

Radiofrequency electromagnetic fields in public spaces in Ireland

Results of the RF EMF Monitoring Programme 2021-2022



Table of Contents

1. Introduction	2
2. Radiofrequency EMF in Ireland.....	3
3. International guidelines for radiofrequency EMF.....	3
4. The EPA’s radiofrequency EMF monitoring programme	5
5. How we measured	6
6. Main measurement results.....	7
6.1. Results for specific telecommunication technologies	8
6.2. Other measurements done to inform our monitoring	8
6.3. Other data available on EMF levels in Ireland	10
7. Conclusions	10
8. Glossary.....	12
9. Appendix	13
10. References	18

Key Findings:

- Radiofrequency electromagnetic fields (EMF) are used by telecommunication technologies and may lead to public exposure.
- The EPA’s radiofrequency EMF monitoring programme aims to assess the typical level of radiofrequency EMF in busy urban areas at street level in Ireland.
- Our measurements show that the typical radiofrequency field level that people experience in busy urban areas in Ireland is around 1 V/m.
- This value can be compared to 28 V/m which is the lowest guideline limit recommended by the European Commission and other international bodies for public exposure to radiofrequency EMF. According to the World Health Organisation, no health effects have been identified for members of the public at EMF exposure levels below this limit.
- This level is comparable to the levels found in urban areas in other European countries.
- The typical level from 5G in busy urban environments is around 0.3 V/m. This value is similar to the typical levels from other mobile technologies such as 2G, 3G and 4G.
- The typical radiofrequency field level near masts and other telecommunication sites measured by the Commission for Communications Regulation is around 2 V/m. This is also well below the strictest guideline limit of 28 V/m.

1. Introduction

Wireless telecommunications like radio and television broadcasting, mobile telephones and Wi-Fi are examples of everyday technologies that use radio waves, also known as radiofrequency electromagnetic fields. While needed in a modern society, wireless telecommunications lead to public exposure to radiofrequency electromagnetic fields in our daily surroundings.

Electromagnetic fields together with optical and ionising radiation make up the electromagnetic spectrum (Figure 1 below). The spectrum is divided into two main parts comprising ionising and non-ionising radiation. Ionising radiation has enough energy to break up (ionise) molecules and directly damage cells in the body due its high energy. Ionising radiation is a known carcinogen and is generally classified in terms of its energy. Non-ionising radiation does not have enough energy to directly break up molecules, so it is commonly classified in terms of its frequency¹. Electromagnetic fields or EMF are part of the non-ionising radiation spectrum. Their frequencies range between 0 Hertz (Hz) and 300 Giga Hertz (GHz). The Environmental Protection Agency (EPA) have responsibilities²³ in relation to public exposure to EMF, which include:

- providing advice and information to the Government and the general public on public exposure to EMF; and
- carrying out monitoring of public exposure to EMF to inform its advice function.

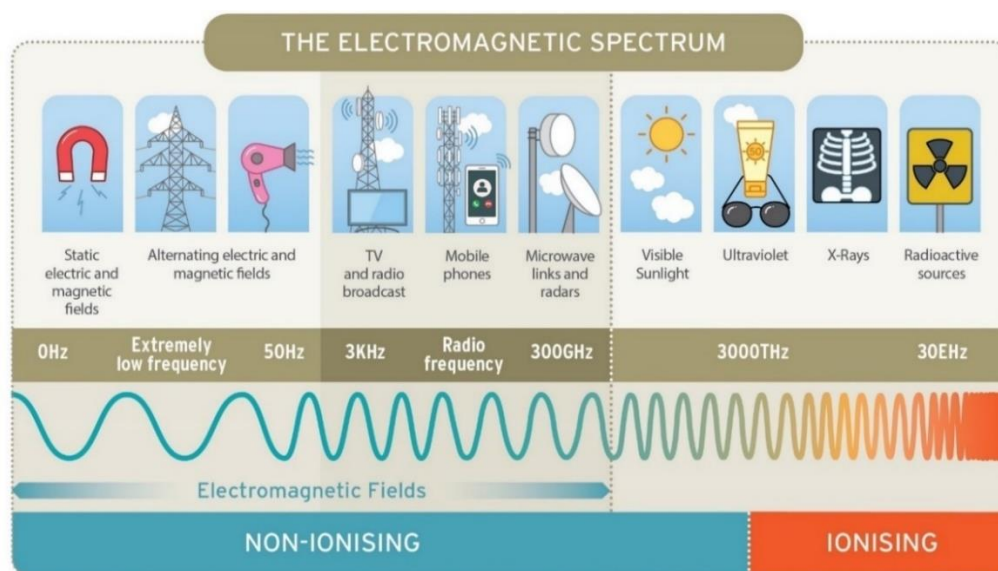


Figure 1. The electromagnetic spectrum.

¹ Frequency is measured in units called [Hertz](#) (Hz). Radiofrequencies are usually described in terms of thousands of Hertz, known as kilohertz (kHz), millions of Hertz, known as Mega Hertz (MHz) or billions of Hertz, known as Giga Hertz (GHz).

² The Radiological Protection Act 1991 (Non-Ionising Radiation) Order 2019, S.I. 190 of 2019 (Government of Ireland, 2019) extended the functions of the EPA to cover public exposure to EMF. It is available at <https://www.irishstatutebook.ie/eli/2019/si/190/made/en/pdf>

³ Optical radiation including ultraviolet, visible light or infrared radiation are not in the EPA's remit.

2. Radiofrequency EMF in Ireland

Electromagnetic fields with frequencies between around 3 kilo Hertz (kHz) and 300 Giga Hertz (GHz) are known as radiofrequency EMF. In Ireland, the radiofrequency electromagnetic spectrum is a national resource, managed and regulated by the Commission for Communications Regulation (ComReg). ComReg allocates, by licence or general authorisation, different radio frequencies for specific telecommunication services, such as mobile telephony, wireless communications and TV or radio broadcasting⁴. ComReg also carry out compliance monitoring of the EMF levels in the vicinity of licensed telecommunication sites (commonly known as “masts”) to ensure that EMF emissions comply with the licence requirements, which include exposure limit recommendations based on international guidelines. EMF data collected by ComReg are publicly available (see section 6.3 below for more details on these data).

3. International guidelines for radiofrequency EMF

EMF exposure limit recommendations or guidelines are developed and periodically updated by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)⁵. Compliance with these guidelines protects the public from potential, well-known negative health effects of high EMF exposure levels, such as increased body temperature and burns. The ICNIRP guidelines are endorsed by the European Commission and recognised by the World Health Organization.

EMF guidelines covering the frequency range between 0 Hz and 300 GHz were issued by ICNIRP in 1998 (ICNIRP, 1998) and adopted by the European Commission through the EC Recommendation 1999 (EC, 1999). These recommendations have been implemented in most European countries (ITU, 2021).

In 2020, ICNIRP updated their guidelines for radiofrequency EMF (ICNIRP, 2020). These guidelines are implemented in some European countries (ITU, 2021) and, at the time of writing this report, are under consideration by the European Commission⁶. In Ireland, compliance with the ICNIRP 2020 guidelines for radiofrequency EMF is a requirement of authorisations issued by ComReg.

At a distance sufficiently far from an RF emitting antenna, only the RF electric field needs to be measured, as compliance with the limits for RF electric fields ensures compliance with the limits for RF magnetic fields. Radiofrequency electric fields are measured in units of volts per metre (V/m) and this is the unit used throughout this report. The amount of energy absorbed by the body from radiofrequency EMF depends on its frequency. Therefore, EMF guidelines depend on the specific EMF frequency measured. These guidelines are based on the latest scientific evidence and are aimed at protecting people from potential, well-known negative

⁴ Visit <https://www.comreg.ie/industry/radio-spectrum/> to find out more on how the radiofrequency spectrum is allocated in Ireland.

⁵ Visit <https://www.icnirp.org/> to find out more about ICNIRP.

⁶ https://health.ec.europa.eu/system/files/2022-08/scheer_o_044_0.pdf

effects due to high exposure levels (EC, 1999; ICNIRP, 2020). Current recommended public exposure limits for radiofrequency electric fields are as follows (see Figure 2 below for clarification):

- For frequencies between 10 and 400 MHz, the recommended exposure limit is 28 V/m. This range typically includes services such as FM radio, digital radio and TETRA;
- For frequencies between 400 MHz and 2 GHz, the recommended limits are between 28 V/m and 61 V/m, depending on the specific EMF frequency. This frequency range typically includes the radiofrequencies used by digital TV, 2G, 4G and some 3G bands.
- For frequencies above 2 GHz, the recommended limit is 61 V/m. This typically includes the radiofrequencies used by some 3G bands, 5G and Wi-Fi.

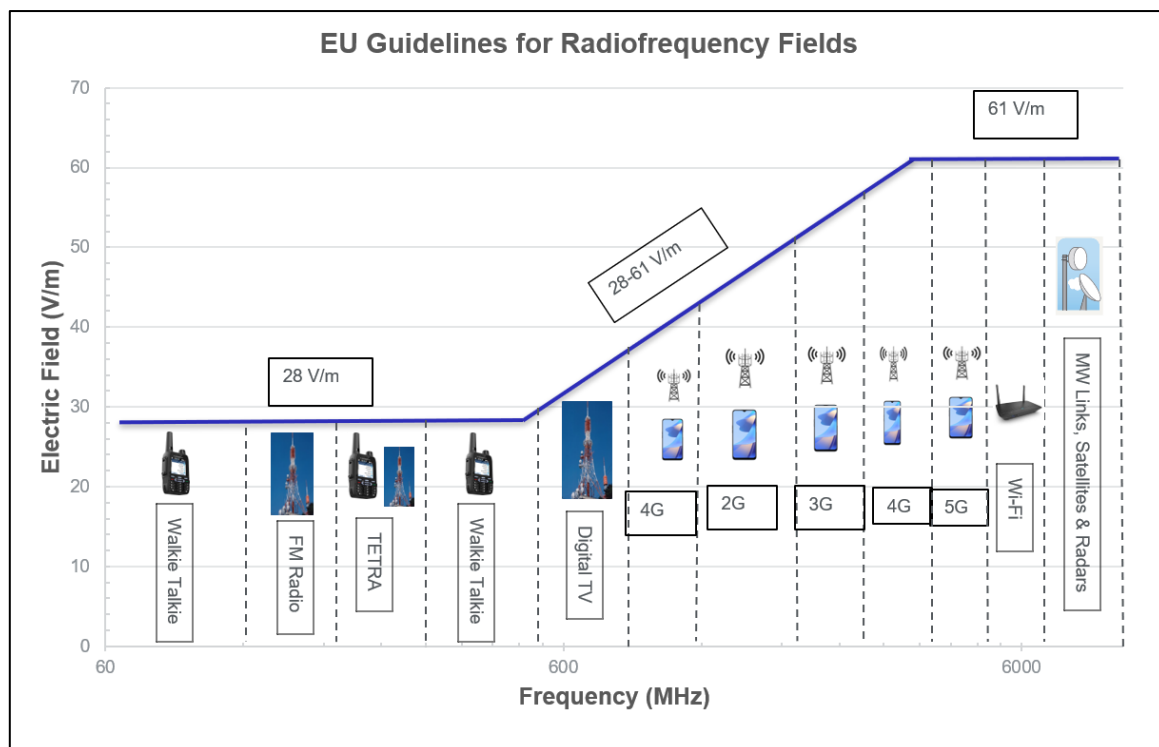


Figure 2. ICNIRP guidelines for radiofrequency electric fields. There are no telecommunication emissions below 10 MHz that may expose the public in Ireland.

- A measured electric field level of less than 28 V/m complies with recommended exposure limits for ALL radiofrequencies.
- A measured electric field level of less than 61 V/m complies with recommended exposure limits for radiofrequencies used by MOST COMMON telecommunication technologies.

4. The EPA's radiofrequency EMF monitoring programme

The aim of the EPA's monitoring of radiofrequency EMF is to assess the typical levels of exposure that people experience in everyday environments in Ireland. Measurements were therefore made in places where people gather. That is, in locations at street level in busy public spaces such as town and city centres where public amenities are present, and where people are exposed to multiple radiofrequency sources at the same time. These sources typically include signals from telecommunication masts and towers but also from other sources such as Wi-Fi networks, and mobile phones from other people.

The 2016 Census (Central Statistics Office, 2016) was used to select census towns, cities and suburbs (called settlements) with around 10,000 or more inhabitants which were included in our monitoring programme. Within these settlements, measurement locations were selected based on available information on footfall and local knowledge of busy areas. Figure 2 below shows a typical measurement location⁷.



Figure 2. Radiofrequency electromagnetic field measurement survey carried out at Malahide town centre (Co Dublin).

The EPA's monitoring programme therefore differs from the compliance monitoring performed by ComReg which measures radiofrequency EMF levels close to telecommunication sites, such as masts and towers, to assess compliance of specific sites with exposure limit recommendations⁸.

⁷ More information about our programme can be found at www.epa.ie/environment-and-you/radiation/emf/emf-monitoring-programme/

⁸ Visit <https://www.comreg.ie/industry/radio-spectrum/> for information on how ComReg allocates and monitors compliance with conditions attached to licences and general authorisations.

5. How we measured

People in public spaces at street level are typically several meters away from radiofrequency EMF-emitting devices, in the so-called “[far-field](#)” area. At this distance, radiofrequency electric and magnetic fields are proportional and only one of them needs to be measured. Typically, only radiofrequency electric fields are measured, as compliance with the limits for electric fields ensures compliance with the limits for magnetic fields (EC, 1999). Therefore, only radiofrequency electric fields, commonly measured in volts per meter (V/m), are mentioned in this report. Measurements were carried out in 55 selected locations throughout the country known to have regular high footfall. High quality, calibrated measurement equipment was used to carry out all our measurements⁹.

Two types of radiofrequency electric field measurements were performed in our monitoring programme:

- Firstly, measurements in a wide band of frequencies, that is 100 kHz to 90 GHz, were performed to assess the combined radiofrequency field levels from all relevant sources together. These wideband measurements cover the frequencies associated with all relevant radiofrequency sources, from broadcasting and mobile telephony to satellites and radars. Above 90 GHz, mainly technologies used to explore outer space or for research purposes exist and they do not lead to public exposure.
 - Two probes were used to cover this wide band of frequencies; one that measures between 100 kHz and 6 GHz and another one covering between 100 MHz and 90 GHz. The first probe covers the most common telecommunication technologies. The second probe was used to assess emissions from less common technologies such as satellite antennas, radars and microwave links.
- Secondly, frequency-specific measurements between 27 MHz and 6 GHz were performed to assess the contribution from each of the most commonly used technologies. Frequency-specific measurements allow to assess the emissions from each technology separately and their contribution to the total exposure level assessed by the wideband measurements. As part of these frequency-specific measurements, we measured the typical levels of radiofrequency fields used by 5G networks currently in place in Ireland. Since 2019, this technology uses the [3.6 GHz band](#). Other 5G frequencies, such as the [700 MHz band](#) and the [26 GHz band](#), are not currently available in Ireland but may be used in the future. Therefore, only the 3.6 GHz band was measured while other 5G frequency bands will be included in future monitoring programmes. More information about the frequency-specific measurements can be found in Section 6.1 below and in the [Appendix](#).

⁹ See appendix for further information on the equipment used in the monitoring programme.

6. Main measurement results

Our main results come from the wideband radiofrequency electric field measurements made in the 55 locations measured between March 2021 and May 2022. These measurements were carried out using two probes covering a total frequency range between 100 kHz and 90 GHz. Summarised results from Probe 1 (100 kHz – 6 GHz) are presented below (see Table 1). They represent typical RF electric field levels due to emissions from the main telecommunication services in Ireland, described in detail in the [Appendix](#). Results from Probe 2 (100 MHz – 90 GHz) cover technologies that use frequencies above 6 GHz, such as some microwave links, satellite antennas and radars, but not some common sources like FM radio. Results from wideband Probe 1 and 2 were similar so only Probe 1 results are shown here. Results from Probe 2 and frequency-specific measurements can be consulted on the [EPA website](#). The map below (Figure 3) shows the locations where measurements were performed, and the range of results obtained using Probe 1. Detailed results from Probe 1 for each location can be found in the [Appendix](#).

Table 1: Summary results from wideband measurements in 55 locations.

	Probe 1 (100 kHz – 6 GHz)
Average	1.41 V/m
Median	0.82 V/m
Range	0.1 V/m to 5.34 v/m

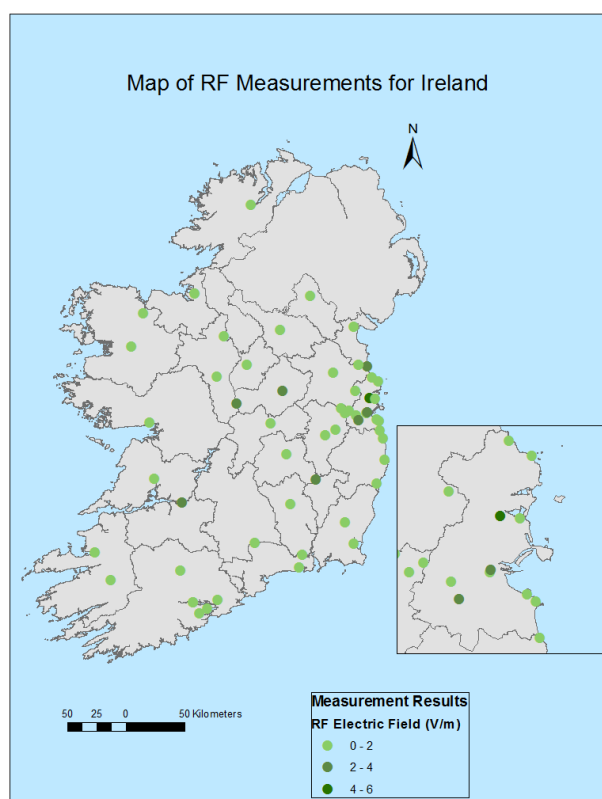


Figure 3. Map of radiofrequency (RF) electric field measurements in the frequency range 100kHz-6GHz carried out in public spaces between 2021-2022.

- Our results show that, although there is a small variability between the measured locations, all results obtained were low and well below current exposure limits recommended in EC 1999 and ICNIRP 2020.
- Based on our measurements, we estimated that the typical radiofrequency electric field level in busy urban areas anywhere in the country is about 1 V/m.
- The results obtained for signals below and above 6 GHz were similar. This means that emissions from technologies above 6 GHz, like microwave links, radars and satellite antennas, do not increase the total public exposure level.

6.1. Results for specific telecommunication technologies

Radiofrequency electric field levels vary depending on the telecommunication technology. Frequency-specific measurements were carried out to assess the level of radiofrequency electric field from each relevant telecommunication technology currently in use in Ireland.

Average radiofrequency electric field levels from specific technologies, including 5G (3.6 GHz), ranged between 0.004 V/m and 3.29 V/m. The typical level from 5G was 0.3 V/m. These levels are slightly lower than those for total radiofrequency electric field, which ranged between 0.10 V/m and 5.34 V/m. This is normal since the latter represent the cumulative effect of all technologies in the frequency range between 100 kHz and 6 GHz measured together. Further information about frequency-specific measurements can be found in the [Appendix](#).

The results for individual technologies as well as for cumulative exposure, comprising all technologies measured together, all were well below current exposure limits recommended in EC 1999 and ICNIRP 2020.

6.2. Other measurements done to inform our monitoring

In addition to the main 55 measurement surveys carried out as part of our monitoring programme, two more locations were measured. These two locations were deliberately chosen to assess the potential lowest and highest radiofrequency EMF levels that the public may be exposed to in Ireland. These measurements were done to put context on the results obtained in the main monitoring programme, which were performed to assess typical exposure levels at street level in busy public spaces.

To assess the lowest possible level of exposure in Ireland, measurements were carried out at a remote rural location shown in Figure 4. This site, located at Ballycroy National Park, Co Mayo, was selected given the low density of telecommunication masts and the poor mobile coverage in the area¹⁰. The average electric field level for the frequency range 100 kHz – 6

¹⁰ Information on the location of masts and mobile phone coverage is published by ComReg. <https://coveragemap.comreg.ie/map>; www.comreg.ie/nir-reports/

GHz at this site was 0.17 V/m. Frequency-specific measurements were all below the limits of detection of the equipment used. This means that the levels from each individual telecommunication technology were so low that they could not be detected with our equipment and only the levels from all technologies together were high enough to be detected.



Figure 4. Measurement site at Ballycroy National Park, Co Mayo.

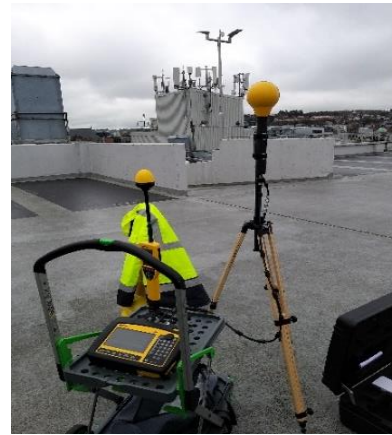


Figure 5. Measurement site near base station at multi-story car park in Cork city.

To assess the highest level of radiofrequency EMF that a member of the public may be exposed to in Ireland, measurements were performed at a location near a telecommunication site above ground level shown in Figure 5. This site, located on the roof of a multi-story car park in Cork city, contains a large telecommunication base station with several antennas. This site was selected based on results previously obtained at the same location by ComReg as part of their monitoring programme. This site allowed us to measure radiofrequency EMF levels near a mast in an area with public access but well above street level and therefore closer to the mast. The maximum electric field level measured at this site for the range 100 kHz – 6 GHz was 29.9 V/m. Based on ComReg data and our own measurements, this value represents the maximum radiofrequency field level measured in a public space in Ireland. However, EMF levels at this site were still below the recommended limits for each specific technology. That is, frequency-specific measurements performed at this site, as well as those previously carried out by ComReg¹¹, were all below the corresponding exposure limits. Mobile technologies - for which exposure limits range between 36 V/m and 61 V/m, depending on the technology and its frequency - contributed the most to the overall level of 29.9 V/m. The only technology detected on this site below 400 MHz (FM radio) had a value of 0.2 V/m. The recommended exposure limit for this technology is 28 V/m (EC, 1999; ICNIRP, 2020).

¹¹ <https://www.comreg.ie/media/2021/09/Cork-Grafton-Mall.pdf>

Table 2. Results of wideband measurements (100 kHz – 6GHz) in two extra locations

	Measurement location	
	Ballycroy National Park	Roof of Cark park at Grafton Mall, Cork City
Average	0.17 V/m	29.9 V/m

6.3 Other data available on EMF levels in Ireland

Every year, ComReg measures radiofrequency EMF levels in public areas at some 80 different sites throughout the country as part of its radio spectrum management function. These measurements are made in the vicinity of licensed telecommunication equipment such as masts and towers. They are, therefore, different from those carried out by the EPA which are carried out at busy locations at street level and not always close to masts. To date, some 1,400 sites have been surveyed by ComReg¹². EPA analysis of the radiofrequency electric field data measured by ComReg in the range 100 kHz - 3 GHz throughout the country since 2008 close to telecommunication sites are as follows (Table 3):

Table 3. Summary results from ComReg measurements between 2008 and 2022.

	RF Electric Field
Average	2.05 V/m
Median	1.40 V/m
Range	0.04 V/m - 8.3 V/m

Peak values up to 9 V/m (at street level) have been recorded by ComReg in some locations. Although these values are slightly higher than the results we obtained at street level in busy urban areas, they are all several times below current international limits for public exposure set by ICNIRP (ComReg, 2022).

7. Conclusions

Radiofrequency electric field measurements covering a frequency range between 100 kHz and 90 GHz were carried out at street level in 55 busy outdoor urban areas throughout the country between March 2021 and May 2022. Measurement locations were selected to assess typical radiofrequency EMF levels of the Irish population where people usually gather and may be exposed to several radiofrequency EMF sources at the same time.

The measurements performed to assess the exposure level from the most relevant radiofrequency EMF sources taken together showed that the typical level in the frequency range 100 kHz to 6 GHz is 1.41 V/m. In some locations, levels as low as 0.10 V/m and up to 5.34 V/m were recorded. These results are well below the recommended exposure limits for the public set by the European Commission and ICNIRP (EC, 1999; ICNIRP, 2020). Typical

¹² Some of ComReg’s EMF measurement reports are available at [Siteviewer](#). ComReg’s most recent measurement reports can be found [here](#).

exposure levels from specific telecommunication technologies, including 5G (3.6 GHz), ranged between 0.004 V/m and 3.29 V/m. The typical level from 5G was 0.3 V/m. As expected, these levels are below the levels measured from all technologies taken together. Thus, the levels from specific technologies, including 5G, were also below recommended exposure limits.

The results of the measurements made in the frequency range 100 MHz and 90 GHz, carried out to assess emissions from sources with frequencies above 6 GHz, were similar to those obtained for the frequency range 100 kHz to 6 GHz. This means that exposure to EMF from technologies such as radars, microwave links and satellite antennas is low and does not contribute significantly to the total public exposure.

Typical exposure values at street level in busy outdoor urban locations anywhere in the country were estimated by analysing the 55 measurements carried out as part of our monitoring programme (Olsson, 2005). Based on this analysis, the typical radiofrequency electric field level in similar locations anywhere in the country is around 1 V/m.

The values above represent the radiofrequency EMF exposure levels that members of the public are typically exposed to in Ireland. The results obtained in our main monitoring work can be compared to the average electric field level of 0.17 V/m measured in a remote rural area with very low density of masts and poor mobile phone coverage, as well as with the reading of 29.9 V/m on a building roof close to a mast, which represent the probable lowest and highest levels that the public may be exposed to in most situations.

EPA results can also be compared with the measurements made by ComReg between 2008-2022 as part of their monitoring programme, which range between 0.04 V/m and 8.3 V/m, with an average of 2.05 V/m and peak values up to 9.0 V/m (at street level). Our results are slightly lower than those obtained by ComReg, since the latter are obtained near telecommunications sites (in the so-called [line-of-sight](#)). EPA results, however, represent typical EMF levels in public spaces which only occasionally were close to telecommunication sites.

Table 4. Summary of radiofrequency EMF measurement data available for Ireland

Statistic	EPA measurements in at street level in busy urban areas (1)	EPA measurements in a location likely to have high RF EMF levels (2)	EPA measurements in a location likely to have low RF EMF levels (2)	ComReg compliance monitoring near masts at street level (3)	EC 1999 and ICNIRP recommended limits (4)
Average	1.41 V/m	29.9 V/m	0.17 V/m	2.05 V/m	28-61 V/m
Median	0.82 V/m	--	--	1.4 V/m	
Range	0.10 V/m to 5.34 V/m	--	--	0.04 V/m to 8.3 V/m	

Note: EPA measurements in the frequency range 100 kHz to 6 GHz. ComReg measurements in the frequency range 100 kHz to 3 GHz. 1) Summary statistics calculated from 55 (6-minute) measurements; 2) Summary statistics calculated from 1 single (6-minute) measurement; 3) Summary statistics calculated from 1,018 (6-minute) measurements compiled from publicly available ComReg reports; 4) ICNIRP limits depend on frequency (see section 3 above for more details).

8. Glossary

- **Hertz:** A unit used to classify the frequency of an electromagnetic field. One hertz equals one cycle per second.
- **Far-field:** A region of the electromagnetic field which typically starts at a distance of two times the squared dimension (D) of the emitting antenna, divided by the field wavelength (λ), out to infinity. In practice, members of the public who are a few metres from an antenna are always in the far field.
- **5G:** The fifth generation of wireless telecommunication technology. Currently, 5G only uses the 3.6 GHz band in Ireland. Other frequency bands associated with 5G, that is 700 MHz and 26 GHz, are not yet in operation in Ireland.
- **Line-of-sight:** A term commonly used to describe when a telecommunication antenna is visible on a straight line by the person doing the assessment.

9. Appendix

The table below contains the results for mean radiofrequency electric field in volts per metre (V/m) for the frequency range 100 kHz-6 GHz measured in each location using a wideband equipment. These results represent the emissions from the main telecommunication technologies present in urban environments, such as mobile telephony, TV and radio broadcasting and Wi-Fi. Detailed wideband results from Probe 2 can be consulted on the [EPA website](#).

Table A1. Results of wideband radiofrequency electric fields in the range 100kHz-6GHz measured in 55 busy urban locations between 2021-2022.

County	City/Town	Location	Mean Electric Field (V/m) [100kHz-6GHz]
Carlow	Carlow	The Liberty Tree	2.79
Cavan	Cavan	Market Square	0.46
Clare	Ennis	O'Connell Square	0.21
Cork	Cobh	Sandymount Street	0.13
Cork	Cork city	Grand Parade	1.66
Cork	Cork city	Patrick Street	1.03
Cork	Mallow	Market Square	1.60
Cork	Midleton	Main Street	0.50
Cork	Carrigaline	Main Street	1.14
Donegal	Letterkenny	Upper Main Street	1.03
Dublin	Balbriggan	Drogheda St-Railway St	0.90
Dublin	Clondalkin	The Mill Shopping Centre	1.23
Dublin	Dalkey	Castle Street	0.27
Dublin	Dublin city	King St-Grafton St	0.38
Dublin	Dublin city	Westmoreland St-Fleet St	2.22
Dublin	Dun Laoghaire	Georges Street Lower	1.68
Dublin	Malahide	New Street	0.84
Dublin	Skerries	Strand Street	0.10
Dublin	Swords	Main Street	5.34
Dublin	Tallaght	The Square Shopping Centre	2.97
Galway	Galway city	William Street	0.97
Kerry	Killarney	High Street	0.43
Kerry	Tralee	Russell Street	0.33
Kildare	Celbridge	Maynooth Road	1.06
Kildare	Leixlip	Main Street	0.29
Kildare	Maynooth	Main Street	0.88
Kildare	Naas	Main Street	1.01
Kildare	Newbridge	Main Street	0.72
Kilkenny	Kilkenny	The Parade	1.13
Laois	Portlaoise	Main Street	0.28
Leitrim	Carrick-On-Shannon	Main Street	0.41
Limerick	Limerick city	O'Connell Street	2.70
Longford	Longford	Market Square	0.78
Louth	Drogheda	West Street	0.61
Louth	Dundalk	Market Square	1.18

Table A1. Results of wideband radiofrequency electric fields in the range 100kHz-6GHz measured in 55 busy urban locations between 2021-2022.

County	City/Town	Location	Mean Electric Field (V/m) [100kHz-6GHz]
Mayo	Ballina	Pearse Street	0.19
Mayo	Castlebar	Market Street	0.63
Meath	Ashbourne	Killegland Street	1.12
Meath	Bettystown	Coast Road	2.85
Meath	Navan	Market Square	0.17
Monaghan	Monaghan	Church Street	1.04
Offaly	Tullamore	O'Connor Square	0.53
Roscommon	Roscommon	Main Street	0.81
Sligo	Sligo	Wine Street	0.37
Tipperary	Clonmel	Mitchell St	0.82
Waterford	Tramore	Strand Road	1.20
Waterford	Waterford city	Great George's Street	0.50
Westmeath	Athlone	Dublin Gate Street	2.49
Westmeath	Mullingar	Blackhall Place	2.14
Wexford	Enniscorthy	Market Square	0.14
Wexford	Wexford	Bullring Square	0.78
Wicklow	Arklow	Saint Mary's Park	1.33
Wicklow	Bray	Promenade	0.47
Wicklow	Greystones	Dart station	0.48
Wicklow	Wicklow	Fitzwilliam Square	0.32

Figure A1 below shows the results for typical radiofrequency electric field levels in volts per metre (V/m) by telecommunication technology. As shown on the graph, exposure levels from all measured technologies were below the ICNIRP recommended exposure limits. Detailed frequency-specific results can be consulted on the [EPA website](#).

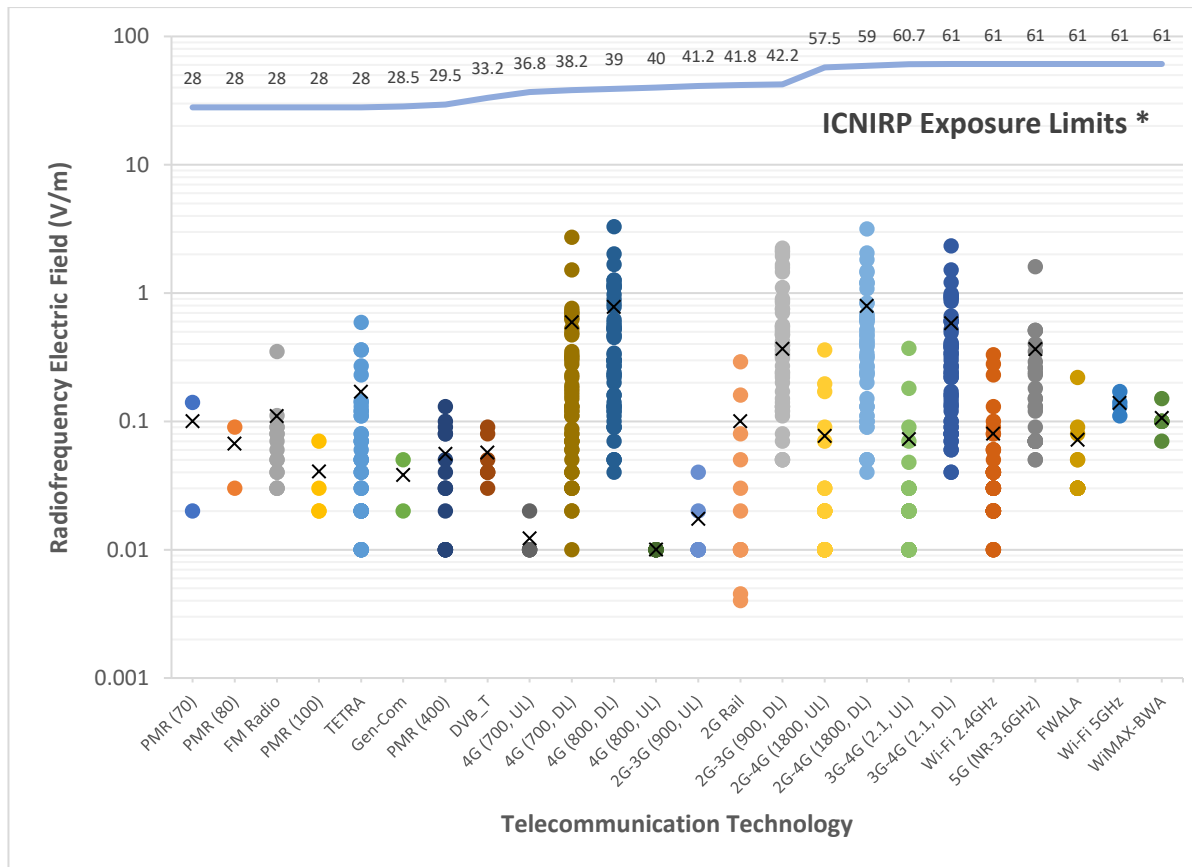


Figure A1. Frequency-specific radiofrequency electric field average level in volts per metre (V/m) for the frequency range 27 MHz – 6 GHz. Each coloured data point represents the mean result from each technology at a measured location. Black X's represent the mean value for each technology. The Y-axis shows the RF electric field in a logarithmic scale to clearly show both the measured levels and the limits. See Table A2 below for descriptions of the acronyms used in the graph.

Table A2 below outlines the most common telecommunication technologies currently present in urban environments in Ireland as well as descriptions of the acronyms used on Figure A1 above.

Table A2. Telecommunication signals identified in the monitoring programme 2021-2022.

Telecommunication Signal	Description	Frequency Range
PMR (70 MHz band)	Professional Mobile Radio	68-74.8 MHz
PMR (80 MHz band)	Professional Mobile Radio	75.2-87.5 MHz
FM Radio	Frequency Modulated Radio	87.5-108 MHz
PMR (100 MHz band)	Professional Mobile Radio	138-156.8 MHz
TETRA	Terrestrial Trunked Radio	390-400 MHz
General Communications	License exempt services ¹	410-450 MHz
PMR (400 MHz band)	Professional Mobile Radio	450-470 MHz
DVB-T	Terrestrial Digital Video Broadcasting	470-694 MHz
4G (700, UL)	Mobile phone, 700 MHz Band, Uplink	703-733 MHz
4G (700, DL)	Mobile phone, 700 MHz Band, Downlink	758-788 MHz
4G (800, DL)	Mobile phone, 800 MHz Band, Downlink	791-821 MHz
4G (800, UL)	Mobile phone, 800 MHz Band, Uplink	832-862 MHz
2 (900, UL)	Mobile phone, 900 MHz band, Uplink	880-915 MHz
2G Rail	Rail Telecommunication System	921.2-924.6 MHz
2G-3G (900, DL)	Mobile phone, 900 MHz band, Downlink	925-960 MHz
2G-4G (1800, UL)	Mobile phone, 1800 MHz band, Uplink	1710-1785 MHz
2G-4G (1800, DL)	Mobile phone, 1800 MHz band, Downlink	1805-1880 MHz
3G-4G (2.1, UL)	Mobile phone, 2100 MHz band, Uplink	1920-1980 MHz
3G-4G (2.1, DL)	Mobile phone, 2100 MHz band, Downlink	2110-2170 MHz
Wi-Fi 2.4GHz	Wireless internet, 2.4 GHz Band	2400-2483.5 MHz
5G (NR-3.6GHz)	Mobile phone, 5G New Radio, 3600 MHz band	3410-3750 MHz
FWALA	Fixed Wireless Access Local Area	3750-3800 MHz
Wi-Fi 5GHz	Wireless internet, 5 GHz Band	5150-5725 MHz
BWA	Broadband Wireless Access	5725-5875 MHz

Notes: 1) License exempt services include remote controls and similar devices.

Table A3. Characteristics of EMF equipment used in the monitoring programme.

Meter 1:	NBM-550 (Wideband survey meter)
Frequency range:	0 Hz to 90 GHz
Calibration dates:	July 2019; December 2021
Uncertainty (expanded):	± 0.2 dB ($\pm 2.3\%$)
Probe 1 (meter 1):	EF0691 (Isotropic E-field)
Frequency range:	100 kHz - 6 GHz
Calibration dates:	July 2019; December 2021
Uncertainty (expanded):	± 1.50 dB ($\pm 18.8\%$)
Probe 2 (meter 1):	EF9091 (Isotropic E-field)
Frequency range:	100 MHz – 90 GHz
Calibration dates:	July 2019; December 2021
Uncertainty (expanded):	± 1.50 dB ($\pm 18.8\%$)
Meter 2:	SRM-3006 (Frequency-selective & spectrum analyser)
Frequency range:	9 kHz – 6 GHz
Calibration dates:	July 2019; December 2021
Uncertainty (expanded):	± 0.2 dB ($\pm 2.3\%$)
Probe 1 (meter 2):	3501/03 (Isotropic E-field)
Frequency range:	27 MHz – 3 GHz
Calibration dates:	July 2019; December 2021
Uncertainty (expanded):	± 1.30 dB ($\pm 16.1\%$)
Probe 2 (meter 2):	3502/01 (Isotropic E-field)
Frequency range:	420 MHz – 6 GHz
Calibration dates:	July 2019; December 2021
Uncertainty (expanded):	± 1.30 dB ($\pm 16.1\%$)

10. References

Central Statistics Office (2016) *Census 2016 Profile 2 - Population Distribution and Movements*. <https://data.cso.ie/table/E2052>.

ComReg (2022) *Third Interim Report 2022 - Programme of Measurement of Non-Ionising Radiation*. Available at: https://www.comreg.ie/?dml_download=third-interim-report-2022-programme-of-measurement-of-non-ionising-radiation.

EC (1999) 'Council recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC)', *Official Journal of the European Communities*, pp. 199: 59–70.

ICNIRP (1998) 'Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection', *Health physics*. *Health Phys*, 74(4), pp. 494–521. Available at: <https://pubmed.ncbi.nlm.nih.gov/9525427/> (Accessed: 10 June 2022).

ICNIRP (2020) 'Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz). International Commission on Non-Ionizing Radiation Protection', *Health physics*. *Health Phys*, 118(5), pp. 483–524.

ITU (2021) *ITU Regional Assessment on EMF Exposure Limits and Risk Communication Challenges*. Available at: <https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Pages/Projects/EMF/About.aspx>.