2014

# Interference caused by mobile telephones

Spack Karin

Witschi Electronic Ltd

08.05.2014

# Interference caused by mobile telephones

All Witschi devices with the CE label fulfil EMC directives according to 89/336/EEC and **2004/108/EC**.

**Immunity** is tested according to **Test Standard IEC 61000-4-3**. The objective of this test is to check immunity to electromagnetic fields which are generated, for example, by mobile telephones.

Fields are generated successively using horizontal and vertical polarisation. The field strength (test level) is **3V/m**. The frequency range tested is 80 to 1,000 MHz.

In addition since 2008, 1,400 to 2,000 MHz are tested with 3 V/m and 2 to 2.7 GHz with 1 V/m.

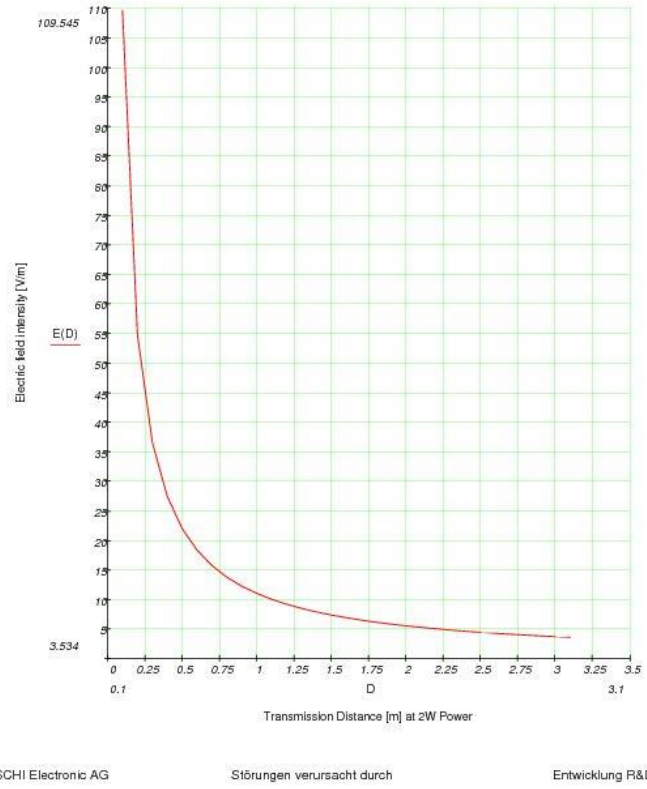
**Information on radiation intensity emitted from mobile telephones when reception conditions are poor:**

In the case of mobile telephones, the transmission power is continuously kept at the lowest value automatically. Therefore, when telephoning from indoors, a greater transmission power is required than in the open air. Consequently, depending on the location of the persons telephoning, signal strengths are subject to continuous fluctuations. Peak values can greatly exceed the values typically measured.

**Distance to achieve various interference field strengths:**

| | **3 V/m** | 10 V/m | 100 V/m | Remark |
|---|---|---|---|---|
| GSM mobile telephone | **About 3 m** | About 1 m | Under 1 cm | At max. transmission power (**2 watts** at 900 MHz) |

⇨ **In order to prevent interference and measurement errors when using mobile telephones, a minimum distance of 3 m from the measuring device is recommended.**



# Recommendations of Witschi Electronic Ltd

Dear Customers

The most important information is as follows:

**In order to prevent interference and measurement errors when using portable telephones (mobile telephones and DECT cordless telephones), a minimum distance of 3 m from the measuring device is recommended.**

You will find more detailed information on the following pages about:

1. Mobile telephones
2. Cordless (DECT) telephones
3. Bluetooth
4. WLAN (WiFi)
5. Electric field strengths in any place
6. Electric field strengths in any place with an antenna with absolute gain $G_i$
7. Standards used for the EMC testing of Witschi devices

Please do not hesitate to contact us if you have any questions.

Witschi Electronic Ltd

# Further useful information

Source: www.bag.admin.ch/themen/strahlung/00053/index.html?lang=en

## 1. Mobile telephones

**GSM** (Global System for Mobile Communications) is a digital mobile communications standard that is used above all for telephony and transmitting SMS messages ("texting"). The GSM standard uses frequencies in the 900 MHz band (GSM-900, D-network) or 1,800 MHz band (GSM-1800, E-network). Triband mobile phones can also operate using the 1,900 MHz band (GSM-1900) and these frequencies are primarily used in the USA. Newer quadband mobiles (also commonplace in the USA) also operate at 850 MHz. Whilst the base stations for mobile telephones have a transmission power of around 50 watts, mobile telephones can manage with a transmission power of max. **2 watts** (D-network) and **1 watt** (E-network).

However, mobile telephones can also be used for sending data and surfing the internet, **GPRS** (General Packet Radio System) and **Edge** (Enhanced data rate for global evolution) are further developments of GSM that can be used for data traffic.

**UMTS** (Universal Mobile Telecommunication System), the new (third) generation in mobile telecommunications, has an increased data rate in comparison with GSM and is better suited to data and multimedia services. However, it is also used for telephony and SMS messaging. UMTS will replace the GSM standard in the medium term. The max. transmission power is **250mW.**

| | GSM | | UMTS |
|---|---|---|---|
| Transmission frequency (MHz) | 900 | 1,800 | 2,100 |
| Peak transmission power (mW) | 2,000 | 1,000 | 125 - 250 |
| Max. transmission frequency (mW) | 240 | 120 | 125 -250 |

## 2. Cordless (DECT) telephones

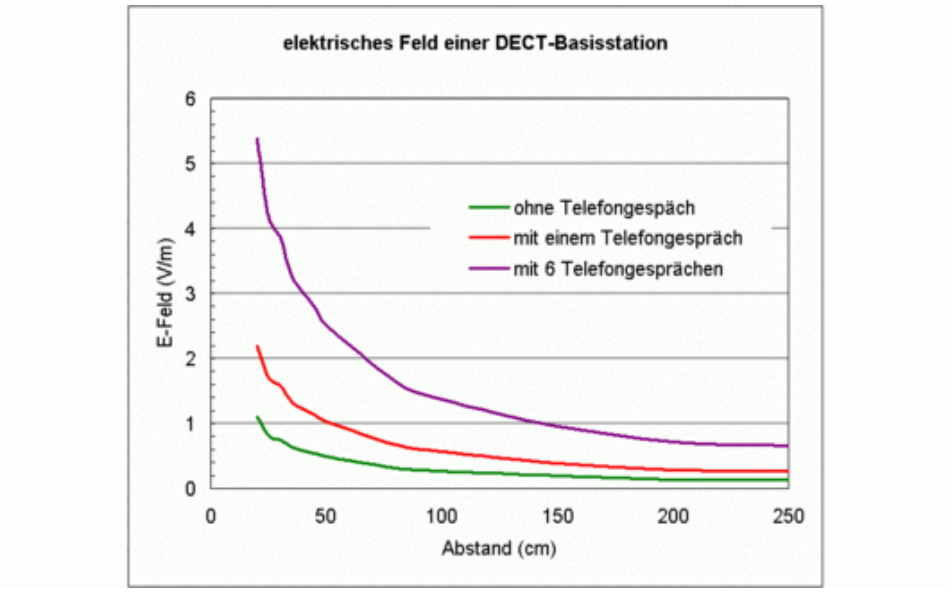
Most cordless telephones nowadays are DECT telephones (DECT: Digital Enhanced Cordless Telecommunications). They consist of a base station and one or more handsets. The handset only radiates during a telephone conversation and the base station normally radiates all the time.

The radiation from the base station and handsets is very small. That of the handset is approximately 40 times smaller than the recommended limit value, and that of the base station is quickly reduced by distance. So at a distance of 20 cm it is around 25 times smaller than the recommended limit value and at a 1 m distance in the region of 100 times.

| | Transmission power of base station (mW) | Transmission power of handset (mW) |
|---|---|---|
| Peak transmission power | 250 | 250 |
| Telephone call | 10 | 10 |

| | | |
|---|---|---|
| Standby mode | 2.5 | 0 |

The **electric field** close to a DECT base station when one or more mobile telephones are in and out of operation is shown in the graph below. A strong dependency on distance is apparent from it. The field strengths measured are always well below the limit value recommended by the ICNIRP of 60 V/m. Even during six simultaneous calls, the field at a distance of 20 cm is 10 times smaller than this limit value.




## 3. Bluetooth

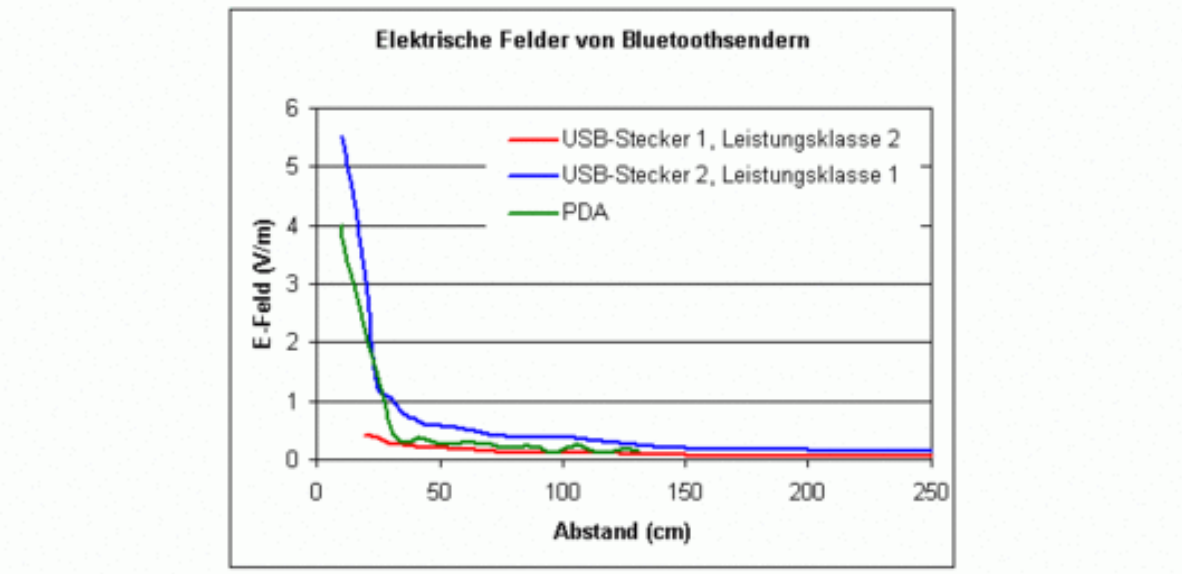
Bluetooth radio connections (IEEE 802.15.1) are used for voice and data transmission over short distances. By using Bluetooth, you can connect different devices wirelessly, e.g. a mobile phone with a handsfree device or a laptop with a printer or mouse. Bluetooth devices are allocated to three different transmission power classes, namely 1, 2 and 3. The radiation from Bluetooth devices in power classes 2 and 3 is weak and limited to the local area. Most Bluetooth applications used close to the body belong to these two classes. Bluetooth transmitters in the most powerful class, i.e. 1, can lead to radiation exposure similar to a mobile phone, but only if they are operated in immediate proximity to the body.

**Power classes of Bluetooth transmitters**

| Power class | Peak transmission power (mW) | Max transmission power (mW) | Min transmission power (mW) | Range (m) |
|---|---|---|---|---|
| 1 | 100 | 76 | 1 | 100 |
| 2 | 2.5 | 1.9 | 0.25 | 40 |

| | | | | |
|---|---|---|---|---|
| 3 | 1 | 0.8 | | 10 |

The electric field close to Bluetooth USB connector antennae in operation at maximum transmission power is shown in Figure 3. The field quickly diminishes as the distance from the device increases. The measured field strengths of Bluetooth devices at a distance of 20 cm lie below the limit value of 61 V/m recommended by the ICNIRP by a factor of more than 20 or 150.




Maximum electric field (e-field) as a function of the distance for two Bluetooth USB connectors of different power classes and a PDA. The field very quickly diminishes as the distance increases. The measurements were made at maximum transmission power.

## 4. WLAN (WiFi)

WLAN-capable mobile and cordless telephones are increasingly being used for internet telephony. The standards 802.11b and 802.11g use the 2.4 GHz ISM frequency band with a maximum permissible transmission or radiated power (EIRP) of 100 mW.

How high the radiation emitted from devices is depends on the transmission power and prevailing data traffic. Radiation is at its greatest during maximum data traffic. It diminishes quickly when the distance from the transmitter is decreased. At maximum transmission power and with maximum data traffic at a distance of 20 cm, it is also 10 times smaller and at a 1 m distance 40 times smaller than the recommended limit value.

*Tabelle 1 auf Seite 5:* Properties of the various WLAN Standards of the IEEE. The Standard used most frequently is currently 802.11g.

*Figur 2 auf Seite 5:* Electric field (e-field) as a function of the distance for two different WLAN access points (AP), two different PC cards and a PDA. Access point 2 can be operated with standards 802.11 a, b and g and PC card 2 with 802.11 b and g.

*Table 1*

| IEEE Standard | 802.11a | 802.11b | 802.11g | 802.11h |
|---|---|---|---|---|
| Max. transmission power (mW) | 200 | 100 | 100 | 200/1000 |
| Average beacon transmission power (mW) | 1 | 0.5 | 0.5 | 0.5 |
| Average max. transmission power (mW) | < 200 | < 100 | < 100 | < 200 |
| Frequency (MHz) | 5,150 –5,250 | 2,400 – 2,483.5 | 2,400 – 2,483.5 | 5,150 –5,350<br>5,470 -5,725 |
| Range (m) | 50 | Up to 200 | 50 | 50 |
| Power control | No | No | Yes, static | Yes, dynamic |
| Max. gross data transfer rate (MBit/s) | 54 | 11 | 54 | 54 |
| Propagation | Little | Outdated | Most extensive | Little |

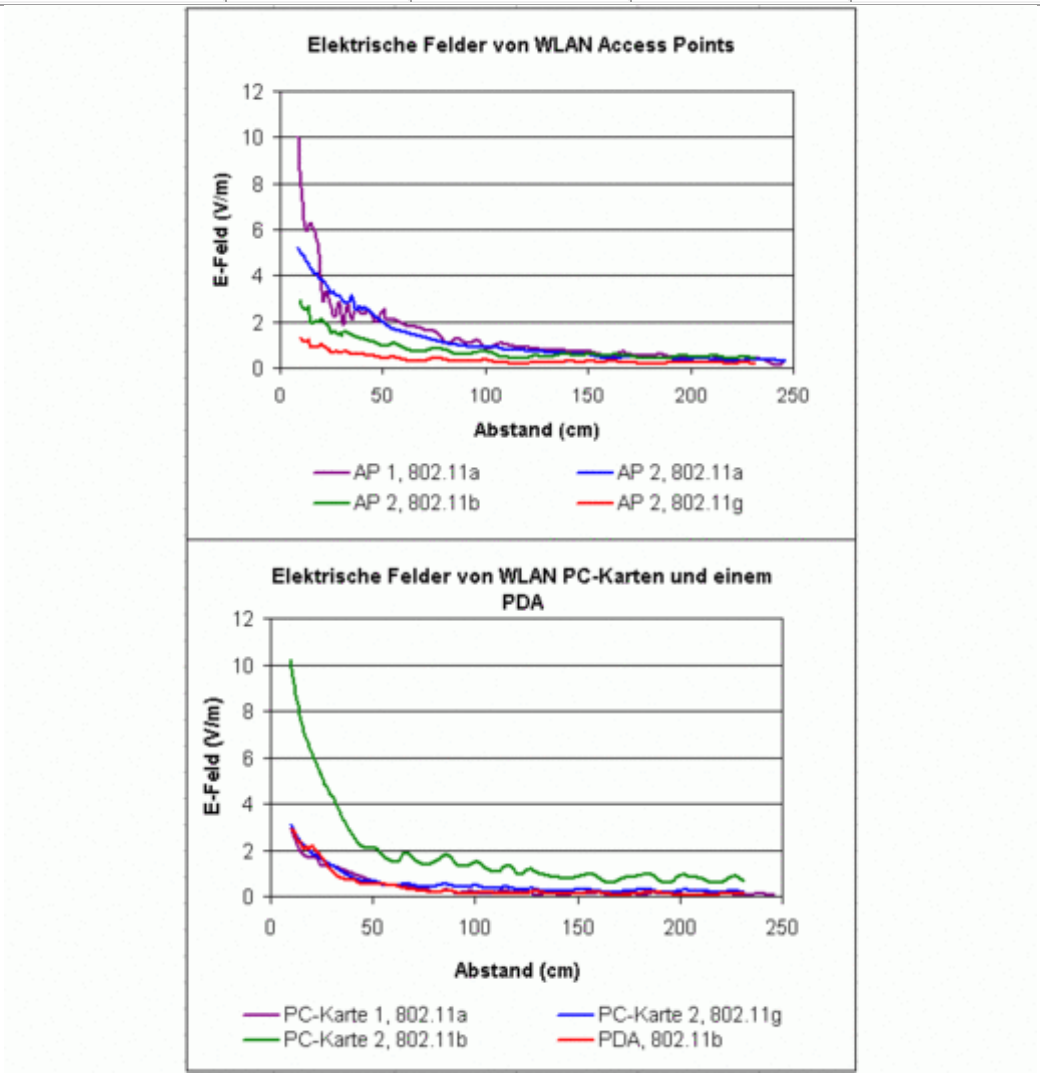



*Figure 2*

## 5. Electric field strength in any place

It goes without saying that wherever a human voice is received by a mobile telephone, there must be radio waves. However, it essentially depends on the distance from the transmitting antenna whether or not there will be radio waves present there. The strength of the radio waves is indicated by the electric field strength at this location.

If you examine the properties of radio waves and antennae in theory, you use a virtual antenna, a so-called "isotropic antenna", as a reference. Such antennae have a pointed shape and can transmit radio waves in all directions with a specific field strength and receive from everywhere.

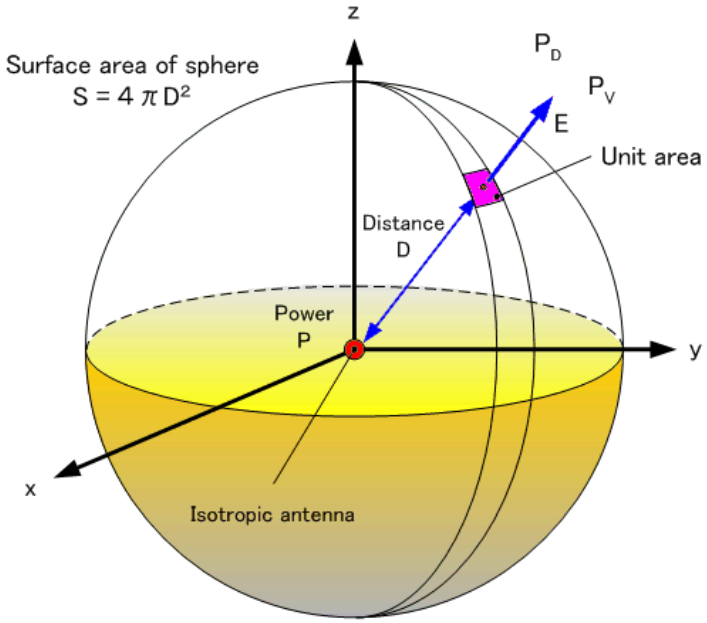
As can be seen in the following diagram, one designates the ground coverage at point D [m] removed from an isotropic antenna with P [W] power rating as power density [W/m2]. That is the value shown under (2).

Also the value for the Poynting vector* PV [W/m2] is at this point (1), whereby an electric field strength E [V/m] is assumed. As the power density and the Poynting vector are the same, assuming (1) = (2), the electric field strength is at the remote point D [m](3).

** The term "Poynting vector" takes its name from John Henry Poynting.*

## 6. Electric field strength in any place with an antenna with absolute gain $G_i$

According to the above-mentioned formulae, generally one takes an antenna with absolute gain $G_i$ in order to establish the field strength of point D [m]. Replace $G_i$ with the true value.




①Poynting vector $P_V = \frac{E^2}{120\pi}$

②Power density $P_D = \frac{P}{4\pi D^2}$

③Electric field intensity in D[m] point

①=②, we get, $E = \frac{\sqrt{30P}}{D}$

④Electric field intensity with absolute gain antenna Gi

$$E = \frac{\sqrt{30PG_i}}{D} \quad [V/m]$$

※Note
P: Power [W]
S: Surface area [$m^2$]
D: Transmission distance [m]
E: Electric field intensity [V/m]
$G_i$: Absolute gain of antenna [times]
$P_D$: Power density [$W/m^2$]
$P_V$: Poynting vector [$W/m^2$]

| Type of antenna | Absolute gain | |
|---|---|---|
| | True value (times) Gi | Decibel value |
| Isotropic | 1 | 0 |
| Hertzian Dipole | 1.5 | 1.76 |
| λ/2Dipole | 1.64 | 2.15 |
| λ/4Monopole | 3.28 | 5.15 |

# 7. Standards used for the EMC testing of Witschi devices

| Test Type / Type d'essai / Art der Prüfung | | Result / Résultat / Ergebnis | |
|---|---|---|---|
| Emission / Emission / Störaussendung | | EN 61000-6-3 | EN 61000-6-4 |
| Interference voltage<br>Tension perturbatrice<br>Störspannung | CISPR 22 Cl A/B | | |
| Radiated electromagnetic field<br>Champ perturbateur<br>Störfeldstärke | CISPR 22 Cl A/B | | |
| Harmonics<br>Harmoniques<br>Oberschwingungen | EN / IEC 61000-3-2 | | |
| Voltage fluctuations (flicker)<br>Fluctuations de tension<br>Spannungsschwankungen | EN / IEC 61000-3-3 | | |
| Immunity / Immunité / Störfestigkeit | | EN 61000-6-1 | EN 61000-6-2 |
| Electromagnetic fields<br>Champs électromagnétiques<br>Elektromagnetische Felder | EN / IEC 61000-4-3 | | |
| Radio frequency common mode<br>Fréquence radio en mode commun<br>HF-Strom common mode | EN / IEC 61000-4-6 | | |
| Magnetic fields (industrial frequencies)<br>Champs magnétiques (fréq. industrielles)<br>Magnetfelder (Industriefrequenzen) | EN / IEC 61000-4-8 | | |
| Voltage dips and interruptions<br>Creux et coupures de tension<br>Spannungsein- und Unterbrüche | EN / IEC 61000-4-11 | | |

montena emc sa

CH-1728 Rossens - Switzerland - phone +41 26 411 93 33 - fax +41 26 411 93 30 -
www.emc.montena.com - office.emc@montena.com