

MEASUREMENT OF THE LOW FREQUENCY MAGNETIC FIELD FROM MOBILE HANDSETS

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Abstract

Exposure to the magnetic field produced by mobile phones during electromagnetic communication is perceived as a possible health issue and appropriate methods for measuring this have been developed and will be reported. This includes recent concerns regarding frequency components up to 40 kHz.

Introduction

This work involved the measurement of the total peak magnetic flux density from mobile handsets. Communication using these handsets works on protocols that determine when the handset is transmitting microwave radiation. A series of time slots exists and transmission occurs during at least one of these before the next series commences. This on/off nature of the transmission introduces a time varying power demand on the battery. The electrical current produced by the battery will also vary with time. Since electric currents produce magnetic fields, these handsets produce a time varying magnetic field. The magnitude of the magnetic flux density has been measured for handsets working to GSM (Global System for Mobile communication) and TETRA (Terrestrial Trunked Radio) protocols.

Measurement of ELF (Extremely Low Frequency) waveforms from mobile handsets

Protocol timeslots correspond to a low frequency modulation of the transmission from mobile handsets and requires a measurement technique that is capable of detection at these frequencies. The method should also have sensitivity sufficient to avoid signal to noise problems. To meet these requirements, a fluxgate magnetometer was used. When the waveform for which a measure of the magnetic field strength is required is non-sinusoidal it is essential that the magnetometer reproduces the shape of the waveform. Considering the Fourier components of such a waveform, the magnetometer being used requires calibration for both amplitude and phase response. When only the peak value is required, it is the amplitude response that is important. The frequency dependence of the amplitude response of the fluxgate magnetometer used was measured and is shown in Figure 1. Fluxgate magnetometers typically operate at DC and a modification was

made by the manufacturer that allowed a bandwidth of 5 kHz.

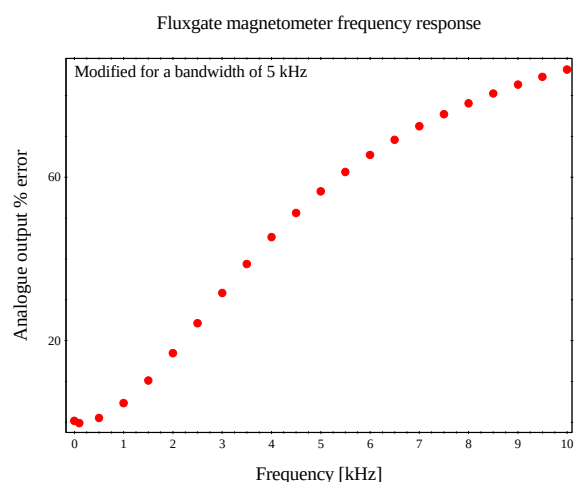


Figure 1. Frequency response of a fluxgate magnetometer modified to have a bandwidth of 5 kHz.

For GSM transmission the duration of a timeslot corresponds to a square wave with a frequency of 867 Hz and for TETRA a square wave with a frequency of 34 Hz. Referring to Figure 1, measurement of the peak value of the magnetic flux density for these frequencies will not require significant correction. The magnitude of the total peak magnetic flux density was measured for two GSM and two TETRA handsets and the measured values compared to NRPB guidelines for magnetic flux density levels [1]. Shown in Figure 2 is the output voltage waveform obtained from the fluxgate magnetometer when this was placed close to the handset. The shape of this waveform corresponds to the GSM timeslot protocol. The small positive voltage observed is a consequence of the AC coupling of the voltmeter and the space to mark ratio of the waveform. An error can therefore be introduced if an AC coupled instrument is used to measure the peak magnetic flux density. What is required is the total magnetic flux density and this is the total change between the flat regions of the

waveform and therefore the sum of the magnitudes of the two peak values. If only the peak with the larger magnitude is measured than an error of – 12.5% will occur for a GSM type waveform.

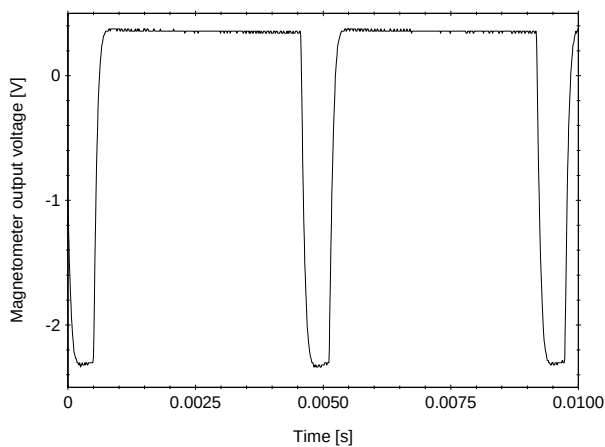


Figure 2. Magnetic flux density waveform from a mobile handset.

For the handsets tested the maximum value of the total peak magnetic flux density was higher for the GSM handsets. All handsets produced a DC magnetic flux density that was considerably larger than the AC total peak value. The maximum total peak magnetic flux density measured was 24.41 μT . This can be compared to the NRPB [1] guidelines of 1.6 mT at 50 Hz. For pacemakers these guidelines state that interference is unlikely to occur for time varying magnetic fields of less than 20 μT . Due to the decrease in the measured magnetic flux density with distance from the phone surface a value of less than 20 μT will be quickly achieved.

Recent work [2] has highlighted a need to make measurements of the magnetic field from mobile handsets at frequencies up to 40 kHz. Here the concern is the size of the current that these fields could induce. As can be seen from Figure 1, this fluxgate magnetometer cannot be used up to a frequency of 40 kHz. To make these measurements, a new approach is required. Recent advances in Hall probe element production have resulted in specifications that claim a frequency of 100 kHz. These have been developed for the measurement of the magnetic field from pulse magnetisers and for this reason the sensitivity is typically a few mV/ μT . For a magnetic flux density of only a few μT the voltage produced will need to be measured using a tuned detector. This will be discussed along with other possible techniques such as a coil based sensor with a suitably selected magnetic core. Using the method selected, results on a number of exposure handsets used in other clinical trials of the funding programme will be presented.

Acknowledgement

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References

- [1] National Radiological Protection Board, *Board Statement on Restrictions on Human Exposure to Static and Time Varying Electromagnetic Fields and Radiation*, Volume 4, No.5, 1993.
- [2] Kari Jokela, Lauri Puranen and Ari-Pekka Sihvonen, "Magnetic field exposure and mobile phones", *Health Physics*, Vol. 86, No.1, 2004.