

1. Survey Summary

Address of Transmitter Site Surveyed:	Forbes St, Grand Canal Dock, Dublin 2
Site Type:	GSM, UMTS, LTE
Survey Date:	24/06/2019

Measurement Location: (at point of maximum non-ionising radiation near site)	Beside traffic light, at junction of Forbes St and Sir John Rogersons Quay.
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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	20	45.7	W	6	14	16.6

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)	Below ICNIRP Public Limits (Compliant)
Total Exposure Quotient: (Assessment of cumulative emissions from multiple transmitters)	Below ICNIRP Public Limits (Compliant)

2. Surveyors

Survey conducted for ComReg by:	Compliance Engineering Ireland Ltd.	
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Survey Engineer(s):	Report Writer:	Report Reviewer:
Michael Reilly, BEng	Michael Reilly, BEng	John McAuley, MEng

3. Survey Location Details

Designated Transmitter Site Photo



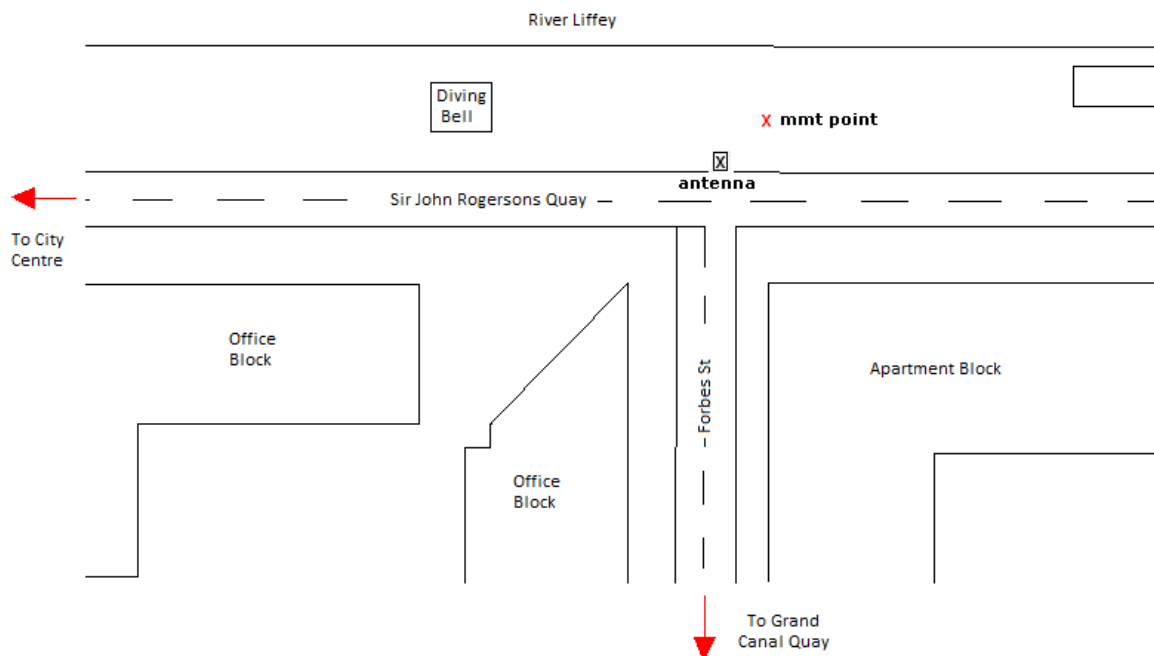
Survey Weather

Sky: Overcast

Temperature:
14° C

Relative Humidity:
48 %

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.erdocdb.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

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 $\max(\lambda, D, D^2/4\lambda)$

radiated EMF, the relationship between E and H becomes very complex and there is no direct correlation between both components of the EMF.

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>ISOTROPIC PROBE</p> <p>FIELD STRENGTH METER</p> <p>Used to measure the overall electric or magnetic field present over a range of frequencies (e.g. 100kHz to 3GHz).</p>	<p>SPECTRUM ANALYSER WITH TRIPOD MOUNTED ANTENNA CONNECTED</p>  <p>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>	<p>PORTABLE SPECTRUM ANALYSER WITH ANTENNA DIRECTLY CONNECTED</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.

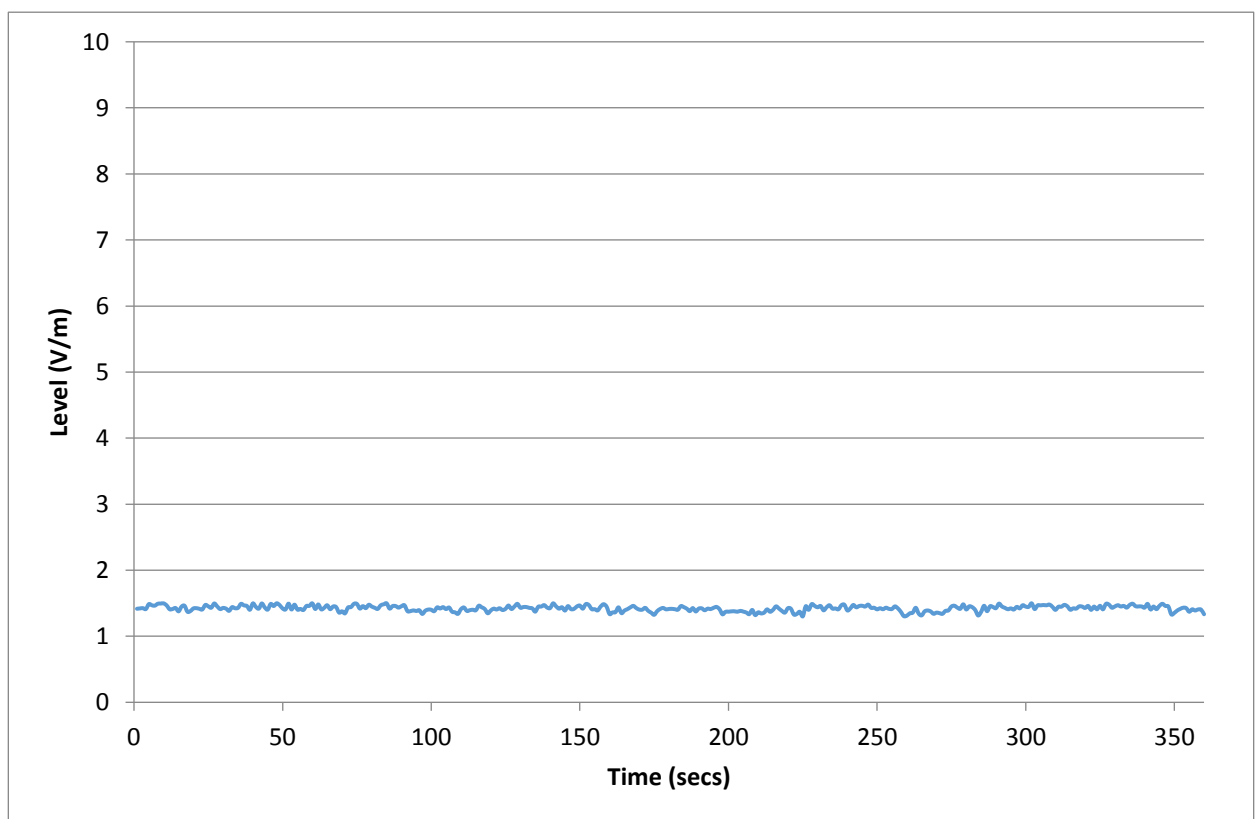
7. Full Survey – Broadband Measurements

The purpose of these measurements was to get an overview of the intensity of the electromagnetic field present at the point of maximum NIR near the site. There, the field strength meter 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 **60 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).

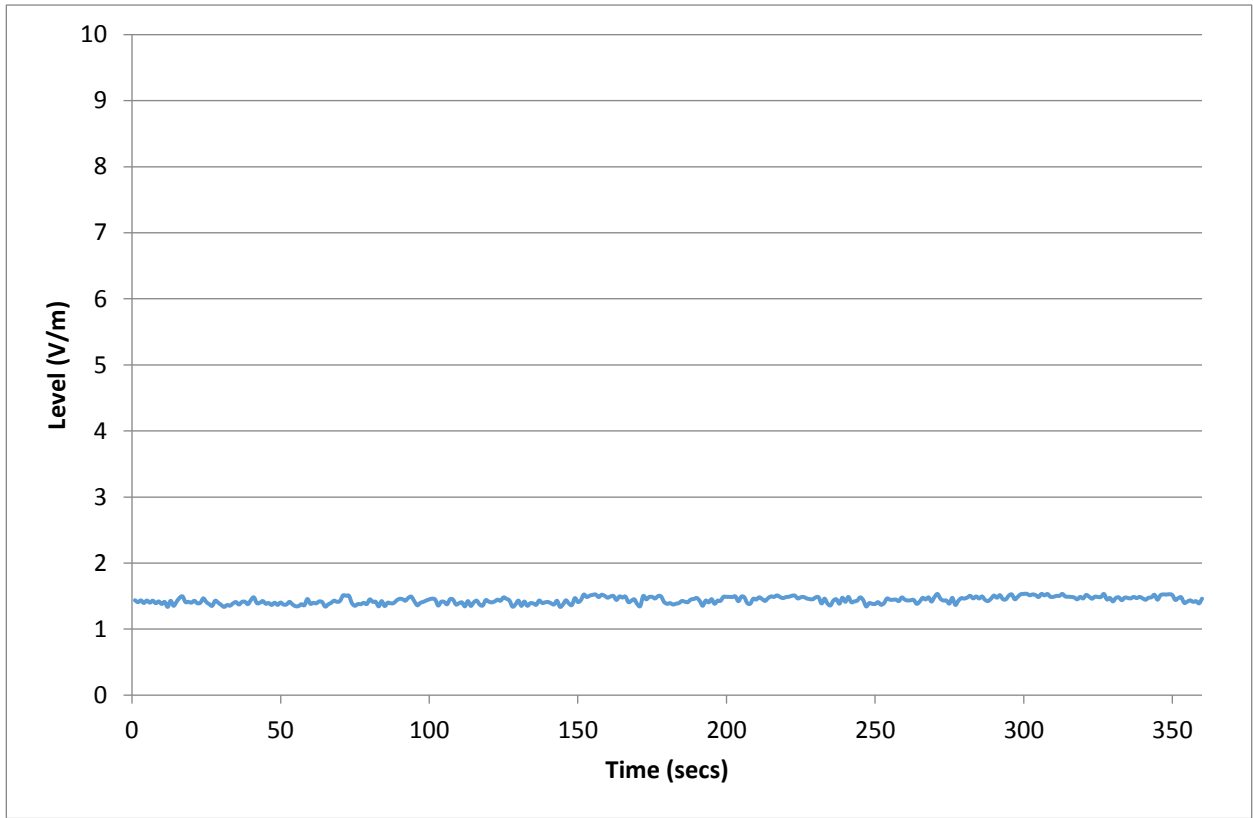
Electric field strengths recorded over 6 minute period using 3 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	1.42 V/m	Peak Measurement V/m:	1.50 V/m
Date:	24/06/2019	Start Time:	15:14
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:	1.44 V/m	Peak Measurement V/m:	1.53 V/m
Date:	24/06/2019	Start Time:	15:21
Meter:	NBM-550	Probe:	EF 6091
Frequency Range:	100 MHz – 60 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	92.890	0.01490	0.01490	28.0	1879.195
FM Radio	96.680	0.01129	0.01129	28.0	2480.071
FM Radio	106.800	0.01077	0.01077	28.0	2599.814
FM Radio	102.190	0.01058	0.01058	28.0	2646.503
FM Radio	90.700	0.00961	0.00961	28.0	2912.722
FM Radio	106.000	0.00934	0.00934	28.0	2998.501
FM Radio	101.770	0.00931	0.00931	28.0	3006.873
FM Radio	94.870	0.00835	0.00835	28.0	3352.892
FM Radio	100.280	0.00804	0.00804	28.0	3480.855
FM Radio	98.110	0.00795	0.00795	28.0	3520.241
FM Radio	88.530	0.00769	0.00769	28.0	3641.566
FM Radio	104.390	0.00733	0.00733	28.0	3822.004
FM Radio	98.670	0.00693	0.00693	28.0	4039.821
FM Radio	103.800	0.00670	0.00670	28.0	4182.226
FM Radio	100.900	0.00669	0.00669	28.0	4188.482
FM Radio	93.460	0.00536	0.00536	28.0	5225.831
FM Radio	91.290	0.00533	0.00533	28.0	5255.255
FM Radio	89.210	0.00492	0.00492	28.0	5695.688
FM Radio	89.990	0.00481	0.00481	28.0	5817.577
FM Radio	95.990	0.00474	0.00474	28.0	5904.682
PMR	REDACTED	0.00165	0.00165	28.0	17010.936
T-DAB	227.420	0.01537	0.01537	28.0	1821.731
TETRA	REDACTED	0.01277	0.01806	28.0	1550.430
TETRA	REDACTED	0.01089	0.01886	28.0	1484.464
TETRA	REDACTED	0.00984	0.01704	28.0	1643.368
TETRA	REDACTED	0.00861	0.01490	28.0	1878.653
TETRA	REDACTED	0.00755	0.01307	28.0	2142.302
TETRA	REDACTED	0.00599	0.01037	28.0	2699.701
TETRA	REDACTED	0.00586	0.01015	28.0	2757.729
TETRA	REDACTED	0.00538	0.00933	28.0	3002.565
TETRA	REDACTED	0.00492	0.00852	28.0	3287.738
TETRA	REDACTED	0.00471	0.00815	28.0	3433.689
TETRA	REDACTED	0.00465	0.00806	28.0	3474.276
TETRA	REDACTED	0.00450	0.00780	28.0	3590.008
TETRA	REDACTED	0.00431	0.00746	28.0	3753.380
TETRA	REDACTED	0.00410	0.00709	28.0	3947.694
TETRA	REDACTED	0.00367	0.00636	28.0	4401.254
TETRA	REDACTED	0.00331	0.00573	28.0	4888.360
TETRA	REDACTED	0.00297	0.00514	28.0	5446.701
TETRA	REDACTED	0.00295	0.00510	28.0	5489.239
TETRA	REDACTED	0.00260	0.00451	28.0	6212.839
TETRA	REDACTED	0.00244	0.00423	28.0	6617.195

TETRA	REDACTED	0.00202	0.00286	28.0	9796.630
TETRA	REDACTED	0.00201	0.00348	28.0	8038.691
TETRA	REDACTED	0.00195	0.00338	28.0	8281.664
TETRA	REDACTED	0.00164	0.00284	28.0	9875.264
TETRA	REDACTED	0.00164	0.00283	28.0	9887.344
TETRA	REDACTED	0.00156	0.00271	28.0	10342.807
TETRA	REDACTED	0.00150	0.00259	28.0	10806.021
TETRA	REDACTED	0.00142	0.00245	28.0	11408.474
TETRA	REDACTED	0.00121	0.00209	28.0	13371.222
TETRA	REDACTED	0.00118	0.00205	28.0	13676.656
TETRA	REDACTED	0.00099	0.00171	28.0	16380.391
PMR	REDACTED	REDACTED	REDACTED	REDACTED	1570.537
PMR	REDACTED	REDACTED	REDACTED	REDACTED	1847.845
PMR	REDACTED	REDACTED	REDACTED	REDACTED	2405.477
PMR	REDACTED	REDACTED	REDACTED	REDACTED	2775.951
PMR	REDACTED	REDACTED	REDACTED	REDACTED	5916.448
PMR	REDACTED	REDACTED	REDACTED	REDACTED	6366.294
PMR	REDACTED	REDACTED	REDACTED	REDACTED	7345.370
PMR	REDACTED	REDACTED	REDACTED	REDACTED	10030.850
PMR	REDACTED	REDACTED	REDACTED	REDACTED	25621.650
PMR	REDACTED	REDACTED	REDACTED	REDACTED	28377.909
PMR	REDACTED	REDACTED	REDACTED	REDACTED	30740.300
PMR	REDACTED	REDACTED	REDACTED	REDACTED	30979.487
PMR	REDACTED	REDACTED	REDACTED	REDACTED	32661.954
PMR	REDACTED	REDACTED	REDACTED	REDACTED	36138.937
DVB-T	544.510	0.04459	0.05262	32.1	609.798
DVB-T	570.360	0.04231	0.04993	32.8	657.737
DVB-T	737.870	0.01795	0.02118	37.4	1763.381
DVB-T	577.500	0.01753	0.02069	33.0	1597.404
DVB-T	584.730	0.01620	0.01912	33.2	1739.336
DVB-T	769.810	0.01311	0.01547	38.1	2466.095
DVB-T	662.960	0.00766	0.00903	35.4	3919.396
LTE	816.000	0.11360	0.32490	39.3	120.894
LTE	806.000	0.06380	0.18247	39.0	213.936
LTE	796.000	0.08040	0.22994	38.8	168.709
GSM	948.438	0.18080	0.36160	42.3	117.106
GSM	928.375	0.08510	0.17020	41.9	246.153
GSM	955.656	0.06565	0.13130	42.5	323.734
UMTS FDD	943.000	0.22020	0.82230	42.2	51.349
UMTS FDD	937.000	0.21480	0.80213	42.1	52.472
UMTS FDD	953.500	0.12840	0.47949	42.5	88.550
UMTS FDD	932.500	0.06304	0.23541	42.0	178.361
GSM	1843.380	0.31420	0.62840	59.0	93.945
LTE	1815.000	0.14940	0.52338	58.6	111.923
LTE	1830.000	0.12350	0.49958	58.8	117.739
LTE	1855.000	0.15820	0.63995	59.2	92.540
LTE	1875.000	0.04930	0.17271	59.5	344.735
UMTS FDD	2112.500	0.34250	1.08309	61.0	56.320

UMTS FDD	2122.500	0.20840	0.65902	61.0	92.561
UMTS FDD	2117.500	0.20730	0.65554	61.0	93.052
UMTS FDD	2147.500	0.11600	0.36683	61.0	166.291
UMTS FDD	2142.500	0.10240	0.32382	61.0	188.377
UMTS FDD	2127.500	0.08627	0.27281	61.0	223.598
UMTS FDD	2132.500	0.07502	0.23724	61.0	257.128
UMTS FDD	2152.500	0.06619	0.20931	61.0	291.430
UMTS FDD	2157.500	0.04782	0.15122	61.0	403.383
UMTS FDD	2137.500	0.03381	0.10692	61.0	570.534
WiFi	2432.500	0.02962	0.04819	61.0	1265.855
WiFi	2442.020	0.02478	0.04031	61.0	1513.100
WiFi	2410.530	0.02278	0.03706	61.0	1645.945
WiFi	2470.260	0.02215	0.03604	61.0	1692.759
WiFi	2416.420	0.02068	0.03364	61.0	1813.086
LTE	3421.143	0.03454	0.14712	61.0	414.621
LTE	3590.762	0.00269	0.01146	61.0	5321.707
WiFi	5220.476	0.00198	0.00846	61.0	7213.933
WiFi	5538.405	0.00177	0.00754	61.0	8093.718
BWA/WIMAX	5802.381	0.00178	0.00928	61.0	6569.914

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	0.002205	1

Overall Conclusions of the Survey

Frequency Selective Measurements: (Individual emissions measured at specific frequencies)	Below ICNIRP Public Limits (Compliant)
Total Exposure Quotient: (Assessment of cumulative emissions from multiple transmitters)	Below ICNIRP Public Limits (Compliant)

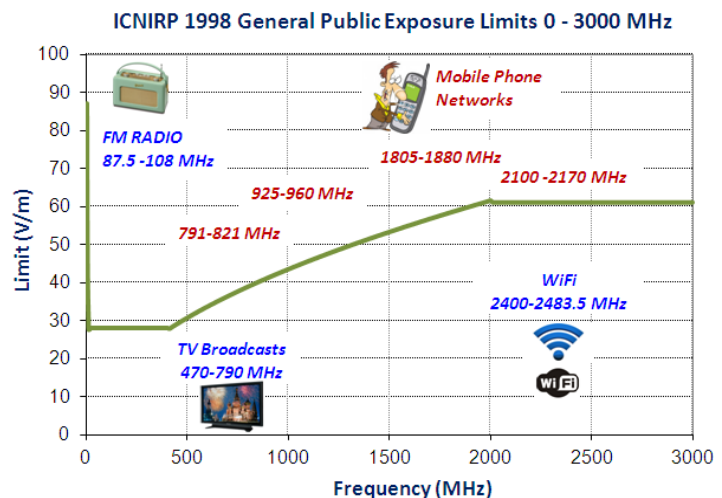
Adjusted Levels

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.