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Test Report

Report Number:

F212211E4

Equipment under Test (EUT):

**Type 3 AIS AtoN Station
N323**

Applicant:

Alltek Marine Electronics Corporation

Manufacturer:

Alltek Marine Electronics Corporation



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

- [1] **ANSI C63.26-2015**, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
- [2] **FCC CFR 47 Part 80**, Stations In The Maritime Services
- [3] **FCC CFR 47 Part 2**, Frequency allocations and radio treaty matters; general rules and regulations
- [4] **RSS-182 Issue 6 June 2021**, Maritime Radio Transmitters and Receivers in the Band 156 – 162.5 MHz
- [5] **RSS-Gen Issue 5 February 2021 Amendment 2**, General Requirements for Compliance of Radio Apparatus
- [6] **KDB 971168 D01 V03R01 April 2018**, Measurement Guidance for Certification of Licensed Digital Transmitters

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following. "Passed" indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account as stated in the introduction of ANSI C63.26 (2015). However, the measurement uncertainty is calculated and shown in this test report.

Tested and
written by:

Signature

Reviewed and
approved by:

Signature

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The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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1 Identification

1.1 Applicant

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Country:	Taiwan
Name for contact purposes:	Mr. Albert LEE
Phone:	+886-2-8691-8568
Fax:	+886-2-8691-9569
eMail Address:	albertlee@alltekmarine.com
Applicant represented during the test by the following person:	---

1.2 Manufacturer

Name:	Alltek Marine Electronics Corporation
Address:	14F-2, No. 237, Sec. 1, Datong Rd., Xizhi Dist., New Taipei City, 22161
Country:	Taiwan
Name for contact purposes:	Mr. Albert LEE
Phone:	+886-2-8691-8568
Fax:	+886-2-8691-9569
eMail Address:	albertlee@alltekmarine.com
Manufacturer represented during the test by the following person:	---

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkKS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-05 and D-PL-17186-01-06, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment Under Test)

Test object: *	Type 3 AIS AtoN Station
PMN: *	N323
HVIN: *	N323
FCC ID: *	WZ7ATON-N321-N323
IC: *	9547A-N321N323
Serial number: *	B1K320005
PCB identifier: *	M-PCB-N323MBV2
Software version / FVIN: *	V3
Lowest internal frequency: *	32.768 kHz

*: Declared by the applicant.

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

Remark: All tests were performed on one sample as described above

1.5 Technical data of equipment

Power supply: *	External DC power supply		
Supply voltage: *	$U_{Nom} = 12.0 \text{ V}_{DC}$	$U_{Min} = 9.6 \text{ V}_{DC}$	$U_{Max} = 31.2 \text{ V}_{DC}$
Alignment range: *	156.025 to 162.025 MHz		
Switching range: *	156.025 to 162.025 MHz		
Channel separation: *	25 kHz		
Type of modulation:	GMSK		
Data rate: *	9600 bps per channel		
Rated RF output power: *	12.5 W / 41 dBm		
Antenna connector: *	SO-239		
Antenna gain: *	N/A		
Temperature range: *	-35 °C to 55 °C		
Equipment used for testing:	Laptop PC (supplied by the laboratory) with test software (N323 Test Program) and RS422 to USB / RS232 converter (both supplied by the applicant)		
Ancillary Equipment:	None		

*: Declared by the applicant.

Ports/Connectors

Identification	Connector type		Length *
	EUT	Ancillary	
PWR/USB	7 Pin, C Size	Banana plug	2 m
GPS	TNC-female	-	Not used
VHF	UHF-female	-	Directly connected
Data	18 Pin, C Size	9 pole D-Sub	1 m

*: Length during test

1.6 Dates

Date of receipt of test sample:	18.10.2021
Start of test:	18.11.2021
End of test:	29.11.2021

2 Operational states

The EUT is an AIS Type 3 AtoN transceiver. It contains two AIS receivers, which are continuously receiving on a certain frequency and an AIS transmitter, which operates on one channel.

If not otherwise stated, for the documented receiver tests the receivers were set as follows: receiver A receiving on 156.025 MHz and receiver B receiving on 162.025 MHz.

If not otherwise stated, the EUT was supplied with 12 V_{DC} by an external power supply. The NMEA0183 interface of the EUT was connected to the RS232 interface of a laptop PC via a NMEA0183 to RS232 converter during all measurements. With the help of a test software (N323 Test-Program) all used transmitter operation modes could be adjusted, for the receiver test cases the test software was also used.

Because the EUT will be fixed mounted on a buoy, it was classified as other device and not as table-top device according to [1], so it was positioned on the center of the non-conducting support during the radiated measurements.

The radiated measurements inside the semi anechoic chamber were carried out in three orthogonal orientations of the EUT, which were defined as follows:

- Position 1: EUT placed on its long housing side, the connectors of the EUT showing away from the measuring antenna.
- Position 2: EUT placed on its short housing side the connectors of the EUT showing away from the measuring antenna.
- Position 3: EUT placed on its long housing side, the connectors of the EUT showing upwards.

For details of the different positions, please refer annex B of this test report.

3 Additional information

The tested sample was not labeled as required by the FCC / ISED.

4 Overview

Application	Frequency range [MHz]	FCC CFR 47 Part 80 [2] FCC CFR 47 Part 2 [3]	RSS-182 [4] RSS-Gen [5]	Status	Refer page
Bandwidths	156.025 to 162.025	80.205 [2], 2.1049 [3]	6.7 [5]	Passed	8 et seq.
Transmitter frequency tolerances	156.025 to 162.025	80.209 [2], 2.1055 [3]	5.5 [4], 6.11 [5]	Passed	10 et seq.
Spurious emissions on antenna terminals	0.009 to 2000	80.211 [2], 2.1051 [3]	5.9 [4], 6.13 [5]	Passed	12 et seq.
Modulation requirements	156.025 to 162.025	80.213 [2], 2.1047 [3]	5.8 [4]	Passed	14
Transmitter power	156.025 to 162.025	80.215 [2], 2.1046 [3]	5.6 [4], 6.12 [5]	Passed	16 et seq.
Radiated spurious emissions	30 to 2000	80.211 [2], 2.1051 [3]	6.13 [5]	Passed	17 et seq.
Suppression of interference aboard ships	0.009 to 2000	80.217 (b) [2]	7.4 [5]	Passed	21 et seq.

5 Test results

5.1 Bandwidths

5.1.1 Method of measurement (bandwidths)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be disabled, the transmitter shall work with its maximum data rate.

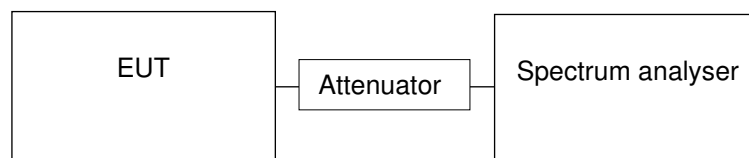
The following spectrum analyser settings according to [1] shall be used:

- Span: App. 1.5 times the OBW, centred on the actual channel.
- Resolution bandwidth: 1 % to 5 % of the OBW.
- Video bandwidth: three times the resolution bandwidth.
- Set the reference level of the instrument either above the measured peak conducted output power level or as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (OBW/RBW)]$ below the reference level.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

26 dB bandwidth: After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 26 dB below the first line (or the peak marker). The frequency lines shall be set on the intersection points between the second display line and the measured curve.

99% bandwidth: Use the 99% power bandwidth function of the instrument

Test set-up:



5.1.2 Test results (bandwidths)

Ambient temperature:	22 °C
Relative humidity:	37 %

Date:	18.11.2021
Tested by:	Thomas KÜHN

Measured conducted at antenna port, modulated with PRBS.

The plots of this measurement are shown in annex A.1 and A.2 of this test report.

26 dB bandwidth			
TX frequency	Bandwidth [kHz]	Limit [kHz]	Test result
156.025 MHz	11.779	20.0	Passed
162.025 MHz	11.699	20.0	Passed
99 % bandwidth [kHz]			
TX frequency	Bandwidth [kHz]	Limit [kHz]	Test result
156.025 MHz	9.415	Not specified	-
162.025 MHz	9.615	Not specified	-
Measurement uncertainty		<10 ⁻⁷	

Test equipment (please refer to chapter 6 for details)

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5.2 Transmitter frequency tolerances

5.2.1 Method of measurement (transmitter frequency tolerances)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable.

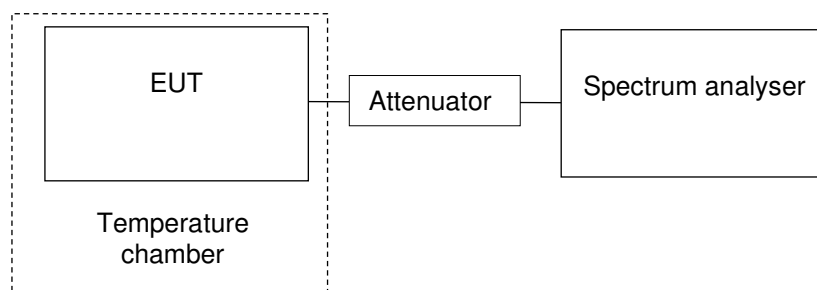
The following spectrum analyser settings according to [1] shall be used:

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Span: 10 kHz.
- Resolution bandwidth: 100 Hz.
- Video bandwidth: 300 Hz.
- Sweep time: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

The following procedure in accordance to FCC CFR 47 Part 2.1055 (a) (2) shall be used:

- 1) The EUT has to be placed inside the temperature chamber.
- 2) Start temperature is the highest operating temperature, which is declared by the applicant or 50 °C, whatever is higher.
- 3) After the temperature is stabilized, the EUT has to be switched on without modulation. After trace stabilization the marker shall be set on the signal peak. The transmitting signal shall be documented and the EUT has to be switched off.
- 4) The temperature than shall be changed in 10 deg steps in the temperature range 50 °C to -20 °C and step 3) must be repeated.
- 5) In case the lowest operating temperature declared by the applicant is lower than -20 °C, repeat step 3) for this temperature.

Test set-up:



5.2.2 Test results (transmitter frequency tolerances)

Ambient temperature:	22 °C
Relative humidity:	26 %

Date:	29.11.2021
Tested by:	Thomas KÜHN

Position of EUT: The EUT was set-up on a non-conducting support inside the temperature chamber.

Cable guide: For further information of the cable guide refer to the pictures in annex B of this test report.

Supply voltage: During this test the EUT was powered with 9.6 V_{DC} to 31.2 V_{DC} by an external power supply.

Frequency stability							
Test conditions		Nominal frequency 156.025 MHz		Nominal frequency 162.025 MHz		Limit[[ppm]	Test result
Temp.	Voltage	TX frequency [MHz]	Frequency error [ppm]	TX frequency [MHz]	Frequency error [ppm]		
+55 °C	U _{nom} (12.0 V _{DC})	156.025025	+0.16	162.025025	+0.15	±5	Passed
+50 °C	U _{nom} (12.0 V _{DC})	156.025033	+0.21	162.025033	+0.20	±5	Passed
+40 °C	U _{nom} (12.0 V _{DC})	156.025001	+0.01	162.025001	+0.01	±5	Passed
+30 °C	U _{nom} (12.0 V _{DC})	156.024970	-0.2	162.024970	-0.19	±5	Passed
T _{nom} (+20 °C)	U _{nom} (12.0 V _{DC})	156.024939	-0.39	162.024939	-0.38	±5	Passed
	U _{min} (9.6 V _{DC})	156.024939	-0.39	162.024939	-0.38	±5	Passed
	U _{max} (31.2 V _{DC})	156.024939	-0.39	162.024939	-0.38	±5	Passed
+10 °C	U _{nom} (12.0 V _{DC})	156.024963	-0.17	162.024963	-0.17	±5	Passed
0 °C	U _{nom} (12.0 V _{DC})	156.024963	-0.17	162.024963	-0.17	±5	Passed
-10 °C	U _{nom} (12.0 V _{DC})	156.024983	-0.11	162.024983	-0.10	±5	Passed
-20 °C	U _{nom} (12.0 V _{DC})	156.025013	+0.08	162.025013	+0.08	±5	Passed
-30 °C	U _{nom} (12.0 V _{DC})	156.024913	-0.56	162.024913	-0.54	±5	Passed
-35 °C	U _{nom} (12.0 V _{DC})	156.025000	0.00	162.025000	0.00	±5	Passed

Test equipment (please refer to chapter 6 for details)

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5.3 Spurious emissions on antenna terminals

5.3.1 Method of measurement (spurious emissions on antenna terminals)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable.

The following spectrum analyser settings according to [1] shall be used:

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Resolution bandwidth (conducted spurious emissions):
 - 9 kHz to 150 kHz: 1 kHz,
 - 150 kHz to 30 MHz: 10 kHz,
 - 30 MHz to 1 GHz: 100 kHz,
 - 1 GHz to 2 GHz: 1 MHz.Where the RBW above is below 30 kHz, it has to be ensured, that there is at least $10 \times \log(30/\text{RBW})$ of margin between the trace and the limit line of RSS-182, which requires a bandwidth of 30 kHz.
- Resolution bandwidth (spectrum mask): 300 Hz
- Video bandwidth: Three times the RBW.
- Sweep points: At least span / RBW
- Detector function: Peak.
- Trace mode: Max hold.

Test set-up:



5.3.2 Test results (spurious emissions on antenna terminals)

Ambient temperature:	22 °C
Relative humidity:	37 %

Date:	18.11.2021
Tested by:	Thomas KÜHN

Measured conducted at antenna port, modulated with PRBS.

Results according to FCC 47 CFR Part 80.211 (f) [2]:

The plots for the spectrum mask according to FCC 47 CFR Part 80.211 (f) (1) + (2) [2] are shown in Annex A.3 of this test report.

Test result (according to FCC 47 CFR Part 80.211 (f) (1) + (2) [2]: Passed

The plots for transmitter spurious emissions to FCC 47 CFR Part 80.211 (f) (3) [2] are shown in Annex A.4 of this test report the results are presented below:

Transmitter spurious emissions on antenna port (transmit PRBS on 156.025 MHz)				
Frequency range	Maximum power measured [dBm]	Limit [dBm]	Margin [dB]	Test result
9 kHz to 150 kHz	-44.0	-13.0	31.0	Passed
150 kHz to 30 MHz	-37.6	-13.0	24.6	Passed
30 MHz to 1 GHz	-28.3	-13.0	15.3	Passed
1 GHz to 2 GHz	-49.0	-13.0	36.0	Passed
Transmitter spurious emissions on antenna port (transmit PRBS on 162.025 MHz)				
Frequency range	Maximum power measured [dBm]	Limit [dBm]	Margin [dB]	Test result
9 kHz to 150 kHz	-43.5	-13.0	30.5	Passed
150 kHz to 30 MHz	-37.1	-13.0	24.1	Passed
30 MHz to 1 GHz	-28.9	-13.0	15.9	Passed
1 GHz to 2 GHz	-48.2	-13.0	35.2	Passed

Results according to RSS-182, clause 5.9.1 [4]:

The plots for the spectrum mask according to RSS-182, clause 5.9.1 (i), (ii) [4] for Equipment with 25 kHz Channel Spacing are shown in Annex A.3 of this test report.

Test result (according to RSS-182, clause 5.9.1 (i) + (ii) [4]): Passed

The plots for transmitter spurious emissions to RSS-182, clause 5.9.1 (iii) [4] for Equipment with 25 kHz Channel Spacing are shown in Annex A.4 of this test report the results are presented below:

Transmitter spurious emissions on antenna port (transmit PRBS on 156.025 MHz)							
Frequency range	Maximum power measured [dBm]	Used RBW [kHz]	Bandwidth correction [dB] *	Corrected maximum power [dBm] **	Limit [dBm]	Margin [dB]	Test result
9 kHz to 150 kHz	-44.0	1	14.8	-29.2	-13.0	16.2	Passed
150 kHz to 30 MHz	-37.6	10	4.8	-32.8	-13.0	19.8	Passed
30 MHz to 1 GHz	-28.3	100	-5.2	-33.5	-13.0	20.5	Passed
1 GHz to 2 GHz	-49.0	1000	-15.2	-64.2	-13.0	51.2	Passed
Transmitter spurious emissions on antenna port (transmit PRBS on 162.025 MHz)							
Frequency range	Maximum power measured [dBm]	Used RBW [kHz]	Bandwidth correction [dB] *	Corrected maximum power [dBm] **	Limit [dBm]	Margin [dB]	Test result
9 kHz to 150 kHz	-43.5	1	14.8	-28.7	-13.0	15.7	Passed
150 kHz to 30 MHz	-37.1	10	4.8	-32.3	-13.0	19.3	Passed
30 MHz to 1 GHz	-28.9	100	-5.2	-34.1	-13.0	21.1	Passed
1 GHz to 2 GHz	-48.2	1000	-15.2	-63.4	-13.0	50.4	Passed

*: bandwidth correction was calculated with $10 \cdot \log(30/\text{used RBW}[\text{kHz}])$

** : The corrected maximum power was calculated with Maximum power + bandwidth correction

Test equipment (please refer to chapter 6 for details)

11 - 14

5.4 Modulation characteristics

5.4.1 Method of measurement (modulation characteristics)

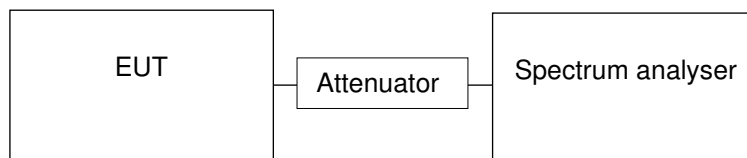
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator.

The following spectrum analyser settings according to [1] shall be used:

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- IF-bandwidth: 300 kHz.
- Demodulation-bandwidth: 25 kHz.
- Measuring time: 24 ms.
- Video bandwidth: 300 Hz.
- Sweep mode: Single.
- Detector function: Peak.
- Trace mode: Clear write.
- Range: 1 kHz / division.

The EUT has to transmit either PRBS, 01010101 or 00001111.

Test set-up:



5.4.2 Test results (modulation characteristics)

Ambient temperature:	22 °C
Relative humidity:	37 %

Date:	18.11.2021
Tested by:	Thomas KÜHN

Operation mode: Transmit on 156.025 MHz and 162.025 MHz, measured conducted at antenna port.

The plots of this measurement are shown in annex A.5 of this test report.

Test result: Passed

Test equipment (please refer to chapter 6 for details)
11 - 14

5.5 Transmitter power

5.5.1 Method of measurement (transmitter power)

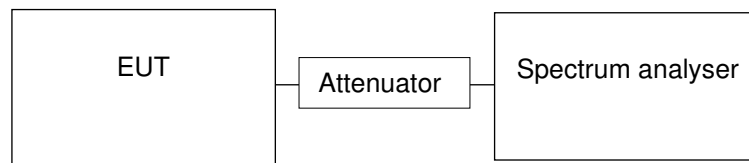
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable.

According to [6] the following spectrum analyser settings shall be used:

- Span: \geq two times the OBW.
- Resolution bandwidth: \geq OBW.
- Video bandwidth: \geq three times the RBW.
- Sweep: \geq 10 times (number of sweep points in sweep) x (transmission symbol period).
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilization the marker shall be set on the signal peak.

Test set-up:



5.5.2 Test results (transmitter power)

Ambient temperature:	22 °C
Relative humidity:	37 %

Date:	18.11.2021
Tested by:	Thomas KÜHN

Operation mode: Transmit modulated with PRBS, measured conducted at antenna port.

The plots of this measurement are shown in annex A.6 of this test report.

TX frequency	Transmitter power		Limit according to [2]	Limit according to [4]	Result
	Measured	Rated			
156.025 MHz	40.9 dBm / 12.3 W	41 dBm / 12.5 W	Up to 25 W	Up to 25 W, \pm 1 dB of the rated power	Passed
162.025 MHz	40.9 dBm / 12.3 W	41 dBm / 12.5 W			Passed

Test equipment (please refer to chapter 6 for details)
11 - 14

5.6 Radiated emissions

5.6.1 Method of measurement (radiated emissions)

The EUT is measured in the frequency range from 30 MHz to 2 GHz in a semi anechoic chamber with a metal ground plane, which was covered by pyramid absorbers for measurements above 1 GHz. The test site has been validated to the requirements of ANSI C63.4. The EUT was placed on a non-conducting support with a height of 80 cm (below 1 GHz) and 1.5 m (above 1 GHz) respectively and was measured in three orthogonal orientations. It was placed at a distance of 3 meters from the receiving antenna. Both polarizations (vertical and horizontal) have been evaluated and the turn table has been turned to 360° to maximize the emissions.

The receiving antenna is raised from 1 to 4 m below 1 GHz and 1 to 2.5 m above 1 GHz and tilted for measurements above 1 GHz.

The frequency range from 30 MHz to 2 GHz has been measured using the field strength method [1]. The measured field strength using the field strength method is then converted to an ERP or EIRP [dBm] using the formula:

$E \text{ [dB}\mu\text{V/m]} = \text{EIRP [dBm]} - 20\log(d) + 104.8$ according to chapter 5.2.7 (c) [1].

→ $\text{EIRP} = E - 95.25$ (d = 3 m measuring distance)

$\text{ERP [dBm]} = \text{EIRP} - 2.15 \text{ dB}$

Level (dBm) \triangleq ERP (below 1GHz) or EIRP (above 1 GHz)

Procedure preliminary measurement:

The following procedure is used:

1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarisation and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat 1) to 2) with the horizontal polarisation of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height is reached.
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for that value.
7. Repeat 1. to 6. with for three orthogonal orientations of the EUT.

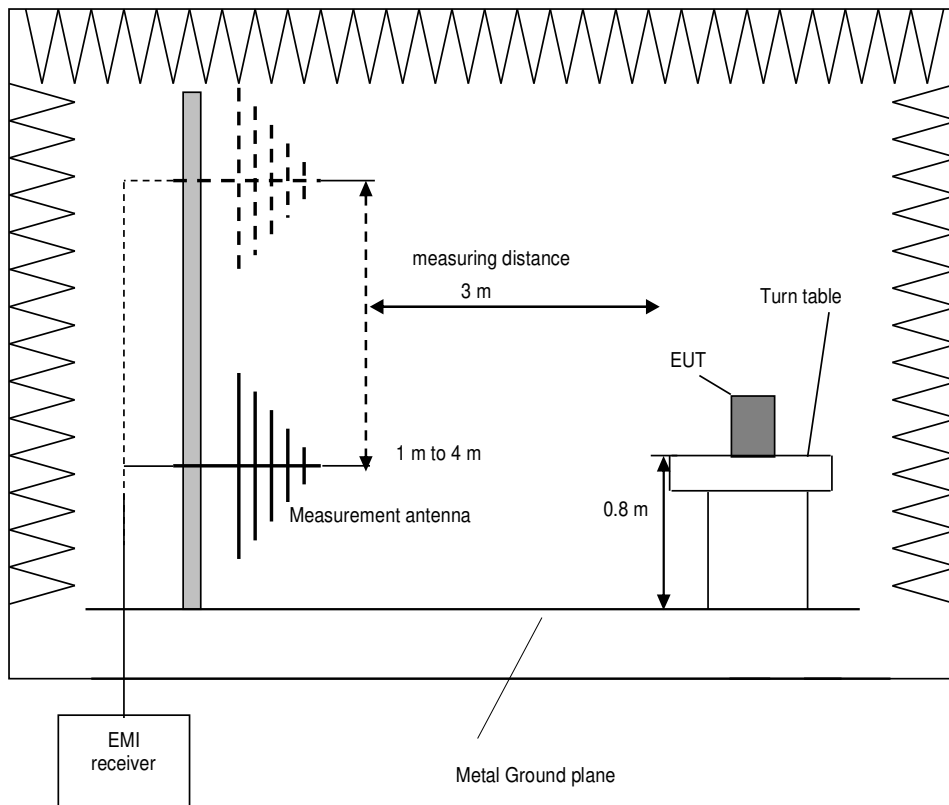
Procedure final measurement:

The following procedure is used:

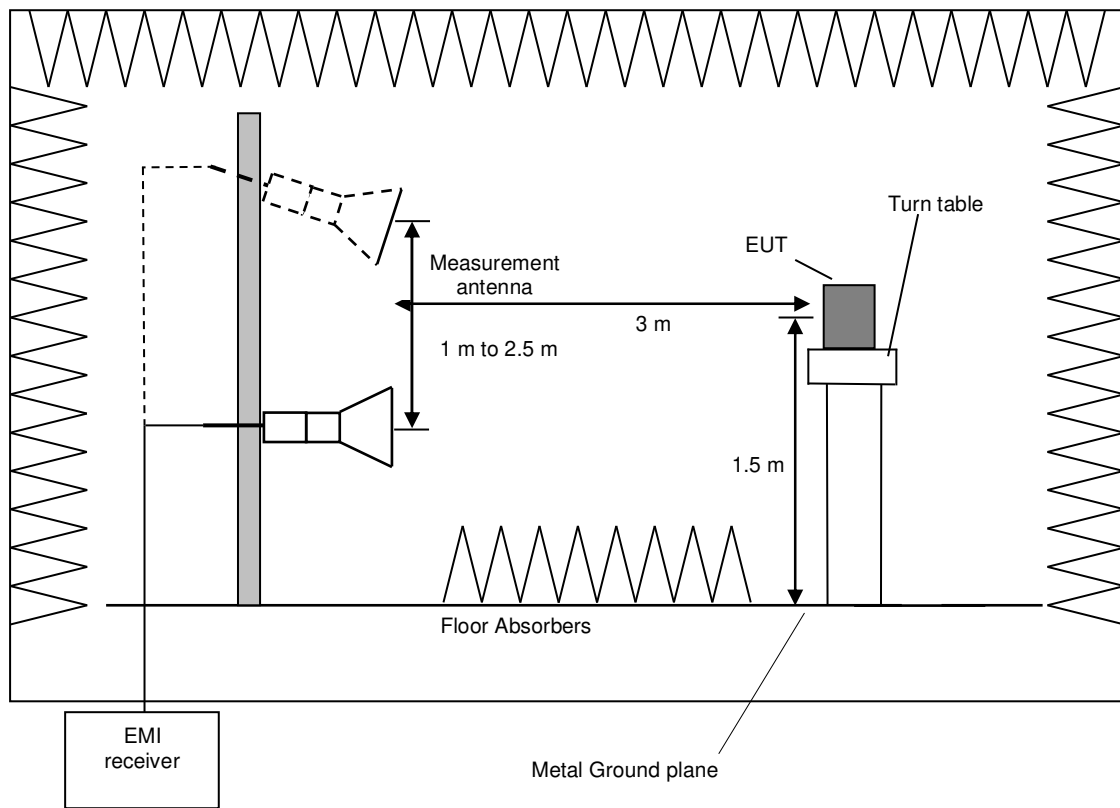
1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW of the pre-scan of the selected peaks.
3. The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the value obtained in the preliminary measurement, and to monitor the emission level.
4. The worst azimuth turntable position is found by varying the turntable azimuth by +/- 25° from the value obtained in the preliminary measurement, and to monitor the emission level.
5. The final measurement is performed at the worst-case antenna height and the worst-case turntable azimuth
6. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.
7. Repeat 1. to 6. with for three orthogonal orientations of the EUT.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	100 kHz
1 GHz to 2 GHz	1 MHz



Test setup for measurements below 1 GHz



Test setup for measurements above 1 GHz

5.6.2 Test results (radiated emissions)

5.6.2.1 Radiated emission measurement (30 MHz to 2 GHz)

Ambient temperature:	22 °C
Relative humidity:	32 %

Date:	22.11.2021
Tested by:	Thomas KÜHN

Position of EUT: The EUT was set-up on a non-conducting support of a height of 0.8 m (30 MHz to 1 GHz) or a non-conducting support of a height of 1.5 m (1 GHz to 2 GHz) on a turntable. The distance between EUT and antenna was 3 m. The EUT was positioned in three orthogonal orientations. Because the EUT will be fixed mounted on a ship, it was classified as other device and not as table-top device according to [1], so it was positioned on the middle of the non-conducting support during this measurement.

Cable guide: For detail information of test set-up, the used positions and the cable guide refer to the pictures in annex B of this test report.

Test record: The plots of this measurement are documented in annex A.7 of this test report.

Supply voltage: During this test the EUT was powered with 12 V_{DC} by an external power supply.

Frequency range: The preliminary measurement was carried out in the frequency range 30 MHz to 2 GHz, according to [2] / [4].

Operation mode: Transmit on 156.025 MHz and 162.025 MHz, modulated with PRBS, antenna port terminated with 50 Ω.

The plots of this measurement are shown in annex A.7 of this test report.

The following frequencies were found during the preliminary measurement less than 20 dB below the limit:

Transmitter operates on 156.025 MHz									
Frequency [MHz]	MaxPeak [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Bandwidth [kHz]	Height [cm]	Pol.	Pos.	Azimuth [deg]	Test result
1560.250	67.5	82.2	14.7	1000	152	Vert.	2	150	Passed
1716.275	68.8	82.2	13.4	1000	159	Vert.	3	287	Passed
1872.300	68.9	82.2	13.3	1000	211	Vert.	2	142	Passed
Transmitter operates on 162.025 MHz									
Frequency [MHz]	MaxPeak [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Bandwidth [kHz]	Height [cm]	Pol.	Pos.	Azimuth [deg]	Test result
1944.300	66.8	82.2	15.4	1000	193	Vert.	2	150	Passed

Test equipment (please refer to chapter 6 for details)
1 - 12

5.7 Suppression of interference aboard ships/Receiver spurious emissions

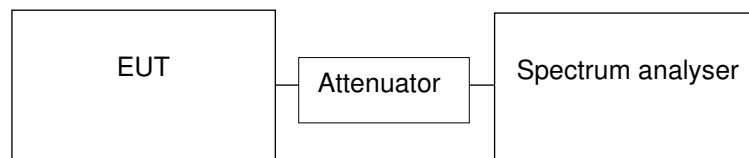
5.7.1 Method of measurement (suppression of interference aboard ships/receiver spurious emissions)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable.

The following spectrum analyser settings according to [1] shall be used:

- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
- Resolution bandwidth (conducted spurious emissions):
 - 9 kHz to 150 kHz: 1 kHz,
 - 150 kHz to 30 MHz: 10 kHz,
 - 30 MHz to 1 GHz: 100 kHz,
 - 1 GHz to 2 GHz: 1 MHz.
- Video bandwidth: Three times the RBW.
- Sweep points: At least span / RBW
- Detector function: Peak.
- Trace mode: Max hold.

Test set-up:



5.7.2 Test results (suppression of interference aboard ships)

Ambient temperature:	22 °C
Relative humidity:	37 %

Date:	18.11.2021
Tested by:	Thomas KÜHN

Measured conducted at antenna port, receiver A receiving on 156.025 MHz and receiver B receiving on 162.025 MHz.

The plots of this measurement are shown in annex A.8 of this test report.

Results according to FCC 47 CFR Part 80.217 (b):

Receiver spurious emissions on antenna port (receive on 156.025 MHz and 162.025 MHz)				
Frequency range	Maximum power measured [dBm]	Limit [dBm]	Margin [dB]	Test result
9 kHz to 150 kHz	-66.5	-4.0	62.5	Passed
150 kHz to 30MHz	-71.9	-4.0	67.9	Passed
30 MHz to 100 MHz	-70.7	6.0	76.7	Passed
100 MHz to 300 MHz	-67.5	16.0	83.5	Passed
300 MHz to 2 GHz	-58.8	26.0	84.8	Passed

Results according to RSS-Gen. clause 7.4

Receiver spurious emissions on antenna port (receive on 156.025 MHz and 162.025 MHz)				
Frequency range	Maximum power measured [dBm]	Limit [dBm]	Margin [dB]	Test result
30 MHz to 100 MHz	-70.7	-57.0	13.7	Passed
100 MHz to 300 MHz	-67.5	-57.0	10.5	Passed
300 MHz to 1 GHz	-69.7	-57.0	12.7	Passed
1 GHz to 2 GHz	-58.5	-53.0	5.5	Passed

Test equipment (please refer to chapter 6 for details)
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6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. Due
1	Semi anechoic chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
2	RF Switch Matrix	OSP220	Rohde & Schwarz	-	482976	Calibration not necessary	
3	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
4	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
5	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
6	System software EMC32 M276	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
7	Antenna (Bilog)	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
8	Log.-Per. Antenna	HL050	Rohde & Schwarz	100908	482977	13.08.2019	08.2022
9	EMI Test receiver ESW	ESW44	Rohde & Schwarz	101819	483149	07.09.2020	09.2022
10	Cable C417	Sucoflex 118	Huber+Suhner	500654/118	-	Calibration not necessary	
11	Power supply	TOE8951	Toellner	81996	481253	Calibration not necessary	
12	Multimeter	971A	Hewlett Packard	JP39009358	480721	17.02.2021	02.2022
13	20 dB attenuator	WA8 / 18-20-34	Weinschel	-	481450	Calibration not necessary	
14	Spectrum Analyser	FSU46	Rohde & Schwarz	200125	480956	25.02.2021	02.2022
15	Temperature chamber	MK 240	Binder	08-55251	480972	08.07.2020	07.2022

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA	ANSI C63.4-2014	03.03.2021	03.2023
Semi anechoic chamber M276 (with floor absorbers)	483227	1 GHz – 2 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	22.02.2021	02.2023

8 Measurement uncertainties

Measurement uncertainties	
Description	ULab
Bandwidth measurement	9.0×10^{-8}
RF frequency	$\pm 4.5 \times 10^{-8}$
RF power	+0.66 dB / -0.72 dB
Conducted spurious emissions	± 2.3 dB
Radiated spurious emissions	± 5.1 dB

9 Report history

Report Number	Date	Comment
F212211E4	08.12.2021	Document created

10 List of annexes

Annex A	Measurement results	21 pages
Annex B	Test setup photographs	10 pages