TEST REPORT

Test Report No. : UL-RPT-RP11456397JD18L V2.0

Manufacturer	:	Neeo AG
Model No.	:	6336-BRAIN
FCC ID	:	2AKK7-BR633601
Test Standard(s)	:	FCC Part 15.207

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2. The results in this report apply only to the sample(s) tested.
3. This sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

Date of Issue: 22 May 2017

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Company Signatory:

Sarah Williams
Senior Engineer, Radio Laboratory
UL VS LTD

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This laboratory is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

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1. Customer Information

Company Name:	Neeo AG
Address:	Ritterquai 8 4500 Solothurn Switzerland

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.207
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.207
Site Registration:	FCC: 209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Date:	04 April 2017

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	✓
Key to Results ✓ = Complied ✗ = Did not comply		

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Neeo
Model Name or Number:	6336-BRAIN
Test Sample Serial Number:	Not marked or stated *(Radiated sample)*
Hardware Version:	Hardware Rev. 5
Software Version:	0.23.0
FCC ID:	2AKK7-BR633601

3.2. Description of EUT

The Equipment Under Test was a base station for home automation. It contains Z-Wave, *Bluetooth* BR/EDR/ LE, IEEE 802.15.4 and WLAN transceivers. It is powered from 5.2 VDC via a 120 VAC 60 Hz AC/DC adaptor.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Tested Technology:	Z-Wave		
Power Supply Requirement:	Nominal	5.2 VDC via 120 VAC 60 Hz adaptor	
Type of Unit:	Transceiver		
Modulation:	FSK		
Data Rates:	908.4 MHz: 40 kbit/s		
Transmit Frequency Range:	902 MHz to 928 MHz		
Transmit Channel Tested:	**Channel ID**	**Channel Frequency (MHz)**	
	2	908.4	

Tested Technology:	*Bluetooth*		
Type of Unit:	Transceiver		
Channel Spacing:	1 MHz		
Mode:	Basic Rate		
Modulation:	GFSK		
Packet Type: (Maximum Payload)	DH5		
Data Rate (Mbit/s):	1		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	**Channel ID**	**Channel Number**	**Channel Frequency (MHz)**
	Middle	39	2441

Technology Tested:	*Bluetooth* Low Energy (Digital Transmission System)		
Type of Unit:	Transceiver		
Channel Spacing:	2 MHz		
Modulation:	GFSK		
Data Rate:	1 Mbit/s		
Transmit Frequency Range:	2402 MHz to 2480 MHz		
Transmit Channels Tested:	**Channel ID**	**RF Channel**	**Channel Frequency (MHz)**
	Middle	0	2402

Additional Information Related to Testing (continued)

Technology Tested:	WLAN (IEEE 802.11b) / Digital Transmission System	
Type of Unit:	Transceiver	
Modulation Type:	DBPSK	
Data Rates:	802.11b	1 Mbps
Channel Spacing:	20 MHz	
Transmit Frequency Range:	2412 MHz to 2462 MHz	
Transmit Channels Tested:	**Channel Number**	**Channel Frequency (MHz)**
	6	2437

Technology Tested:	IEEE 802.15.4 / 6LoWPAN / Digital Transmission System	
Type of Unit:	Transceiver	
Modulation Type:	O-QPSK	
Data Rate:	250 kb/s	
Transmit Frequency Range:	2405 MHz to 2480 MHz	
Transmit Channels Tested:	**Channel Number**	**Channel Frequency (MHz)**
	26	2480

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Laptop PC
Brand Name:	Dell
Model Name or Number:	E5400
Serial Number:	01160

Description:	USB to TTL Serial Cable. Length 1.8 metres
Brand Name:	FTDI Chip
Model Name or Number:	TTL-232R-3V3-AJ
Serial Number:	Not marked or stated

Description:	AC/DC Adaptor
Brand Name:	Liteon
Model Name or Number:	PA-1100-25
Serial Number:	KPO1003005 6088111EPE03

Description:	HDMI Cable. Length 3 metres
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Now TV Box for HDMI Termination
Brand Name:	Sky
Model Name or Number:	2400SK
Serial Number:	1MM4DE006281

Description:	Infra-Red Sensor for Termination
Brand Name:	Neeo
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Ethernet cable. Length 0.8 metres
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

- The EUT was tested in the following operating mode(s): Pre-scans were performed with the EUT transmitting in Z-Wave, IEEE 802.15.4, *Bluetooth* BR, *Bluetooth* LE, WLAN and 6LoWPAN modes. The worst case mode was found to be Z-Wave, Bluetooth LE and 6LoWPAN transmitting simultaneously. Final measurements were performed in this configuration.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- The EUT was powered via an AC/DC power adaptor, which was in turn connected to a LISN. The LISN input was connected to a 120/240 VAC 60 Hz single phase power supply.
- A laptop PC with an open source terminal application Tera Term V4.83 was used to place the EUT into test mode. The application was used to enable a continuous transmission mode, at full power and to select the test channels, data rates and modulation schemes as required. The procedure to set up and control the EUT was supplied by the customer in a document titled ‘userManual-Radio.txt’ dated 12/12/2016.
- Transmitter AC conducted spurious emissions tests were performed with all EUT ports terminated.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6. Measurement Uncertainty* for details.

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Andrew Edwards	**Test Date:**	18 May 2017
Test Sample Serial Number:	Not marked or stated *(Radiated sample)*		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

Environmental Conditions:

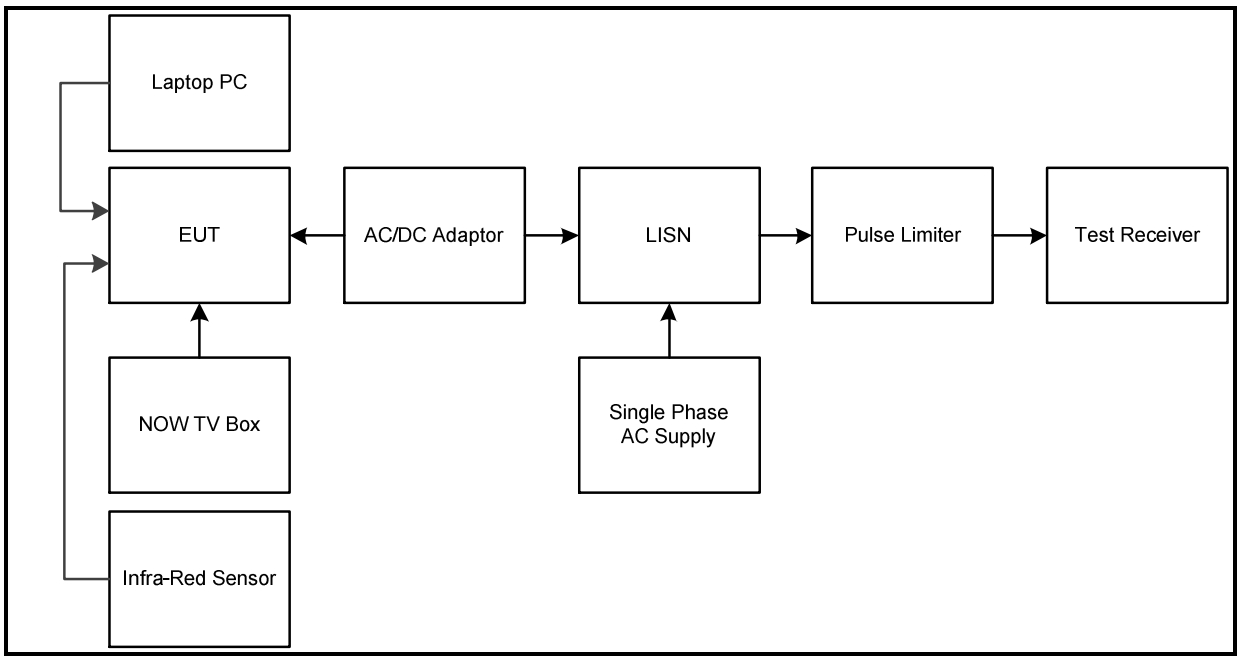
Temperature (°C):	22
Relative Humidity (%):	50

Note(s):

1. The EUT was connected to the AC/DC Adaptor output. The AC/DC Adaptor input was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the AC/DC Adaptor.
3. A pulse limiter was fitted between the LISN and the test receiver.
4. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
5. Pre-scans at 120 VAC 60 Hz for Live and Neutral were performed with the EUT transmitting in Z-Wave, IEEE 802.15.4, *Bluetooth* BR, *Bluetooth* LE, WLAN and 6LoWPAN modes. The worst case mode was found to be Z-Wave, Bluetooth LE and 6LoWPAN transmitting simultaneously. Final measurements were performed in this configuration. Pre-scan result plots for all other modes are archived on the UL VS LTD IT server and available for inspection if required.

Transmitter AC Conducted Spurious Emissions (continued)

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.672	Live	36.5	56.0	19.5	Complied
19.779	Live	31.3	60.0	28.7	Complied
22.249	Live	40.1	60.0	19.9	Complied
24.720	Live	52.7	60.0	7.3	Complied
27.195	Live	53.8	60.0	6.2	Complied
29.666	Live	43.1	60.0	16.9	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.650	Live	30.3	46.0	15.7	Complied
19.775	Live	30.1	50.0	19.9	Complied
22.250	Live	32.5	50.0	17.5	Complied
24.720	Live	42.3	50.0	7.7	Complied
27.195	Live	48.3	50.0	1.7	Complied
29.666	Live	39.0	50.0	11.0	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

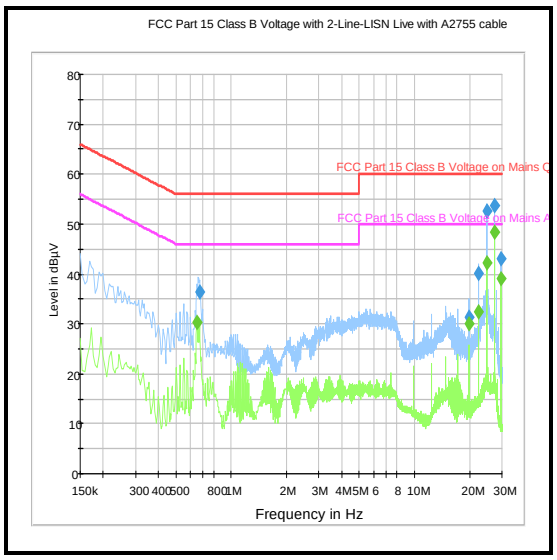
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.663	Neutral	38.9	56.0	17.1	Complied
19.779	Neutral	34.3	60.0	25.7	Complied
22.254	Neutral	39.6	60.0	20.4	Complied
24.725	Neutral	50.8	60.0	9.2	Complied
27.195	Neutral	52.5	60.0	7.5	Complied
29.670	Neutral	44.0	60.0	16.0	Complied

Results: Neutral / Average / 120 VAC 60 Hz

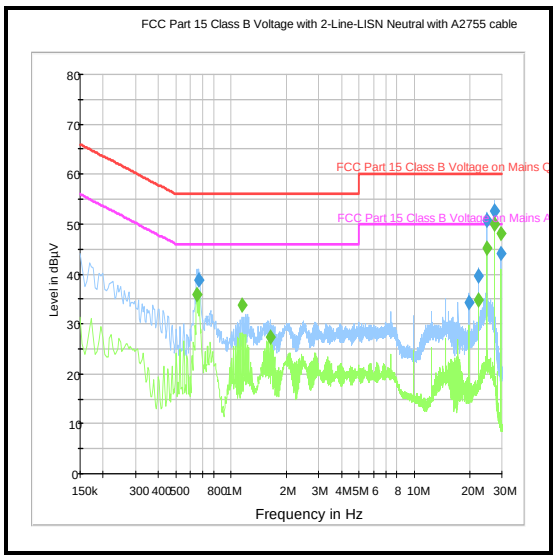
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.650	Neutral	35.9	46.0	10.1	Complied
1.149	Neutral	33.7	46.0	12.3	Complied
22.250	Neutral	34.8	50.0	15.2	Complied
24.725	Neutral	45.3	50.0	4.7	Complied
27.195	Neutral	49.9	50.0	0.1	Complied
29.670	Neutral	48.0	50.0	2.0	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 120 VAC 60 Hz



Live



Neutral

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.672	Live	37.4	56.0	18.6	Complied
22.254	Live	45.4	60.0	14.6	Complied
24.729	Live	47.5	60.0	12.5	Complied
26.223	Live	29.4	60.0	30.6	Complied
27.200	Live	43.1	60.0	16.9	Complied
29.675	Live	25.0	60.0	35.0	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.672	Live	31.5	46.0	14.5	Complied
2.252	Live	30.9	46.0	15.1	Complied
22.254	Live	40.8	50.0	9.2	Complied
24.729	Live	42.5	50.0	7.5	Complied
27.200	Live	36.4	50.0	13.6	Complied
29.675	Live	21.3	50.0	28.7	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

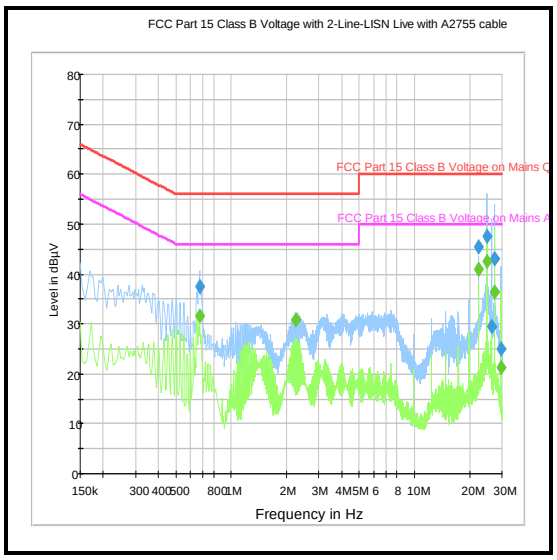
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.672	Neutral	40.7	56.0	15.3	Complied
1.451	Neutral	32.9	56.0	23.1	Complied
2.301	Neutral	32.9	56.0	23.1	Complied
22.259	Neutral	41.0	60.0	19.0	Complied
24.729	Neutral	44.0	60.0	16.0	Complied
27.200	Neutral	39.4	60.0	20.6	Complied

Results: Neutral / Average / 240 VAC 60 Hz

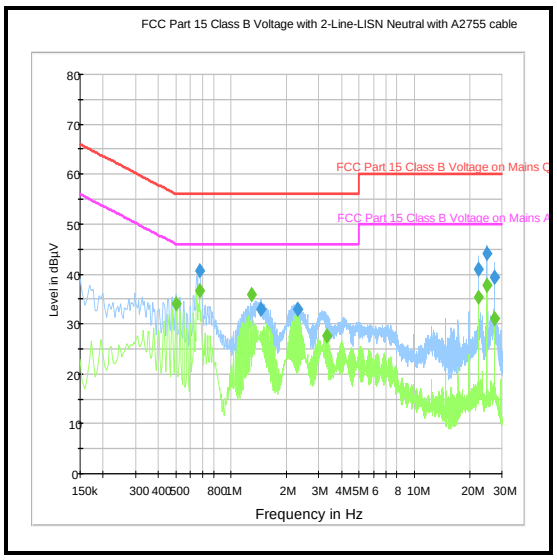
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.501	Neutral	34.1	46.0	11.9	Complied
0.672	Neutral	36.8	46.0	9.2	Complied
1.298	Neutral	35.8	46.0	10.2	Complied
3.327	Neutral	27.7	46.0	18.3	Complied
22.254	Neutral	35.3	50.0	14.7	Complied
24.729	Neutral	37.6	50.0	12.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 240 VAC 60 Hz



Live



Neutral

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2013	Thermohygrometer	Testo	608-H1	45046419	10 Jun 2017	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	20 Jul 2017	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	22 Mar 2018	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	07 Nov 2017	12

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version
2.0	8, 10, 12-17	-	Updated due to additional testing requested by the TCB

--- END OF REPORT ---