TECHNICAL REPORT

REPORT Nr.: 2013900900-EMF	ALTER TECHNOLOGY TÜV NORD, S.A.U. LABORATORIO DE EQUIPOS Y CERTIFICACIÓN C/ Majada, 3. 28760 TRES CANTOS Madrid (Spain) Telf.: +34 918041893 Fax: +34 918041664	Date: 05/07/2013

TEST: EMF **PRODUCT:** CLAY-IQ **CODE:** See clause 3	**ORDERED BY:** SALTO SYSTEMS, S.L. **ADDRESS:** C/ Arkotz, 9 Pol. Lanbarren 20180 Oiartzun Spain

TEST SPECIFICATIONS:

EN 50385 (2002)	Product Standard to Demonstrate the Compliance of Radio Base Stations and Fixed Terminal Stations for Wireless Telecommunication Systems with the Basic Restrictions or the Reference Levels Related to Human Exposure to Radio-Frequency Electromagnetic Fields (110 MHz – 40 GHz)—General Public.
EN 50383 (2002)	Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz – 40 GHz)

REFERENCE DOCUMENTS:

Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz). 1999/519/EC

Technical File CLAY-IQ REPEATER Version 1.1 (14/06/2013)

The results of this report are representative only of the sample/s tested

PERFORMED BY:	APPROVED BY:
G. Blázquez	M. González
Laboratory Technician	Laboratory Manager

ALTER TECHNOLOGY TÜV NORD, S.A.U. Tomas Alba Edison, 4, Parque Científico y Tecnológico Cartuja
41092 SEVILLA, SPAIN

1 OBJET

The purpose of this technical report is to verify through theoretical analysis that the radiated electromagnetic field strength from IBR equipment (taking into account the antenna data) is in accordance with the test specification applied. So, that complies with the Reference Levels detailed within Council Recommendation of 12 July 1999 (1999/519/EC).

2 ANALYSIS RESULTS

The EUT (Equipment Under Test) COMPLIES at the points of investigation with the requirements of basic restrictions to protect the general public from EMF exposure described in the standards mentioned above.

3 EUT IDENTIFICATION

The CLAY-IQ equipment is an electronic equipment that interfaces two networks with different protocol. The Salto CLAY-SALLIS network (Zigbee network) and the CLAY system servers (GPRS network). The CLAY-IQ is designed to interface between Salto CLAY locks and CLAY servers. Salto CLAY locks communicates with the CLAY-IQ through the Zigbee network, and the EUT communicates with CLAY servers via GPRS network.

The CLAY-IQ belongs to a product family that is composed by two models: CLAY-IQ and CLAY-REPEATER. The only difference between them is that CLAY-IQ model has a GPRS module and CLAY-REPEATER not.

The CLAY-IQ has two antennas connected: one of them, PCB 2.4 GHz Inverted F antenna designed by Texas Instruments, works in the 2.4 GHz band; and, another, pentaband SMD antenna model W3544A of PULSE, works in the GSM band.

The CLAY-REPEATER only has got connected the PCB 2.4 GHz Inverted F antenna designed by Texas Instruments that works in the 2.4 GHz band.

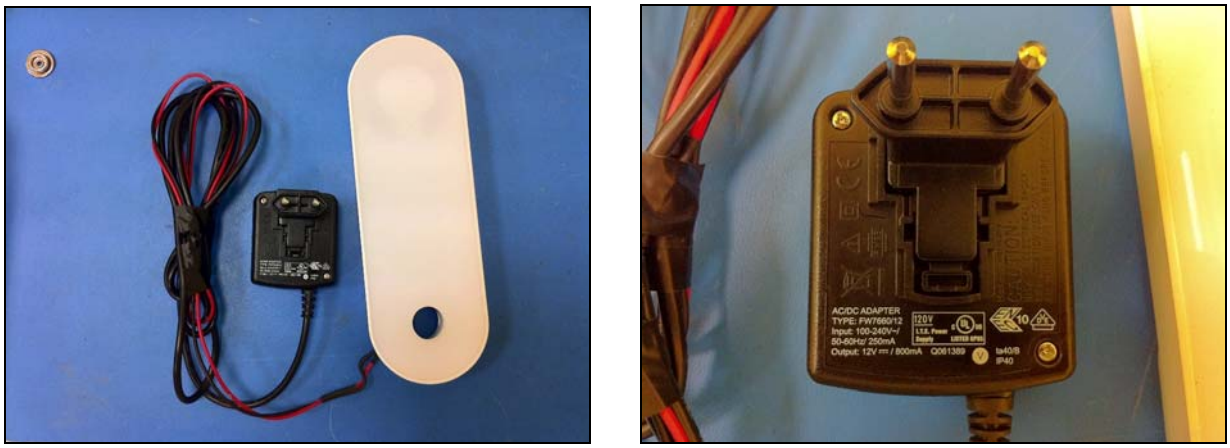

Figure 1. EUT identification

4 EMF LIMITS

The reference levels for limiting exposure are obtained from the basic restrictions for the condition of maximum coupling of the field to the exposed individual, thereby providing maximum protection

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (μT)	Equivalent plane wave power density S_{eq} (W/m^2)
0-1 Hz	-	$3,2 \times 10^4$	4×10^4	-
1-8 Hz	10000	$3,2 \times 10^4/f$	$4 \times 10^4/f^2$	-
8-25 Hz	10000	4000/f	5000/f	-
0,025-0,8 kHz	250/f	4/f	5/f	-
0,8-3 kHz	250/f	5	6,25	-
3-150 kHz	87	5	6,25	-
0,15-1 MHz	87	0,73/f	0,92/f	-
1-10 MHz	$87/f^{1/2}$	0,73/f	0,92/f	-
10-400 MHz	28	0,073	0,092	2
400-2 000 MHz	$1,375\ f^{1/2}$	$0,0037\ f^{1/2}$	$0,0046\ f^{1/2}$	f/200
2-300 GHz	61	0,16	0,2	10

Table 4.1 - Reference levels for electric, magnetic and electromagnetic fields (0 Hz to 300 GHz, unperturbed rms values)

5 EMF ASSESMENT ANALYSIS

Compliance with the basic restrictions of the standard is demonstrated by establishing the boundaries or distances at which the EMF levels do not exceed the general-public limits. Therefore, Respect of all recommended reference levels will ensure respect of basic restrictions.

The compliance boundaries are established by the methodologies given by the basic standard EN 50383 (2010). The manufacturer must ensure that the safe boundaries are not compromised. The separation distance from the device must be maintained to a minimum distance such that the EMF levels are below the general-public limits.

The CLAY-IQ has two antennas connected: one of them, PCB 2.4 GHz Inverted F antenna designed by Texas Instruments, works in the 2.4 GHz band; and, another, pentaband SMD antenna model W3544A of PULSE, works in the GSM band.

The CLAY-REPEATER only has got connected the PCB 2.4 GHz Inverted F antenna designed by Texas Instruments that works in the 2.4 GHz band.

The CLAY-IQ and the CLAY-REPEATER shall be operated in a manner that ensures that the public is not exposed to RF energy levels over the specified limit.

5.1 ASSESSMENT METHOD

The reference methodology for Far-field region is selected considering free space analysis in calculation, provided that the environment influence is shown as negligible.

EMF (ElectroMagnetic Field) evaluation is carried out by calculation of electromagnetic fields relating to reference levels, since compliance to the reference levels guarantees compliance to the basic restrictions.

5.2 EUT PARAMETERS

Zigbee frequency band	2400 – 2483.5 MHz
GSM frequency bands	824 – 960 MHz 1710 – 1880 MHz 1850 – 1990 MHz 1920 – 2170 MHz
Maximum output power Zigbee module	5 dBm
Maximum output power GSM module	33 dBm
Gain PCB 2.4 GHz Inverted F antenna of Texas Instruments	3.3 dBi
Gain Pentaband SMD antenna model W3544A of PULSE	1 dBi

5.3 EMF EXPOSURE EVALUATION

The far field calculations are accurate when the distance, r, from an antenna of length D to a point of investigation is greater than

$$r = \frac{2D^2}{\lambda}$$

Where

D: Maximum dimension of antenna
λ: wavelength

1. To ensure the far field,

- Wavelength depends on the transmission frequency :
  - Zigbee band: 2.4 to 2.4835 GHz:
    - f_{max} = 2483.5 MHz → λ_{min} = 120.797 mm
    - f_{min} = 2400 MHz → λ_{max} = 125 mm
  - GSM bands: 824 – 960 MHz; 1710 – 1880 MHz; 1850 – 1990 MHz and 1920 – 2170 MHz.
    - f_{max} = 2170 MHz → λ_{min} = 138.249 mm
    - f_{min} = 824 MHz → λ_{max} = 364.078 mm
- Maximum dimension of antenna:
  - Zigbee: PCB invereted F antenna: D = 25.58 mm
  - GSM: Pentaband SMD antenna: D = 26 mm

With these parameters:

- Worst case for Zigbee :
  - o $r = \frac{2D^2}{\lambda}$; when $\lambda = \lambda_{min}$ → r = 10.83 mm
- Worst case for GSM:
  - o $r = \frac{2D^2}{\lambda}$; when $\lambda = \lambda_{min}$ → r = 9.78 mm

To ensure the far field with these parameters, r must be: r > 1 cm

2. The field calculation does not take into account the antenna size, which is assumed to be a point source. A hypothetical isotropic antenna is used as a reference to compare the performance of practical antennas: P watts is radiated, from a point, uniformly over the surface of sphere of radius r

   The power flux density S:

$$S = E \times H = \frac{E^2}{\eta} = \frac{P}{4\pi r^2}$$

   In free space conditions:

$$E = \eta_o \times H = \frac{\sqrt{30 \times P \times G}}{r}$$

   Where

   P: transmitted power in watts;
   r: distance from observation point to the antenna (m);
   η0: characteristic impedance of free space;
   G: antenna gain relative to an isotropic antenna

   To comply with a field strength limit of:

- For GPS frequencies, between 400 – 2000 MHz, E = 1,375 $f^{1/2}$ V/m; worst case when $f=f_{min}$= 824 MHz, then E = 39.47 V/m. Substituitng values:
  - ➢ P (GSM module) = 33 dBm → 1.995 W and G = 1 dBi

$$r = \frac{\sqrt{30 \times P \times G}}{E} = 0{,}196m$$

- For Zigbee frequencies, E = 61 V/m. Substituitng values:
  - ➢ P (Zigbee)= 5 dBm → 3.16 mW and G = 3.3 dBi

$$r = \frac{\sqrt{30 \times P \times G}}{E} = 0{,}009m$$

When the protection distances are less than 10 cm, this distance should be considered as the minimum safety distance.

Summarizing:

When the safety distance between:

- CLAY-IQ and human body is $r \geq 0.2m$ (rounded up),
- CLAY-REPEATER and human body is $r \geq 0.1m$,

then the E-field strength is less than 61 V/m for frequencies upper 2 GHz and it is less than 39.5 V/m (worst case) for frequencies below 2 GHz as required in Annex III table 2 of EC Council recommendation (1999/5197EC) for compliance with reference level. See table 4.1 Reference levels for electric, magnetic and electromagnetic fields (0 Hz to 300 GHz, unperturbed rms values) at GSM and Zigbee frequencies.