EMI – TEST REPORT

- Human Exposure -

Type / Model Name	:	PR 30-HVS A12
Product Description	:	Rotating Laser
Applicant	:	Hilti AG
Address	:	Feldkircherstrasse 100
		9494 SCHAAN, LIECHTENSTEIN
Manufacturer	:	HILLOS GmbH
Address	:	Prüssingstraße 41
		07745 JENA, GERMANY
Licence holder	:	Hilti AG
Address	:	Feldkircherstrasse 100
		9494 SCHAAN, LIECHTENSTEIN

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Test Report No. : T40621-00-03TK	05. July 2016 Date of issue

Deutsche Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 1, Subpart I - Procedures Implementing the National Environmental Policy Act of 1969

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable device

OET Bulletin 65, 65A, 65B Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

KDB 447498 D01 v06	RF Exposure procedures and equipment authorisation policies for mobile and portable devices, October 23, 2015.
KDB 865664 D01	SAR Measurement Requirements for 100 MHz to 6 GHz, February 7, 2014.
ANSI C95.1: 2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2
RSS-102, Issue 5, March 2015	Radio Frequency (RF) Exposure Compliance of Radio-communication Apparatus (All Frequency Bands)

2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – Detailed photos see Attachment A

2.2 Equipment category

ZigBee device, portable equipment.

2.3 Short description of the equipment under test (EUT)

The EUT is a rotating laser alignment system and is equipped with an RF transceiver operating within the frequency range from 2.4 GHz up to 2.4835 GHz making available to the user to control the whole alignment system remotely. The RF section is not modified.

Number of tested samples : 1
Serial number : 176150035
Firmware version : Series firmware

Items	Description
IEEE 802.15.4	3 channel WPAN
IEEE 802.15.4 chipset type	Texas Instruments CC2520
Modulation	GFSK
Frequency range	2400 MHz to 2483.5 MHz
Channel numbers	3
Data rate (kbps)	250
Antenna type	PCB

EUT configuration:
(The CDF filled by the applicant can be viewed at the test laboratory.)

2.4 Variants of the EUT

None

2.5 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan and tested frequencies:

Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2405	2	2440	3	2480

2.6 Transmit operating modes

The EUT uses GFSK and provide following data rate:

250 kbps (kbps = *kilobits per second)*

2.7 Antenna

The following antennas shall be used with the EUT:

Characteristic	Certification name	Plug	Frequency range (MHz)	Gain
Omni	F-type PCB-antenna	none	2400 -2483.5	N/A

2.8 Power supply system utilised

Power supply voltage, V_{nom} : 12 VDC Lithium accumulator battery
Power supply voltage (alternative) : none

2.9 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- Power supply battery Model : B 12 / 2.6 Li-Ion
- _____ Model : _____

2.10 Determination of worst case conditions for final measurement

Measurements were performed in all three orthogonal axes and the settings of the EUT were changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in X position with the following settings:

IEEE Standard	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
802.15.4	1, 2, 3	1, 2, 3	+5 dBm	DSSS	GFSK	250 kbps

250 kbps, GFSK with TX continuous modulated.

2.10.1 Test jig

No test jig was used for test.

2.10.2 Test software

No special test software was used.

3 TEST RESULT SUMMERY

Bluetooth Low Energy device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz :

FCC Rule Part	RSS Rule Part	Description	Result
15.247(i)	RSS 102, 2.5.2	MPE	passed
KDB 447498	-	SAR exclusion consideration	passed
-	RSS 102, 2.5.1	SAR exemption evaluation	passed
OET Bulletin 65	RSS102, 3.2	Co-location, Co-transmission	not applicable

3.1 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 31 May 2016

Testing concluded on : 29 June 2016

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this document
2016.07.05 08:19:48 +02'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Tobias Kammerer
I´m the author of this document
2016.07.05 08:17:32 +02'00'

Tobias Kammerer
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement protocol for FCC and IC

4.4.1 General information

4.4.1.1 Test methodology

The Open Area test site is a listed Open Site under the Canadian Test-Sites File-No:

IC 3009A-1

The anechoic chamber site is a listed chamber under the Canadian Test-Sites File-No:

IC 3009A-2

In compliance with RSS 210 testing for RSS compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.1.2 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.1.3 Details of test procedures

In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

5 TEST CONDITIONS AND RESULTS

5.1 Maximum peak output power

Note:
No separate measurements were performed. The measurement values for fieldstrength are taken out of the test report T40709-00-01TK, section 5.2 (performed at CSA Group Bayern). All measurements were related to the radiated peak output power to perform the human exposure evaluation.

5.1.1 Applicable standard

According to FCC Part 15, Section 15.249(a):
For systems using digital modulation in the 2400-2483.5 MHz band, the average fieldstrentgh limit of the transmitter shall not exceed 94 µV/m (50 mV/m).

5.1.2 Test result

Frequency	Reading level PK	Bandwidth	Correction factor	Corrected level PK	Limit PK	Duty cycle correction factor K_E	Corrected level AV	Limit AV
(MHz)	(dBµV)	(kHz)	(dB)	dB(µV/m)	dB(µV/m)	(dB)	dB(µV/m)	dB(µV/m)
2405	116.6	1000	-12.1	104.5	114	-35.8	68.7	94
2440	114.3	1000	-10.9	103.4	114	-35.8	67.6	94
2480	112.5	1000	-10.9	101.6	114	-35.8	65.8	94

Note: The correction factor includes cable loss and antenna factor.

Calculation of the radiated isotropic output power

TX		Test results radiated			
		Fieldstrength E (dBµV/m)	$EIRP_{PK}$ (dBm)	Duty cycle corr. factor K_E	$EIRP_{AV}$ (dBm)
Lowest frequency (MHz):	2405				
T_{nom}	V_{nom}	104.5	9.2	-17.9	-8.7
Middle frequency (MHz):	2440				
T_{nom}	V_{nom}	103.4	8.2	-17.9	-9.7
Highest frequency (MHz):	2480				
T_{nom}	V_{nom}	101.6	6.3	-17.9	-11.6

Average Power Limit according to FCC Part 15, Section 15.249(a):

Frequency	Field strength of fundamental	
(MHz)	(mV/m)	dB(µV/m)
902 - 928	50	94
2400 - 2483.5	**50**	**94**
5725-5875	50	94
24000 - 24250	250	108

The requirements are **FULFILLED.**

Remarks: _____

_____

6 HUMAN EXPOSURE

6.1 Maximum permissible exposure (MPE)

6.1.1 Applicable standard

According to FCC Part 15, Section 15.247(i):
Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.
The test methods used comply with ANSI/IEEE C95.1, "IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz".
This test report shows the compliance with the limits for Maximum Permissible Exposure (MPE) specified in FCC Part 1, Section 1.1310 and the criteria to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in FCC Part 1, Section 1.1307(b).

6.1.2 Description of Measurement

The maximum total power input to the antenna has been measured conducted as described in clause 5.3 of this document. Through the Friis transmission formula, the known maximum gain of the antenna and the maximum power, can be calculated the MPE in a defined distance away from the product.

Friis transmission formula: $$P_d = \frac{P_{out} * G}{4 * \Pi * r^2}$$

Where:
P_d =power density (mW/cm^2)
P_{out} = output power to antenna (mW)
G = gain of antenna (linear scale)
r = distance between antenna and observation point (cm)

According to FCC Rules 47CFR 2.1093(b) the EUT is not a portable device. The EUT is designed to be used that radiating structures are 20 cm outside of the body of the user. (r = 20 cm)

6.1.3 Test result

FCC:

Channel frequency (MHz)	P_{EIRP} (dBm)	P (mW)	P (W)	P_d (mW/cm^2)	Limit P_d (mW/cm^2)
2405	9.2	8.399	0.008399	0.001671	1.0
2440	8.2	6.580	0.006580	0.001309	1.0
2480	6.3	4.278	0.004278	0.000851	1.0

IC:

Channel frequency (MHz)	P_{EIRP} (dBm)	P (mW)	P (W)	P_d (mW/cm^2)	P_d (W/m^2)	Limit P_d (W/m^2)
2405	9.2	8.399	0.008399	0.001671	0.01671	5.36
2440	8.2	6.580	0.006580	0.001309	0.01309	5.41
2480	6.3	4.278	0.004278	0.000851	0.00851	5.47

FCC-Limits for maximum permissible exposure (MPE):

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 3.0	614	1.63	100	30
3.0 – 30	824/*f*	2.19/*f*	180/ f^2	30
30 - 300	27.5	0.073	0.2	30
300-1500	---	---	*f*/1500	30
1500-100000	---	---	1	30

f = Frequency in MHz

IC-Limits according to RSS-102:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	**Electric Field (V/m rms)**	**Magnetic Field (A/m rms)**	**Power Density (W/m2)**	**Reference Period (minutes)**
0.003-1021	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ $f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ $f^{0.25}$	0.1540/ $f^{0.25}$	8.944/ $f^{0.5}$	6
48-300	22.06	0.05852	1,291	6
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619$f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10^{-4} $f^{0.5}$	6.67 x 10^{-5} f	616000/ $f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

The requirements are **FULFILLED.**

Remarks: _____

_____

6.2 SAR test exclusion considerations

6.2.1 Applicable standard

According to General RF Exposure Guidance:
Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

6.2.2 Determination of the standalone SAR test exemption threshold

The minimum separation distance results from the application of the EUT which is a stationary device. This distance is much more than 5 mm. To determine a worst case consideration the distance is assumed to ≤ **5** mm from antenna to the hand of the user.In this case the threshold is determined for 1-g limit.

The formula under 4.3.1 1) for 100 MHz to 6 GHz for standalone equipment is used:
[(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]*[√f(GHz)] ≤ 3.0

Result of 1-g SAR limit evaluation:

Channel frequency (MHz)	$P_{EIRP\ AV}$ (dBm)	P_{EIRP} (mW)	1-g SAR (1)	Limit1-g SAR (1)
2405	-8.7	0.14	0.0422	3.0
2440	-9.7	0.11	0.0333	3.0
2480	-11.6	0.07	0.0218	3.0

Limit according to KDB 447498 D01 General RF Exposure Guidance v06, Appendix A:

Frequency (MHz)	5	10	15	20	25	mm
150	39	77	116	155	194	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	**10**	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

The requirements are **FULFILLED.**

Remarks: _____

_____

6.3 SAR test exemption considerations

6.3.1 Applicable standard

According to RSS-102, Issue 5, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus: Requirements and measurement techniques used to evaluate RF exposure compliance of radiocommunication apparatus that are designed to be used within the vicinity of the human body.

6.3.2 Determination of the standalone SAR test exemption threshold

The minimum separation distance results from the application of the EUT which is a stationary device. This distance is much more than 5 mm. To determine a worst case consideration the distance is assumed to ≤ **5** mm from antenna to the hand of the user.In this case the threshold is determined for 1-g limit.

Result of SAR exemption evaluation:

Channel frequency (MHz)	$P_{EIRP\ AV}$ (dBm)	EIRP (mW)	IC SAR test exemption limit (mW)
2405	-8.7	0.14	4.09
2440	-9.7	0.11	4.00
2480	-11.6	0.07	3.90

Limit according to RSS-102, section 2.5.1, Table 1:

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤ 300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Conclusion: The Threshold level is much smaller than the limit, no SAR measurement is necessary.

The requirements are **FULFILLED.**

Remarks: _____

_____

6.4 Co-location and Co-transmission

Applicable standard:
OET Bulletin 65, Edition 97-01, Section 2: Multiple-transmitter sites and Complex Environments

The FCC's MPE limits vary with frequency. Therefore, in mixed or broadband RF fields where several sources and frequencies are involved, the fraction of the recommended limit (in terms of power density or square of the electric or magnetic field strength) incurred within each frequency interval should be determined, and the sum of all fractional contributions should not exceed 1.0, or 100 % in terms of percentage.

Remarks: Not applicable, the EUT has only one transmitter