

1. Survey Summary

Address of Transmitter Site Surveyed:	Knockanore, Lahesheragh North, Co. Kerry
Site Type:	GSM, UMTS, LTE, FM, TETRA
Survey Date:	12/06/2019

Measurement Location: (at point of maximum non-ionising radiation near site)	At gate of RTE compound
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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	31	25.0	W	9	36	17.7

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



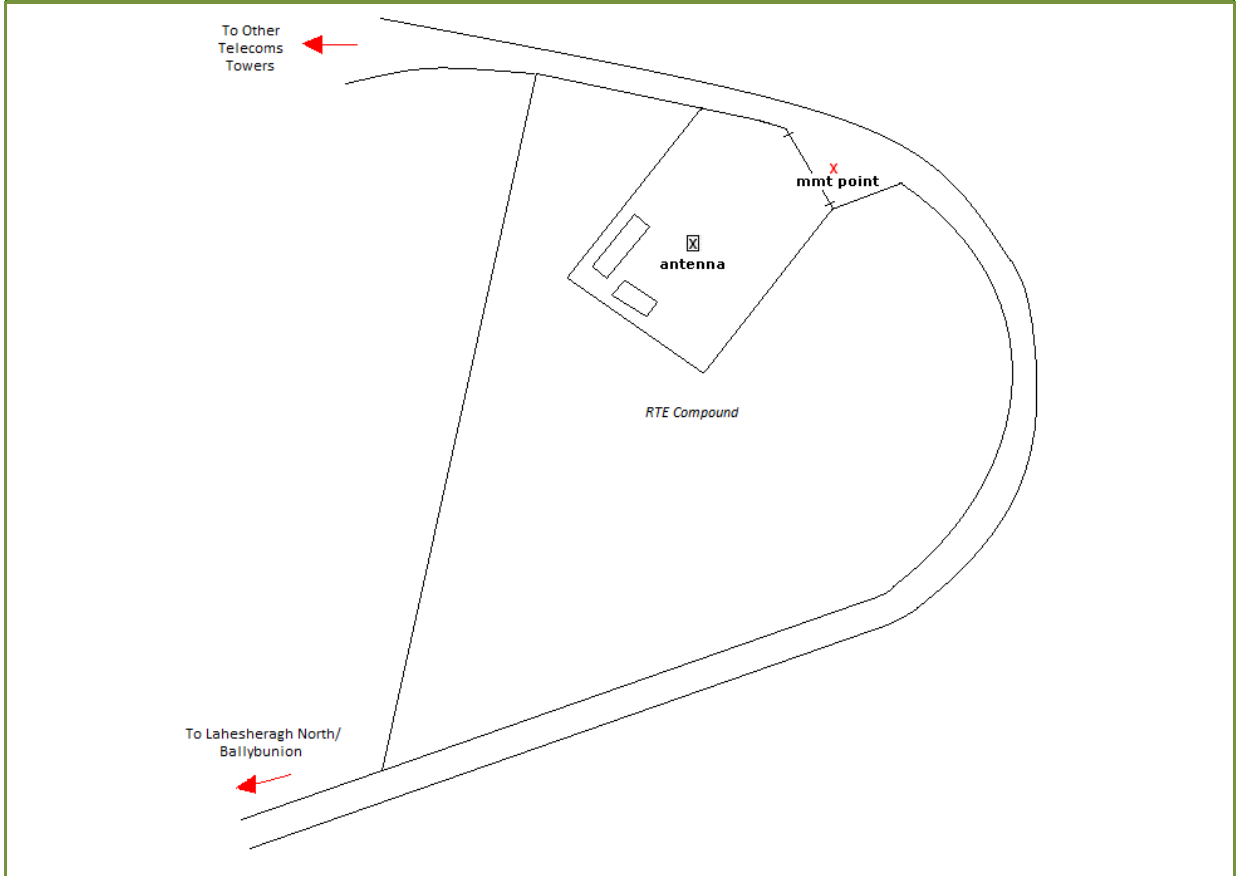
Survey Weather

Sky: Cloudy

Temperature:
12° C

Relative Humidity:
50 %

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


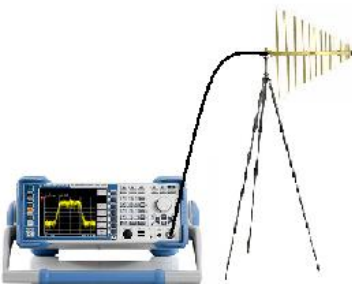

⁹ Within a distance of $\max(\lambda, D, D^2/4\lambda)$

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.

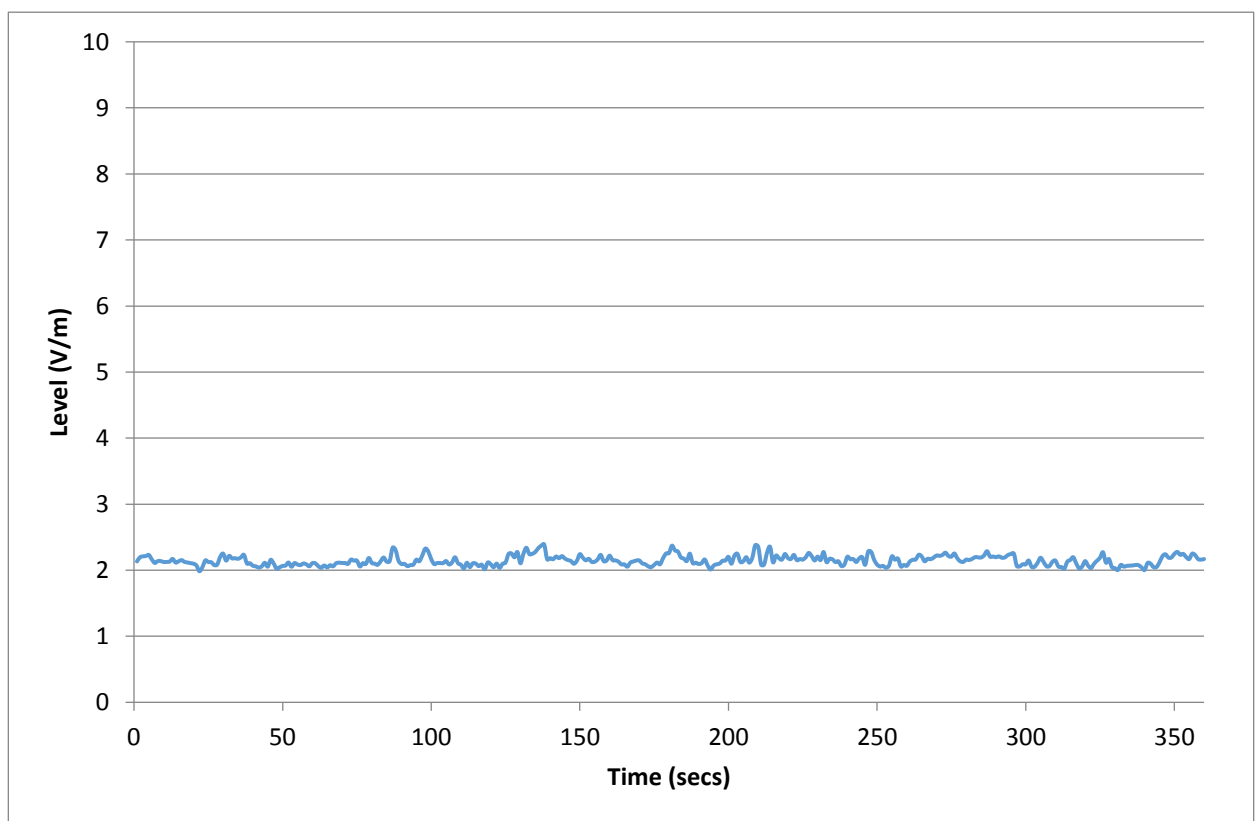
7. Full Survey – Broadband Measurements

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).

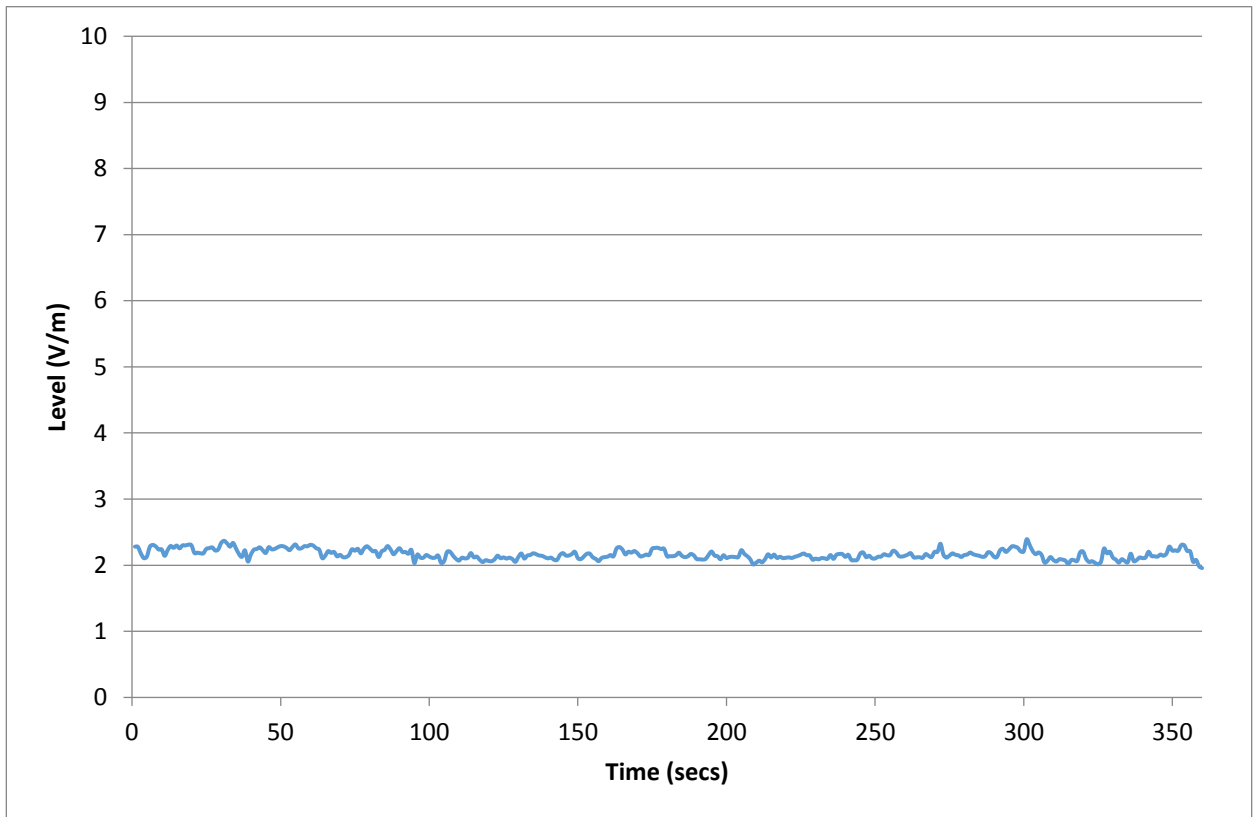
Electric field strengths recorded over 6 minute period using 3 GHz probe at point of maximum NIR



Acquisition Mode: 1 Sec. Sampling

Mean Measurement V/m:	2.15 V/m	Peak Measurement V/m:	2.39 V/m
Date:	12/06/2019	Start Time:	09:27
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:	2.16 V/m	Peak Measurement V/m:	2.39 V/m
Date:	12/06/2019	Start Time:	09:35
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	97.590	1.12000	1.12000	28.0	25.000
FM Radio	100.990	1.00900	1.00900	28.0	27.750
FM Radio	98.690	0.13140	0.13140	28.0	213.090
FM Radio	93.580	0.11040	0.11040	28.0	253.623
FM Radio	91.380	0.08900	0.08900	28.0	314.607
FM Radio	89.200	0.08491	0.08491	28.0	329.761
FM Radio	102.710	0.00597	0.00597	28.0	4692.475
FM Radio	92.210	0.00593	0.00593	28.0	4724.144
FM Radio	95.490	0.00546	0.00546	28.0	5132.906
FM Radio	104.590	0.00544	0.00544	28.0	5150.846
FM Radio	95.950	0.00509	0.00509	28.0	5502.063
FM Radio	94.430	0.00491	0.00491	28.0	5700.326
FM Radio	90.500	0.00486	0.00486	28.0	5760.132
PMR	REDACTED	0.01023	0.01023	28.0	2737.048
PMR	REDACTED	0.00808	0.00808	28.0	3467.063
TETRA	REDACTED	0.29440	0.50992	28.0	54.911
TETRA	REDACTED	0.00276	0.00478	28.0	5857.177
TETRA	REDACTED	0.00276	0.00478	28.0	5857.177
TETRA	REDACTED	0.00258	0.00446	28.0	6273.111
TETRA	REDACTED	0.00247	0.00428	28.0	6542.213
TETRA	REDACTED	0.00233	0.00403	28.0	6950.046
TETRA	REDACTED	0.00227	0.00393	28.0	7124.640
TETRA	REDACTED	0.00224	0.00388	28.0	7220.102
TETRA	REDACTED	0.00213	0.00369	28.0	7578.906
TETRA	REDACTED	0.00196	0.00339	28.0	8252.071
TETRA	REDACTED	0.00179	0.00310	28.0	9046.339
TETRA	REDACTED	0.00176	0.00305	28.0	9179.902
TETRA	REDACTED	0.00176	0.00305	28.0	9190.340
TETRA	REDACTED	0.00166	0.00287	28.0	9767.860
TETRA	REDACTED	0.00153	0.00264	28.0	10600.530
TETRA	REDACTED	0.00149	0.00258	28.0	10856.822
TETRA	REDACTED	0.00148	0.00257	28.0	10908.102
TETRA	REDACTED	0.00128	0.00221	28.0	12659.207
TETRA	REDACTED	0.00118	0.00205	28.0	13676.656
TETRA	REDACTED	0.00116	0.00201	28.0	13948.065
PMR	REDACTED	REDACTED	REDACTED	REDACTED	1795.067
PMR	REDACTED	REDACTED	REDACTED	REDACTED	5695.978
PMR	REDACTED	REDACTED	REDACTED	REDACTED	8153.505
DVB-T	682.130	0.38400	0.45312	35.9	79.254
DVB-T	659.430	0.38300	0.45194	35.3	78.128
DVB-T	747.300	0.06404	0.07557	37.6	497.413
DVB-T	672.500	0.03446	0.04066	35.7	876.903

DVB-T	692.500	0.03203	0.03780	36.2	957.356
DVB-T	498.130	0.01211	0.01429	30.7	2147.573
DVB-T	473.700	0.01117	0.01318	29.9	2270.488
LTE	816.000	0.10950	0.31317	39.3	125.420
LTE	806.000	0.18580	0.53139	39.0	73.461
LTE	796.000	0.04570	0.13070	38.8	296.809
GSM	946.574	0.81900	1.63800	42.3	25.827
GSM	955.750	0.35270	0.70540	42.5	60.261
GSM	927.156	0.16510	0.33020	41.9	126.795
UMTS FDD	953.500	0.51060	1.90674	42.5	22.267
UMTS FDD	943.000	0.25960	0.96943	42.2	43.555
UMTS FDD	937.000	0.08662	0.32347	42.1	130.120
UMTS FDD	932.500	0.01374	0.05131	42.0	818.330
GSM	1842.130	0.00251	0.00501	59.0	11779.453
LTE	1815.000	0.00300	0.01051	58.6	5573.772
LTE	1830.000	0.14630	0.59181	58.8	99.390
LTE	1855.000	0.08240	0.33332	59.2	177.667
LTE	1875.000	0.00450	0.01576	59.5	3776.768
UMTS FDD	2127.500	0.22450	0.70994	61.0	85.923
UMTS FDD	2117.500	0.13180	0.41679	61.0	146.356
UMTS FDD	2122.500	0.10870	0.34374	61.0	177.459
UMTS FDD	2112.500	0.06167	0.19502	61.0	312.790
UMTS FDD	2132.500	0.06040	0.19100	61.0	319.367
UMTS FDD	2152.500	0.01134	0.03586	61.0	1701.037
UMTS FDD	2147.500	0.00957	0.03025	61.0	2016.491
LTE	3491.095	0.00922	0.03928	61.0	1553.141
LTE	3510.905	0.00621	0.02647	61.0	2304.765
LTE	3529.476	0.01134	0.04830	61.0	1263.043
LTE	3549.905	0.01406	0.05989	61.0	1018.551
LTE	3590.762	0.00389	0.01659	61.0	3676.440
BWA/WIMAX	3744.286	0.01594	0.15189	61.0	401.609
WiFi	5183.651	0.03204	0.16723	61.0	364.774
WiFi	5235.714	0.01087	0.05674	61.0	1074.993
WiFi	5289.683	0.00523	0.02731	61.0	2233.277
WiFi	5499.143	0.00470	0.02454	61.0	2485.783
WiFi	5642.024	0.00141	0.00301	61.0	20250.476
WiFi	5675.214	0.00269	0.01406	61.0	4340.006
BWA/WIMAX	5750.714	0.00269	0.00813	61.0	7506.779
BWA/WIMAX	5771.190	0.00259	0.00781	61.0	7811.828
BWA/WIMAX	5795.476	0.00819	0.04274	61.0	1427.118
BWA/WIMAX	5864.524	0.00213	0.00642	61.0	9500.658

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	0.008705	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)

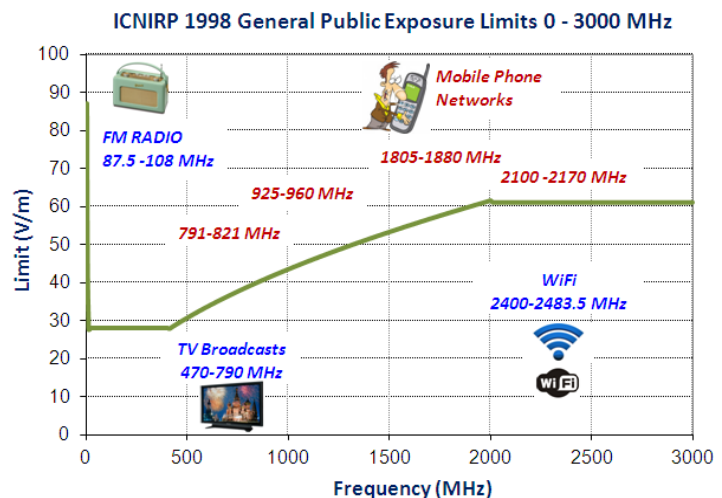
Adjusted Levels

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.