Test Report

Report on practical testing of Low Frequency WPT with conducted power transfer of up to 15W with an ERP of 3μW With T-Coil & Broadcast receivers

SUMMARY OF RESULTS

Copsey Communications Consultants

Edgcott House
Lawn Hill
Edgcott
Buckinghamshire
HP18 0QW
United Kingdom

In conjunction with Wireless Power Consortium & EHIMA Members

Important notice

Individual copies of the present document can be obtained from:
info@copsey-comms.com

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF).

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other Copsey Communications Consultants documents are available from
info@copsey-comms.com

If you find errors in the present document, please send your comment to the following service:
info@copsey-comms.com

Copyright Notification

No part may be reproduced except as authorized by written permission.
The copyright and the foregoing restriction extend to reproduction in all media.

© Copsey Communications Consultants 2019.
All rights reserved.

Contents

Foreword....4
1 Executive Summary....4
2 Introduction....6
3 T-Coil....6
3.1 T-Coil Transmitter or Inductive Loop....6
3.2 T-Coil Receivers....7
3.3 T-Coil Receiver Interference levels....7
4 Broadcast Radio Receivers....8
4.1 Background....8
4.2 Location....8
4.3 Environment....8
4.4 Broadcast Receivers....8
4.4.1 Radio 1....8
4.4.2 Radio 2....9
4.4.3 Other Radio Receivers....9
5 WPT....10
5.1 WPT Qi Standard....10
5.2 Qi Technology Overview....10
5.3 Effective Radiated Power....11
5.4 Equipment Tested....11
5.4.1 Unit 1....11
5.4.2 Unit 2....11
5.4.3 Unit 3....11
5.4.4 Unit 4....11
6 Test Set up Hearing Aids....12
6.1 General....12
6.2 T-Coil Transmitter or Inductive Loop....12
6.2 Hearing Aid Test Unit....13
6.3 Hearing aids....14
6.4 Results....14
7 Test Set up Radio....15
7.1 General....15
7.2 Results....15
7.2.1 Radio 1....15
7.2.1 Radio 2....16
8 Definitions, symbols and abbreviations....16
8.1 Symbols....16
8.2 Abbreviations....16
Annex 1 About the Wireless Power Consortium....17
History....18

Foreword

In recent years the interference potential of the various types of low frequency (below 30MHz) Wireless Power Transfer devices has been explored on a mathematical basis in a number of fora. We believe that this is the first time that practical testing has been carried out and we express our thanks to both the Wireless Power Consortium, EHIMA members and loop manufacturers for providing equipment and facilities for these practical tests.

It should be emphasised that these results are only valid for the equipment used but gives a good indication of a general nature for low power WPT devices. Further testing is planned for when higher power portable devices and electric vehicle systems (both WPT and plug in) are available

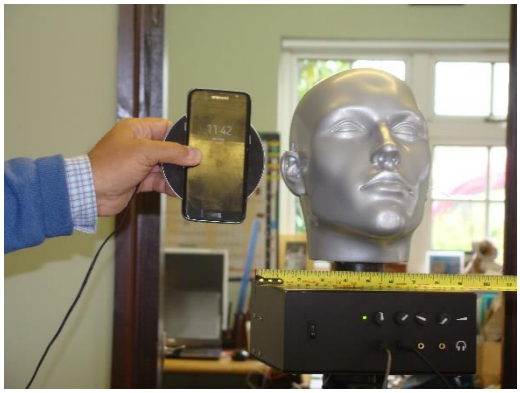
1 Executive Summary

Some four WPT charging devices where tested against three hearing aids using T-Coil and two broadcast radio receivers.

It should be noted that whilst the devices are marketed as 7-10-15W etc., this is the conducted power transfer rating. The devices are designed for efficient near field power transfer and the radiated e.r.p. is typically around of 3µW e.r.p.

The test set up was:

Results can best be described by the following pictures:



In all cases the WPT device could be operated within a few mm whilst charging at its maximum conducted power into a mobile phone, transfer power of up to 15W without causing interference to the various hearing aids

In all cases bar one the WPT device could be placed on top of the radio whilst DAB or FM was being received via the telescopic antenna without interference to reception in the interference case some 3cm was needed to provide interference free reception

In all cases the portable radio on either MW or LW, when on a station (including distant stations >100 miles) could be operated without interference at a few cm, it should be noted that the harmonics and main signals of the WPT device can be tuned in which case as shown below approximately 91.5cm separation gave no interference on fundamental or spurious from WPT device, common for all tests

2 Introduction

The T-coil has been in use since 1927 and is the only universal world-wide communication systems for the hard of hearing it can be found in many environments from domestic to business and is common or in some Countries mandated in mobile and land line phones.

It will be available where the blue ear symbol is displayed:

It uses a base band audio signal of up to 10 kHz and concerns where expressed that the WPT devices operating in the 140 kHz range at close proximity especially in a domestic situation would either block the T-Coil signals or interfere with them generating stress in the T-Coil user many of which will be in the upper age range or children. During the tests we took advantage of the test setup to also carry our practical tests with broadcast receivers which will also be found in similar domestic environment to both T-Coil and WPT charging devices

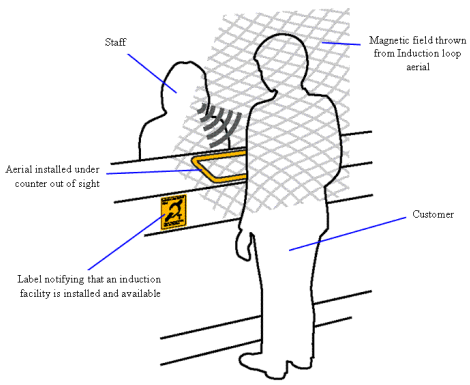
3 T-Coil

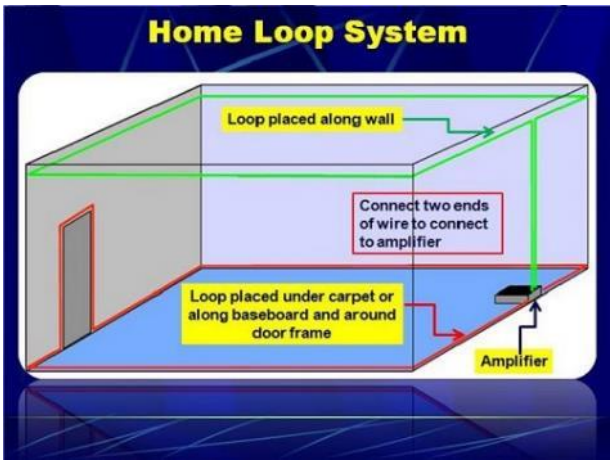
3.1 T-Coil Transmitter or Inductive Loop

A hearing loop (sometimes called an audio induction loop) is a special type of sound system for use by people with hearing aids. The hearing loop provides a magnetic, wireless signal that is picked up by the hearing aid when it is set to 'T' (Telecoil) setting.

The hearing loop consists of a microphone (or microphones) to pick up the spoken word; an amplifier which processes the signal which is then sent through the final piece; the loop cable, a wire placed around the perimeter of a specific area i.e. a living or meeting room, a church, a service counter etc. to act as an antenna that radiates the magnetic signal to the hearing aid.

Below is a diagram of a hearing loop at a shop counter or bank and a home setup





3.2 T-Coil Receivers

These come in a variety of types although the majority of modules are made by the same company

Plug in module for Hearing aid

Over rear unit to enhance phones etc.

Neck loop

T-Coil incorporated in Hearing Aid

3.3 T-Coil Receiver Interference levels

The T-Coil system requires field strengths not to exceed the following:

Frequency range	min. field strength to cause interference at 1 M
50Hz – 12kHz	0.3mA/m
>12kHz – 100kHz	300mA/m
Receiver sensitivity	-98dBVrms to -95dBVrms

4 Broadcast Radio Receivers

4.1 Background

The objective was to create a typical home environment where both radio reception and WPT devices would coexist and identify any coexistence issues..

4.2 Location

Edgcott is in a rural location some 20 miles NE from Oxford and approximately 70 miles NNE of London it is a radio "quite area".

BBC FM and DAB transmitters are located at Oxford some 15 miles line of sight

BBC MW and LW are located at Droitwich approximately 70 miles

BBC Wales Transmitter >120M

4.3 Environment

The room in use is single story, approximately 8m x 4M and 2.4M high with a double brick cavity wall and three windows and an outside door.

Equipment was mounted on a wooden table with three people in the room

4.4 Broadcast Receivers

Two Main test broadcast receivers where used:

4.4.1 Radio 1

Sony ICF-403L FM/MW/LW 3 band radio

Telescopic Antenna for FM and internal ferrite for medium and long wave

4.4.2 Radio 2

Roberts Bluetune 100 FM/DAB

4.4.3 Other Radio Receivers

At various points the following receivers where used to confirm the interference potential of the WPT devices

ICOM IC 7100 25-2000MHz mains operated using: Moonraker Skyscan Mobile Scanner Antenna 25-2000 MHz

Sony ICF 2001D LW/MW/FM/SW internal antenna and telescopic

Signal hound Software receiver/spectrum analyser 1Hz to 4.4GHz using: TengKo Scanner Antenna Gain: 3dB,

Receive Frequency: 30MHz - 1200 MHz

5 WPT

5.1 WPT Qi Standard

Over the last 10 years, there has been a multiplicity of wireless power transfer charging standards developed for small electronic devices, such as smart phones. In the last few years there has been considerable consolidation of WPT standards.

With the maturing of the technology and its wide consumer adoption, the Qi Standard developed by the Wireless Power Consortium (WPC) first published in 2010, has established itself as the most popular global standard for low power wireless charging.

- Qi used for wide range of mobile devices such as, mmobile phone, camera, mp3 player, headset …
- Qi is built into more than 100 smartphone models
- Qi is built into more than 90 car models
- Qi charging stations are built into thousands of installations in public places and offices
- Qi increasingly being built into home furniture

5.2 Qi Technology Overview

Qi provides a method of contactless power transfer from a Base Station to a Mobile Device that is based on near field magnetic induction between coils.

A Baseline Power Profile supports transfer of up to about 5 W and an Extended Power Profile supports transfer of up to about 15 W of power using an appropriate secondary coil (having a typical outer dimension of around 40 mm). Qi is designed to operate at frequencies in the 87 - 205 kHz range. A simple communications mechanism is used to initiate manage and terminate power transfer. Foreign object detection is included in the standard as a safety feature.

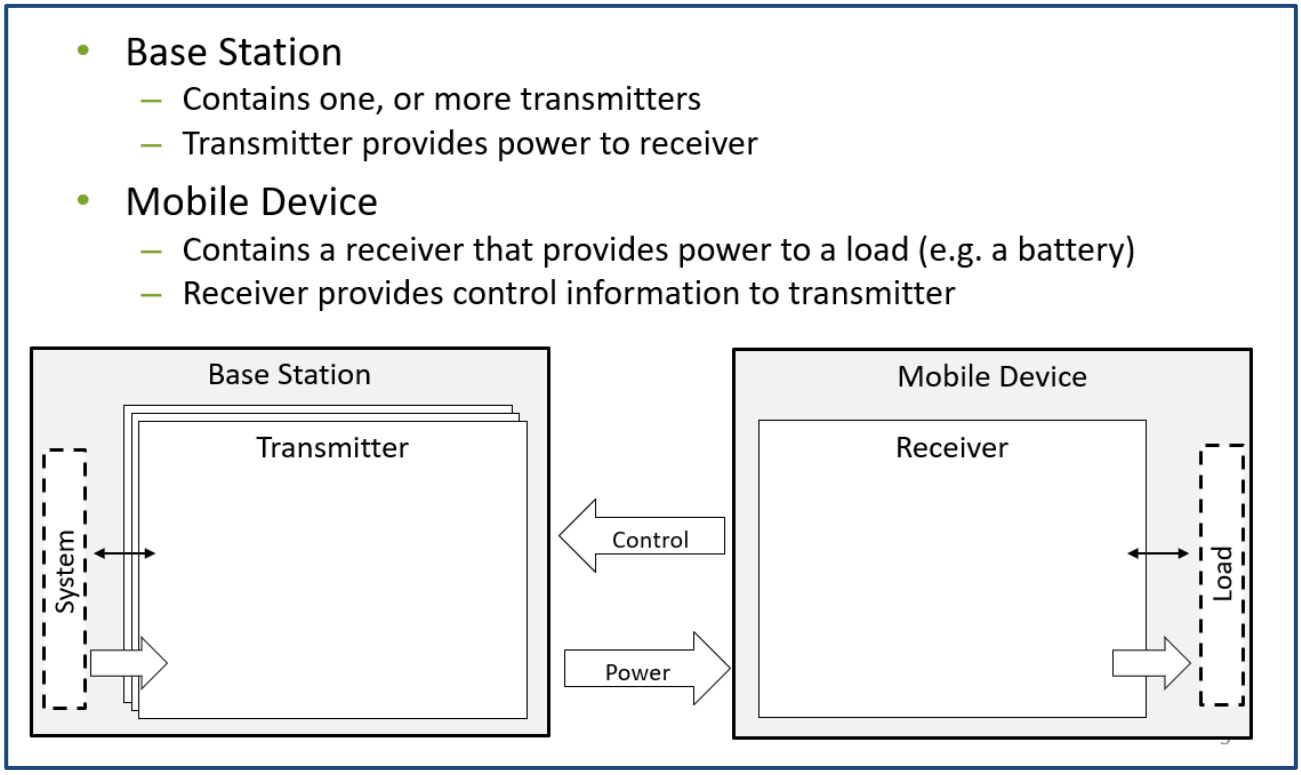


Figure 1 Overview of Qi

5.3 Effective Radiated Power

WPT devices use magnetic induction and are not designed to transmit power over any significant distance. Typically the transmission distance is in the range of millimetres. Qi applications, generate reasonably high magnetic field strengths close to the transmitter and are not designed to produce a radiating Electric field. Qi transmitter coils are extremely inefficient transmitters of electric fields.

Qi transmitter devices typically transfer 5 – 15 Watts. In addition to the wanted power transfer, there is a small leakage of radio energy. The regulations permit a maximum of +42 dBµA/m (at 10m). Devices are typically measured with levels between -10 to +10 dBµA/m when operating in power transfer mode. Taking as an example of +10 dBµA/m = 61.5 dBuV/m which is an ERP of 2.9 µW.

5.4 Equipment Tested

Some twelve units were available but due to time constraints we selected four units based on maximum conducted power and number of coils

5.4.1 Unit 1

Design MP-A4 single coil 15 Watts 110-205 kHz

5.4.2 Unit 2

Design A36 dual coil 5 Watts. 120 -130 kHz

5.4.3 Unit 3

Design MP-A5 single coil 10 Watts. 126 – 134 kHz.

5.4.4 Unit 4

Design A28 2 dual coil 5 Watts. 110 – 205 kHz.

6 Test Set up Hearing Aids

6.1 General

The room in use is single story, approximately 8m x 4M and 2.4M high with a double brick cavity wall and three windows.

Equipment was mounted on a wooden table with three people in the room. The T-Coil was fed with a test signal generator which was varied between voice and music. Prior to each test sequence a check was made to ensure no interference was present. Each WPT device was switched onto maximum charge and a Samsung S7 with low battery (10-40%) was used as load.

Each unit was moved into proximity of the hearing aid until interference was heard

6.2 T-Coil Transmitter or Inductive Loop

The unit used is a true current mode, audio-frequency induction loop amplifier, and is designed to cover rooms up to 50m2. The loop was installed in the roof space above the ceiling

Frequency response -3dB: 120Hz to 5kHz as per BS EN 60118-4

Maximum RMS output current 4A @ 1kHz

Input signal level: Mic: -60dB unbalanced; Line: -27dB stereo
Unbalanced; Outreach: -10dB balanced.

AGC range (3dB change in output
Current), reference rated I/P voltage: 10dB

Induction loop systems require careful testing and calibration prior to operation. BS EN 60118-4 - Magnetic field strength in audio-frequency induction loops for hearing aid purposes, recommends that the achievable magnetic field strength of an induction loop
system over a ‘covered area’ should be 400 mA RMS per metre.
This was achieved using a magnetic field strength meter and a loop listener (for measuring background noise, frequency response and metal compensation).

The signal generator also supplies constant music or voice output which was used during all testing

6.2 Hearing Aid Test Unit

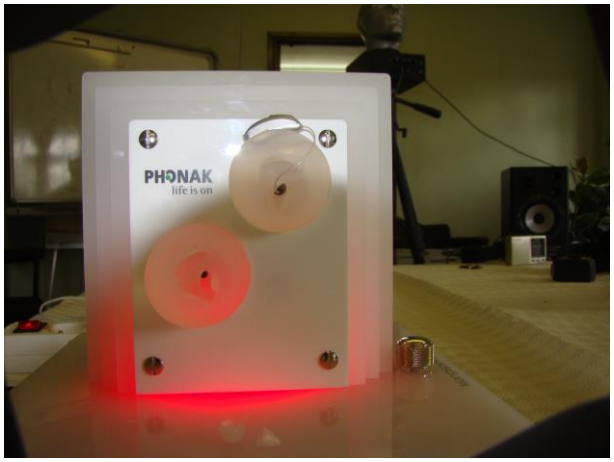
Two units where used to house the Hearing aids and provide audio outputs

First Test system was Charlie Head: Battery operated unit, hearing aid output goes via an acoustic coupling then into audio amplifier and onto a 3.5 audio jack

. The audio output was connected to an external speaker via a 3.5mm audio lead, so that any degradation in sound quality could be monitored

Head phones were also used to confirm the quality of the signal

Second test system was a mains operated “Klangfinder” demonstration unit shown below with the audio amplifier output going into a 3.5mm stereo output socket. The acoustic coupling transducer is designed to represent the average adult human ear



The output was connected to an external speaker via a 3.5mm audio lead, so that any degradation in sound quality could be monitored

Head phones were also used to confirm the quality of the signal

6.3 Hearing aids

Three representative pairs of hearing aids where used all with T-Coil switched on, the hearing aids were programmed to a program with the external mic activated to represent normal use. One pair where a representative standard hearing aid and the other two pairs where Bluetooth enabled

The two Bluetooth enable hearing aids were programmed with a mild loss and the hearing aid mics were activated to represent a realistic scenario. The output was transferred via an external hearing aid medium receiver to the acoustic coupling of the Charlie Head or Klangfinder.

6.4 Results

These can best be described by the visual images below; in all tests the audio output was monitored by three critical people using the audio output of the test signal generator into the input of the loop system. Both test systems where in use and gave the same results

7 Test Set up Radio

7.1 General

The room in use is single story, approximately 8m x 4M and 2.4M high with a double brick cavity wall and three windows. Equipment was mounted on a wooden table with three people in the room. . Prior to each test sequence a check was made to ensure no interference was present. Each WPT device was switched onto maximum charge and an Samsung S7 with low battery (10-40%) was used as load.

Each unit was moved into proximity of the broadcast receiver until interference was heard

7.2 Results

7.2.1 Radio 1

There are two conditions for Radio 1

Condition 1 where the frequency or harmonics of the WPT device where tuned to

Condition 2 where the radio was tuned to a broadcast station

Condition 1

Approximately 91.5cm separation gave no interference on fundamental or spurious from WPT device, common for all tests

Condition 2

No interference on fundamental or harmonics from WPT device, common for all tests when radio tuned to broadcast stations including BBC radio Wales (distant station)

7.2.1 Radio 2

Testing was carried out on both FM and DAB stations in all but one case the results were no interference with WPT on top of set adjacent to the telescopic antenna

In the one case with unit 4 a 2cm gap was required when placed on top of radio, no interference front sides or back

8 Definitions, symbols and abbreviations

8.1 Symbols

For the purposes of the present document, the following symbols apply:

dB	decibel
dBm	power ratio in dB (decibels) referenced to one milliwatt (mW)
kHz	kilohertz – 1 thousand cycles per second
MHz	Mega Hertz – 1 million cycles per second
mW	mille Watts
µW	micro Watts
W	Watts

8.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AM	Amplitude Modulation
DAB	Digital audio broadcasting
EHIMA	European Hearing Instrument Manufacturer's Assn
ERP	Effective Radiated Power
FM	Frequency Modulation
LW	Long Wave
RF	Radio Frequency
SW	Short Wave
WPT	Wireless Power Transfer

Annex 1 About the Wireless Power Consortium

Established in 2008, the Wireless Power Consortium is an open, collaborative standards development group of more than 600 member companies from around the globe. WPC's members include Apple, ASUS, Belkin, Bosch, Canon, ConvenientPower, Dell, Google, Haier, Huawei, IKEA, Lenovo, LG, MediaTek, mophie, NXP, Panasonic, Royal Philips, Samsung, Sony, TDK, Verizon Wireless and Xiaomi. These brands are large and small competitors and ecosystem partners, from all parts of the industry and all parts of the globe that collaborate with a single purpose: worldwide compatibility of all wireless chargers and wireless power sources. As of May 2019 the consortium has certified more than 3700 devices.

As wireless charging continues to evolve beyond consumer handheld devices, there are myriad of other new applications, such as laptops, tablets, drones, robots, connected car and the intelligent cordless kitchen. The WPC maintains and develops standards for a variety of different wireless power profiles. More information at

www.wirelesspowerconsortium.com

History

Document history		
V0.1	20 May 2010	Document creation
V0.2	22 May 2019	Section 5 and Annex 4 on WPT added
V0.3	8 June 2019	Expanded sections from notes & photos of testing
V0.4	10 June 2019	Editorial check