Prüfbericht-Nr.: *Test report no.:*	**SE24JYLM-002**	**Auftrags-Nr.:** *Order no.*:	290100495	Seite 1 von 8 *Page 1 of 8*
Kunden-Referenz-Nr.: *Client reference no.:*	1774198	**Auftragsdatum:** *Order date:*	2023.10.25	
Auftraggeber: *Client:*	IKEA of Sweden AB			
Prüfgegenstand: *Test item:*	Hub for smart products			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	DIRIGERA / E2315			
Auftrags-Inhalt: *Order content*:	RF Exposure Evaluation			
Prüfgrundlage: *Test specification:*	FCC 47 CFR 2.1091 IEEE Std. C95.1:2005			

Wareneingangsdatum: *Date of sample receipt:*	2023.12.06
Prüfmuster-Nr.: *Test sample no:*	N/A
Prüfzeitraum: *Testing period:*	2023.12.15 – 2024.03.12
Ort der Prüfung: *Place of testing:*	Lund, Sweden
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland Sweden
Prüfergebnis*: *Test result*:*	Pass

überprüft von: reviewed by:	X Mohammed Ebbeni Signed by: Mohammed Ebbeni	**genehmigt von:** authorized by:	X Signed by: Hakan Ahlberg
Datum: 2024.05.13 *Date:*		**Datum: 2024.05.13** *Date:*	
Stellung / *Position:*	Senior Test Engineer	**Stellung** / *Position:*	Lab Manager
Sonstiges / *Other:*	-		

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery:*	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
** Legend:*	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Revision History SE24JYLM-002SE24JYLM-002

Revision	Date	Remarks	Author
001	2024.04.11	First Release	Mohammed Ebbeni
002	2024.05.13	Change Antenna Gain	Mohammed Ebbeni
Note: Latest revision report will replace all previous reports			
This report based on RF Exposure FCC 47CR 2-1091 IEEE C95 Template version 1.1			

Statement of Compliance

Evaluation was performed based on FCC 47 CFR 2.1091 and IEEE C95.1:2005, together with the “General Population / Uncontrolled” requirements set out in FCC 47 CFR 1.1310 Table 1 (B)

The calculations below show that the the IKEA DIRIGERA / E2315 device is compliant with these requirements at a distance of 20cm for all possible combinations of wireless transmitter technologies

Table of Contents

1. GENERAL INFORMATION

1.1 Test Site

Test Facility:	**TÜV Rheinland Sweden AB**
Address:	**Mobilvägen 10**
	223 62 Lund
	Sweden
Swedac Registration Number: **FCC Test Firm Registration Number:** **ISED Test Site Registration Number:**	**10325** **517458** **24753**

1.2 Client Information

Company Name:	**IKEA of Sweden AB**
Address:	**Tulpanvägen 8**
	343 34 Älmhult
	Sweden
Contact Person:	**Gurudeep Manjulgud Devraj**
Contact e-Mail / Telephone	**gurudeep.manjulgud.devraj@inter.ikea.com**

2. PRODUCT INFORMATION

2.1 General Description

Model name:	DIRIGERA
Manufacturer:	IKEA of Sweden AB, SE-343 81 Älmhult
Model number / Marketing name:	E2315
FCC ID:	FHO-E2315
Description:	Hub for smart products
Ancillary Equipment:	N/A

2.2 Device Usage and Evaluation Distance

The device is an IoT smart product hub, with wireless connections. No human handling or interfacing is directly needed during normal operation.

2.3 Wireless Technologies and Bands Supported by the EUT

Technology	Band	Frequency Range (Tx)	Evaluation Performed
Zigbee	2.4 GHz	2400 MHz - 2483.5 MHz	YES
Thread	2.4 GHz	2400 MHz - 2483.5 MHz	YES

2.4 Simultaneous Transmission Configurations

The device uses two separate transmitters for Zigbee and Thread, therefore it is possible that both could transmit simultaneously.

2.5 Conducted Power and Antenna Gain

Technology	Channel	Frequency (MHz)	Max. Conducted Output Power (dBm)*	Max. Time-Averaged Output Power (dBm)**	Antenna Gain (dBi)***
Zigbee	Low ch# 11	2405	11,36	11,36	0,5
Zigbee	Mid ch# 19	2445	10,25	10,25	0,5
Zigbee	High ch# 26	2480	9,36	9,36	0,5
Thread	Low ch# 11	2405	10,5	10,5	0,5
Thread	Mid ch# 19	2445	10,25	10,25	0,5
Thread	High ch# 26	2480	9,49	9,49	**0,5**

* Obtained from test reports number SE23CMXT-001 and SE23JNJR-001 performed in Lund at TUV Rheinland Sweden AB.
** A duty cycle of 100% is assumed.
*** Obtained from module datasheet.

3. TEST METHODS

3.1 Test Standards

Testing was performed according to the following standards / references

Standard	Version	Description
47 CFR 2.1091	-	Radiofrequency radiation exposure evaluation: mobile devices.

3.2 Additional references

Standard	Version	Description
IEEE Std. C95.1	2005	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

3.3 Limits

Extract from 47 CFR § 1.1310 - Radiofrequency radiation exposure limits

Table 1B
Limits for Maximum Permissible Exposure (MPE)
(Limits for general Population / Uncontrolled Exposure)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field strength (A/m)	Power Density (mW/cm^2)	Averaging Time (minutes)
0.3 - 1.34	614	1.63	*100	30
1.34 - 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 - 10000	-	-	1.0	30

Notes:

1. f = frequency in MHz
2. * = Plane-wave equivalent power density

4. EVALUATION DETAILS

4.1 Power Density (S) at 20cm Distance for Each Band and Technology

The Power Density at 20cm separation distance has been calculated for each of the transmitter technologies supported by the device according to a re-arrangement of the Friis formula, as below:

$$S = \frac{P * G}{4\pi * r^2}$$

Where:

- "S" is power density in mW/cm²
- "P" is maximum avg. conducted power (incl. tolerances) in mW according to data from the manufacturer
- "G" is the peak antenna gain (numerical) according to data from the manufacturer
- "r" is the separation distance (20 cm)
- The lowest frequency in each band has been chosen, to give the most conservative limit
- The limits listed are from FCC 47 CFR §1.1310 Table 1 (B): "Limits for General population / Uncontrolled".
- From 300MHz to 1500MHz, the limit is f/1500 mW/cm² where "f" is the frequency in MHz.
- From 1500MHz to 100000MHz, the limit is 1.0 mW/cm²

Technology	Frequency (MHz)	Power (dBm)	P (mW)	Gain (dBi)	G (Num.)	r (cm)	S (mW/cm²)	Limit (mW/cm2)
Zigbee	2405	11,36	13,7	0,50	1,12	20	0,003	1,000
Zigbee	2445	10,25	10,6	0,50	1,12	20	0,002	1,000
Zigbee	2480	9,36	8,6	0,50	1,12	20	0,002	1,000
Thread	2405	10,5	11,2	0,50	1,12	20	0,003	1,000
Thread	2445	10,25	10,6	0,50	1,12	20	0,002	1,000
Thread	2480	9,49	8,9	0,50	1,12	20	0,002	1,000

Therefore, the power density radiated from the device is well under the specified limit on all examined technologies and channels when a separation distance of 20cm is maintained.

4.2 Minimum Compliance Distance for Each Band and Technology

Similarly, the minimum separation distance where the device meets the RF Exposure limit has been calculated for each of the transmitter technologies supported by the device.

$$r_{min} = \sqrt{\frac{P * G}{4\pi * S_{lim}}}$$

Where:

- "r_{min}" is the minimum separation distance in cm
- "S_{lim}" is the power density limit in mW/cm²

Technology	Frequency (MHz)	Power (dBm)	P (mW)	Gain (dBi)	G (Num.)	S_{lim} (mW/cm²)	r_{min} (cm)
Zigbee	2405	11,36	13,7	0,50	1,12	1,000	1,11
Zigbee	2445	10,25	10,6	0,50	1,12	1,000	0,97
Zigbee	2480	9,36	8,6	0,50	1,12	1,000	0,88
Thread	2405	10,5	11,2	0,50	1,12	1,000	1,00
Thread	2445	10,25	10,6	0,50	1,12	1,000	0,97
Thread	2480	9,49	8,9	0,50	1,12	1,000	0,89

The table above states that the power density from the RF exposure will reach the limits when the device is operating within a distance of ≤ 1.1 cm from human body.

4.3 Simultaneous Transmission Calculations

All relevant combinations of transmitters have been evaluated at 20cm distance below, using the following equation, rearranged from IEEE Std. C95.1:2005 Annex D.2:

$$\sum_{i-1}^{n}\left(\frac{S_i}{S_{L,i}}\right) = "Evaluation\ Result"$$

Where:

- S_i is the power density for transmitter 'i'
- $S_{L,i}$ is the power density MPE limit from Table 1(B) of 47 CFR §1.1310

If the evaluation result is ≤ 1, the device is compliant with the limits even for the simultaneous transmission configuration.

Calculation of Ratio $S_i/S_{L,i}$ for Possible Transmitter Technologies and bands

Technology	Frequency (MHz)	S_i (mW/cm^2)	Limit $S_{L,i}$ (mW/cm^2)	$S_i/S_{L,i}$
Zigbee	2405	0,003	1,000	0,0031
Zigbee	2445	0,002	1,000	0,0024
Zigbee	2480	0,002	1,000	0,0019
Thread	2405	0,003	1,000	0,0025
Thread	2445	0,002	1,000	0,0024
Thread	2480	0,002	1,000	0,0020

Evaluation of Compliance at 20cm for Worst Case Combinations of Transmitters

Tech. 1	Frequency 1 (MHz)	Tech 1 Band 1 $S_i/S_{L,i}$	Tech. 2	Frequency 2 (MHz)	Tech 2 Band 2 $S_i/S_{L,i}$	Sum $S_i/S_{L,i}$	Compliant?
Zigbee	2405	0,0031	Thread	2445	0,0025	0,0056	YES

The table above shows the compliance evaluation for all possible combinations of transmitters.