

## NONSTOP PULSED 2.4 GHZ RADIATION INSIDE US HOMES

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### **Abstract**

The use of DECT (Digital Enhanced Cordless Telecommunication) cordless phones has been a major health and environmental concern in Europe and especially in Germany for years. The biological concern arose from studies on HF (high frequency) sources such as GSM cellular phones and towers. Digital cordless phones are also available in the USA – marketed as 2.4 GHz digital technology. A digital cordless phone was placed in a representative private home in California and HF measurements were conducted at different locations inside, using frequency selective spectrum analysis to obtain the cordless phone power densities. The results showed that the radiation patterns and levels emitted by the small cordless phone base station are almost identical to the DECT technology – also digitally pulsed and permanent microwave radiation. The power density values presented for each room inside the home can be compared to average DECT cordless phone radiation exposures found in German homes. The maximum power density was found to be over 500,000  $\mu\text{W}/\text{m}^2$  at a normally encountered distance (about 1 - 2 feet) if the base station is placed on an office desk or bedside table. The radiation peak values in the same room are higher than those encountered in proximity to cellular base stations located near residential buildings.

### **Introduction**

DECT cordless phones usage has been a major health and environmental concern in Europe and especially in Germany for years. Now multiple handsets cordless phones are also available in the USA – extolled as 2.4 GHz digital technology with multiple handsets following the DFHSS (Digital Frequency Hopping Spread Spectrum) standard which is almost identical to DECT. The biological concern arose from studies on high frequency (HF) sources such as cellular phones and cellular phone base stations with GSM technology. The digital pulsed pattern of GSM and DECT radiation has come under suspicion to cause e.g. brain cancer, lymphoma, and changes in the brain blood barrier. The problem with the cordless DECT phones is, that the base station permanently emits full power pulsed microwave radiation, whether the phone is used or not. This creates constant exposure to high levels of the most critical type of HF radiation known throughout the entire home or office. The DECT technology is a European standard for cordless phones in the range of microwave radiation (1.8 to 1.9 Gigahertz, GHz). Identical permanently emitting portable phones with the special option of multiple handsets are available in the US and therefore the exposure issues are relevant for US population. In the US, the cordless phone manufacturers established the 2.4 GHz digital pulsed technology in the range of 2.4 – 2.5 GHz. Cordless phones such as e.g. the GIGASET (same name as a DECT cordless phone series by the same manufacturer in Germany) are available in USA.

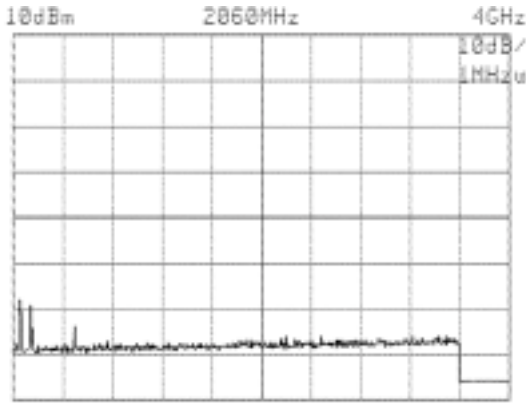
### **Methods**

A GIGASET cordless phone model was selected as a representative DFHSS 2.4 GHz phone for typical home and office usage. The base station was purchased in the US and placed on a wooden office desk in a representative 3 bedroom residential building in California. In the first test set, the power density in the room was measured prior to the activation of the base station to obtain background levels at the test site. Power density measurements were performed at different distances and directions from the phone (see table 1 and 2) with an Advantest R4131C spectrum analyzer (Rohde & Schwarz) and a calibrated periodic logarithmic log.per. antenna UKLP 9140-A (Schwarzbeck). The power density measurements were conducted under real-life conditions and only peak values (pulse maximum) were measured. All measurements were conducted following VDB guideline (VDB 2002) and the Swiss BUWAL guideline (BUWAL 2002). The power density levels are given in  $\mu\text{W}/\text{m}^2$  (microwatt per square meter). 1  $\mu\text{W}/\text{m}^2$  equals 0.1  $\text{nW}/\text{cm}^2$  (nanowatt per square centimeter). The background level was  $<0.3 \mu\text{W}/\text{m}^2$  (-58 dBm) in the range of all wireless, analogue or digital cordless, and cellular phone applications (0.3 to 3.5 GHz). See figure 1.

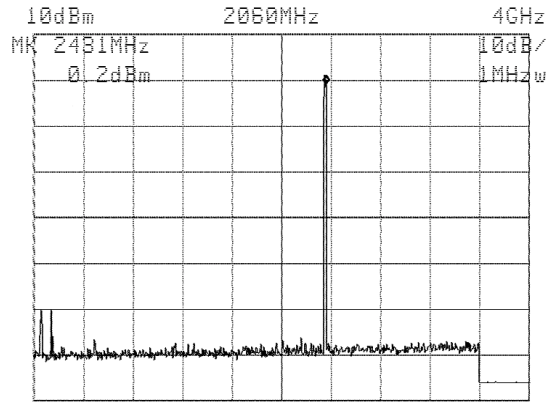
**Results**

High frequency measurements were conducted and showed that the radiation patterns and levels emitted by GIGASET 2.4 GHz cordless phone base station are identical to the DECT technology – also digitally pulsed with permanent microwave radiation. For comparison, the radiation levels from the GIGASET located in the same room are even higher than encountered in proximity (50 to 100 feet) to most cellular base station located on pole mount positions or on top of office buildings. However, in this case the source of the radiation is a desktop personal cordless phone.

**Figure 1: Spectrum analysis (no 2.4 GHz)**



**Figure 2: Spectrum analysis (with 2.4 GHz)**



After the phone was plugged in, the radiation level rose to 673,000  $\mu\text{W}/\text{m}^2$  (+0.2 dBm) in a normally encountered distance (about 1 - 2 feet) if the base station is placed on an office desk. See figure 2. The following power density levels were obtained :

**Table 1: 2.4 GHz cordless phone base station power density levels in the same room**

	<b>US GIGASET (2.4 GHz)*</b>	<b>GERMANY GIGASET (DECT)**</b>
<b>Distance</b>	DFHSS (Digital Frequency Hopping Spread Spectrum) digital pulsed 100 Hz frequency range 2450 MHz	DECT (Digital Enhanced Cordless Telecommunication) digital pulsed 100 Hz frequency range 1880 MHz
30 centimeter - 12.5"	673,000 $\mu\text{W}/\text{m}^2$	405,000 $\mu\text{W}/\text{m}^2$
50 centimeter – 19.8"	280,000 $\mu\text{W}/\text{m}^2$	146,000 $\mu\text{W}/\text{m}^2$
1 meter - 39.4"	72,000 $\mu\text{W}/\text{m}^2$	36,000 $\mu\text{W}/\text{m}^2$
2 meter - 78.8"	23,000 $\mu\text{W}/\text{m}^2$	9,100 $\mu\text{W}/\text{m}^2$

\*this study, \*\*OEKO-TEST 1996

The results of the US GIGASET showed similar power densities when compared with the power densities reported for the GIGASET sold in Germany with DECT technology. Physical barriers such as e.g. wood framed walls, cabinets, closets have only a limited shielding effect inside a building. To evaluate a real life radiation exposure, the base station was placed on a desk in a bedroom (home office) and the actual power densities were measured in the different rooms. In this experimental test set, the real life effect of such a cordless phone installed in an average home and its associated radiation exposures were evaluated. The following values were obtained during our test set. The measurements showed a significant exposure for the occupants (see also table 2 and floor plan in appendix, figure 4)

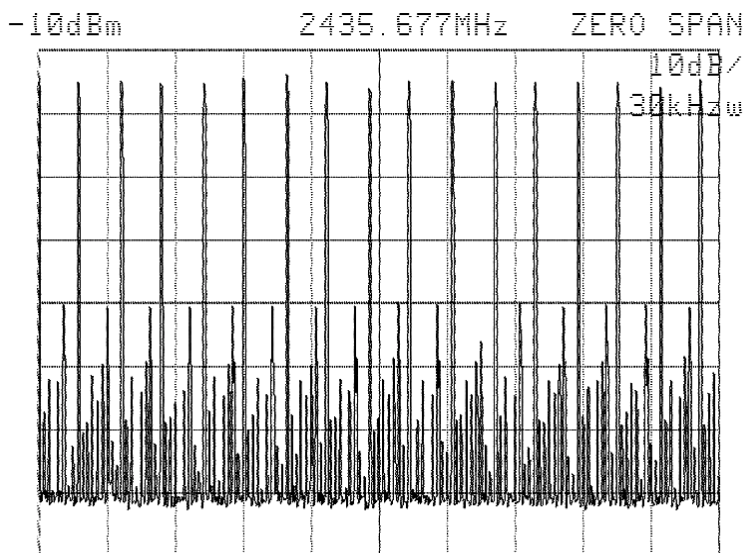
**Table 2: 2.4 GHz cordless phone base station power density levels in the house**

<b>Room</b>	<b>Power Density (maximum pulse peak value)</b>
Office with phone	33,800 $\mu\text{W}/\text{m}^2$
Master bedroom	13,500 $\mu\text{W}/\text{m}^2$
Bedroom 2	5,400 $\mu\text{W}/\text{m}^2$
Bedroom 3	680 $\mu\text{W}/\text{m}^2$
Living room	140 $\mu\text{W}/\text{m}^2$
Family room	50 $\mu\text{W}/\text{m}^2$
Outside	9 $\mu\text{W}/\text{m}^2$

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Besides the permanent emission from such a base station, the pulsed nature of the signal was analyzed and is displayed in figure 3. The spectrogram shows the periodic pulsed signal. The dynamic range of the power density covers the full range scale from minimum (pause) to maximum (pulse) and is sending out pulses every 10 milliseconds (ms) or 100 Hz (Hertz).

**Figure 3: Pulsed signal of 2.4 GHz DFHSS technology – ZERO SPAN (GIGASET cordless phone base station)**



### Summary

The levels encountered are considerably high for an indoor source, which emits permanently. The radiation peak values in the same room are higher than those encountered in proximity to cellular base stations located at pole mount or roof top positions. Even in the master bedroom and in the second bedroom, the power density levels were in the range of or above the 95. percentile radiation level just recently obtained from a study of cellular phone tower measurements in residential areas (HAUMANN 2002). For comparison, thermal (guidelines), other non-thermal (recommendations), and cellular tower exposure reference values are listed in the table 3 below.

**Table 3: Comparison of Standard Threshold Values and Recommendations**

Comparison of Standard Threshold Values and Recommendations (electromagnetic fields, non ionizing radiation)	Total Power Density
<b>Standards, &gt; 2,000 MHz (e.g.)</b>	
FCC/ANSI - USA	10,000,000 $\mu\text{W}/\text{m}^2$
Germany, England, Finland and Japan	10,000,000 $\mu\text{W}/\text{m}^2$
Belgium	1,200,000 $\mu\text{W}/\text{m}^2$
Switzerland and Italy	90,000 $\mu\text{W}/\text{m}^2$
<b>Recommendations / References (e.g.)</b>	
Ecolog Study, Germany (ECOLOG 2000)	10,000 $\mu\text{W}/\text{m}^2$
Cellular tower radiation - high exposure level, 95. percentile (HAUMANN 2002)	6,300 $\mu\text{W}/\text{m}^2$
Salzburg, Austria (RESOLUTION 2000)	1,000 $\mu\text{W}/\text{m}^2$
EU Parliament (STOA 2001)	100 $\mu\text{W}/\text{m}^2$
Cellular tower radiation – background level, 20. percentile (HAUMANN 2002)	15 $\mu\text{W}/\text{m}^2$
Low exposure, Oeko-Test (OEKO TEST 2001)	10 $\mu\text{W}/\text{m}^2$
Nighttime exposure, Baubiology Standard (SBM 2000)	0.1 $\mu\text{W}/\text{m}^2$
Natural cosmic microwave radiation (MAES 2000)	< 0.000001 $\mu\text{W}/\text{m}^2$

Many European researcher, physicians, environmental professionals and toxicologist signed a resolution requesting the immediate stop of the DECT technology. This petition was delivered to the Germany Environmental Minister Mr. Jürgen Trittin in October of 1999 (RESOLUTION 1999). The Germany magazine "Oeko-Test" (equivalent to the US magazine Consumer Test) had 16 DECT cordless phones tested, published the measurement results, and rated all phones as not recommendable due to the constant emission of high levels of pulsed radiation (OEKO-TEST 1999).

### Conclusions

As long as the only base for official standards on high frequency radiation are thermal effects and heating of the body tissue (**FCC, ICNIRP, ANSI, IEEE, NCRP**) there is no need for the industry to invest into safer products. More and more scientists state that the view of energy absorption only is insufficient to describe the possible effects on human health. Potential biological effects need to be considered due to

- 1.) Non-thermal or low intensity levels of HF radiation,
- 2.) Chronic versus acute exposure and,
- 3.) Pulsed HF radiation, which is reported to be more bioactive than constant wave HF radiation.

The human body reacts much more complex than acknowledged in the thermal model and is very sensitive to extreme periodic stimuli. The biological system takes the "energy" as well as the "information" which is brought e.g. by the continuous pulsed modulation pattern.

Much experimental evidence of non-thermal influences of microwave radiation on living systems has been published in the scientific literature during the last 30 years – relating both to *in vitro* and *in vivo* studies – and were reviewed just recently by the STOA commission of the European Parliament (STOA 2001). From the use of microwave wireless technologies e.g. the following non-thermal biological effects have been reported:

- Changes in the electrical activity in the human brain,
- Increase in DNA single and double strand breaks from HF exposure to 2.45 GHz,
- Increased lymphoma rates (2 fold) in transgenic mice exposed twice a day exposed to 30 minutes of cell phone (GSM) signals over 18 month,
- Increased permeability of the blood-brain barrier in rats,
- Observation of an increase in resting blood pressure during exposure,
- Increased permeability of the erythrocyte membrane,
- Effects on brain electrochemistry (calcium efflux),
- Increase of chromosome aberrations and micronuclei in human blood lymphocytes,
- Synergistic effects with cancer promoting and certain psychoactive drugs,
- Depression of chicken immune systems,
- Increase in chicken embryo mortality,
- Effects on brain dopamine/opiate electrochemistry,
- Increases in DNA single and double strand breaks in rat brain,
- Stressful effects in healthy and tumor bearing mice,
- Neurogenetic effects and micronuclei formation in peritoneal macrophage.

In this review study, a threshold of  $1000 \mu\text{W}/\text{m}^2$  was evaluated for non-thermal biological effects. For locations with any long-term exposure, a further safety factor of 10 was recommended for pulsed cellular phone radiation sources as cellular phone base stations. In this case, the power densities should not exceed  $100 \mu\text{W}/\text{m}^2$ .

The constant High-Tec HF radiation brought into the US homes and offices by 2.4 GHz digital technology cordless phones is definitely a big step in the wrong direction in terms of environmental health protection and radiation exposure prevention. This reveals a complete misunderstanding of progress for our new millennium.

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Appendix

Figure 4: Floor plan with exposure data

