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Test report

362154-1TRFEMC

Date of issue: November 26, 2018

Applicant:

Casa Systems

Product:

Apex Strand Small Cell

Model:

LTE4001-41

Specifications:

- FCC 47 CFR Part 15, Subpart B – Verification
- ICES-003 Issue 6

Lab and test locations

Company name	Nemko USA Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
State	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
FCC Site Number	Test Firm Registration Number: 392943 Designation Number: US5058
ISED Test Site	2040B-3

Tested by	Martha Espinoza, Wireless Engineer
Tester signature	
Reviewed by	Juan Manuel Gonzalez, EMC & Wireless Business Development Manager
Review date	November 26, 2018
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart B – Verification	Title 47: Telecommunication; Part 15—Radio Frequency Devices
ICES-003 Issue 6 April 2017 (NVLAP Accreditation Pending)	Information Technology Equipment (ITE) – Limits and methods of measurement

1.2 Test methods

ANSI C63.4-2014	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Details of changes made to test report
362154-3TRFEMC	Original report issued

Notes: None

Section 2 Summary of test results

2.1 Emissions Test results

Table 2.1-1: *FCC 47 CFR Part 15, Subpart B and ICES-003 Issue 6 results*

Test description	Verdict
FCC 15.109 Radiated disturbance	Pass
FCC 15.107 Conducted disturbance at mains port	Pass

Notes: Class B Emissions

Section 3 Equipment under test (EUT) details

3.1 Applicant

Company name	Casa Systems
Address	100 Old River Road # 100
City	Andover
State	MA
Postal/Zip code	10810
Country	U.S.A.

3.2 Manufacturer

Company name	Casa Systems
Address	100 Old River Road # 100
City	Andover
State	MA
Postal/Zip code	10810
Country	U.S.A.

3.3 Sample information

Receipt date	September 11, 2018
Nemko sample ID number	362154

3.4 EUT information

Product name	Apex Strand Small Cell
Model	LTE4001-41
Model variant	N/A
Serial number	ENG. Sample
Power requirements	*–40 to -90 V_{AC}, 45Watts*
Description/theory of operation	The Apex Strand Small Cell is a medium-power RF emitting eNodeB for LTE RAN. This node is capable of emitting up to 2W RF power per sector. Each Unit supports two sectors with radio access capabilities (4G) that is responsible for radio transmission (4 antennas) and reception from UEs in a LTE network. The Apex Strand Small Cell provides radio coverage for LTE enabled devices and or handsets within a home residential or enterprise coverage area. The Apex Strand Small Cell incorporates all the capabilities and functions of a standard eNode B. Model LTE4001-41 operates in Band 41. The device includes a pre-certified Wifi radio for management functions only, accessed by service personnel. The Apex Strand Small Cell is mountable from an available aerial strand. The main advantage of the Apex Strand Small Cell include: · Ease of installation: No dedicated LTE Backhaul needed. Can use available Cable, Gigabit Ethernet or Gigabit optical network for EPC backhaul. · Increased subscriber density: The AeMS should manage up to 1M HeNBs.· Easy integration: Uses X.509 digital certificates to authenticate with the service provider's back-end management systems.· Cost effectiveness: Supports Plug-and-Play provisioning, does not require a dedicated installation, and uses existing infrastructure with minimal intervention.
Operational frequencies	2496 – 2690 MHz (LTE Band 41) ; 2.4 GHz (Wi-Fi Band)
Software details	Qualcomm Default production V1.0

3.5 EUT exercise and monitoring details

A software was used for emulating the adequate signal into Pico cell model while it was monitored through the same program. For this specific case, the device was tested in standby mode and the LTE and Wi-Fi signals were turned off.

3.6 EUT setup details

Table 3.6-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
N/A	N/A	N/A	N/A

Table 3.6-2: *EUT interface ports*

Description	Qty.
SMA Port	3
Coaxial Port	1

Table 3.6-3: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop Computer	Dell	Inspiron 15	1G1RYN2	N/A
AC Adapter	Dell	HA45NM140	DP/N 00285K	N/A
Power supply	Lectro	Minimite, 4A, 60VAC	1610F0400213	N/A

Table 3.6-4: *Inter-connection cables*

Cable description	From	To	Length (m)
DC Cable	EUT	Power supply	1

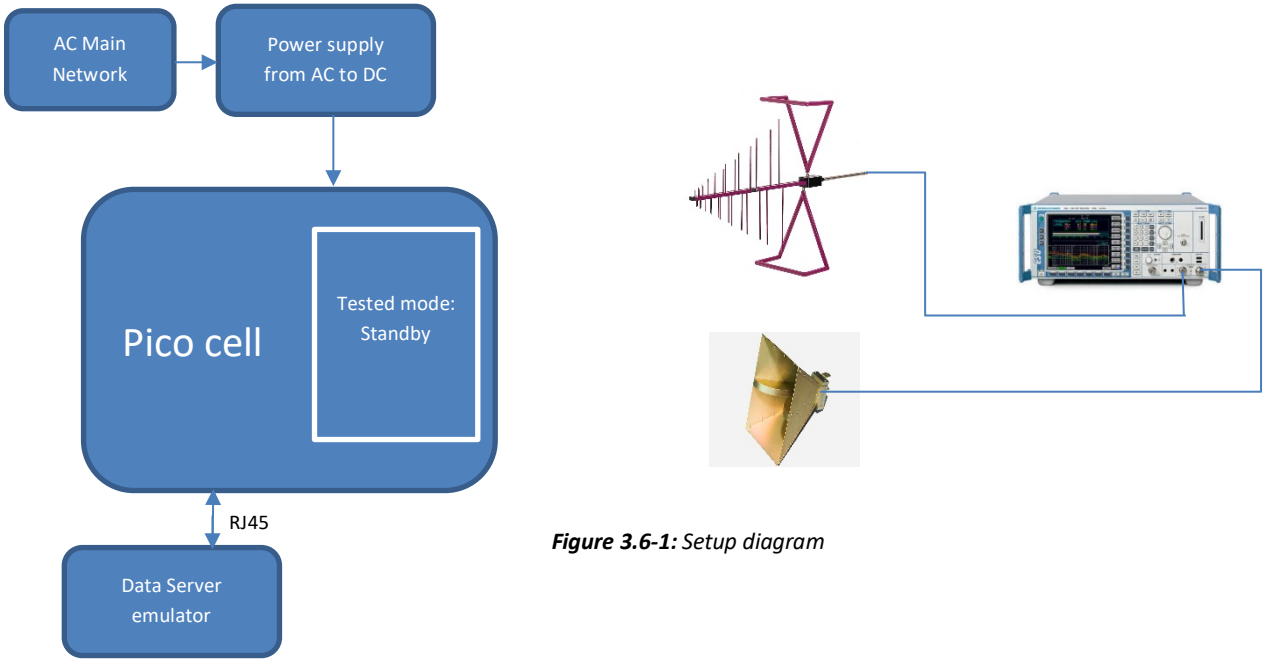


Figure 3.6-1: *Setup diagram*

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

None

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	21.1 °C
Relative humidity	58.7 %
Air pressure	86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Nemko USA Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Test name	Measurement uncertainty, dB
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7 Terms and definitions

7.1 Product classifications definitions

7.1.1 Title 47: Telecommunication – Part 15-Radio Frequency devices, Subpart A – General

Class A digital device	A digital device that is marketed for use in a commercial, industrial or business environment, exclusive of a device which is marketed for use by the general public or is intended to be used in the home.
Class B digital device	A digital device that is marketed for use in a residential environment notwithstanding use in commercial, business and industrial environments. Examples of such devices include, but are not limited to, personal computers, calculators, and similar electronic devices that are marketed for use by the general public. Note: The responsible party may also qualify a device intended to be marketed in a commercial, business or industrial environment as a Class B device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B digital device. If a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B digital device, regardless of its intended use.

7.1.2 ICES-003

Class B ITE	limits of radio noise for ITE for residential operation
Class A ITE	limits of radio noise for ITE for non-residential operation
Conditions	Only ITE intended strictly for non-residential use in commercial, industrial or business environments, and whose design or other characteristics strongly preclude the possibility of its use in a residential environment, shall be permitted to comply with the less stringent Class A limits. All ITE that cannot meet the conditions for Class A operation shall comply with the Class B limits. The ITE shall comply with both the power line – conducted and the radiated emissions limits within the same Class, with no intermixing.

7.2 General definitions

7.2.1 Title 47: Telecommunication – Part 15-Radio Frequency devices, Subpart A – General

Digital device (Previously defined as a computing device)	An unintentional radiator (device or system) that generates and uses timing signals or pulses at a rate in excess of 9,000 pulses (cycles) per second and uses digital techniques; inclusive of telephone equipment that uses digital techniques or any device or system that generates and uses radio frequency energy for the purpose of performing data processing functions, such as electronic computations, operations, transformations, recording, filing, sorting, storage, retrieval, or transfer. A radio frequency device that is specifically subject to an emanation requirement in any other FCC Rule part or an intentional radiator subject to subpart C of this part that contains a digital device is not subject to the standards for digital devices, provided the digital device is used only to enable operation of the radio frequency device and the digital device does not control additional functions or capabilities. Note: Computer terminals and peripherals that are intended to be connected to a computer are digital devices.

7.2.2 ICES-003

Information technology equipment (ITE)	Information Technology Equipment (ITE) is defined as devices or systems that use digital techniques for purposes such as data processing and computation. ITE is any unintentional radiator (device or system) that generates and/or uses timing signals or pulses having a rate of at least 9 kHz and employs digital techniques for purposes such as computation, display, data processing and storage, and control.

Section 8 Testing data

8.1 Radiated disturbance

8.1.1 References

FCC 15.109 & ANSI C63.4-2014

8.1.2 Test summary

Verdict	Pass		
Test date	October 23, 2018	Temperature	23 °C
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	1000 mbar
Test location	10m semi anechoic chamber	Relative humidity	54 %

8.1.3 Notes

None

8.1.4 Setup details

EUT setup configuration	Table top
Test facility	10m Semi Anechoic Chamber(SAC)
Measuring distance	3 m
Antenna height variation	1–4 m
Turn table position	0–360°
Measurement details	A preview measurement was generated with receiver in continuous scan or sweep mode while the EUT was rotated and antenna adjusted to maximize radiated emission. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver/spectrum analyzer settings for frequencies below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	– Peak (Preview measurement) – Quasi-peak (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 1000 ms (Quasi-peak final measurement)

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (Preview measurement) Peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 100 ms (Peak and CAverage final measurement)

8.1.4 Setup details, continued

Table 8.1-1: *Radiated disturbance equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	1 Year	04/28/2019
Antenna, Bilog	Schaffner-Chase	CBL6111C	E1763	2 Years	11/28/2018
Antenna, Horn	ETS	3117-PA	E1139	2 Years	01/26/2020

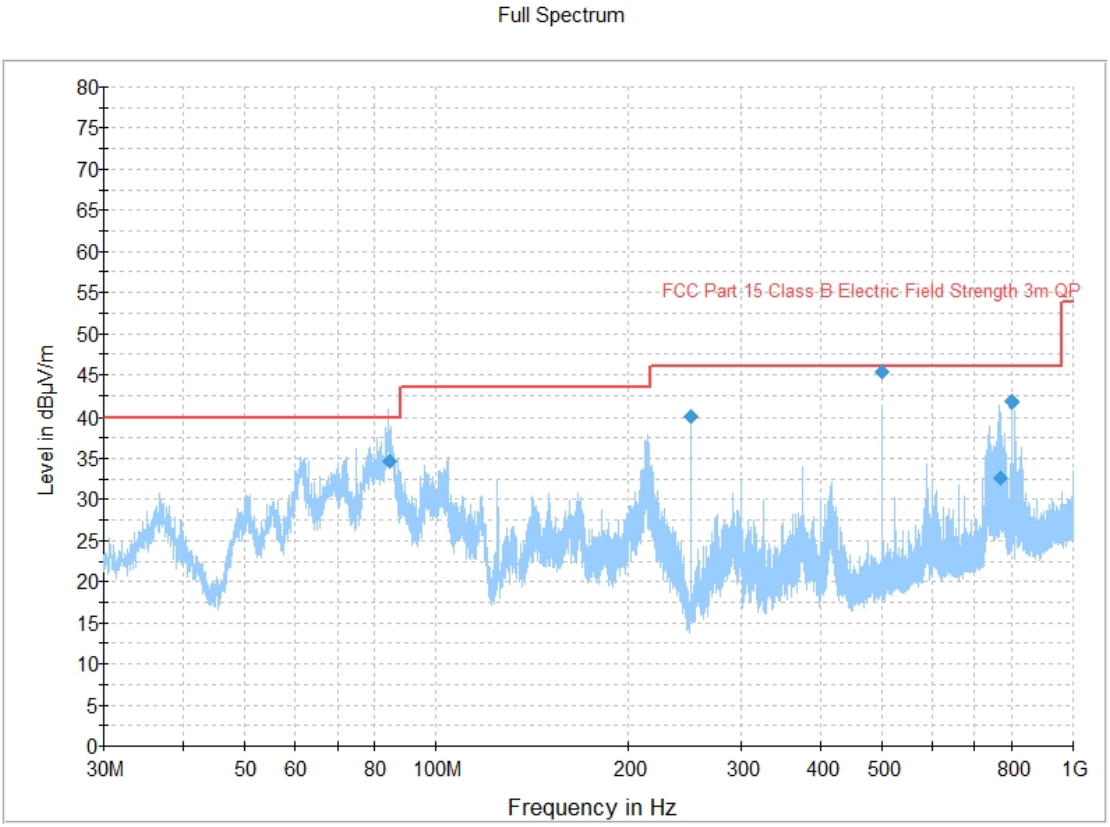
Notes: None

Table 8.1-2: *Radiated disturbance test software details*

Manufacturer of Software	Details
R&S	EMC32 V10.00.00

Notes: None

8.1.5 Test data -Radiated Disturbance (Standby Mode)



Note: The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators. No considerable emissions were observed above 18 GHz.

Figure 8.1-1: *Radiated field strength plot (From 30 to 1000 MHz). Horizontal polarization.*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
84.526000	34.73	40.00	5.27	1000.0	120.000	214.0	H	358.0	9.6
249.988333	40.10	46.00	5.90	1000.0	120.000	102.0	H	228.0	15.0
499.997333	45.29	46.00	0.71	1000.0	120.000	138.0	H	216.0	21.1
767.373667	32.58	46.00	13.42	1000.0	120.000	135.0	H	198.0	25.8
800.018333	41.83	46.00	4.17	1000.0	120.000	139.0	H	204.0	25.7

Table 8.1-3: *Radiated field strength measurement results*

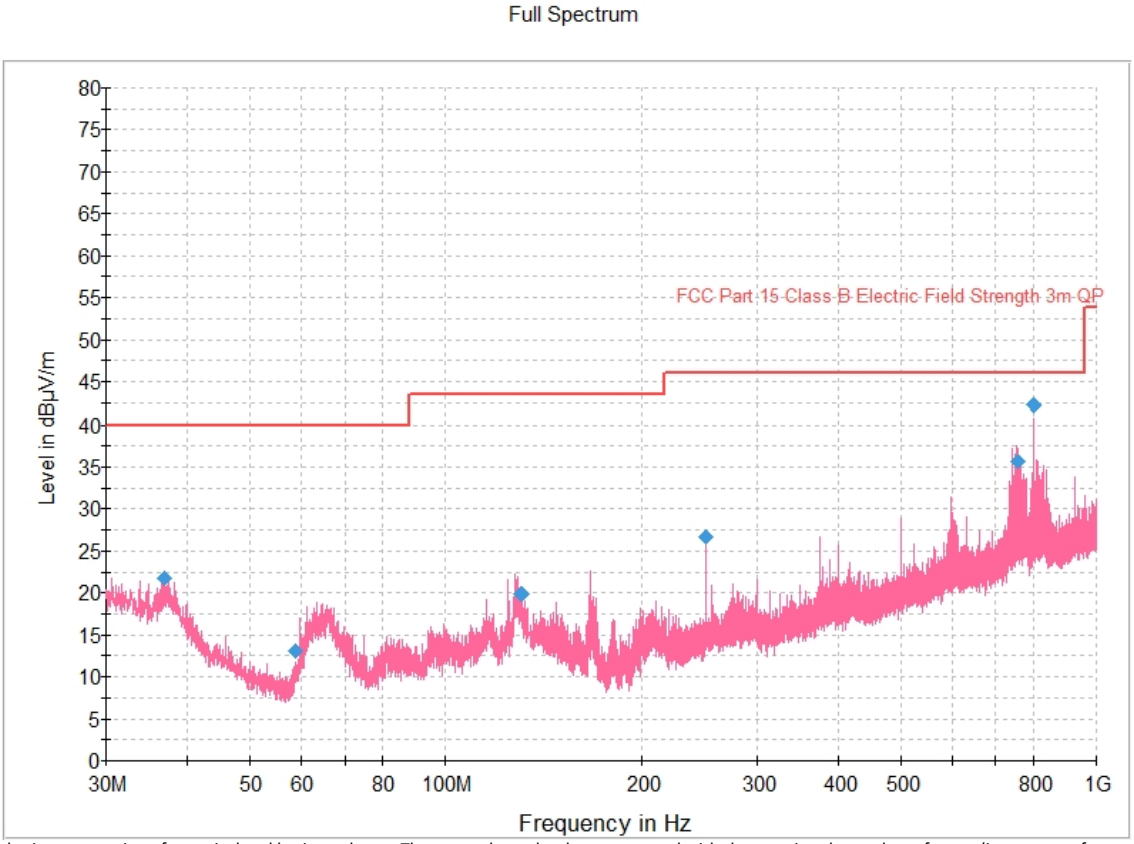
Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (dB)

[3] The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 46.02 dBµV/m (field strength) = 44.82 dBµV (receiver reading) + 1.2 dB (Correction factor)

8.1.5 Test data -Radiated Disturbance (Standby Mode), continued



Note: The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators. No considerable emissions were observed above 18 GHz.

Figure 8.1-2: *Radiated field strength plot (From 30 to 1000 MHz). Vertical polarization.*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
36.924333	21.71	40.00	18.29	1000.0	120.000	125.0	V	4.0	16.8
58.659000	13.02	40.00	26.98	1000.0	120.000	119.0	V	-2.0	7.0
130.269333	19.89	43.50	23.61	1000.0	120.000	145.0	V	103.0	13.7
249.996000	26.64	46.00	19.36	1000.0	120.000	130.0	V	164.0	15.0
756.285000	35.60	46.00	10.40	1000.0	120.000	102.0	V	156.0	25.6
799.978333	42.34	46.00	3.66	1000.0	120.000	213.0	V	137.0	25.7

Table 8.1-4: *Radiated field strength measurement results*

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 46.02 dBµV/m (field strength) = 44.82 dBµV (receiver reading) + 1.2 dB (Correction factor)

8.1.5 Test data -Radiated Disturbance (Standby Mode), continued

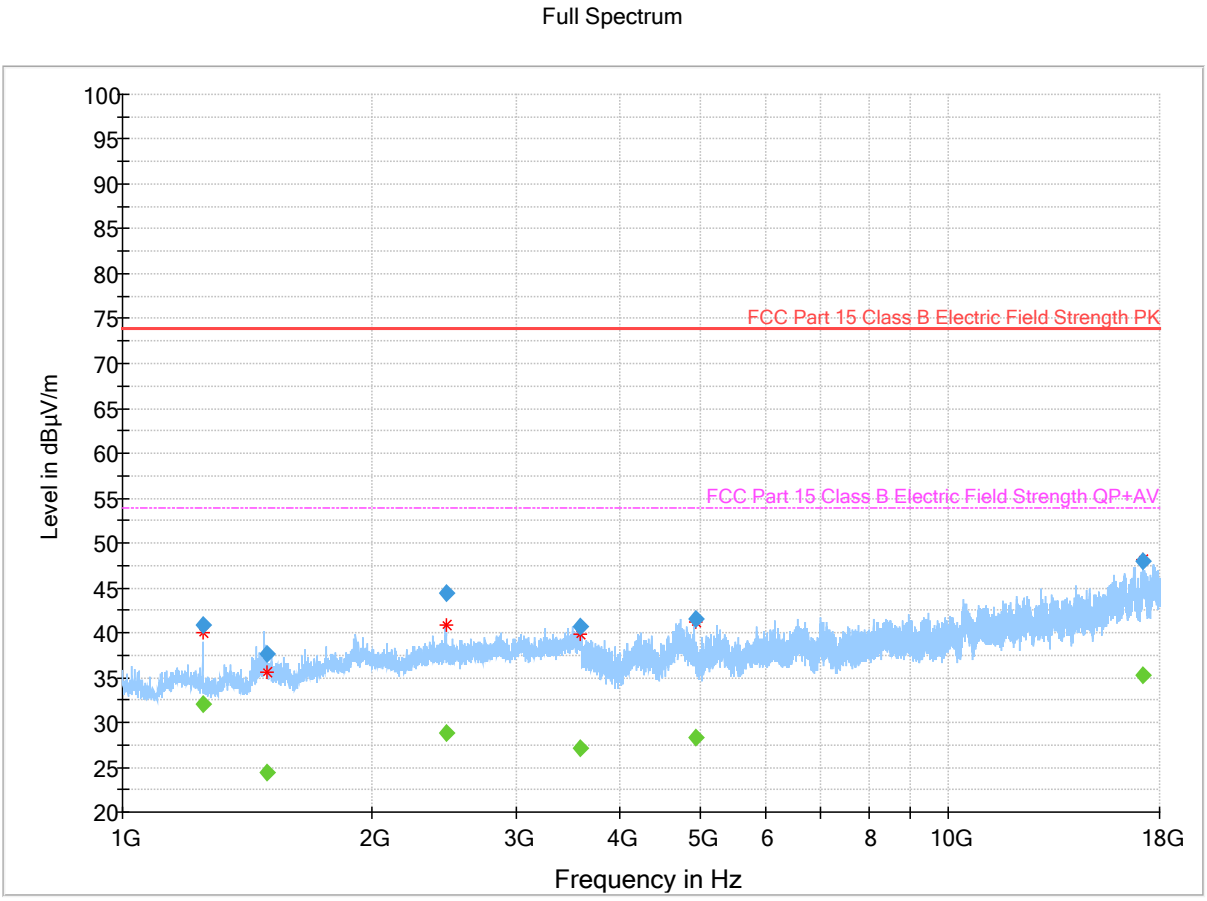


Figure 8.1-3: *Radiated field strength plot (From 1 to 18 GHz)*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1250.100000	40.86	---	73.90	33.05	5000.0	1000.000	115.5	H	154.0	-13.5
1250.100000	---	32.06	53.90	21.84	5000.0	1000.000	115.5	H	154.0	-13.5
1494.600000	---	24.37	53.90	29.53	5000.0	1000.000	165.1	H	-2.0	-14.4
1494.600000	37.68	---	73.90	36.22	5000.0	1000.000	165.1	H	-2.0	-14.4
2461.133333	---	28.75	53.90	25.15	5000.0	1000.000	145.2	V	33.0	-9.5
2461.133333	44.41	---	73.90	29.49	5000.0	1000.000	145.2	V	33.0	-9.5
3573.866667	---	27.16	53.90	26.74	5000.0	1000.000	347.7	H	0.0	-5.7
3573.866667	40.61	---	73.90	33.29	5000.0	1000.000	347.7	H	0.0	-5.7
4933.033333	---	28.27	53.90	25.63	5000.0	1000.000	182.2	H	214.0	-2.4
4933.033333	41.49	---	73.90	32.41	5000.0	1000.000	182.2	H	214.0	-2.4
17199.666667	47.93	---	73.90	25.97	5000.0	1000.000	146.8	V	18.0	12.3
17199.666667	---	35.22	53.90	18.68	5000.0	1000.000	146.8	V	18.0	12.3

Table 8.1-5: *Radiated field strength measurement results*

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) – amplifier gain (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 46.02 dBµV/m (field strength) = 44.82 dBµV (receiver reading) + 1.2 dB (Correction factor)

Figure 8.1-4: *Radiated measurement setup photo*

Figure 8.1-5: *Radiated measurement setup photo – 30 MHz – 1 GHz (Standby Mode)*

8.1.1 Setup photos, continued

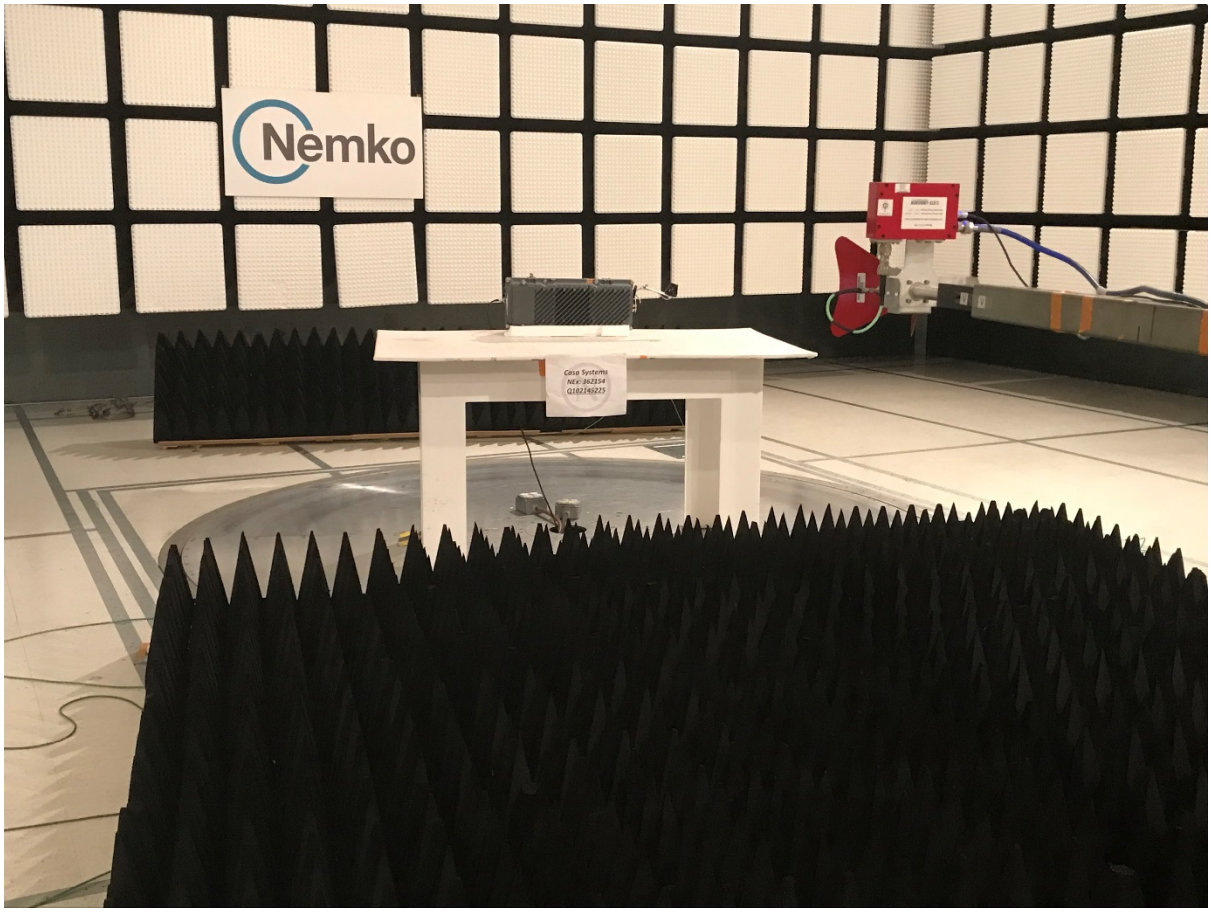


Figure 8.1-6: *Radiated measurement setup photo – 1 – 18 GHz (Standby Mode)*

8.2 Conducted disturbance at mains port (Standby Mode)

8.2.1 References

FCC 15.107 & ANSI C63.4-2014

8.2.2 Test summary

Verdict	Pass		
Test date	October 17, 2018	Temperature	23 °C
Test engineer	Martha Espinoza, Wireless Engineer	Air pressure	1007 mbar
Test location	Table Top	Relative humidity	28 %

8.2.3 Notes

None

8.2.4 Setup details

Port under test	AC Mains Input
EUT setup configuration	Table top
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	– Peak and Average (Preview measurement) – Quasi-peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak and Average preview measurement) – 1000 ms (Quasi-peak final measurement) – 160 ms (CAverage final measurement)

Table 8.2-1: *Conducted disturbance at mains port equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESCI 7	E1767	1 Year	02/21/2019
Two Line V-Network	Rohde & Schwarz	ENV216	E1019	1 Year	07/24/2019

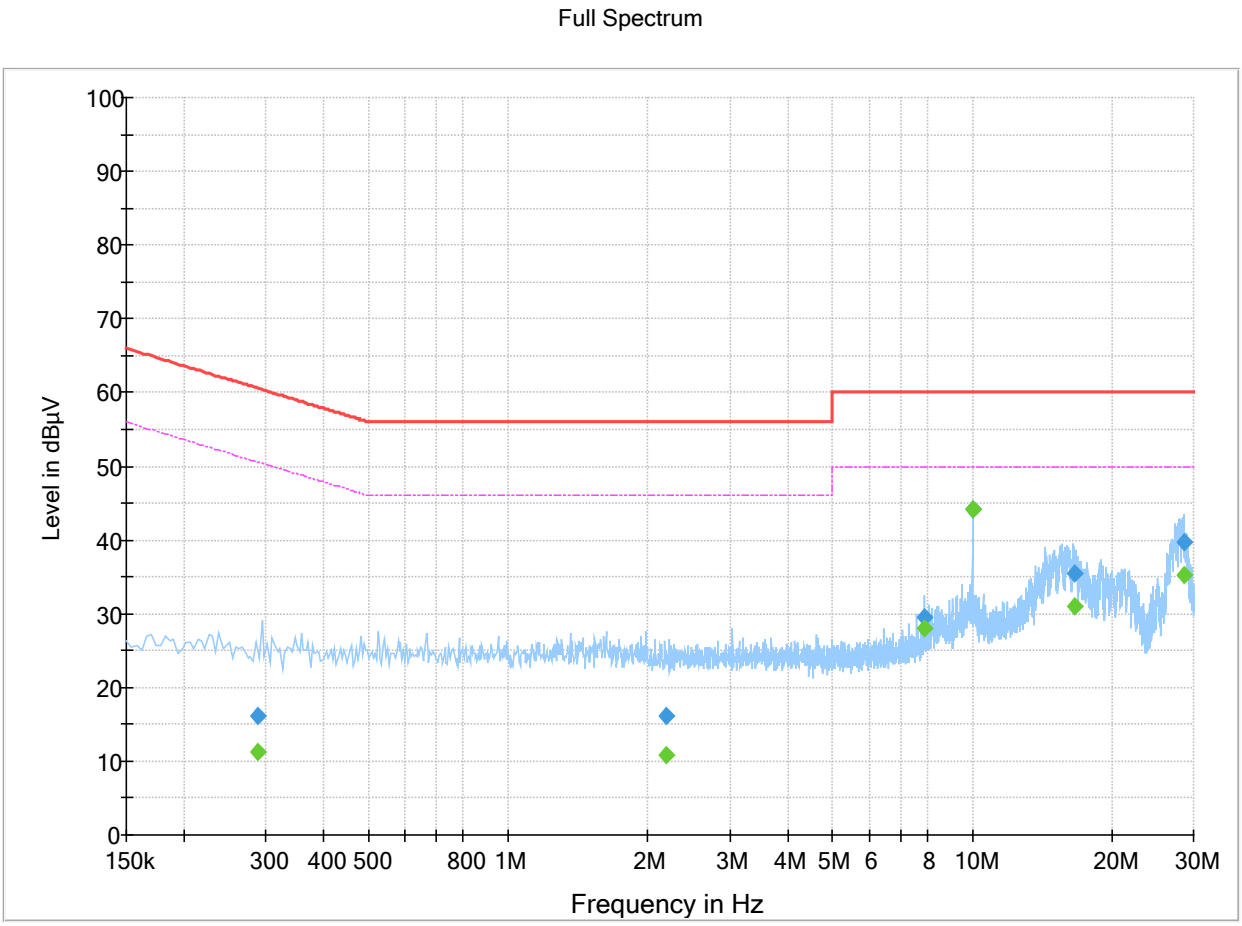
Notes: None

Table 8.2-2: *Conducted disturbance at mains port test software details*

Manufacturer of Software	Details
Rohde-Schwarz	EMC 32 V10.0

Notes: None

8.2.5 Test data 150KHz to 30 MHz (Standby Mode)



The spectral plot has been corrected with transducer factors. (i.e. cable loss, LISN factors, and attenuators)

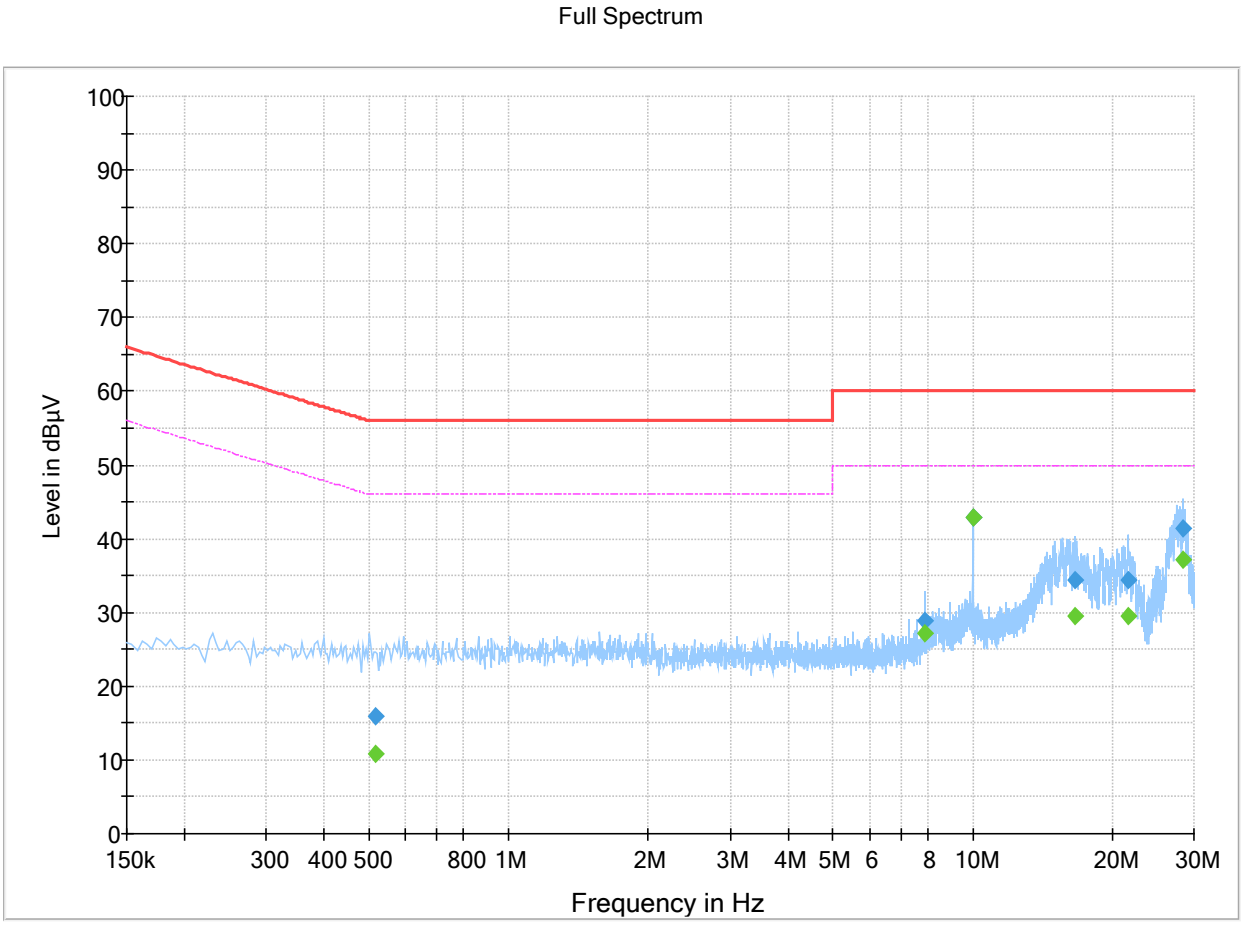
Figure 8.2-1: *Conducted disturbance at mains port spectral plot. Standby mode, LISN/Line, 120 V and 60HZ*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.288500	---	11.18	50.57	39.39	5000.0	9.000	L1	ON	19.5
0.288500	16.23	---	60.57	44.34	5000.0	9.000	L1	ON	19.5
2.183500	---	10.90	46.00	35.10	5000.0	9.000	L1	ON	19.5
2.183500	16.20	---	56.00	39.80	5000.0	9.000	L1	ON	19.5
7.888500	---	27.99	50.00	22.01	5000.0	9.000	L1	ON	19.6
7.888500	29.51	---	60.00	30.49	5000.0	9.000	L1	ON	19.6
10.000500	---	44.10	50.00	5.90	5000.0	9.000	L1	ON	19.6
10.000500	44.12	---	60.00	15.88	5000.0	9.000	L1	ON	19.6
16.571500	---	30.96	50.00	19.04	5000.0	9.000	L1	ON	19.7
16.571500	35.44	---	60.00	24.56	5000.0	9.000	L1	ON	19.7
28.568500	---	35.26	50.00	14.74	5000.0	9.000	L1	ON	20.1
28.568500	39.65	---	60.00	20.35	5000.0	9.000	L1	ON	20.1

Notes:
[1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Table 8.2-3: *Conducted disturbance – from AC mains power port (Quasi-Peak) results (Standby mode).*

8.2.5 Test data 150KHz to 30 MHz (Standby Mode)



The spectral plot has been corrected with transducer factors. (i.e. cable loss, LISN factors, and attenuators)

Figure 8.2-2: *Conducted disturbance at mains port spectral plot. Standby mode, LISN/Neutral.*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.515500	---	10.93	46.00	35.07	5000.0	9.000	N	ON	19.5
0.515500	15.96	---	56.00	40.04	5000.0	9.000	N	ON	19.5
7.892500	---	27.20	50.00	22.80	5000.0	9.000	N	ON	19.6
7.892500	28.81	---	60.00	31.19	5000.0	9.000	N	ON	19.6
10.000500	---	42.85	50.00	7.15	5000.0	9.000	N	ON	19.6
10.000500	42.86	---	60.00	17.14	5000.0	9.000	N	ON	19.6
16.676500	---	29.44	50.00	20.56	5000.0	9.000	N	ON	19.7
16.676500	34.39	---	60.00	25.61	5000.0	9.000	N	ON	19.7
21.668500	---	29.48	50.00	20.52	5000.0	9.000	N	ON	19.9
21.668500	34.44	---	60.00	25.56	5000.0	9.000	N	ON	19.9
28.480500	---	37.15	50.00	12.85	5000.0	9.000	N	ON	20.1
28.480500	41.32	---	60.00	18.68	5000.0	9.000	N	ON	20.1

Notes:
[1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.

Table 8.2-4: *Conducted emissions – from AC mains power port (Quasi-Peak) results (Standby mode).*

8.2.6 Setup photos

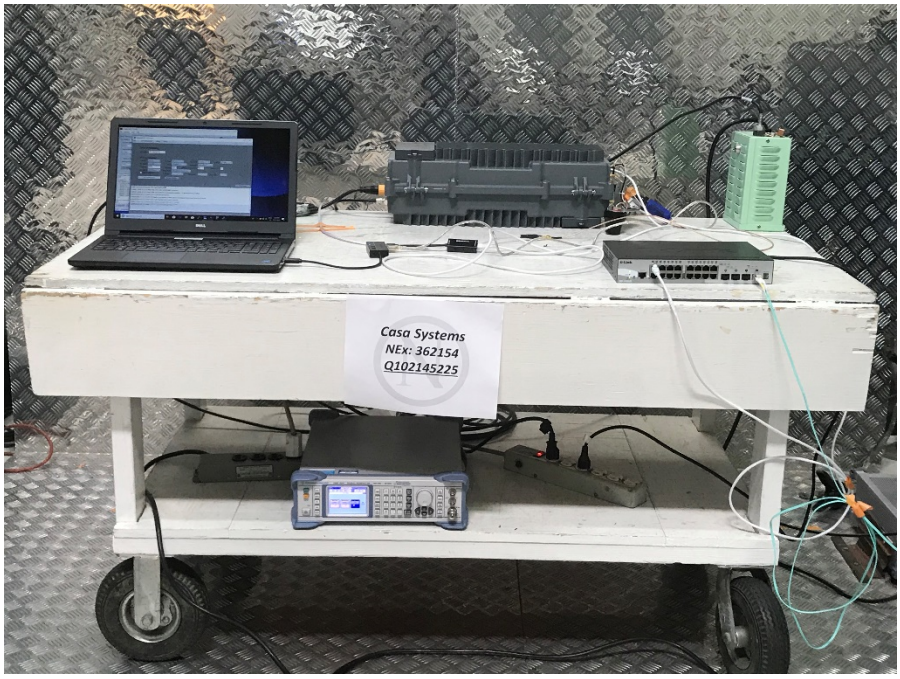


Figure 8.2-3: *Conducted disturbance at mains port setup photo*

Figure 8.2-4: *Conducted disturbance at mains port setup photo*

Section 9 EUT photos

9.1 External photos

Figure 9.1-1: *Front view photo*

Figure 9.1-2: *Side view photo*

9.1 External photos, continued

Figure 9.1-3: *Side view photo*

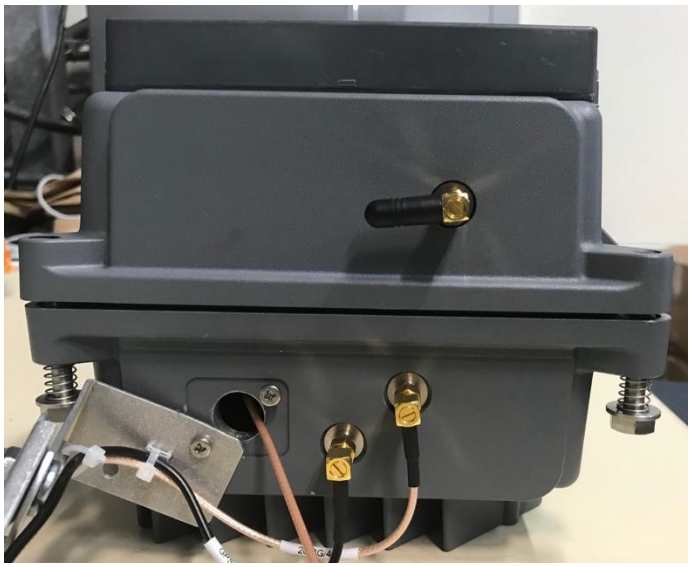
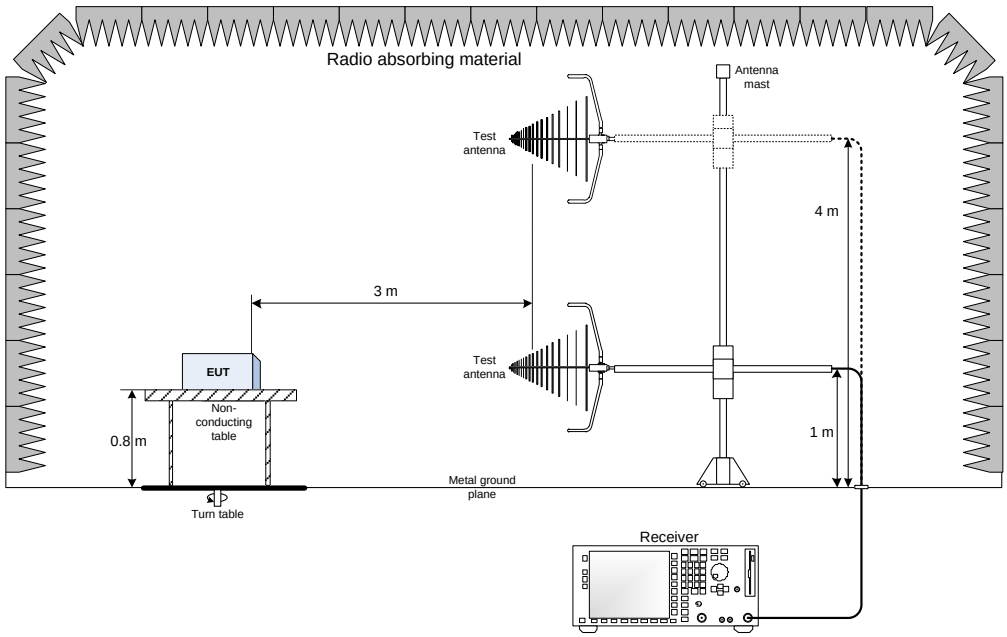


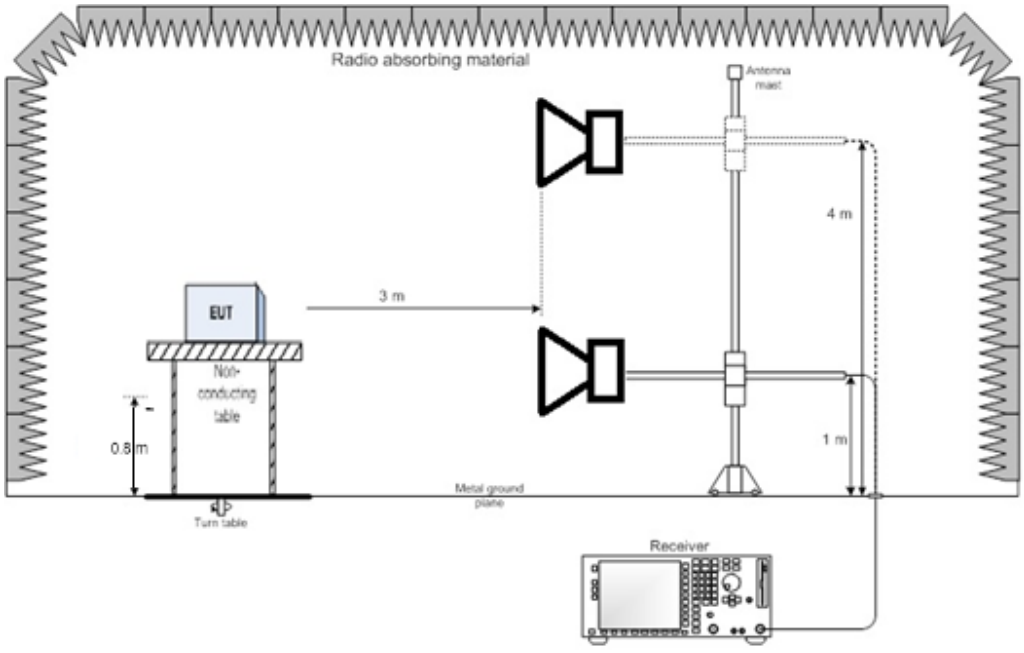
Figure 9.1-4: *Side view photo*

Section 10 Block diagrams of test set-ups

10.1 Radiated emissions set-up



30-1000MHz Setup



Above 1GHz Setup

Thank you for choosing