

DECT and Health – Facts and Figures

List of Content

List of Content	1
0 Introduction	2
1 What does “DECT” mean?	2
2 Applications of DECT	2
3 Technical figures and operation principles	3
3.1 Frequency and modulation	3
3.2 Power	4
4 Biological impact and health consequences of radio waves	5
4.1 Background	5
4.2 Health data base	5
4.3 Thermal effects	7
4.4 Non-thermal Effects	8
4.5 Exposure guidelines and limit values	8
5 Exposure from DECT cordless telephones	10
6 Impact of radio waves from DECT	11
7 Conclusion	11
8 Where can I go for further information?	11
Annex 1: Results of recent evaluations of current scientific knowledge	13
Annex 2: Questions & Answers	15

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0 Introduction

DECT technology and especially cordless phones are very popular in today's society. DECT is the major standard for cordless telecommunication applications. Millions of people around the world use DECT cordless phones in their daily life. With so many people using DECT technology, it is natural that there are people asking whether it is safe. The following information is designed to help answer this question.

1 What does "DECT" mean?

DECT (Digital Enhanced Cordless Telecommunications) is a flexible digital radio access standard for cordless communications in residential, corporate and public environments. DECT provides for voice and multimedia traffic, and contains many forward-looking technical features that allow DECT-based cordless systems to play a central role in important existing and new communications developments such as Internet access and interworking with other fixed and wireless services such as ISDN and GSM/UMTS.

The DECT standard makes use of several advanced digital radio techniques to achieve efficient use of the radio spectrum; it delivers high speech quality and security with low risk of radio interference and low power technology.¹

2 Applications of DECT

The Digital Enhanced Cordless Telecommunications (DECT) standard provides a general radio access technology for wireless telecommunications, operating in the 1880 to 1930 MHz frequency band.

DECT handsets and base stations have been available on the market since 1993. The majority of DECT product shipments are in the residential and business applications. DECT has also proven to be cost effective for the low-end consumer market. Most of the shipments in this market segment concern single base station and single handset configurations.

Moreover, DECT has been designed to provide access to any type of telecommunication network thus supporting numerous different applications and services. Infrastructures using the DECT technology can support traffic densities up to 10'000 Erlang/km²/floor, which is comparable to 100'000 users in office environments.

¹ See DECT-Forum site for more information: <http://www.dect.org/>

A DECT system comprises a Fixed Part, utilizing one or more base stations, and one or more Portable Parts (cordless terminals, handsets). There is no limit to the size of the infrastructure as far as the number of base stations and cordless terminals is concerned.

3 Technical figures and operation principles

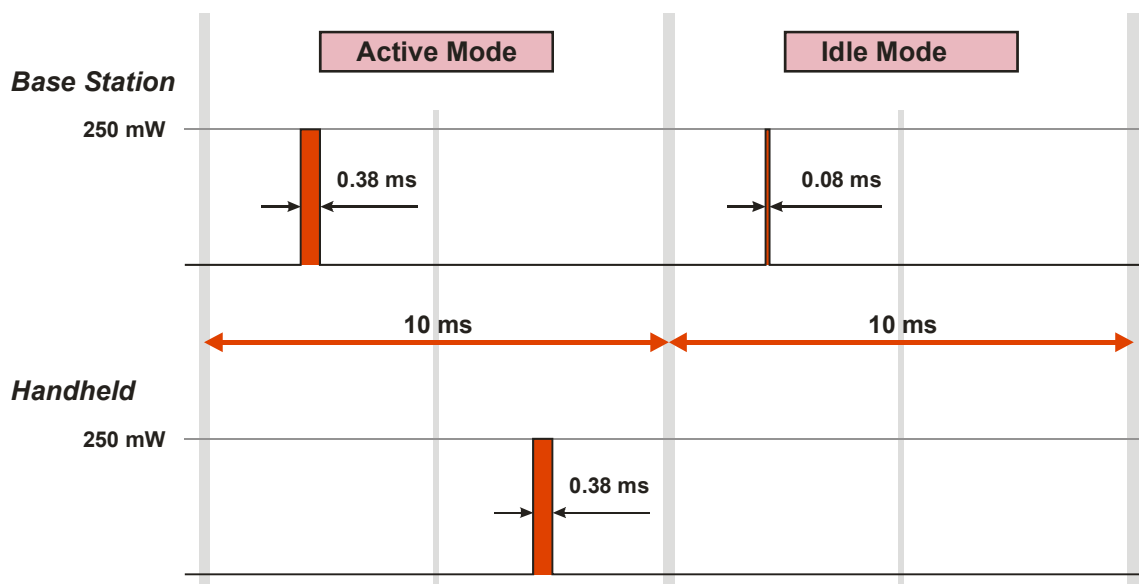
Some technical figures are necessary in order to discuss questions surrounding DECT and health.

DECT is used for a huge variety of applications in telecommunications (see section 2 Applications of DECT). These lead to a certain variety of technical figures. The following information refers mainly to home and office applications where questions concerning health have been raised in the past. For applications such as Wireless Local Loop, WWL, which uses high gain antennas, deviations may occur.

3.1 Frequency and modulation

DECT operates in the radio frequency range of **1880 – 1930 MHz**. It uses TDMA (Time Division Multiple Access) and TDD (Time Division Duplex) to enable several simultaneous duplex calls using the same frequency. This means that base station and handset transmit only during the temporal time slots which are assigned to them. The total DECT TDMA frame is 10 milliseconds (ms) long.

The time frame (10 ms) contains 12 time slots for uplink (signal from the base station to a handheld) and 12 time slots for downlink (signal from a handheld to the base station). The length of a time slot is 0.38 ms. During a communication (active mode), the handset and the base station transmit during 0.38 ms per 10 ms frame. When not in communication (Idle mode) the handset does not transmit at all, and the base station transmits only during 0.08 ms per frame.



3.2 Power

The DECT radio transmission power in the pulse is fixed to **250 mW (max)**.

The **handset** transmits only when it is active (active mode), and only during one time slot of 0.38 ms. Therefore, the handset is active only during 4% of the time during a conversation. This means, the average radio transmitting power is about **10 mW**. More than one time slot can be used for applications designed for high data transfer. This leads to a higher average power accordingly.

In the active mode, the **base station** has the same transmitting power as the mobile part (**10 mW**), for the common application with one mobile part.

The situation is different, when more than one user are active simultaneously. The DECT standard allows a maximum of 12 handsets to be connected to the base station at the same time. Most base stations, however, support only up to eight handsets of which up to six can be active at any one time. Therefore the average transmit power of a DECT base station is limited to about 60 mW when 6 users are active simultaneously.

In idle mode the handset does not transmit, and transmitting **power is zero**. The base station transmits during 0.08 ms every 10 ms, giving an average idle power of **2.0 mW**, independent of number of handsets.

4 Biological impact and health consequences of radio waves

4.1 Background

DECT systems use radio-frequency electromagnetic fields or “radio waves” as the transmission medium. It is important to make a distinction between non-ionizing and ionizing electromagnetic fields: Radio-frequency electromagnetic fields are non-ionizing, which means that they are not powerful enough to destroy molecular bonds (unlike other types of fields such as X-rays)

Radio applications are nothing new. Modern radio applications such as DECT, GSM, UMTS, WLAN, etc. use the same kind of electromagnetic signals that have already been in use for a century, for example in radio and television broadcasting and in a wide variety of medical applications. The new technologies are therefore using an established medium for modern purposes.

Are there biological effects or health consequences due to the exposure to radio waves? Which are the relevant figures? Which limit values prevent the public from health consequences? These questions can only be answered on the basis of scientific data. Evaluation of scientific knowledge has to be done by independent, interdisciplinary, scientific expert groups. Most important for such evaluation in the area of non-ionizing electromagnetic fields is the “International Commission on Non-Ionizing Radiation Protection” (ICNIRP). ICNIRP is an independent group of experts established to evaluate the state of knowledge about the effects of non-ionizing radiation (NIR) on human health and well being, and to provide science-based advice on protection against harmful effects of NIR. ICNIRP provides scientific advice to the World Health Organization (WHO) on all aspects of NIR and health².

4.2 Health data base

Since the advent of radio applications, scientific and medical investigations have been conducted into radio-frequency electromagnetic fields. These provide us with a clear picture of both the potential risks of radio-frequency fields and their benefits in medical applications. In addition to this comprehensive body of scientific knowledge, intensive investigations have been conducted specifically with regard to modern telecommunication systems as DECT: To date, more than 100 million € have been in-

² For further information see ICNIRP website: www.icnirp.de

vested in national and international research programs, the results of which are catalogued in the public database of the World Health Organization (WHO)³.

Overall, there are well over 1300 papers, published by scientific journals (peer-reviewed), in the historic radio-frequency biological effects database addressing health issues in general. Included in these 1300 papers are more than 350 independent, peer reviewed studies conducted at frequencies used by mobile communication systems as DECT.

Regarding non-ionizing fields in general, the World Health Organization (WHO) in 2004 summarized: "In the area of biological effects and medical applications of non-ionizing radiation Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals."⁴

Therefore the scientific data base for evaluation of possible health consequences of radio waves from DECT systems and other telecommunication technologies is very extensive. These data form also the base for international guidelines for radio waves which ensure safety of the user and of the environment.

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³ For further information see WHO Database: www-nt.who.int/peh-emf/database.htm

⁴ www.who.int/peh-emf/about/WhatIsEMF/en/index1.html

What research has been undertaken and what is currently underway?

The following summary of relevant studies has been derived from two databases – the World Health Organization's (WHO) and the Institute of Electrical and Electronics Engineers (IEEE) – both of which are available from the WHO website³:

Scientific Papers Describing Biological and Health Effects of RF Fields

Research Study Type	Ongoing ^A	Published ^B
Epidemiology	25	98
Human Studies	20	131
Long-term Animal Studies	18	32
Other Human, Animal and Cellular Studies	63	1066
Totals	126	1327

^A From WHO database

^B From IEEE database

Status: 02/2004

4.3 Thermal effects

Electromagnetic fields at radio frequencies only penetrate a short distance into the body. The depth depends on the frequency used and is smaller for higher frequencies. The energy of these fields is absorbed and transformed into the movement of molecules. Friction between moving molecules results in a temperature rise depending on the intensity of exposure. This effect is used in domestic microwave ovens for instance.

That means radio waves can cause the heating of tissues that leads to an increase in the body temperature. This is known as the **thermal effect**. Although the body has its effective ways of regulating its temperature, nevertheless, if the exposures to radio waves are too high, the body may no longer be able to cope.

Energy absorption from radio waves in tissues is measured as a **specific absorption rate (SAR)** within a given tissue mass averaged over 6 minutes. The unit of SAR is watts per kilogram (W/kg). SAR depends on the frequency and the intensity of the fields, and the tissue characteristics.

Induced heating in body tissues may provoke various physiological and thermoregulatory responses, including a decreased ability to perform mental or physical tasks as body temperature increases. Similar effects have been reported in people subject to heat stress: for example, those working in hot environments or suffering a prolonged fever.

ICNIRP summarizes regarding whole body exposure: "... Exposure to more intense fields, producing SAR values in excess of **4 W/kg**, can overwhelm the thermoregula-

tory capability of the body and produce harmful levels of tissue heating.” And “... They [data on human responses on high-frequency electromagnetic fields] are fully supportive of the conclusion drawn from laboratory work, that adverse biological effects can be caused by temperature rises in tissue that exceed 1°C”⁵

Consequently, WHO Fact sheet 183 explains:

“...A SAR of at least 4 W/kg is needed to produce adverse health effects in people exposed to RF fields in this frequency range....”⁶

DECT technology uses power levels which are far too low to produce harmful thermal effects, as described in section 5 below.

4.4 Non-thermal Effects

While thermal effects are undisputable, the actual discussion about effects of radio waves from DECT and other telecommunication systems refers often to so called ‘non-thermal’ effects. That means effects from exposure to low-levels of radio waves, too low to produce body-heating.

Speculations are made regarding possible relations to cancer and other diseases.

Various independent, national and international expert groups have reviewed the scientific literature over the past 10 years and have consistently concluded that there is no credible or convincing evidence for non-thermal effects that could lead to health consequences at exposure levels too low to produce body-heating. Annex 1 lists a few recent examples.

4.5 Exposure guidelines and limit values

Exposure guidelines have been developed by ICNIRP and are based on a careful analysis of the scientific literature (taking into account both thermal and non-thermal effects) and provide protection against all identified hazards of exposure to radio wave for all members of the community. Significant safety factors are incorporated into exposure limits – that is, the limits are set well below the level at which adverse health effects are known to occur. There are no known adverse health effects at exposure levels below these guideline levels.

⁵ „Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)”: Health Physics 74 (4):494-522, 1998); For further information see www.icnirp.de

⁶ www.who.int/docstore/peh-emf/publications/facts_press/efact/efs183.html

ICNIRP guidelines have been widely adopted internationally and turned into national safety standards.

The analysis of scientific data shows that all established health effects of exposure to radio waves are clearly related to heating. Consequently the limit values recommended by ICNIRP are designed to prevent thermally induced health effects. These depend on SAR.

The basic restriction for whole body exposure is **0.08 W/kg**, the basic restriction for partial body exposure is **2.0 W/kg** (head and trunk; averaged over 10 g).

The level of heating that will occur from exposure to radio waves within the exposure guidelines is extremely low, and the body's normal thermoregulatory processes effectively dissipate any heat away that might be generated. Partial body exposure occurs from sources at or nearby the body (handset) while whole body exposure normally refers to a distant source (base station). In the latter case, reference values can be used for exposure assessment. Reference values are electric and magnetic field strength and power flux density respectively. Compliance with reference values ensures that basic restrictions (SAR) are met. Reference values are much easier to assess than basic restrictions. They form limit values for fixed sources as mobile phone base stations. The energy absorption is highly dependent on the frequency of the electromagnetic field. Therefore reference values are frequency dependant. ICNIRP recommends a reference value of **9.5 W/m²** (power flux density) for radio waves in the DECT frequency range (1880 MHz – 1930 MHz).

Various independent, national and international expert groups have reviewed the scientific literature over the past 10 years and have consistently concluded that there is no credible or convincing evidence that exposure within ICNIRP exposure limits causes any adverse human health effects. Among these groups are Health Council of the Netherlands (2004), National Radiological Protection Board (UK, 2003), Swedish Radiation Protection Agency (2003), and Royal Society of Canada (1999)⁷.

Accordingly, WHO has stated recently

“Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields.” WHO, 2004⁸

Exposure from DECT applications is at very low level, as indicated in section 5. Therefore regarding usage of DECT it is in accordance with WHO to conclude, that the extensive available data base (see section 4.2 above) does not confirm the existence of any health consequences.

⁷ For further information see Annex 1

⁸ www.who.int/peh-emf/about/WhatIsEMF/en/index1.html

5 Exposure from DECT cordless telephones

In order to discuss the possibility of health impacts from DECT systems, it is necessary to evaluate to which amount the body is exposed to radio waves from DECT systems.

Exposure depends on power output of the source and on distance. Worst case conditions are considered by assuming a **zero distance** between body and DECT base station or between body and handset.

Transmitted power of active **Portable Parts** according DECT Standard is so low, 0.01 W, that even under the unrealistic assumption that all power is absorbed in one point of the body, exposure would be below the limit value of 2 W/kg which ensures safety of the user ($0.01 \text{ W}/10\text{g} = 1 \text{ W}/\text{kg}$). Under more realistic conditions, calculations and measurements have shown that worst case exposure from handsets is in the range of **3-4%** of the limit value. When not active (idle mode) the power is zero and no exposure occurs.

In the active mode, the **base station** has the same transmitting power as the mobile part, for the common application with one mobile part. While the handset is used in contact to the body, there is a distance between the user and the base station normally. Therefore exposure is very much below exposure from handsets and even if the user touches the base station with his head, exposure is only in the range of **3-4%** of the limit value.

Exposure assessment from a distant source can also be done by verification of compliance with reference values ($9.5 \text{ W}/\text{m}^2$ for the DECT frequency range). Measurement of power flux density at 1 m distance from DECT base stations have shown values about **0.01 W/m²** or about 1000 times below the reference value.

Transmitting power increases with increasing number of active users. Correspondingly worst case exposure increases also. Nevertheless, even under the assumption that 12 users (handhelds) are active simultaneously, exposure is far below the limit values (maximum possible number of users according to the DECT-standard; transmitting power about half of the maximum transmitting power of a GSM 900 mobile telephone).

In the passive mode (idle mode) the base station transmits only a marginal power of 0.002 W which may lead to an exposure less than 1% of the limit value.

6 Impact of radio waves from DECT

Exposure to radio waves from DECT systems is far below the limit values which provide protection against all identified hazards of exposure to radio waves for all members of the community.

These limit values are part of various national and international regulations and standards. In the European Union, compliance with the limit values standards is shown by the CE mark.

7 Conclusion

DECT systems use radio-frequency electromagnetic fields or “radio waves” as the transmission medium. The scientific data base about possible health consequences of these fields is very extensive, especially in comparison to other environmental factors (see section 4), and therefore conclusions can be drawn with a very high level of certainty.

The conclusions of the DECT Forum concerning the discussion about health effects of radio wave exposure from DECT systems are based upon the conclusions of many expert review panels, established by official national and international entities. These panels have reviewed the extensive scientific literature over the past years and have consistently concluded that there is no credible or convincing evidence that exposure within the limits applied to wireless communications causes any adverse human health effects. DECT handhelds and base stations meet these limits and have to be considered as harmless to human health therefore.

8 Where can I go for further information?

To find more information please visit any of the following websites:

- World Health Organization
www.who.int/peh-emf
- The International Commission on Non-Ionizing Radiation Protection
www.icnirp.de
- UK National Radiological Protection Board
www.nrpb.org
- Mobile Manufacturers Forum
www.mmfa.org

- DECT Forum
www.dect.org
- United States Food and Drug Administration (FDA)
www.fda.gov/cdrh/ocd/mobilphone.html
- Research Association for Radio Applications (Forschungsgemeinschaft Funk (FGF))
www.fgf.de/english/index.html

Annex 1: Results of recent evaluations of current scientific knowledge

Health Council of the Netherlands, 2003

Annual (2003) update on the potential health effects of EMF from communication technologies has been published in 2004:

“The Committee concludes that there is no convincing evidence that, in experimental animals, the incidence of lymphomas and other types of tumours is influenced by life-time, virtually daily exposure to electromagnetic fields such as those used in mobile telecommunications.”

“Some people attribute a variety of symptoms to exposure to electromagnetic fields. However, past work involving experimental exposure has shown that there is no causal relationship between these symptoms and any kind of exposure.”

www.gr.nl/pdf.php?ID=886%20

National Radiological Protection Board (NRPB), 2003

An independent Advisory Group (AGNIR) has reviewed the evidence for health effects from radiofrequency transmissions and published the report in 2004: “Health effects from radiofrequency electromagnetic fields” in which AGNIR states that the weight of evidence does not suggest that there are adverse health effects and has concluded that there is no biological evidence for mutation or tumor causation by RF exposure.

www.nrpb.org/publications/documents_of_nrpb/abstracts/absd14-2.htm

Swedish Radiation Protection Agency (SSI), 2003:

In their first annual report, SSI’s Independent Expert Group on Electromagnetic Fields focused among other things on blood-brain-barrier (BBB): “Overall, results published or communicated on the BBB have drawn a lot of attention but a careful analysis of the available data does not indicate the existence of a health risk.”

www.ssi.se/english/EMF_exp_Eng_2003.pdf

Australian Radiation Protection and Nuclear Safety Agency, 2003

The Committee on Electromagnetic Energy Public Health Issues concludes: “The weight of national and international scientific opinion is that there is no substantiated evidence that exposure to low level RF EME causes adverse health effects.”

www.arpana.gov.au/pubs/eme_comitee/fact1.pdf

Royal Society of Canada, 1999

The Canadian health authorities requested the Royal Society of Canada to undertake a comprehensive evaluation of the potential health effects of RF fields.

“Scientific studies performed to date suggest that exposure to low intensity non-thermal RF fields do not impair the health of humans or animals.”

www.rsc.ca/english/RFreport.pdf

Annex 2: Questions & Answers

Which standards apply to DECT products?

DECT products are constructed according to standards of the series ETSI EN 300 175 and ETSI EN 301 406 and use radio frequencies between 1880 and 1930 MHz. DECT products meet the requirements in the safety standards EN 50 360 and EN 50 385. The same safety guidelines and limits apply here as to other mobile phone appliances.

However, DECT works with such low power levels that the field strengths generated are far lower than the limit values

Can the radio-frequency fields from DECT heat up the human body inadmissibly?

No, the transmitting power of DECT appliances is too low to be able to heat up the body to an inadmissible degree. The amount by which the body could be heated theoretically, even in the worst-case scenario, is far below the threshold values at which the temperature increase could have a harmful effect to health.

Is there a link between the use of DECT phones and harmful effects to health?

Despite intensive research worldwide there is no evidence of a link between harmful effects to health or illness and the fields generated by DECT phones.

Can DECT phones cause cancer?

There is no scientific suspicion that there is a link between cancer and the use of DECT phones. The research projects conducted in various countries clearly indicate overall that there is no such risk.

Can DECT phones cause cataracts?

The eye is particularly sensitive to thermal effects. This was taken into account when the 'International Commission on Non-Ionizing Radiation Protection' (ICNIRP) was setting the limit values. There are no indications that cataracts are caused by the intensities found in the use of DECT phones.

Are there people who have a reaction because they are particularly sensitive to the fields generated by DECT phones (electromagnetic hypersensitivity)?

There are people who say that electromagnetic fields have an effect on how they feel physically. There is however no scientific evidence that indicates any sort of hypersensitivity (electromagnetic hypersensitivity) to the fields emitted by DECT telephones. Nor is there a recognised biological mechanism that would explain hypersensitivity.

Can DECT phones cause problems during pregnancy?

Tests carried out on animals show that the fields generated by DECT appliances do not increase the risk to unborn life (e.g. miscarriage, deformity, low birth weight or congenital illness).

Is the health of children put at risk by the electromagnetic fields from hand-held RF transmitters, e.g. DECT and mobile phones?

The Health Council of the Netherlands has carried out a scientific study regarding use of RF transmitters as mobile phones by children. According to its report of 2003 there is no scientific reason to recommend a restriction.

(Electromagnetic Fields: Annual Update 2003; www.gr.nl/pdf.php?ID=886%20)

Do DECT appliances affect the functioning of hearing aids, heart pacemakers or other medical equipment e.g. in hospitals and ambulances?

Theoretically, DECT appliances could affect equipment, but there is a very low probability of this happening due to their low transmitting power. However, this depends on the medical equipments sensitivity regarding electromagnetic fields. Therefore people who have a pacemaker fitted or wear a hearing aid should ask their doctor about possible effects.