from here ICNIRPemfgdl.pdf

If the maximum power output or averaged power output is greater than 10W EIRP or 6.1W ERP in a six-minute time period an EMF compliance check is required.

Ofcom have made available a downloadable spreadsheet EMF calculator v1.0 that will calculate the compliance distance from the centre of the antenna.

The calculator does **not** account for the following which may reduce the compliance distance of the installation.

- Feeder loss in the system that can affect the EIRP / ERP value.
- SSB average PEP

The above can be calculated separately and adjustments made to the figures that are input into the EMF calculator available to download from here EMF calculator - Ofcom

It is important that when using the EMF Calculator that you use EIRP and dBi together or ERP and dBd together.

When the equipment is used in an **Emergency situation** then the EMF compliance does not apply.

See Schedule 4 section 4 of the Terms, Conditions and Limitation "Ship Radio Licence and Ship Portable Licence"

Further information on **Emergency situations** is set out in Ofcom's "Guidance on EMF Compliance and Enforcement" Section 13. Available from this page link www.ofcom.org.uk/manage-your-licence/emf/compliance-and-enforcement-guidance

Latest documents related to EMF Compliance are also available from the link above.

Refer to the Terms, Conditions and Limitation "Ship Radio Licence and Ship Portable Licence" publication dated 18th May 2021.

Available from here Ship Radio licence and Ship Portable Radio Licence (ofcom.org.uk)

A record of the installation the EMF calculations carried out and mitigation methods used for EMF compliance should be included in a document and be available for inspection by Ofcom.

General Public Definition

As stated in the Terms, Conditions and Limitation "Ship Radio Licence and Ship Portable Licence" publication dated 18th May 2021.

"**General Public**" means any person who is not: (a) the Licensee, owner, operator or installer of the Relevant Radio Equipment; or (b) acting under a contract of employment or otherwise acting for purposes connected with their trade, business or profession or the performance by them of a public function.

Marine MF/HF Transmissions

Marine MF/HF radios operate between 1.6000MHz ~ 27.500MHz

Frequency Bands used.

2MHz
4MHz
6MHz
8MHz
12MHz
16MHz
18MHz
22MHz
25MHz

EMF calculations will only consider the following frequency bands

12MHz
16MHz
18MHz
22MHz
25MHz

Icom Marine Fixed/Mounted MF/HF Transceivers

Icom Marine MF/HF radios have Peak Envelope Power (PEP) of 150W.

When fitted with ATU the output is

125W PEP between 4.000MHz to 27.500MHz ATU insertion loss 0.8dB

85W PEP between 1.600MHz to 3.9999MHz ATU insertion loss 2.47dB

Transmit power output of the radio will exceed the transmit power threshold of 10W EIRP or 6.1W ERP for the modes of transmission except for SSB subject to transmit time and therefore the installation may be required to meet EMF compliance distances for the General Public.

The installation guide of the radio should also be consulted.

Calculating the EMF compliance distance

EIRP (Equivalent Isotropic Radiated Power) Definition

Means equivalent isotropically radiated power which is the product of the power supplied to an antenna and the absolute or isotropic antenna gain in a given direction relative to an isotropic antenna.

ERP (Estimated Radiated Power) Definition

Is the product of the TX power applied to the antenna and its gain in a given direction relative to a half-wave dipole (dBd).

Before entering any values into the Ofcom EMF Calculator, it requires the following parameters.

- Transmitting EIRP
- Frequency

EIRP (Watts) can be calculated by using the EMF Calculator 'Power Calculator Tool'

Enter the TX Power (Watts)

Antenna Gain selectable in dBi or dBd

Coaxial Feeder Loss

The coaxial lead between the radio and the ATU will introduce some attenuation. Coaxial manufacturers publish this information for a given frequency and unit length and will be given in dB/unit length. Manufacturers may provide a graphical representation of the attenuation figures over the operating frequency range of the cable so results of other frequencies can be obtained other than those spot frequencies provided. The attenuation curve will be exponential in nature. As frequency increases the higher the loss per unit length.

Table 1 Loss of RG213U

Frequency (MHz)	dB/100feet	dB/100m	dB/10m
1	0.17	0.55	0.055
10	0.55	1.8	0.18
50	1.3	4.26	0.426
100	1.9	6.23	0.623
200	2.7	8.85	0.885
400	4.1	13.45	1.345
700	6.5	21.32	2.132

For the MF/HF frequencies in use, losses are minimal and can be taken as 0dB unless a very long length of feeder is placed between the transmitter and ATU.

VHF and UHF frequencies cable losses are higher and should be included for EMF compliance. Consult coaxial cable manufacturer specifications of the coaxial cable for losses. Loss figures may vary between manufacturers.

When taking coaxial cable losses into account the power delivered to either the ATU or Antenna will be reduced. The Ofcom EMF Calculator does not take account for these losses and must be calculated separately for the transmit power that is to be entered into the EMF Calculator.

Coaxial Loss Example

The use of a scientific calculator is required.

Transmit power of 150WPEP and a coaxial cable of 100metres and represents a loss of 1.8dB @10MHz which is approximately mid-band of the operating frequencies used.

150WattsPEP convert to dBPEP

$10 \times (\log_{10}PEP)$

$10 \times (\log_{10}150)$

10 x 2.176 = **21.76dBPEP**

$dBPEP - \text{Cable loss} = dBPEP_{\text{including loss}}$

21.76dBPEP – 1.8dB= **19.96dBPEP** $_{\text{including loss}}$

$dBPEP_{\text{including loss}}$ must now be converted back to Watts

$10^{(dBPEPincluding\ loss\ /10)}$

$=10^{(19.96/10)}$

$=10^{(1.996)}$

99.10WattsPEP

The above cable loss calculations also apply to Marine VHF and UHF scenarios but the coaxial loss will be greater as can be seen from the Table 1.

MF/HF Antenna

Marine MF/HF vertical antennas are generally shorter than one wavelength across the operating range.

Procom HF5000 has an equivalent electrical length of 4.4metres

Procom HF7500-3 has an equivalent length of 7.2metres

The recommended ATU for the radio will be able to match the Procom antenna to the transmitter for the given frequency of operation. Both antennas will become less efficient towards the lower operating frequencies.

Antenna gain will vary across the frequency of operation and type of installation. Gain can be as high as 4 to 5dBi for frequencies above 20MHz to around 0dBi for HF5000 @ 10MHz and 0dBi @ 6.4MHz for the HF7500-3. Antenna gain reduces significantly below these frequencies -18dBi @ 1.6MHz for HF5000 and -15dBi for HF7500-3.

Backstay or Random Long Wire antenna should be between 7metres and 15metres in length. This should allow the ATU to tune across the operating frequencies of the transceiver. (1.6MHz to 30MHz). Antenna Gain will vary across the frequency of operation and type of installation and may vary from the Procom Vertical antennas.

Example calculations for EMF compliance the antenna gain has been given a value of **0dBi** equivalent to **-2.15dBd.**

EMF MF/HF Example Calculations

PEP is taken from the output of the ATU so includes internal losses of the ATU. In this case maximum PEP is 125W between 4.0MHz ~ 27.500MHz and 85W between 1.6 ~ 3.9999MHz. The latter not covered in this document.

PEP as 125W the results are as follows

Example 1

Vessel installation consists of the following: -

Marine MF/HF transceiver high power @ 125Watts (PEP)

Transmit mode is F1B(FSK) or J2B(AFSK) both data modes and transmits for 6 minutes.

Highest transmitter PEP Modes are F1B(FSK) and J2B(AFSK).

The highest PEP modes are used for this calculation as it is worst case.

Operating Frequency is between 12MHz and 25MHz

Antenna Gain 0dBi

Coaxial feeder loss 0dB unless extremely long feeder run has been installed.

EIRP= **125W** *This figure to be used in the Ofcom EMF calculator*

Enter the Maximum Transmitter ON time in 6 min period in the Ofcom EMF calculator. In this example 6 should be entered.

The operating frequency should also be entered. As the frequency can be anywhere between 12 MHz and 25MHz two calculations should be made at those frequencies.

Compliance distance @ 12MHz is **3.98metres.**

Compliance distance @ 25MHz is **3.57metres**

The greater distance should be taken as the EMF Compliance distance in this case **3.98metres** in all directions from the centre of the antenna.

Steps should be taken to ensure the General Public cannot get access to the antenna and must be greater than the compliance distance in any direction.

It is unlikely that the transmitter would ever transmit for 6 minutes in these modes.

Example 2

In this example all the parameters are the same as in Example 1 except for Maximum Time transmitting in this case the value should be changed to one minute in six minutes.

Compliance distance result will range from **3.98m for 12MHz** reducing to **1.91m for 25MHz** in all directions.

The greatest distance should be taken as the EMF compliance distance in this case **3.98m** in all directions from the antenna.

Steps should be taken to ensure that the General Public cannot access the antenna and must be greater than the EMF Compliance distance.

It should be noted that any Maximum Transmit Time value above zero will give the same EMF Compliance distance of **3.98metres for 125Watts PEP @12MHz.**

At **25MHz** the EMF Compliance distance varies between **1.91metres** at time >0 to 1.7minutes or 102seconds increasing to **3.57metres** @ 6minutes.

Example 3

Vessel uses SSB J3E(USB) as the **ONLY** mode of transmission.

Should this be the only used transmission mode used it should be recorded on the compliance record.

On an SSB transmission TX power is only present when modulation is present. TX power is proportional to the speech modulation applied. Higher the speech amplitude higher the PEP up to the maximum PEP. The average power of an SSB transmission is approximately 20% of full PEP.

SSB transmission transmitting for six minutes (*Worst Case)*

Operating Frequency is between 12MHz and 25MHz

Antenna Gain 0dBi

Coaxial feeder loss = 0dB unless extremely long feeder run has been installed.

To use the correct EIRP an additional manual calculation is required which is not available on the EMF calculator for an SSB transmission.

Take the EIRP value given in the Power Calculation Tool and multiply by 0.2.

EIRP = 125 x 0.2 = **25W** *This figure to be used in the Ofcom EMF calculator*

Compliance distance result will range from **3.98m @ 12MHz** reducing to **1.91m @ 25MHz** in all directions

The highest value compliance distance value should be taken as the EMF Compliance distance.

Steps should be taken to ensure that the General Public cannot access the antenna and must be greater than the EMF Compliance distance.

It is unlikely that the transmitter would ever transmit for 6 minutes for a voice transmission.

Example 4

In this example all the parameters are the same as in Example 3 except for Maximum Time transmitting in this case the value should be changed to one minute in six minutes.

The average EIRP is **4.17Watts** which is lower than the 10WEIRP threshold and the EMF Calculator reports ‘Low Power. No further assessment required’. It is EMF compliant.

If the maximum time for transmit exceeds 2.4minutes or 144 seconds in any six minutes at this EIRP it will not be compliant.

The EMF compliant distance then becomes **3.98metres @ 12MHz** and **1.91metres @ 25MHz.**

The highest value compliance distance value should be taken as the EMF Compliance distance.

Steps should be taken to ensure that the General Public cannot access the antenna and must be greater than the EMF Compliance distance.

Conclusions for MF/HF Installations

Data Modes F1B(FSK) and J2B(AFSK)

The EMF Compliance distance required to satisfy EMF for a Marine MF/HF installation with a PEP of **125W** in transmit mode F1B(FSK) and J2B(AFSK) between **12MHz** and **25MHz** and transmitting for six minutes in any six minute period worst case is **3.98metres**.

This figure of **3.98metres** should also be used in the case of Maximum Transmit Time the as the EMF Compliance distance @ **12MHz** is the same for time >0 to 6 minutes.

SSB Mode (J3E)

For SSB transmissions where time is considered and is less than 2.4minutes or 144seconds in any six minute period then the installation will be EMF compliant. Where time is greater than 2.4minutes or 144seconds of transmit in any six minute period, the average EIRP becomes greater than 10W EIRP and further action is required to become EMF Compliant.

The EMF Compliance distance becomes **3.98metres.**

MF/HF SSB is the only transmission mode that can achieve a 'Low power. No Further assessment required' subject to the time restraint otherwise the EMF Compliance distance is 3.98metres with a 0dBi antenna.

If the antenna gain is 5dBi then time must be reduced to ~0.76minutes or ~45seconds to achieve a 'Low power. No further assessment required' result in the EMF Calculator.

If you have any doubts that the vessel installation may not be EMF compliant after carrying out the assessment via the EMF Calculator then a professional survey of the vessel should be carried out to ascertain EMF compliance.

Marine VHF and UHF Fixed Installations

VHF 156MHz to 163MHz

A vessel will normally have at least one fixed VHF transceiver operating between 156MHz and 163MHz. If more than one fixed transceiver is fitted and can be used simultaneously then the average power of the number of transceivers fitted should be considered. TX output of Icom Marine VHF fixed installation is 25Watts High Power and 1Watt Low power.

For installation guidance, use the Instruction Manual for antenna placement and type to be used.

AIS Class B Transponders

AIS Class B Transponders can be omitted in most cases as these devices use very short bursts of transmission and are of lower transmit power than Marine VHF voice transceivers.

The Icom MA-510TR for example has an output of 2W. For installation guidance use the Instruction Manual for antenna placement and type to be used.

VHF Handheld Equipment

VHF handheld equipment should be EMF Compliant as the transmit power is below 10W EIRP or 6.1W ERP threshold when used with the supplied manufactures antenna.

Third party antennas are not recommended and when used a check should be made to ensure the radiated power is below the 10W EIRP or 6.1W ERP threshold.

Marine VHF Antennas

Marine VHF antennas are smaller compared with MF/HF antennas.

Antenna Gain may be given in dBi or dBd by the manufacturer.

Common Antenna Gain on vessels will be either 0dBd(2.15dBi) or 3dBd(5.15dBi).

6dBd(8.15dBi) or higher antennas are not so common due to the physical size.

Coaxial Feeder Loss at VHF / UHF

The coaxial lead between the transceiver and the Antenna will introduce some attenuation. Attenuation figures are higher at VHF/UHF than MF/HF. Coaxial manufacturers publish this information for a given frequency and unit length and will be given in dB/unit length. Manufacturers may provide a graphical representation of the attenuation figures over the operating frequency range of the cable so results of other frequencies can be obtained other than those spot frequencies provided. The attenuation curve will be exponential in nature. As frequency increases the higher the loss per unit length.

See Table 1 for Losses of RG213U

VHF and UHF frequencies cable losses are higher and should be included for EMF compliance. Consult coaxial cable manufacturer specifications of the coaxial cable for losses. Loss figures may vary between manufacturers.

When taking coaxial cable losses into account the power delivered to the Antenna will be reduced. The Ofcom EMF Calculator does not take account for these losses and must be calculated separately for the transmit power that is to be entered into the EMF Calculator.

Coaxial Loss Example

The use of a scientific calculator is required.

Transmit 25WattsPEP and a coaxial cable of 100metres and represents a loss of around 7.5dB between 156MHz and 163MHz.

25WattsPEP convert to dBPEP

$10 \times (\log_{10}PEP)$

$10 \times (\log_{10}25)$

$10 \times 1.397 =$ **13.97dBPEP**

$dBPEP - \text{Cable loss} = dBPEP_{\text{including loss}}$

$13.97dBPEP - 7.5dB =$ **6.47dBPEP** $_{\text{including loss}}$

$dBPEP_{\text{including loss}}$ must now be converted back to Watts

$10^{(dBPEP\text{including loss} /10)}$

$=10^{(6.47/10)}$

$=10^{(0.647)}$

4.43WattsPEP

The result is the power applied to the antenna.

This revised power figure including cable loss should be used in the Power Calculator Tool together with the Antenna Gain figure. See examples below.

Example 1

If the Antenna Gain is 0dBi the EMF Power Tool Calculator will give a result of 4.43W EIRP.

As this result is less than 10W EIRP it results in a 'Low Power. No further assessment required'. It is EMF Compliant at worst case six minutes of transmit in six-minute period.

Example 2

If the Antenna Gain is 0dBd equivalent to 2.15dBi the Power Tool Calculator will give a result of 7.27W EIRP.

This result is also less than 10W EIRP and results in a 'Low Power. No further assessment required'. It is EMF Compliant at worst case six minutes of transmit in six-minute period.

Example 3

If the Antenna Gain is 3dBd equivalent to 5.15dBi the power Tool Calculator will give a result of 14.5W EIRP. The result is greater than 10W EIRP and therefore further action is required. Placing this result figure into the EMF Calculator results in a separation distance of 1.22metres for worst case six minutes transmit in six-minute period.

The General Public must at a distance greater than 1.22metres from the antenna in any direction to be EMF compliant.

Example 4

Based on *example 3* above the only change will be the time that the transmitter will be on in a six-minute period. Time is now one minute in six minutes. Entering '1' in the Maximum Transmission Time field results as a 'Low Power. No further assessment required' and is EMF compliant.

A Maximum Transmit Time below 4.14minutes will also result in a 'Low Power. No further assessment required' and is EMF compliant.

Example 5

In this example the coaxial cable will be 10metres between the transceiver and antenna of gain 0dBd [2.15dBi] a more realistic figure for a small to medium sized vessel, with a Maximum Transmission Time of one minute in a six-minute period.

From the coaxial attenuation table the coaxial loss is 0.75dB/10metres.

WattsPEP with Coaxial Loss

The use of a scientific calculator is required.

Transmit 25WattsPEP and a coaxial cable of 10metres and represents a loss of around 0.75dB between 156MHz and 163MHz.

25WattsPEP convert to dBPEP

$10 \times (\log_{10}PEP)$

$10 \times (\log_{10}25)$

10 x 1.397 = **13.97dBPEP**

$dBPEP - \text{Cable loss} = dBPEP_{\text{including loss}}$

13.97dBPEP – 0.75dB= **13.22dBPEP** $_{\text{including loss}}$

$dBPEP_{\text{including loss}}$ must now be converted back to Watts

$10^{(dBPEP\text{including loss} /10)}$

$=10^{(13.22/10)}$

$=10^{(1.322)}$

20.98WattsPEP

This revised figure including cable loss should be used in the Power Calculation Tool with the Antenna Gain figure of 2.15dBi. The result form the Power Calculation Tool should be placed in the EMF Calculator EIRP power field. In this example 34.42Watts.

The EMF calculator produces a ‘Low Power. No further assessment required’ and is EMF compliant.

If your Maximum Transmission Time is increased to above 1.74minutes or 104.4seconds in a six-minute period, further action would be required to be EMF compliant. Distance between the Antenna and General Public in any direction must be greater than the separation distance provided by the EMF Calculator which will range from 1.01metres for a Maximum Transmission Time of 1.75minutes to 1.87metres for 6 minutes.

457MHz to 467MHz – Onboard Communications

Ships Radio Licence where stipulated allows the use of UHF onboard communications. It can be simplex operation handheld to handheld or duplex operation where a repeater is installed to give greater coverage around the vessel. The repeater may radiate from a single antenna or from a distributed antenna system.

Radiated Transmit power for onboard UHF communications is limited to 3.28W EIRP equivalent to 2W ERP and is below the threshold for any action to be taken and should therefore be EMF Compliant. A check should be made to ensure this is the case for the installation.

Transmitter power output should be adjusted to compensate for coaxial losses and antenna gain to ensure the radiated power is below or equal to the limit of 3.28W EIRP / 2W ERP.

UHF Handheld Equipment

UHF handheld equipment should be EMF Compliant as the transmit power is below 10WEIRP or 6.1W ERP threshold when used with the supplied manufacturers antenna. Handheld antennas are not efficient and can reduce the power radiated from the antenna by more than half.

Third party antennas are not recommended and when used a check should be made to ensure the radiated power is below the 10W EIRP or 6.1W ERP threshold.

Conclusions for VHF and UHF Installations

In most vessel installations, it should be possible to be EMF compliant for General Public without any further assessment provided that a common-sense approach has been taken and manufacturer installation guidelines have been followed for the transceiver.

Where high gain antennas have been fitted equal to or greater than 3dBd, and be low mounted with short coaxial cable fitted, further action will be required to ensure the General Public are protected, particularly where high Maximum Transmission Times could exist.

Below are the worst-case compliance distances required for 0dBd, 3dBd, 6dBd antenna’s

Worst Case VHF with 0dBd Antenna and negligible Coaxial Cable loss six-minute transmission in six-minute period.

TX Power (W)	EIRP (W)	ERP (W)	Compliance Separation Distance (m)
25	41.00	25.00	2.04

Worst Case VHF with 3dBd Antenna and negligible Coaxial Cable loss six-minute transmission in six-minute period.

TX Power (W)	EIRP (W)	ERP (W)	Compliance Separation Distance (m)
25	81.81	49.88	2.89

Worst Case VHF with 6dBd Antenna and negligible Coaxial Cable loss six-minute transmission in six-minute period.

TX Power (W)	EIRP (W)	ERP (W)	Compliance Separation Distance (m)
25	163.22	99.53	4.08

For UHF onboard communications these systems should always be EMF compliant if the correct EIRP / ERP are setup correctly. 3.28WattEIRP / 2Watts ERP

Reference Information

Antenna Gain

Antenna Gain can be given in dBi or dBd.

Where Antenna Gain is given in dBi the Gain is referenced to an Isotropic Antenna which radiates equally in all directions in free space.

Where Antenna Gain is given in dBd the Gain is referenced to a Half-Wave Dipole Antenna.

Antenna Gain specified as 2.15dBi is equal to a 0dBd Gain Antenna.

Example

Gain in dBi – 2.15 = dBd equivalent

Gain in dBd + 2.15 = dBi equivalent

Example

Antenna Gain 5.15dBi – 2.15 = 3dBd

Antenna Gain 3dBd + 2.15 = 5.15dBi

Antenna Gain Factor

Antenna Gain Factor can be calculated as a number and will be greater than zero. Gain Factor can be calculated from the formula. *10 raised to the power of (dBi/10)*

$$10^{(dBi/10)}$$

Antenna Gain of 0dBi the Antenna Gain Factor = 1

Antenna Gain of 2.15dBi[0dBd] the Antenna Gain Factor = 1.64

Antenna Gain of 3dBd[5.51dBi] the Antenna Gain Factor = 2

Antenna Gain dBi, dBd, Approximate Gain Factor Table

Gain dBi	Gain dBd	Approximate Gain Factor
2.15	0	1
5.15	3	2
7.15	5	3.16
8.15	6	4

Peak Envelope Power (PEP)

Peak Envelope Power is the root mean square (RMS) value of a single RF cycle at the crest of the modulation.

For Frequency Modulation (FM)F3E VHF/UHF and Frequency Shift Keying (FSK)(F1B) and Audio Frequency Shift Keying (AFSK) (J2B) the PEP is the full carrier power of the transmitter on MF/HF. Other modes of modulation such as CW(A1A) and SSB(J3E) have a lower average PEP.

SSB(J3E) will be approximately 20% of full PEP. Transmitter Power is only present when modulation is applied to the transmitter.

EIRP (Effective Isotropic Radiated Power)

EIRP measured in Watts can be calculated by the following formula

Transmitter Power Watts applied to the Antenna * Antenna Gain Factor

Or

Transmitter Power (dB) = 10 * (Log_{10}Transmitter Power Watts)

EIRP(dB) = Transmitter power (dB) + Antenna Gain (dBi)

EIRP(Watts) = $10^{(EIRP(dB)/10)}$ *10 raised to the power (EIRP(dB)/10)*

Example 6

Transmitter of 5Watts Antenna Gain 2.15dBi

Antenna Gain Factor = $10^{(2.15/10)}$ = 1.64

EIRP(Watts) = 5 x 1.64 = 8.2Watts *rounded to 1 decimal place*

Or

Transmitter Power (dB) = 10 * ($Log_{10}5$) = 6.98

EIRP(dB) = 6.98 + 2.15 = 8.98dB

EIRP(Watts) = $10^{(8.98/10)}$ = 8.2Watts *rounded to 1 decimal place*

ERP (Effective Radiated Power)

ERP is measured in Watts and is referenced to a Half-Wave Dipole Antenna.

ERP is calculated from the be following formula

Transmitter Power Watts applied to the Antenna * Antenna Gain Factor

Or

Transmitter Power dB = 10* (Log_{10} Transmitter Power Watts)

ERP(dB) = Transmitter Power (dB) + Antenna Gain (dBd)

ERP(Watts) = $10^{(ERP(dB)/10)}$ *10 raised to the power (ERP(dB)/10*

Example 7

Transmitter of 5Watts Antenna Gain 3dBd[5.15dBi]

Antenna Gain Factor = $10^{(3/10)}$ = 2 *rounded*

ERP(Watts) = 5 x 2= 10Watts *rounded to 1 decimal place*

Or

Transmitter Power (dB) = 10 * ($Log_{10}5$) = 6.98

ERP(dB) = 6.98 + 3 = 9.98dB

ERP(Watts) = $10^{(9.98/10)}$ = 10Watts *rounded*

ICOM-UK

Separation Distance Calculation

Reflection Coefficient |Γ|

This is the ground reflection coefficient |Γ| The standard value of 0.6 which is used in the base formula given below.

The base formula used is: $S = (1 + |\Gamma|)^2 \frac{Pt}{4\pi R^2}$

Where:

S = Power Density In W/m^2

Pt = Transmitter Power in EIRP

|Γ| = Reflection Coefficient

R = Radius in distance metres from the centre of the antenna

Re-arranging the formula to give the Separation Distance R for a given reference Power Density Sr limit.

$$R = \sqrt{\frac{Pt\,(1 + |\Gamma|)^2}{4\pi Sr}}$$

Refer to **the EMF Calculator Annex Tab** which gives technical information regarding the formulas used to give the Separation Distance obtained by the EMF Calculator.