

1. Survey Summary

Address of Transmitter Site Surveyed:	Killiney Golf Club, Ballinclea Rd, Rocheshill, Killiney, Co. Dublin
Site Type:	GSM, UMTS, LTE
Survey Date:	20/12/2019

Measurement Location: (at point of maximum non-ionising radiation near site)	In car park of golf club, beside transmitter location.
--	--

Measurement Location Coordinates:	LAT	<i>deg</i>	<i>min</i>	<i>sec</i>	LONG	<i>deg</i>	<i>min</i>	<i>sec</i>
	N	53	15	56.3	W	6	7	43.4

Purpose and Conduct of Survey:

The purpose of this survey was to assess compliance with the limits for general public exposure to non-ionising radiation (**NIR**) set by the International Commission on Non-Ionising Radiation Protection (**ICNIRP**) ("**ICNIRP Public Exposure Limits**").

Compliance with the ICNIRP Public Exposure Limits is a condition of a General Authorisation for an electronic communications network/service as well as of various Wireless Telegraphy licences issued by the Commission for Communications Regulation (**ComReg**).

The survey was conducted by:

- measuring the overall electromagnetic field (**EMF**) present at the point of highest exposure in a public area associated with the designated transmitter site;
- identifying the frequency of the principal emissions contributing to the EMF; and
- measuring the intensity (or level) of same.

Overall Conclusions of the Survey

Frequency Selective Measurements:

(Individual emissions measured at specific frequencies)

Total Exposure Quotient:

(Assessment of cumulative emissions from multiple transmitters)

**Below ICNIRP Public Exposure Limits
[Compliant]**

2. Surveyors

Survey conducted for ComReg by:	Compliance Engineering Ireland Ltd.	
--	-------------------------------------	---

Survey Engineer(s):	Report Writer:	Report Reviewer:
Michael Reilly, BEng	Michael Reilly, BEng	John McAuley, MEng

3. Survey Location Details

Designated Transmitter Site Photo



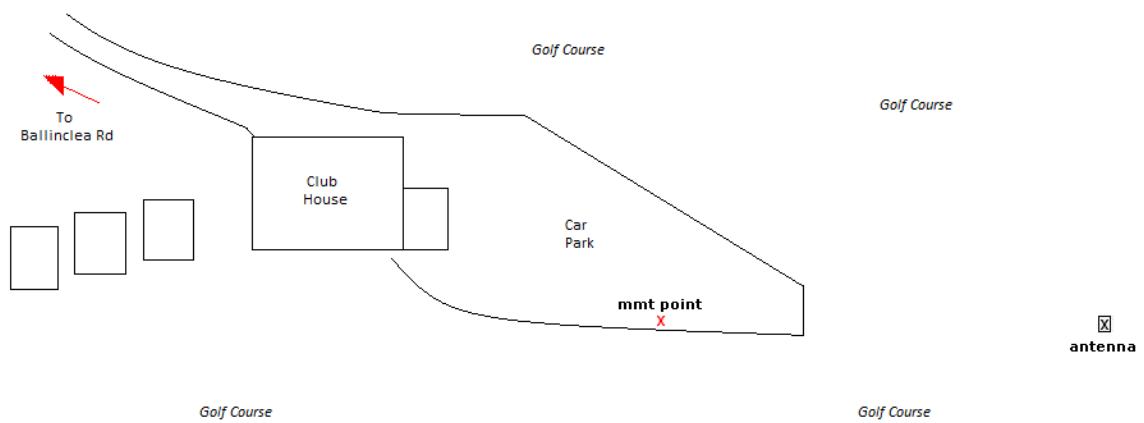
Survey Weather

Sky: Light Cloud

Temperature:
7 ° C

Relative Humidity:
44 %

Map of Designated Transmitter Site and Measurement Location



4. Introductory Note

Purpose of Survey

The survey of the designated transmitter site (“**Designated Site**”) was commissioned by ComReg as part of its Programme of Measurement of Non-Ionising Radiation. The purpose of the survey was to assess whether NIR (occurring within the radio frequency part of the electromagnetic spectrum) from the Designated Site complied with the limits for general public exposure specified in the guidelines published by ICNIRP (“**ICNIRP Public Exposure Limits**”).¹

Compliance with the ICNIRP Public Exposure Limits is a condition of a General Authorisation for the provision of an electronic communications network/service (e.g. mobile phone and broadcasting networks) as well as of various Wireless Telegraphy licences (in respect of transmitting stations) issued by ComReg.

Survey Methodology

Measurements of the NIR from the Designated Site were conducted in accordance with the methodology outlined in ComReg Document 08/51R3². This methodology incorporates many of the measurement methods and procedures outlined in:

- European Electronic Communications Committee (**ECC**) Recommendation (02)04³;
- European Committee for Electrotechnical Standardisation (**CENELEC**) measurement standard EN 50492:2008⁴, and
- measurement techniques developed by the Institut für Mobil- und Satellitenfunktechnik (**IMST**) and the EM-Institut on behalf of the German Federal Office for Radiation Protection.⁵

Note re this Report Version

If you have downloaded this report from www.siteviewer.ie or from www.comreg.ie, you are reading an abbreviated version. In addition to sections 1 to 8, the full extended technical version of this report contains a comprehensive technical record of the measurements and any calculations performed, a list of equipment used, as well as a technical appendix. A copy of the extended report is available on request from ComReg.

¹ Current ICNIRP guidelines:

- “Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)”, ICNIRP, published in ‘Health Physics’, April 1998, Volume 74, No. 4: <http://www.icnirp.org/documents/emfgdl.pdf>
- “Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz to 100 kHz)”, ICNIRP, published in ‘Health Physics’, December 2010, Volume 99, No. 6: <http://www.icnirp.org/documents/LFgdl.pdf>

² <https://www.comreg.ie/publication-download/programme-of-measurement-of-non-ionising-radiation-emissions-methodology-for-the-conduct-of-surveys-to-measure-non-ionising-electromagnetic-radiation-from-transmitter-sites-2>

³ ECC RECOMMENDATION (02)04, “Measuring Non-Ionising Electromagnetic Radiation (9 kHz – 300 GHz)”, ECC, (revised Bratislava 2003, Helsinki 2007): <http://www.erodocdb.dk/Docs/doc98/official/pdf/REC0204.PDF>

⁴ EN 50492:2008, “Basic standard for the in-situ measurement of electromagnetic field strength related to human exposure in the vicinity of base stations”, CENELEC, November 2008: <http://www.cenelec.eu>

⁵ See: <http://www.bfs.de> .

5. Survey Overview

Survey Stages

In accordance with the methodology outlined in ComReg Document 08/51R3, this survey was conducted in three stages:

- 1 Initial Site Survey
- 2 Full Survey – Broadband Measurements
- 3 Full Survey – Frequency Selective Measurements

An outline of each stage, along with the results and conclusions of the measurements, are presented in the following three sections.

Measurement of Electromagnetic Fields

Electromagnetic fields (**EMFs**) can be sub-divided into two components:

- Electric field (**E-field**) (measured in volts per metre or “V/m”); and
- Magnetic field (**H-field**) (measured in amperes per metre or “A/m”).

The E-field and the H-field are mathematically interdependent⁶ in the **radiating near-field**⁷ and the **far-field**⁸, which is located beyond a distance of at least the wavelength of the radiated EMF. The measurement locations for most transmitter installations lie well within the far-field, as the wavelengths of the transmitted signals are relatively short, and the antennas are typically located many metres from any public area.

The following table identifies wavelengths for commonly transmitted signals:

Transmitter Type	Frequency	Wavelength
PMR Low Band VHF	68 MHz	4.41 m
UHF TV	470 MHz	0.64 m
GSM 900 (mobile phone base)	925 MHz	0.32 m
GSM 1800 (mobile phone base)	1805 MHz	0.17 m
UMTS (mobile phone base)	2110 MHz	0.14 m

In the radiating near-field and far-field, only one component needs to be measured, as the other component can be readily derived from it. Normally, it is the E-field which is measured.

In the case of transmitters of very long wavelength signals, such as long wave radio (1.19 km wavelength), the H-field and E-field must be measured separately as the point of measurement will most likely lie within the **reactive near-field**⁹ region. In this region, located within a distance of at least the wavelength of the radiated EMF, the relationship between E and H becomes very complex and there is no direct correlation between both components of the EMF.

⁶ $E \approx H \times Z_0$ (Radiating Near Field) and $E = H \times Z_0$ (Far Field), where Z_0 (characteristic impedance of free space) $\approx 377 \Omega$

⁷ Beyond a distance of $\max(\lambda, D, D^2/4\lambda)$, where λ is the wavelength and D is the antenna's largest dimension




⁸ Beyond a distance of $\max(5\lambda, 5D, 0.6D^2/\lambda)$

⁹ Within a distance of $\max(\lambda, D, D^2/4\lambda)$

Measurement Equipment

The measurement of EMFs is a complex process which involves the use of various meters, spectrum analysers, probes and antennas, appropriate to the frequencies of the emissions being measured.

The table below shows examples of equipment typically used to measure EMFs in NIR surveys.

Initial Site Survey and Broadband Measurements	Frequency Selective Measurements	
 <p data-bbox="352 719 480 770">ISOTROPIC PROBE</p> <p data-bbox="368 965 496 1039">FIELD STRENGTH METER</p> <p data-bbox="220 1126 576 1301">Used to measure the overall electric or magnetic field present over a range of frequencies (e.g. 100kHz to 3GHz).</p>	<p data-bbox="603 577 970 629">SPECTRUM ANALYSER WITH TRIPOD MOUNTED ANTENNA CONNECTED</p> 	<p data-bbox="1038 577 1374 658">PORTABLE SPECTRUM ANALYSER WITH ANTENNA DIRECTLY CONNECTED</p>  <p data-bbox="603 1126 1437 1330">Spectrum analysers are used to measure individual emissions at specific frequencies. Individual emissions contribute to the overall EMF. Examples of individual emissions are a TV signal, and a mobile phone signal for a particular mobile operator. There may be a number of emissions from different transmitters contributing to the overall EMF at a particular location.</p>

6. Initial Site Survey

An initial survey was carried out in the area around the Designated Site in order to determine the point of maximum NIR. This is the location at which the overall E-field strength level measured was somewhat higher than that measured in other areas around the site and represents the highest level of exposure to which a member of the general public might be subjected in the vicinity of the transmitter.

For this initial survey a calibrated field strength meter fitted with a **3 GHz isotropic probe** was used. The meter and probe were used to measure the sum of all electrical fields present at **all frequencies from 100 kHz up to 3 GHz**.

Once the point of maximum NIR was determined, broadband and frequency-selective measurements were conducted at that location (see following two sections). For the duration of all measurements, the various instruments, antennas and probes used were mounted on non-metallic supports.

7. Full Survey – Broadband Measurements

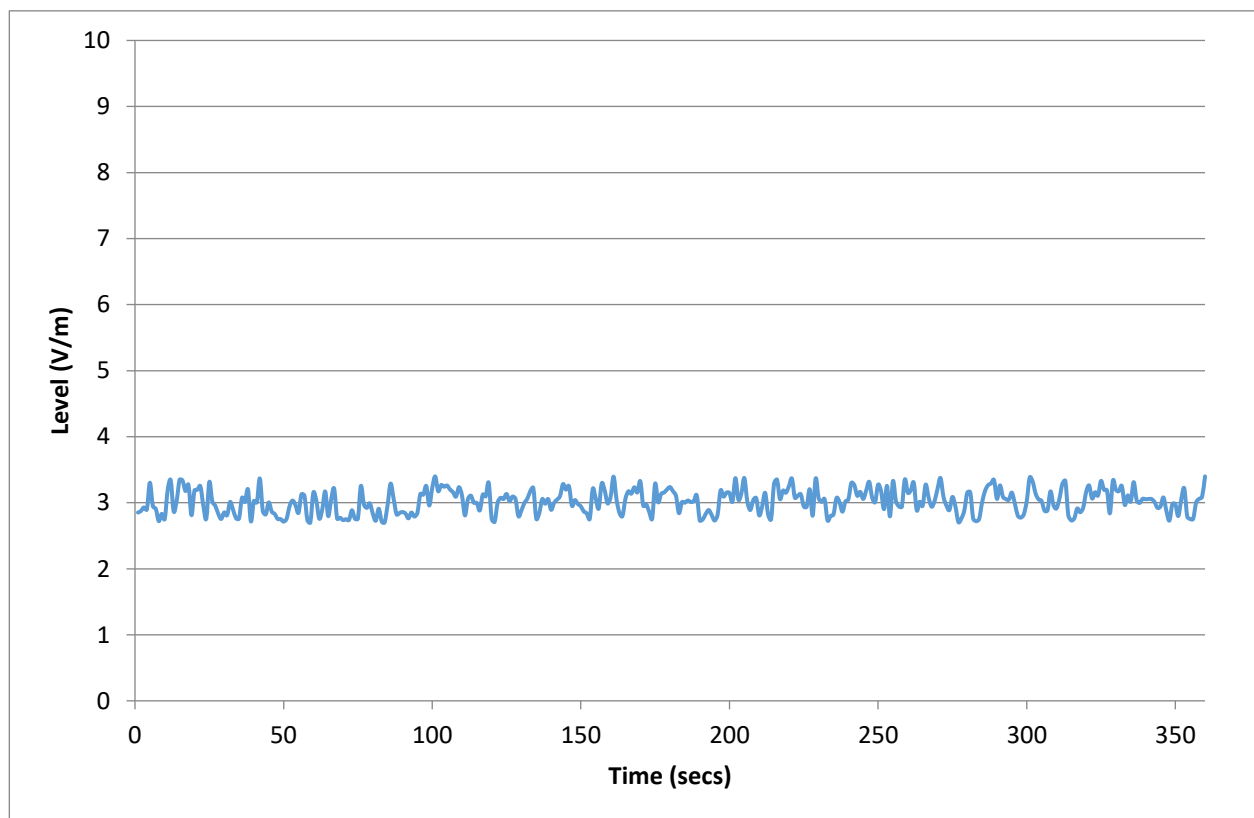
The purpose of these measurements was to get an overview of the intensity of the EMF present at the point of maximum NIR near the Designated Site.

There, the field strength meter (which was mounted on a tripod and fitted with a **3GHz isotropic probe**), was set to record, over a six-minute period, simultaneous measurements of the sum of all received signals within the frequency range of the probe. This measurement was then repeated using a **40 GHz isotropic probe**.

The broadband measurement results presented below show the levels in volts per metre (V/m) recorded during the six-minute period. The average and maximum levels can be compared to the lowest maximum ICNIRP Public Exposure Limits which is 28 V/m.

If a broadband measurement is higher than 28 V/m, it does not necessarily follow that the ICNIRP Public Exposure Limits have been exceeded because the limits are frequency dependent. For example, if the emissions are in the 2100 MHz (mobile phone) frequency band, then the limit which applies is higher at 61 V/m. A more detailed investigation involving frequency selective measurement is necessary to assess compliance with the ICNIRP Public Exposure Limits (see following section).

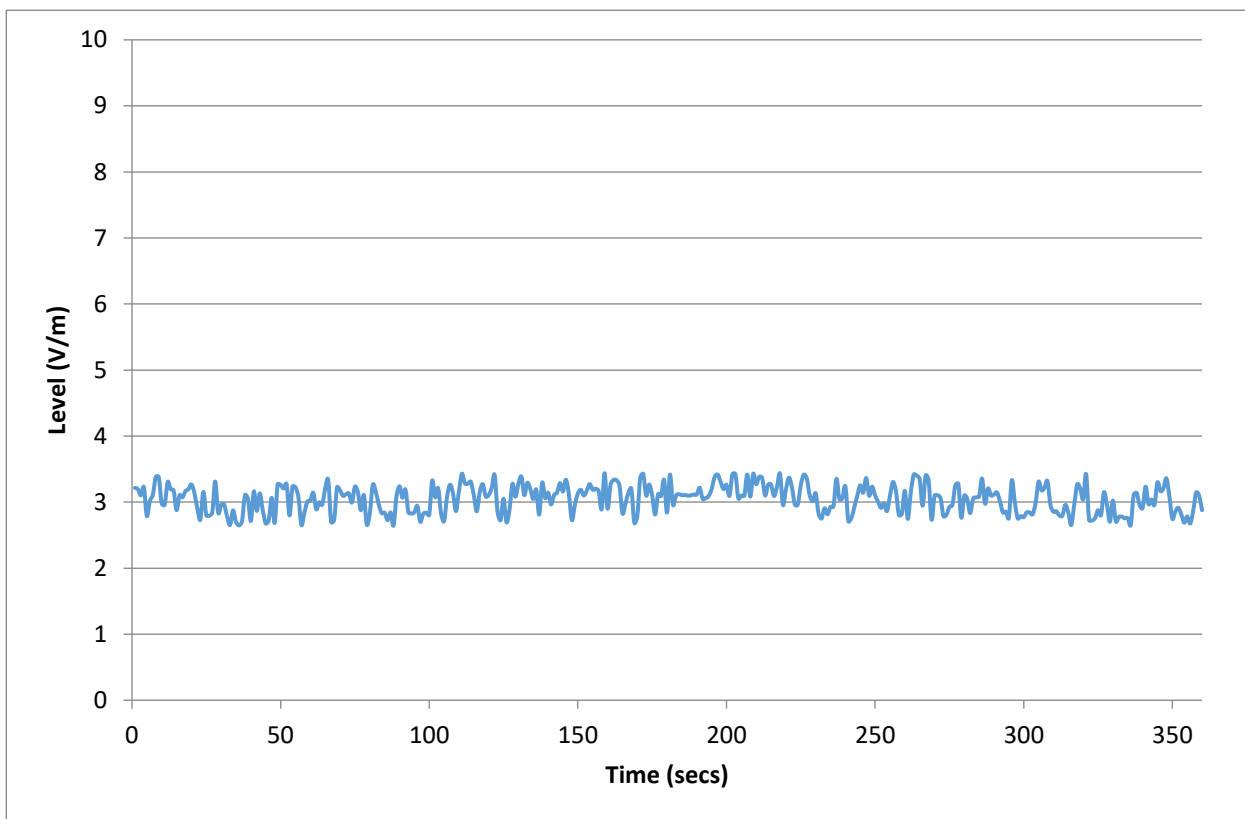
Electric field strengths recorded over 6 minute period using 3 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	3.02 V/m	Peak Measurement V/m:	3.40 V/m
Date:	20/12/2019	Start Time:	11:27
Meter:	NBM-550	Probe:	EF3091
Frequency Range:	100 kHz – 3 GHz		

Electric field strengths recorded over 6 min period using 60 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	3.05 V/m	Peak Measurement V/m:	3.44 V/m
Date:	20/12/2019	Start Time:	11:34
Meter:	NBM-550	Probe:	EF 4091
Frequency Range:	27 MHz – 40 GHz		

Conclusion of the Broadband Measurements

The mean and peak measurements were below the lowest ICNIRP guideline limit of 28 V/m.

8. Full Survey – Frequency Selective Measurements

Basic Measurement Procedure

A more detailed survey was performed at the point of maximum NIR near the Designated Site to identify the individual transmit frequencies and field strengths of each type of emission (e.g. mobile phone (GSM, UMTS and LTE), wireless broadband, TV, radio signals etc.) and their contribution to the total EMF.

The measurements were performed using spectrum analyser equipment and a range of antennas to match the frequency bands in which emissions were measured.

Table of Measurement Results

A list of the measurements made is presented in the table on the following page. For each emission measured, the table shows:

- **Emission Type** (e.g. GSM or UMTS mobile phone, TV etc);
- Transmission **frequency** of the signal;
- **Measured Level** (in volts per metre (V/m));
- **Adjusted Level** (if applicable to account for the characteristics of certain signal types or to compensate for limitations of measurement equipment or to estimate emissions for maximum call or data traffic); and
- **ICNIRP Public Limit**.

Further details of Adjusted Level/s and ICNIRP Public Exposure Limits are in the explanatory notes which follow the table of measurement results.

Assessment of ICNIRP Compliance of Individual Emissions

The levels for each measure (as adjusted where necessary) are compared to the relevant ICNIRP Public Exposure Limit which applies for the particular frequency of the emission. It should be again noted that the ICNIRP Public Exposure Limit varies according to frequency - the limits for the different measurements presented in the tables will vary as the measurements have been performed at different frequencies.

Assessment of ICNIRP Compliance of Cumulative Emissions

The levels measured for individual emissions are used to calculate **Total Exposure Quotients** to assess the cumulative effect of individual emissions from multiple transmitters. Further details of these quotients are in the explanatory notes which follow the table of measurement results.

The calculated values of the Total Exposure Quotients must be ≤ 1 in order for the aggregate of multiple measurements to satisfy the criteria of the ICNIRP Public Exposure Limit.

Table of Frequency Selective Measurement Results

Emission Type	Frequency (MHz)	Measured Level (V/m)	Adjusted Level (V/m)	ICNIRP Exposure Limit (V/m)	Times below Limit [adjusted Values]
FM Radio	98.100	0.05425	0.05425	28.0	516.129
FM Radio	100.290	0.05277	0.05277	28.0	530.605
FM Radio	94.900	0.05000	0.05000	28.0	560.000
FM Radio	101.800	0.04945	0.04945	28.0	566.229
FM Radio	104.390	0.04882	0.04882	28.0	573.535
FM Radio	105.990	0.04664	0.04664	28.0	600.343
FM Radio	103.790	0.04508	0.04508	28.0	621.118
FM Radio	102.150	0.04376	0.04376	28.0	639.854
FM Radio	105.190	0.03736	0.03736	28.0	749.465
FM Radio	106.770	0.03281	0.03281	28.0	853.398
FM Radio	88.490	0.02941	0.02941	28.0	952.057
FM Radio	96.680	0.02925	0.02925	28.0	957.265
FM Radio	90.700	0.02843	0.02843	28.0	984.875
FM Radio	92.900	0.02612	0.02612	28.0	1071.975
FM Radio	89.100	0.01303	0.01303	28.0	2148.887
FM Radio	89.900	0.01145	0.01145	28.0	2445.415
FM Radio	103.200	0.01140	0.01140	28.0	2456.140
FM Radio	93.480	0.01138	0.01138	28.0	2460.457
FM Radio	91.260	0.01025	0.01025	28.0	2731.707
FM Radio	98.680	0.00823	0.00823	28.0	3403.428
FM Radio	100.830	0.00739	0.00739	28.0	3788.391
T-DAB	227.100	0.00855	0.00855	28.0	3275.620
TETRA	REDACTED	0.00759	0.01315	28.0	2129.041
TETRA	REDACTED	0.00642	0.01112	28.0	2518.823
TETRA	REDACTED	0.00454	0.00787	28.0	3559.183
TETRA	REDACTED	0.00429	0.00743	28.0	3767.375
TETRA	REDACTED	0.00311	0.00538	28.0	5203.028
TETRA	REDACTED	0.00287	0.00498	28.0	5626.804
TETRA	REDACTED	0.00234	0.00406	28.0	6896.676
TETRA	REDACTED	0.00218	0.00378	28.0	7415.508
TETRA	REDACTED	0.00207	0.00358	28.0	7813.343
TETRA	REDACTED	0.00198	0.00343	28.0	8160.428
TETRA	REDACTED	0.00180	0.00254	28.0	11011.674
TETRA	REDACTED	0.00171	0.00296	28.0	9464.759
TETRA	REDACTED	0.00171	0.00295	28.0	9481.412
TETRA	REDACTED	0.00164	0.00284	28.0	9863.214
TETRA	REDACTED	0.00163	0.00282	28.0	9929.857
TETRA	REDACTED	0.00162	0.00229	28.0	12236.706
TETRA	REDACTED	0.00155	0.00268	28.0	10429.553
TETRA	REDACTED	0.00148	0.00256	28.0	10922.843
TETRA	REDACTED	0.00131	0.00228	28.0	12302.745
PMR	REDACTED	REDACTED	REDACTED	REDACTED	10654.362

PMR	REDACTED	REDACTED	REDACTED	REDACTED	12894.192
PMR	REDACTED	REDACTED	REDACTED	REDACTED	18433.002
PMR	REDACTED	REDACTED	REDACTED	REDACTED	19776.635
PMR	REDACTED	REDACTED	REDACTED	REDACTED	28936.925
DVB-T	568.740	0.02813	0.03319	32.8	987.888
DVB-T	546.770	0.01951	0.02302	32.2	1396.580
DVB-T	579.170	0.01016	0.01199	33.1	2760.133
DVB-T	584.070	0.00896	0.01057	33.2	3144.409
DVB-T	641.670	0.00809	0.00955	34.8	3648.164
DVB-T	753.180	0.00800	0.00944	37.7	3995.924
LTE	816.000	0.00600	0.01716	39.3	2288.919
LTE	806.000	0.35050	1.00243	39.0	38.942
LTE	796.000	0.92750	2.65265	38.8	14.624
GSM	949.610	1.11900	2.23800	42.4	18.933
GSM	925.844	1.00700	2.01400	41.8	20.774
GSM	957.344	0.57140	1.14280	42.5	37.228
UMTS FDD	932.500	0.59560	2.22416	42.0	18.878
UMTS FDD	953.500	0.41550	1.55161	42.5	27.364
UMTS FDD	937.000	0.32480	1.21291	42.1	34.701
UMTS FDD	943.000	0.25190	0.94068	42.2	44.887
GSM	1842.590	0.00432	0.00865	59.0	6824.980
LTE	1815.000	0.00390	0.01366	58.6	4287.517
LTE	1830.000	0.46630	1.88628	58.8	31.183
LTE	1855.000	0.43020	1.74024	59.2	34.030
LTE	1875.000	0.82590	2.89333	59.5	20.578
UMTS FDD	2127.500	0.33670	1.06475	61.0	57.291
UMTS FDD	2122.500	0.27640	0.87406	61.0	69.789
UMTS FDD	2157.500	0.25960	0.82093	61.0	74.306
UMTS FDD	2117.500	0.25640	0.81081	61.0	75.233
UMTS FDD	2137.500	0.23650	0.74788	61.0	81.563
UMTS FDD	2112.500	0.18850	0.59609	61.0	102.333
UMTS FDD	2132.500	0.14550	0.46011	61.0	132.576
UMTS FDD	2152.500	0.08673	0.27427	61.0	222.412
UMTS FDD	2147.500	0.08461	0.26756	61.0	227.984
UMTS FDD	2142.500	0.05995	0.18958	61.0	321.764
5G NR	3653.905	0.14001	1.19432	61.0	51.075

Total Exposure Quotients [calculated from Adjusted Levels]

Quotient	Frequency Range	Calculated Quotient Value	Limit
Electrical Stimulation Effects	1 Hz to 10 MHz	n/a	1
Thermal Effects	100 kHz and above	0.022524	1

Overall Conclusions of the Survey

Frequency Selective Measurements:
(Individual emissions measured at specific frequencies)

**Below ICNIRP Public Exposure Limits
(Compliant)**

Total Exposure Quotient:
(Assessment of cumulative emissions from multiple transmitters)

**Below ICNIRP Public Exposure Limits
(Compliant)**

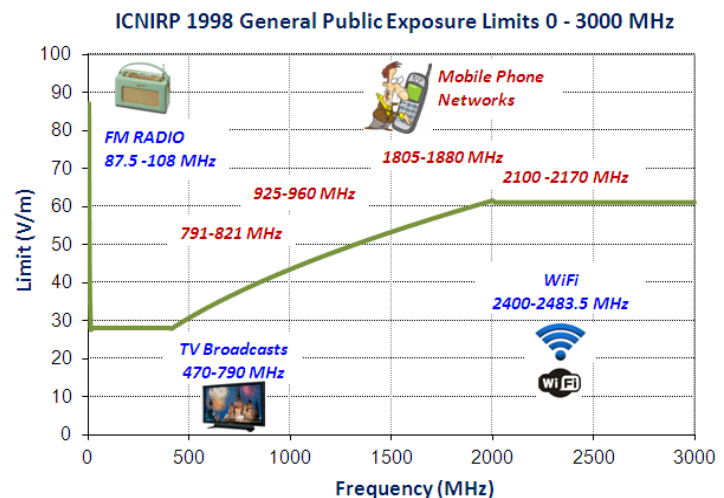
Adjusted Levels

For some emissions, an adjusted level may be required to be derived from the measured level:

- (1) **to compensate for the limited measurement resolution of the spectrum analyser.** For example, a measurement of a DVB-T (digital TV) signal performed with a resolution of 5 MHz needs to be adjusted upwards using a correction factor to account for the energy present within the full 7.61 MHz bandwidth of the signal; and/or
- (2) **to extrapolate to an estimate of the level under maximum traffic or duty cycle from the transmitter.** For example, the base stations of mobile phone networks produce emissions which vary according to the changing volume of calls or data traffic over the course of the day.

ICNIRP Public Exposure Limits

These are set out in the ICNIRP Guidelines as reference levels for the practical assessment of exposure to electric and magnetic fields, as experienced by the general public (excluding occupational exposure and exposure during medical procedures). The limits vary according to the frequency of the emissions as illustrated in the adjacent diagram. For example, the limits for Wi-Fi in the 2400-2483.5 MHz frequency band are higher than those for FM Radio transmissions in the much lower 87.5-108 MHz frequency band.



Total Exposure Quotients

The Total Exposure Quotients (which must be ≤ 1) are calculated in accordance with mathematical formulas specified in the ICNIRP Guidelines to assess the cumulative effect of emissions from multiple transmitters. The quotients in this report are calculated from the Adjusted Levels rather than from the Measured Levels to account for total potential public exposure under maximum traffic conditions.

The two quotients are as follows:

(1) Quotient for Electrical Stimulation Effects (1 Hz to 10 MHz)

This quotient is calculated only in a small number of cases where strong emissions in the frequency range between 1 Hz and 10 MHz are present at the survey location (e.g. near a long wave radio transmitter site). This essentially involves summing the ratios (measured field strength/applicable limit) for each emission.

(2) Quotient for Thermal Effects (100 kHz and above)

The measurements of any emissions above 100 kHz are used to calculate a quotient to assess any thermal (heat) effects. This essentially involves summing the squares of the ratios (measured field strength/applicable limit) for each emission.