
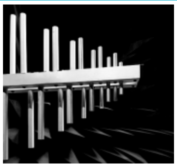
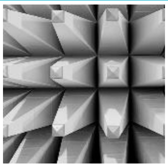

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TEST REPORT

Test Report No.: 1-4124/17-01-02

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-01

Testing Laboratory

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Accredited Test Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-01

Applicant

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Manufacturer

Hammer Fiber Optic Investments Ltd.
311 Broadway
08742 Point Pleasant Beach, NJ/UNITED STATES

Test Standard/s

EN 62311	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)
OET Bulletin 65 - Edition 97-01	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	AIR Transceiver
Model name:	**AIR TVIP-001**
S/N serial number:	n.a.
Frequency:	see technical details
Antenna:	40, 65 or 80 cm reflector antenna
Exposure category:	general population / uncontrolled environment

This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test Report authorised:

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Thomas Vogler
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1 Table of contents

2 General information

2.1 Notes and disclaimer

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2.2 Application details

Date of receipt of order:	2017-04-11
Date of receipt of test item:	2017-04-11
Start of test:	2017-04-11
End of test:	2017-04-11
Person(s) present during the test:	

2.3 Statement of compliance

The EMF values found for the AIR TVIP-001 AIR Transceiver are below the maximum allowed levels according to the standards listed in section 3, when used with an antenna with maximum gain as listed in chapter 4.2.

3 Test standard/s:

Test Standard	Version	Test Standard Description
EN 62311	04.11.2008	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)
OET Bulletin 65 - Edition 97-01	01.08.1997	Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields

4 Test item

4.1 General Description

Information taken from CTC advanced test report 1-2565/16-01-03:

Kind of test item	:	AIR Transceiver
Type identification	:	AIR TVIP-001
S/N serial number	:	Band 2: 21-03907 Band 3: 21-01995
HW hardware status	:	Air pmp bs-90-e usv Air tvip-001-usv
SW software status	:	n.a.
Frequency band TX	:	Band 2: 31.1218 GHz – 31.1502 GHz Band 3: 31.1602 GHz – 31.1886 GHz
Frequency band RX	:	27.50 GHz – 27.95 GHz / 27.95 GHz – 28.35 GHz
Type of radio transmission Use of frequency spectrum	: :	modulated carrier
Type of modulation	:	QPSK, 16QAM, 32QAM, 64QAM
Number of channels	:	10 per band
Antenna	:	internal feed horn / external dish antenna
Power supply	:	12 V DC ±10%
Temperature range	:	-40°C to +60°C

4.2 Antenna system(s)

Reflector size (m)	Concept	Manufacturer	Type	data sheet	pattern / test report
0.40	offset, single-optic	Gibertini	OP 40 E	X	linear pattern
0.65	offset, single-optic	Gibertini	OP 65 E	X	linear pattern
0.80	offset, single-optic	Gibertini	OP 80 E	X	linear pattern

4.3 Technical descriptions and documents

No.	Document(s)
1	AIR CPE mounting guidelines USA – Technical specifications
2	Gibertini E-Series – Technical Specifications

4.4 Additional information

A gain of 41 dBi was assumed for the 80 cm reflector when used at 31 GHz.

5 Evaluating compliance with requirements for human exposure to EMFs

5.1 Introduction

The Directive 2014/54/EU ‘of the European Parliament and of the council of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC’ (RED) determines essential requirements in its article 3. These essential requirements are valid for all radio equipment and telecommunications terminal equipment. For such equipment, the conformity to the essential requirements has to be demonstrated. In order to perform the conformity assessment harmonized standards can be used. The document identifier of these standards is published on the ´Official Journal of the European Community´.
One of the essential requirements is ´the protection of health and safety of persons and of domestic animals and the protection of property´ (article 3.1(a)). This includes the protection against human exposure to radio frequency electromagnetic fields (EMF), which is described in the ´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´ which for its part refers to the ICNIRP Guidelines.
The exposure limits of the ICNIRP Guidelines are comparable to those given in some other available documents, e.g. FCC CFR 47. Therefore, for the purpose of demonstration of conformity to this essential requirement international accepted limits can be determined. However, the mentioned documents do not describe any practical way to find out the exposure values of the equipment under test, which shall be compared to these limits.
That is why in this assessment report the following standards were used to show that the real exposure levels satisfy the essential requirements under RED article 3.1(a):

- FCC OET Bullet No. 65, Edition 97-01, August 1997
  ´Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic fields´
- EN 62 311, 2008
  ´Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)´

Remark: Some other documents are available describing similar methods.

5.2 RF EMF Exposure Limits

In April 1998, ICNIRP (International Commission on Non-Ionizing Radiation Protection) published its ‘Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)’. As shown in Table 5.2-1, the guidelines (Tables 6 and 7) specify the ‘Reference levels on power density for occupational exposure and general public exposure to time-varying electric and magnetic fields (unperturbed rms values)’ between 2 and 300 GHz.

Table 5.2-1: ICNIRP Reference levels within the frequency range 2-300 GHz

Frequency range	Exposure characteristics	Equivalent plane wave power density S_{eq} (W/m²)	Average time period (min)
2 – 10 GHz	occupational	50	6
	general public	10	6
10 – 300 GHz	occupational	50	$68/f^{1.05}$ (f in GHz)
	general public	10	$68/f^{1.05}$ (f in GHz)

Note: For pulsed signals, it is suggested that the peak equivalent plane wave power density, as averaged over the pulse width, does not exceed 1000 times the S_{eq} exposure levels given in the table.

Note: Within the frequency range the 10 – 300 GHz, the basic restrictions are identical to the reference levels. Remarks to the definition of basic restrictions:
1. Power densities are to be averaged over any 20 cm² of exposed area and any $68/f^{1.05}$ minute period (where f is in GHz) to compensate for progressively shorter penetration depth as the frequency increases.
2. Spatial maximum power densities, averaged over 1 cm², should not exceed 20 times the values above.

Compared to the ICNIRP restrictions, FCC CFR 47 specifies the Maximum Permissible Exposure (MPE) levels for occupational/controlled environment and general public/uncontrolled environment, as shown in Table 5.2-2.

Table 5.2-2: FCC MPE limits within the frequency range 1.5-100 GHz

Frequency range	Exposure characteristics	Equivalent plane wave power density S_{eq} (W/m²)	Average time period (min)
1.5 –100 GHz	occupational	50	6
	general public	10	30

A few other documents specify or refer to exposure limits comparable to those given above, e.g.:

- 1999/519/EC: Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)
- WHO: Environmental Health Criteria 137: ´Electromagnetic Fields (300 Hz to 300 GHz)´
- ANSI/IEEE C95.1, 2005:
  ´IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz´
- BRD, Bundesimmissionsschutzgesetz, 26. BImSchV Verordnung über elektromagnetische Felder
- Bundesamt für Umwelt, Wald und Landwirtschaft (BUWAL), Bern/Schweiz
  Schriftenreihe Umwelt Nr. 164, Luft, Mai 1992
  ´Messung nichtionisierender elektromagnetischer Strahlung, 1. Teil: Frequenzbereich 100 kHz bis 300 GHz´
- EN 50384
  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) – Occupational
- EN 50385
  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
- ENV 50166-2, January 1995 (withdrawn in December 1999 by CENELEC)
  ´Human Exposure to Electromagnetic Fields (10 kHz – 300 GHz)´

5.3 Equipment Under Test: relevant technical parameters

Table 5.3-1 shows the technical parameters of the equipment under test, which are relevant for the assessment of safety distances.

Table 5.3-1: Technical parameters of equipment under test

a)	antenna type	parabolic (circular) offset / single reflector			
b)	antenna aperture diameter	D	0.80	m	
c)	antenna aperture width	W	0.80	m	
d)	antenna aperture length	L	0.80	m	
e)	antenna aperture area	A	0.503	m^2	
f)	minimum antenna installation height (height of reflector centre above ground)	h	1.0	m	
g)	minimum elevation angle at geographical area within the system shall operate respectively:	α_{el}	0	°	worst case
h)	antenna gain (worst case)	G_{max}	41.0	dBi	
i)	antenna azimuth pattern	$G_{i(\phi)az}$	available	dB, dBi	
j)	antenna elevation pattern	$G_{i(\phi)el}$	available	dB, dBi	
k)	antenna aperture efficiency	η	0.75	1	
l)	3 dB – antenna main beam width	ϕ_{3dB}	1.00	°	worst case
m)	transmit frequency range	f	31.12 - 31.19	GHz	31.16
n)	wavelength at 31.16 GHz	λ	0.010	m	
o)	effective transmitter output power	P	14.5	dBm	= 28 mW
p)	loss between transmitter and antenna feed horn	a_{dB}	0.00	dB	= 0
q)	polarisation		linear		
r)	kind of modulation (modulation scheme)	k_{mod}	QPSK	1	Q1D
s)	burst rate	r	0.00	1/ms	
t)	burst width	w	0	ms	maximum
u)	transmission duty cycle:	d	100	%	maximum
v)	safety height	H	0	m	assumed

Note: This table contains the technical parameters for the Gibertini E-Series at maximum reflector diameter of 80 cm (antenna variant OP 80E)

5.4 Analytic-practical assessment (prediction method) of safety distances on aperture antennas

Following documents are used to assess the safety distances:

- FCC OET Bullet No. 65, Edition 97-01, August 1997
´Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic fields´
- EN 62 311, 2008
´Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz - 300 GHz)´

In these documents, analytical methods are demonstrated in order to appraisingly calculate the distances from the source of electromagnetic radiation in which the exposure limits are reached. As shown in Table 5.4-1 four exposure regions are defined. Unfortunately the definition of the dimension of these regions are slightly different. Therefore Table 5.4-1 shows both definitions.

Table 5.4-1: Exposure regions

Exposure region		Distance to antenna aperture and density of power flux definition acc. to			
		FCC OET Bullet No. 65		DIN EN 62311	
A	**antenna surface** (reactive near-field)	directly in front of the antenna	$S_{surface} = \frac{4P_t}{A}$	up to $\frac{\lambda}{4}$	$S_{surface} = \frac{4P_t}{A}$
B	**near-field region** (radiated near-field, Fresnel region, Hertzscher Schlauch)	$R_{nf} = \frac{D^2}{4\lambda}$	$S_{nf} = \frac{4\eta P_t}{A}$	$\frac{\lambda}{4} < R_{nf} \leq R_{ff}$	$S_{nf} = \frac{4P_t}{A}$
C	**transition region**	$R_{nf} \leq R \leq R_{ff}$	$S_t = \frac{4\eta P_t R_{nf}}{AR}$	-/-	-/-
D	**far-field region** (Fraunhofer region, Rayleigh-Distance)	$R_{ff} = \frac{0.6D^2}{\lambda}$	$S_{ff} = \frac{P_t G}{4\pi R^2}$	$R_{ff} = \frac{2D^2}{\lambda}$	$S_{ff} = \frac{P_t G}{4\pi R^2}$

whereas: $S_{surface}$ = maximum power density at the antenna surface in W/m²
S_{nf} = maximum near-field power density in W/m²
S_t = power density in the transition region in W/m²
S_{ff} = power density (on axis) in W/m²
R_{nf} = extent of near-field in m
R_{ff} = distance to beginning of near field in m
R = distance to the point of interest in m
P_t = power fed to the antenna feed horn in W
A = physical (geometrical) area of the aperture antenna in m²
D = maximum dimension of antenna (diameter if circular) in m
G = power gain factor in the direction of interest relative to an isotropic radiator
λ = wavelengths in m
η = aperture efficiency (typically 0.5-0.75 for circular apertures)

By use of Table 5.4-1, the distance r_1 in boresight direction (see Figure 1) in which the exposure limit is reached and its exposure region can be ascertained.

Table 5.4-2: Calculation of power feeding the antenna feed horn P_t

kind of correction factor	symbol	equation	unit
loss between transmitter output and antenna input	a_{dB}	$P_{t'} = P * 10^{\frac{a_{dB}}{10}}$	W
modulation scheme	k_{mod}	$P_{t''} = P_{t'} * k_{mod}$	W
average factor for bursted or pulsed signals	k_{avg}	$P_t = P_{t''} * k_{avg}$	W

Table 5.4-3: Reasonable approximation of η (if unknown):

circular apertures: $\eta = G(\frac{\lambda}{\pi D})^2$ **non-circular apertures:** $\eta = G(\frac{\lambda^2}{4\pi A})$	where: η = aperture efficiency (typically 0.5-0.75 for circular apertures) G = gain factor in the direction of interest relative to an isotropic radiator λ = wavelengths in m D = maximum dimension of antenna (diameter if circular) in m A = physical (geometrical) area of the aperture antenna in m²

Spurious emissions and harmonics:

According to ENV 50166-2, ´Human Exposure to Electromagnetic Fields (10 kHz – 300 GHz)´, section 4.2.1.3 and 5.3.1, there is no need to consider spurious emissions or harmonics with levels at least 10 dB below the main signal level. The fulfilment of this condition is taken possession of the requirements regarding the effective use of the RF-spectrum.

Evaluation of sidelobes:

Sidelobes ≤ ca. 60°:

For practical reasons each antenna sidelobe is considered as an ideal single aperture radiator with an aperture efficiency 1, a direction factor which is equal to the sidelobe gain and a spatial orientation of its ´main beam´ at the same angle of the sidelobe relative to boresight of the antenna under consideration.

With

$$G_{i(\phi)} = \frac{4\pi * A'}{\lambda^2} \qquad 60° \leq |\phi|$$

the effective aperture of this single radiation element results to:

$$A' = \frac{G_{i(\phi)} * \lambda^2}{4\pi}$$

For simplification circular aperture area is assumed, so the aperture diameter results to:

$$d = \sqrt{\frac{4A'}{\pi}}$$

Remark: This is a conservative approach on which only the part of vector is interesting which is orthogonal to boresight.

Where: $G_{i(\phi)}$ = antenna gain as a function of ϕ_{az} respectively ϕ_{el}
A´ = aperture area of single virtual radiation element
d = aperture diameter of single virtual radiation element

This diameter d used with the equation of the Rayleigh distance comes to the fact that it's possible to use the simple far-field conditions just for very short distances.
For the antenna under consideration the most critical sidelobes according to the azimuth- and elevation antenna pattern were examined. So it is possible to define safety distances r_3 and r_4 shown in Figure 1.

Sidelobes > 60°:
In an angular region $60° < |\phi| < 180°$, the antenna radiation pattern is well below the isotropic radiator level and dominated by feed spill-over and diffraction effects. Because these effects are generated by local parts of the antenna geometry the transition between near-field and far-field region from these local parts is 5...10 λ. This distance is very small compared to the antenna geometry. For practical reasons it is feasible to define a safety distance, which corresponds to the distances r_3 or r_4 whichever is larger.

$r_5 = \max(r_3 ; r_4)$ $\quad\quad 60° < |\phi| < 180°$

Consideration of antenna installation height, antenna main beam width and min. elevation angle:
When the antenna is aligned at its boresight direction away from ground the safety distance can be reduced to:

$$r_2 = \frac{H - (h - \frac{r_4}{\cos(\alpha_{el})})}{\tan(\alpha_{el} - \frac{\phi_{3dB}}{2})}$$

for dividend ≤ 0 then: $r_2 = 0$

Where:
- r_1 = safety distance without consideration of elevation at operation site in m (safety distance in boresight direction)
- r_2 = safety distance with consideration of elevation at operation site in m
- r_4 = see Figure 1
- h = antenna installation height in m (= distance between the geometrical centre of main reflector and passable environment ground level)
- H = safety height
- α_{el} = minimum elevation angle within the geographical operation area of the transmitter (e.g. for satellite earth station this angle results from coordinates of the operation site (longitude and latitude) and the satellite position)
- ϕ_{3dB} = 3 dB – main beam width

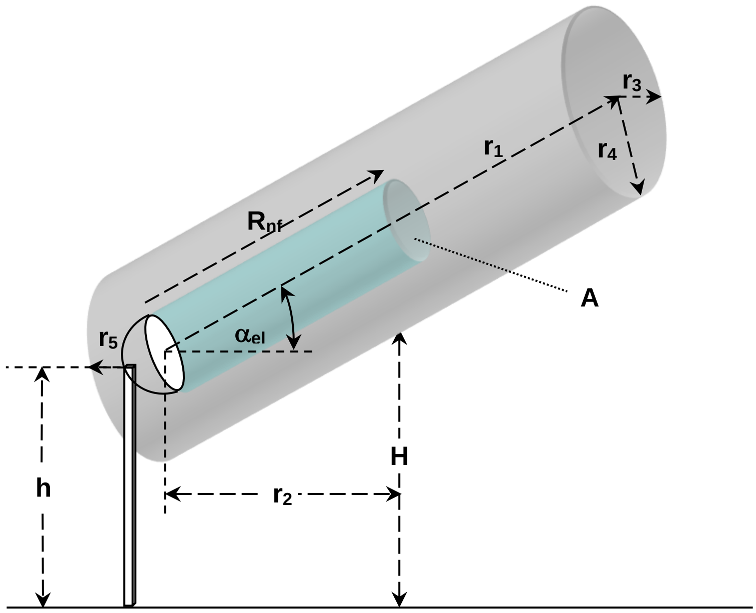

Figure 1

6 Results

With 0.80 m Gibertini E Series (OP 80 E) antenna at Ka-Band frequencies.

Result of calculation	symbol	Quantity	unit
modulation scheme	k_{mod}	1.00	1
average factor for bursted or pulsed signals	k_{avg}	1.00	1
transmit power fed to antenna	P_t	0.03	W
aperture efficiency	η	0.75	1
region A: density of power flux (acc. to FCC and EN)	$S_{surface}$	**0.22**	W/m²
region B: dimension (acc. to FCC)	R_{nf}	16.62	m
region B: dimension (acc. to EN)	R_{nf}	26.10	m
region B: density of power flux @ R_{nf} (acc. to FCC)	S_{nf}	0.17	W/m²
region B: density of power flux @ R_{nf} (acc. to EN)	S_{nf}	0.22	W/m²
region D: dimension (acc. to FCC)	R_{ff}	39.88	m
region D: dimension (acc. to EN)	R_{ff}	132.95	m
region D: density of power flux @ R_{ff} (acc. to FCC)	S_{ff}	0.02	W/m²
region D: density of power flux @ R_{ff} (acc. to EN)	S_{ff}	0.00	W/m²
occupational exposure limit is reached within region (acc. to FCC)	-/-	none	-/-
occupational exposure limit is reached within region (acc. to EN)	-/-	none	-/-
occupational exposure limit is reached at a distance of (acc. to FCC)	r_1	**0.0000**	m
occupational exposure limit is reached at a distance of (acc. to EN)	r_1	**0.0000**	m
general public exposure limit is reached within region (acc. to FCC)	-/-	none	-/-
general public exposure limit is reached within region (acc. to EN)	-/-	none	-/-
general public exposure limit is reached at a distance of (acc. to FCC)	r_1	**0.0000**	m
general public exposure limit is reached at a distance of (acc. to EN)	r_1	**0.0000**	m
safety distance r_3 (see fig. 1) occupational exp. limit, at least W/2	r_3	W/2 + 0	m
safety distance r_3 (see fig. 1) general public exp. limit, at least W/2	r_3	W/2 + 0.01	m
safety distance r_4 (see fig. 1) occupational public exp. limit, at least L/2	r_4	L/2 + 0	m
safety distance r_4 (see fig. 1) general public exp. limit, at least L/2	r_4	L/2 + 0.01	m
safety distance r_5 (see fig. 1) occupational exposure limit only	r_5	0.4029	m
safety distance r_5 (see fig. 1) general public exposure limit only	r_5	0.4066	m
safety distance r_2 (see fig. 1) occupational exposure limit	r_2	n.a.	m
safety distance r_2 (see fig. 1) general public exposure limit	r_2	n.a.	m

Verdict:

$S_{surface}$ = 0.22 W/m² of the antenna reflector is smaller than the general public exposure limit of 10 W/m² and therefore the minimum safety distance r_1 in front of the antenna is **0.00 m**. Overestimating formulas for far field etc. do not apply.
Sidelobe effects do not need to be taken into account.