

1. Survey Summary

Address of Transmitter Site Surveyed:	Waterford Garda Station, 22 Patrick St, Waterford
Site Type:	GSM, UMTS, LTE
Survey Date:	13/06/2019

Measurement Location: (at point of maximum non-ionising radiation near site)	In public car park opposite garda station
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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	52	15	36.0	W	7	6	59.4

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)	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



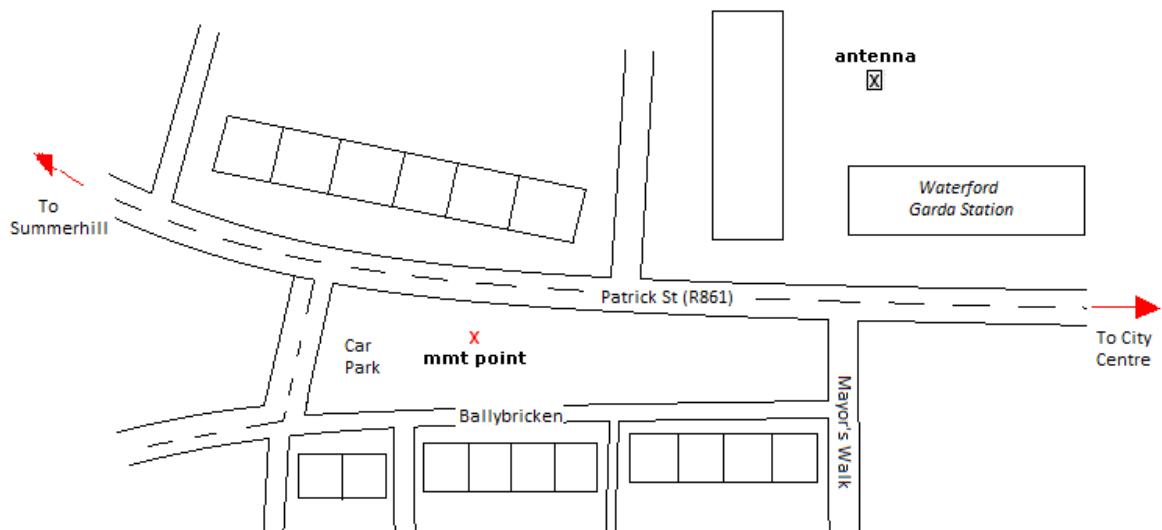
Survey Weather

Sky: *Overcast, Light Rain*

Temperature:
12° C

Relative Humidity:
52 %

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

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 $\max(5\lambda, 5D, 0.6D^2/\lambda)$


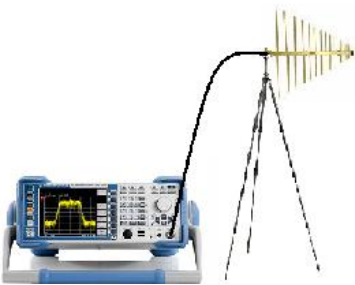

⁹ Within a distance of $\max(\lambda, D, D^2/4\lambda)$

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.

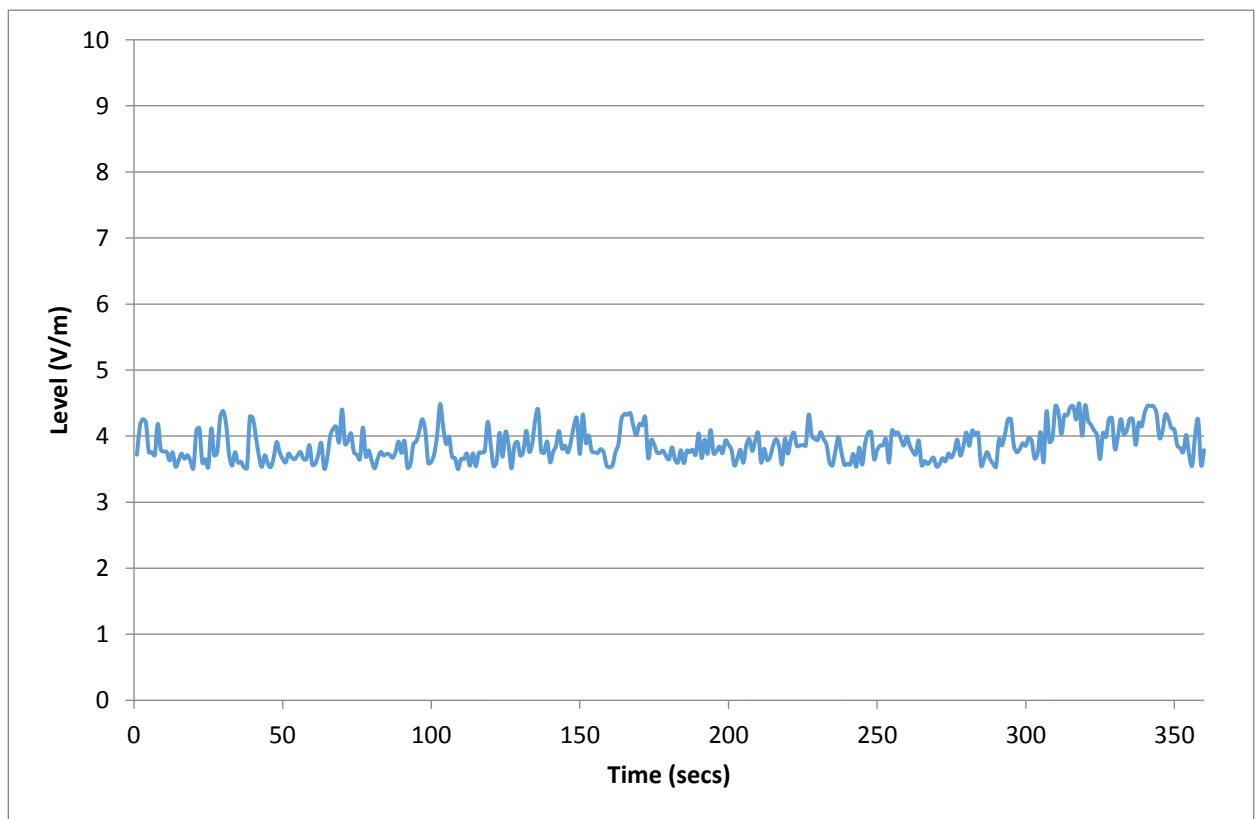
7. Full Survey – Broadband Measurements

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).

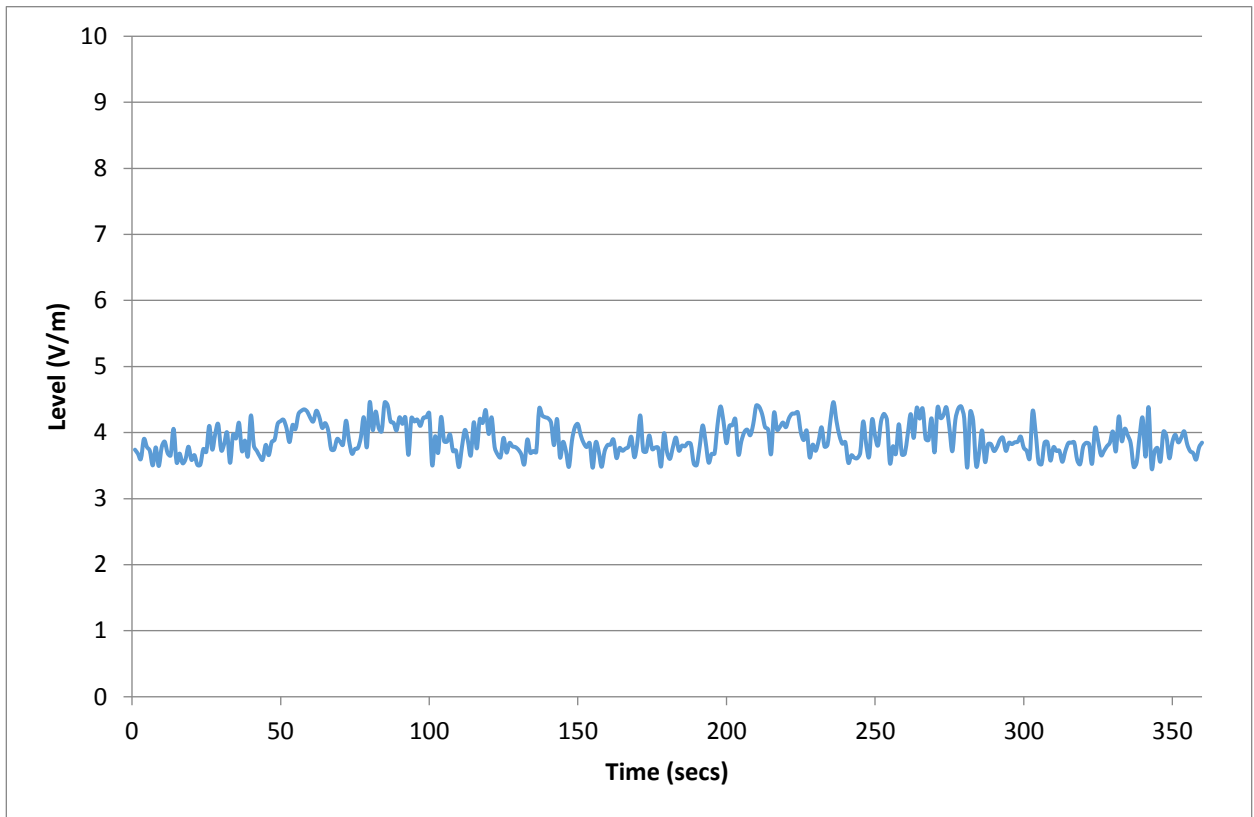
Electric field strengths recorded over 6 minute period using 3 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	3.87 V/m	Peak Measurement V/m:	4.49 V/m
Date:	14/06/2019	Start Time:	11:38
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:	3.90 V/m	Peak Measurement V/m:	4.46 V/m
Date:	14/06/2019	Start Time:	11:45
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	107.400	0.12470	0.12470	28.0	224.539
FM Radio	100.090	0.04573	0.04573	28.0	612.290
FM Radio	90.100	0.02863	0.02863	28.0	977.995
FM Radio	97.890	0.02022	0.02022	28.0	1384.768
FM Radio	92.670	0.01036	0.01036	28.0	2702.703
FM Radio	93.380	0.01015	0.01015	28.0	2758.621
FM Radio	98.590	0.00975	0.00975	28.0	2872.679
FM Radio	105.110	0.00919	0.00919	28.0	3047.785
FM Radio	100.800	0.00837	0.00837	28.0	3346.880
FM Radio	91.190	0.00808	0.00808	28.0	3466.205
FM Radio	88.350	0.00719	0.00719	28.0	3893.215
FM Radio	88.990	0.00667	0.00667	28.0	4199.160
FM Radio	96.000	0.00657	0.00657	28.0	4262.445
FM Radio	95.120	0.00605	0.00605	28.0	4631.161
FM Radio	102.770	0.00538	0.00538	28.0	5200.594
FM Radio	101.380	0.00524	0.00524	28.0	5346.572
FM Radio	99.240	0.00481	0.00481	28.0	5821.206
FM Radio	103.880	0.00442	0.00442	28.0	6334.842
TETRA	REDACTED	0.06573	0.11385	28.0	245.943
TETRA	REDACTED	0.05895	0.10210	28.0	274.229
TETRA	REDACTED	0.00167	0.00289	28.0	9691.731
TETRA	REDACTED	0.00160	0.00277	28.0	10103.630
TETRA	REDACTED	0.00134	0.00233	28.0	12028.131
PMR	REDACTED	REDACTED	REDACTED	REDACTED	2134.235
PMR	REDACTED	REDACTED	REDACTED	REDACTED	2845.446
PMR	REDACTED	REDACTED	REDACTED	REDACTED	3911.649
PMR	REDACTED	REDACTED	REDACTED	REDACTED	6909.723
PMR	REDACTED	REDACTED	REDACTED	REDACTED	31684.358
DVB-T	505.050	0.24130	0.28473	30.9	108.525
DVB-T	481.650	0.16650	0.19647	30.2	153.593
DVB-T	722.390	0.00600	0.00707	37.0	5224.171
LTE	816.000	0.02060	0.05892	39.3	666.676
LTE	806.000	0.47560	1.36022	39.0	28.699
LTE	796.000	0.73110	2.09095	38.8	18.553
GSM	957.342	1.24000	2.48000	42.5	17.155
GSM	927.063	1.04300	2.08600	41.9	20.070
GSM	945.906	0.04711	0.09422	42.3	448.832
UMTS FDD	937.000	1.09200	4.07788	42.1	10.321
UMTS FDD	943.000	0.71820	2.68199	42.2	15.744
UMTS FDD	932.500	0.22010	0.82192	42.0	51.085
UMTS FDD	953.500	0.07444	0.27798	42.5	152.737
GSM	1841.380	0.28350	0.56700	59.0	104.062

LTE	1815.000	1.00000	3.50325	58.6	16.721
LTE	1830.000	0.22410	0.90653	58.8	64.885
LTE	1855.000	0.83650	3.38381	59.2	17.501
LTE	1875.000	0.02400	0.08408	59.5	708.144
UMTS FDD	2122.500	1.06300	3.36152	61.0	18.147
UMTS FDD	2117.500	0.89380	2.82646	61.0	21.582
UMTS FDD	2147.500	0.73670	2.32967	61.0	26.184
UMTS FDD	2152.500	0.64390	2.03620	61.0	29.958
UMTS FDD	2157.500	0.64190	2.02988	61.0	30.051
UMTS FDD	2112.500	0.61520	1.94545	61.0	31.355
UMTS FDD	2127.500	0.32320	1.02206	61.0	59.684
UMTS FDD	2132.500	0.24310	0.76876	61.0	79.349
WiFi	2456.070	0.05939	0.09662	61.0	631.329
WiFi	2437.040	0.04931	0.08022	61.0	760.386
WiFi	2450.200	0.04687	0.07625	61.0	799.971
WiFi	5221.111	0.00170	0.00513	61.0	11902.184
BWA/WIMAX	5812.381	0.00113	0.00240	61.0	25418.854
BWA/WIMAX	5828.333	0.00296	0.00630	61.0	9681.832
BWA/WIMAX	5846.190	0.00713	0.01519	61.0	4016.102
BWA/WIMAX	5856.190	0.00080	0.00171	61.0	35770.725
BWA/WIMAX	5871.667	0.00077	0.00164	61.0	37160.697

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	0.041537	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)

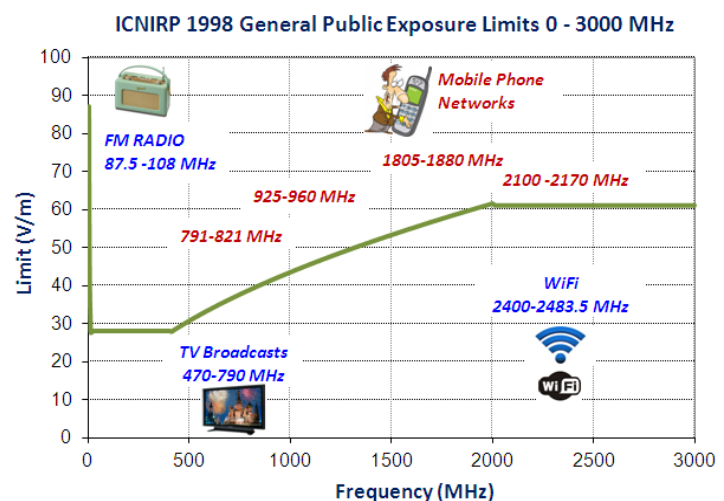
Adjusted Levels

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.