



# EMC Test Report

**Issued Date** : Aug. 04, 2011  
**Project No.** : R1105011  
**Equipment** : AIS Aids to Navigation (AtoN)  
**Model Name** : MANDO-301; MANDO-302;  
MANDO-303  
**Applicant** : Alltek Marine Electronics Corp.  
**Address** : 7F, NO. 605, Ruei Guang Rd., NeiHu,  
Taipei, Taiwan, R.O.C. 114

**Tested by:** Neutron Engineering Inc. EMC Laboratory  
**Date of Receipt:** May 24, 2011  
**Date of Test:** May 24, 2011 ~ Jun. 13, 2011

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**Neutron** represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with the standards traceable to National Measurement Laboratory (**NML**) of **R.O.C.**, or National Institute of Standards and Technology (**NIST**) of **U.S.A.**

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## 1. CERTIFICATION

Equipment : AIS Aids to Navigation (AtoN)  
Brand Name : AMEC  
Model Name : MANDO-301; MANDO-302; MANDO-303  
Applicant : Alltek Marine Electronics Corp.  
Date of Test : May 24, 2011 ~ Jun. 13, 2011  
Standards : EN 301 489-1 V1.8.1 (2008-04)  
EN 301 489-3 V1.4.1 (2002-08)  
EN 55022: 2006 +A1: 2007 Class B  
IEC 61000-4-2: 2008  
IEC 61000-4-3: 2006 +A1: 2007 +A2: 2010  
IEC 61000-4-4: 2004 +A1: 2010  
IEC 61000-4-6: 2008

The above equipment has been tested and found compliance with the requirement of the relative standards by Neutron Engineering Inc. EMC Laboratory.

The test data, data evaluation, and equipment configuration contained in our test report (Ref No. NEI-ETSE-1-R1105011) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of NVLAP and TAF according to the ISO-17025 quality assessment standard and technical standard(s).



**2. SUMMARY OF TEST RESULTS**

Test procedures according to the technical standards:

<b>Emission</b>				
Standard	Test Item	Limit	Judgment	Remark
EN 55022: 2006 +A1: 2007	Conducted Emission	Class B	N/A	
	Conducted Emission At Telecommunication Ports	Class B	N/A	
	Radiated Emission	Class B	PASS	
<b>Immunity</b>				
Section	Test Item	Performance Criteria	Judgment	Remark
IEC 61000-4-2: 2008	Electrostatic Discharge	B	PASS	
IEC 61000-4-3: 2006 +A1: 2007 +A2: 2010	RF electromagnetic field	A	PASS	
IEC 61000-4-4: 2004 +A1: 2010	Fast transients	B	PASS	
IEC 61000-4-6: 2008	Injected Current	A	PASS	

**NOTE:**

(1) " N/A" denotes test is not applicable in this Test Report.



**2.1 TEST FACILITY**

The test facilities used to collect the test data in this report:

- CB05:** B1, No. 37, Lane 365, YangGuang St., NeiHu District 114, Taipei, Taiwan.
- CB06:** B1, No. 37, Lane 365, YangGuang St., NeiHu District 114, Taipei, Taiwan.
- CB08:** (VCCI RN: G-91; FCC RN: 614388; FCC DN: TW1054;  
IC Assigned Code: 4428C-1)  
1F., No. 61, Ln. 77, Sing-ai Rd., Neihu Dist., Taipei City 114, Taiwan (R.O.C.)
- OS02:** (VCCI RN: R-2669; FCC RN: 95335; FCC DN: TW1010;  
IC Assigned Code: 4428A-1)  
No.132-1, Lane 329, Sec. 2, Palian Road, Shijr City, Taipei, Taiwan.

**2.2 MEASUREMENT UNCERTAINTY**

The reported uncertainty of measurement  $y \pm U$ , where expended uncertainty  $U$  is based on a standard uncertainty multiplied by a coverage factor of  $k=2$ , providing a level of confidence of approximately 95%.

The measurement instrumentation uncertainty considerations contained in CISPR 16-4-2.

A. Radiated Measurement :

Test Site	Method	Measurement Frequency Range	Ant. H / V	U , (dB)	NOTE
OS-02	ANSI	30MHz ~ 200MHz	V	2.48	
		30MHz ~ 200MHz	H	2.16	
		200MHz ~ 1,000MHz	V	2.50	
		200MHz ~ 1,000MHz	H	2.66	

Test Site	Item	Measurement Frequency Range	Uncertainty	NOTE	
CB08	Radiated Emission at 3m	Horizontal Polarization	30 - 200MHz	3.35 dB	
			200 - 1000MHz	3.11 dB	
			1 - 18GHz	3.97 dB	
			18 - 40GHz	4.01 dB	
		Vertical Polarization	30 - 200MHz	3.22 dB	
			200 - 1000MHz	3.24 dB	
			1 - 18GHz	4.05 dB	
			18 - 40GHz	4.04 dB	

B. EMS Measurement:

Item	Standard	Expanded Uncertainty		NOTE
ESD(CB06)	IEC 61000-4-2	Voltage	1.6 %	
		Timing	2.8 %	
RS(CB05)	IEC 61000-4-3	2.66 dB		80MHz - 2.5GHz, k=2

Our calculated Measurement Instrumentation Uncertainty is shown in the tables above. These are our  $U_{lab}$  values in CISPR 16-4-2 terminology.

Since Table 1 of CISPR 16-4-2 has values of measurement instrumentation uncertainty, called  $U_{CISPR}$ , as follows:

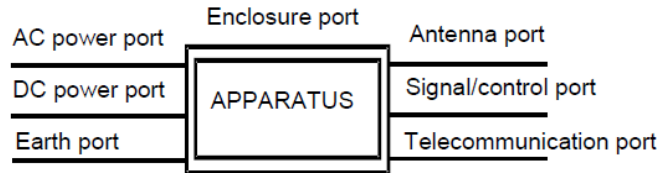
- Conducted Disturbance (mains port) – 150 kHz – 30 MHz : 3.6 dB
- Radiated Disturbance (electric field strength on an open area test site or alternative test site) – 30 MHz – 1000 MHz : 5.2 dB

It can be seen that our  $U_{lab}$  values are smaller than  $U_{CISPR}$ .

**2.3 APPLICABILITY OVERVIEW TABLES**

This section refers to **sub-clause 7** of the standard **ETSI EN 301 489-1**

**Definition of I/O Ports:**



**Figure 1: Examples of ports**

<b>EMC Emission</b>					
Phenomenon	Application	Equipment test requirement			Reference clause in the present document
		Radio and ancillary equipment for fixed use (base station equipment)	Radio and ancillary equipment for vehicular use (mobile equipment)	Radio and ancillary equipment for portable use (portable equipment)	
radiated emission	enclosure of ancillary equipment	applicable for stand alone testing	applicable for stand alone testing	applicable for stand alone testing	8.2
conducted emission	DC power input/output port	applicable	applicable	not applicable	8.3
conducted emission	AC mains input/output port	applicable	not applicable	not applicable	8.4
harmonic current emissions	AC mains input port	applicable	not applicable	not applicable	8.5
voltage fluctuations and flicker	AC mains input port	applicable	not applicable	not applicable	8.6
conducted emission	telecommunication port	applicable	not applicable	not applicable	8.7





<b>EMC Immunity</b>					
Phenomenon	Application	Equipment test requirement			Reference clause in the present document
		Radio and ancillary equipment for fixed use (base station equipment)	Radio and ancillary equipment for vehicular use (mobile equipment)	Radio and ancillary equipment for portable use (portable equipment)	
RF electromagnetic field (80 MHz to 1000 MHz and 1400 MHz to 2700 MHz)	enclosure	applicable	applicable	applicable	9.2
electrostatic discharge	enclosure	applicable	not applicable	applicable	9.3
fast transients common mode	signal, telecommunication and control ports, DC and AC power ports	applicable	not applicable	not applicable	9.4
RF common mode 0,15 MHz to 80 MHz	signal, telecommunication and control ports, DC and AC power ports	applicable	applicable	not applicable	9.5
transients and surges	DC power input ports	not applicable	applicable	not applicable	9.6
voltage dips and interruptions	AC mains power input ports	applicable	not applicable	not applicable	9.7
surges, line to line and line to ground	AC mains power input ports, telecommunication ports	applicable	not applicable	not applicable	9.8



**3. GENERAL INFORMATION**

**3.1 GENERAL DESCRIPTION OF EUT**

Equipment	AIS Aids to Navigation (AtoN)		
Brand Name	AMEC		
Model Name	MANDO-301; MANDO-302; MANDO-303		
OEM Brand/Model Name	N/A		
Model Difference	All models are based on similar electrical circuit except the difference of list below:		
	Model Name	Transmitter(s)	Receiver(s)
	MANDO-301	1	0
	MANDO-302	1	1
	MANDO-303	1	2
All the above models were tested, and the model: MANDO-301 was found to be the worst case during the pre-scanning test. This model of the worst case was used for final testing and collecting test data included in this report.			
Product Description	The EUT is an AIS Aids to Navigation (AtoN).		
	Operation Frequency:	156.025~162.025 MHz	
	Product Class:	Class 1	
	Receiver Class:	Class 3	
	Modulation Type:	GMSK (AIS)	
	Number Of Channel	2 Channels CH1: 161.975 MHz CH2: 162.025 MHz	
	Antenna Designation:	Please refer to the Note 2.	
	Antenna Gain(Peak)	Please refer to the Note 2.	
Based on the application, features, or specification exhibited in User's Manual, the EUT is considered as an ITE/Computing Device. More details of EUT technical specification, please refer to the User's Manual.			
Power Source	DC Voltage supplied from DC Source.		
Power Rating	DC 12V		
Connecting I/O Port(s)	Please refer to the User's Manual		
Products Covered	N/A		
EUT Modification(s)	N/A		
Hardware	M-PCB-CTLNC3, M-PCB-RFNR2		
Software	Version: 1.4.3		

**Note:**

1. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.
2. Table of Filed Antenna:

Antenn	Brand	Model Name	Type	Connector Type	Gain (dBi)
1	AMEC	ALT06-310510	Dipole	Type M	2.86



### 3.2 DESCRIPTION OF TEST MODES

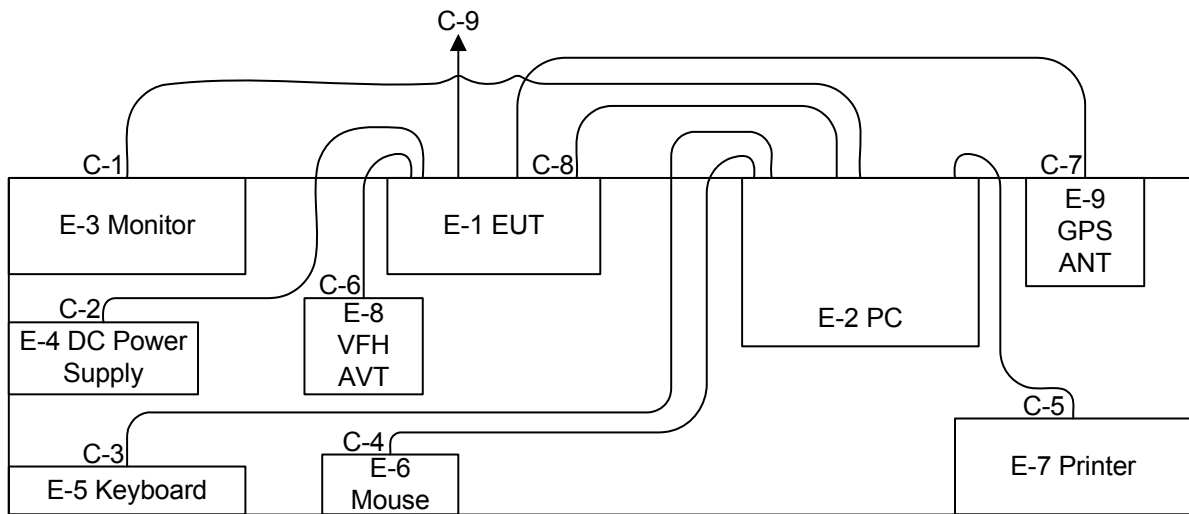
To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Pretest Test Mode	Description
Mode 1	FULL SYSTEM(MANDO-303)
Mode 2	FULL SYSTEM(MANDO-301)

For Radiated Test	
Final Test Mode	Description
Mode 2	FULL SYSTEM(MANDO-301)

For EMS Test	
Final Test Mode	Description
Mode 2	FULL SYSTEM(MANDO-301)

### 3.3 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED



- C-1 D-SUB Cable
- C-2 Power Cable
- C-3 PS/2 Cable
- C-4 PS/2 Cable
- C-5 USB Cable
- C-6 ANT Cable
- C-7 ANT Cable
- C-8 Signal Cable
- C-9 Signal Cable



**3.4 DESCRIPTION OF SUPPORT UNITS**

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Mfr/Brand	Model/Type No.	FCC ID	Series No.	Note
E-1	AIS Aids to Navigation (AtoN)	AMEC	MANDO-301	N/A	N/A	EUT
E-2	PC	DELL	MVT01	DOC	4GCTR18	
E-3	24" LCD Monitor	DELL	2408WFPb	DOC	071863-11	
E-4	DC Power Supply	GOOD WILL	GPC-3030D	N/A	B710591	
E-5	PS/2 K/B	Logitech	Y-SJ17(ACK260A)	DOC	SYU44664880	
E-6	PS/2 Mouse	Logitech	M-SBF69	DOC	HCA44601156	
E-7	Printer	HP	C9025A	DOC	TH4B013021	
E-8	VHF ANT	N/A	N/A	N/A	N/A	
E-9	GPS ANT	AMEC	N/A	N/A	N/A	

Item	Shielded Type	Ferrite Core	Length	Note
C-1	YES	YES	1.8M	
C-2	NO	NO	2.5M	
C-3	YES	NO	1.5M	
C-4	YES	NO	1.7M	
C-5	YES	NO	1.7M	
C-6	YES	NO	0.3M	
C-7	YES	NO	8.0M	
C-8	YES	NO	2.5M	
C-9	YES	NO	3.2M	

Note:

- (1) For detachable type I/O cable should be specified the length in cm in 『Length』 column



**4. EMC EMISSION TEST**

**4.1 RADIATED EMISSION MEASUREMENT**

**4.1.1 LIMITS OF RADIATED EMISSION MEASUREMENT (BELOW 1000MHZ)**

FREQUENCY (MHz)	Class A (at 10m)	Class B (at 1 m)
	dBu V/m	dBu V/m
30 – 230	40	30
230 – 1000	47	37

Notes:

- (1) The limit for radiated test was performed according to as following:  
CISPR 22/ FCC PART 15B /ICES-003.
- (2) The tighter limit applies at the band edges.
- (3) Emission level (dBu V/m)=20log Emission level (u V/m).
- (4) The test result calculated as following:  
 Measurement Value = Reading Level + Correct Factor  
 Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain(if use)  
 Margin Level = Measurement Value – Limit Value

**LIMITS OF RADIATED EMISSION MEASUREMENT (ABOVE 1000MHZ)**

FREQUENCY (MHz)	Class A (dBu V/m) (at 3m)		Class B (dBu V/m) (at 3m)	
	PEAK	AVERAGE	PEAK	AVERAGE
1000-3000	76	56	70	50
3000-6000	80	60	74	54

Notes:

- (1) The lower limit applies at the transition frequency.
- (2) The test result calculated as following:  
 Measurement Value = Reading Level + Correct Factor  
 Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain(if use)  
 Margin Level = Measurement Value – Limit Value

**FREQUENCY RANGE OF RADIATED MEASUREMENT (FOR UNINTENTIONAL RADIATORS)**

Highest frequency generated or Upper frequency of measurement used in the device or on which the device operates or tunes (MHz)	Range (MHz)
Below 108	1000
108 – 500	2000
500 – 1000	5000
Above 1000	5 <sup>th</sup> harmonic of the highest frequency or 6 GHz, whichever is lower

**4.1.2 MEASUREMENT INSTRUMENTS LIST**

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Log-Bicon Antenna	Schwarzbeck	VULB 9160	3173	Nov. 04, 2011
2	Pre-Amplifier	Anritsu	MH648A	M98457	Dec. 13, 2011
3	Test Cable	TIMES	LMR-400	10M-OS01	Jun. 17, 2011
4	Test Cable	TIMES	LMR-400	OS02	Jun. 17, 2011
5	EMI Test Receiver	R&S	ESCI	100082	Mar. 15, 2012
6	System Controller (OS02)	CT	SC100	N/A	N/A
7	Turn Table	Chance Most	CMTB-1.5	N/A	N/A
8	Microwave Pre amplifier	Agilent	8449B	3008A01714	Apr. 18, 2012
9	Microflex Cable	HARBOUR INDUSTRIES	27478 LL142	1m	May. 18, 2012
10	Microflex Cable	AISI	S104-SMAP-1	10m	Aug. 22, 2011
11	Microflex Cable	HARBOUR INDUSTRIES	27478 LL142	3m	Aug. 22, 2011
12	Spectrum Analyzer	R&S	FSP-40	100129	Aug. 31, 2011
13	Horn Antenna (1G)	Schwarzbeck	BBHA 9120 D	9120D-325	Dec. 08, 2011

Remark: " N/A" denotes No Model Name / Serial No. and No Calibration specified.

**4.1.3 TEST PROCEDURE**

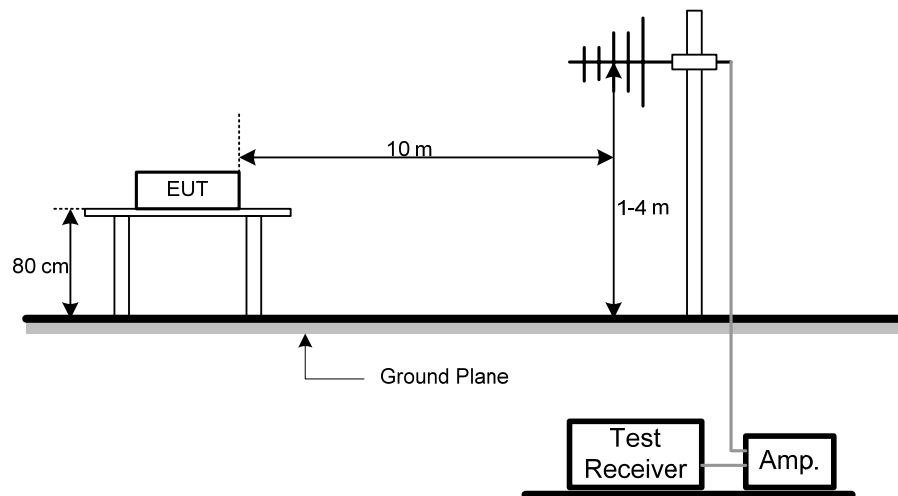
- The measuring distance of at 10 m shall be used for measurements at frequency up to 1GHz. For frequencies above 1GHz, any suitable measuring distance may be used.
- The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3m or 10 meter open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- The height of the equipment or of the substitution antenna shall be 0.8 m; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- The initial step in collecting radiated emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed.
- For the actual test configuration, please refer to the related Item –EUT Test Photos.

**4.1.4 DEVIATION FROM TEST STANDARD**

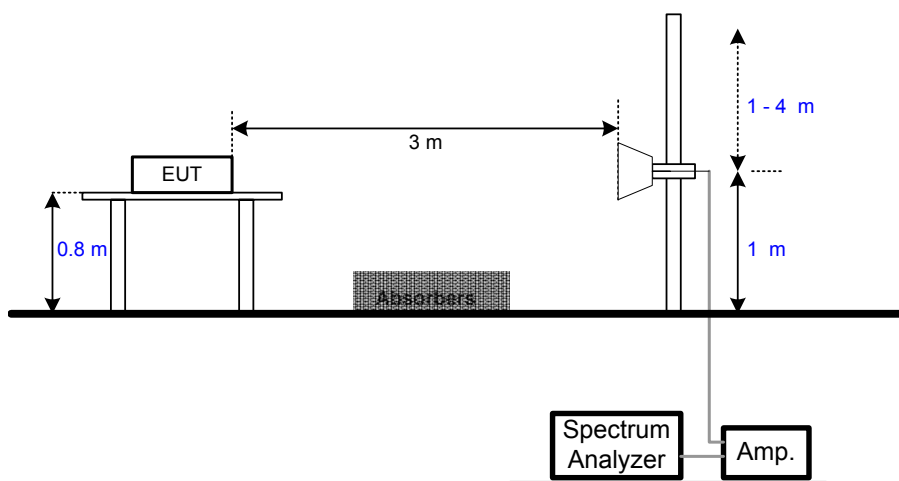
No deviation

#### 4.1.5 TEST SETUP

##### Radiated Emission Test Set-Up Frequency 30 - 1000MHz



##### Radiated Emission Test Set-Up Frequency Above 1 GHz



#### 4.1.6 EUT OPERATING CONDITIONS

The EUT exercise program (EMC.exe) used during radiated and/or conducted emission measurement was designed to exercise the various system components in a manner similar to a typical use. The program contained on a Notebook PC hard disk and is auto-starting on power-up. Once loaded, the program sequentially exercises each system component in turn. The sequence used is:

1. Read (write) from (to) mass storage device (Disk).
2. Send "H" pattern to video port device (LCD Monitor).
3. Send " H " pattern to USB port device (Printer).
4. The EUT send/receive data to/from data port (Automatic Identification System).
5. Repeated from 2 to 4 continuously.





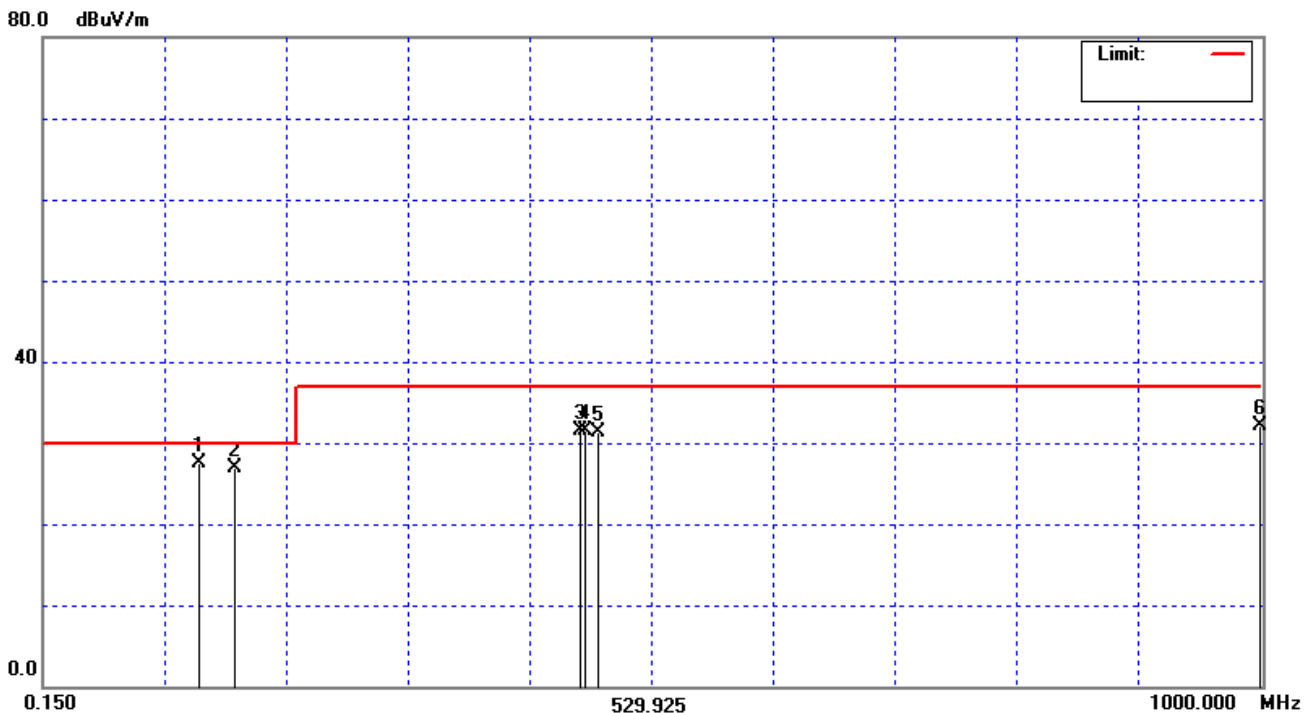
4.1.7 TEST RESULTS-BETWEEN 30MHZ AND 1000MHZ

E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	20°C	Relative Humidity :	86%
Test Voltage :	DC 12V		
Test Mode :	FULL SYSTEM(MANDO-301)		

Freq. (MHz)	Polarization HV	Reading Level (dBuV)	Correct Factor(dB)	Measurement (dBuV/m)	Limit(Quasi-Peak) (dBuV/m)	Margin (dB)	Note
127.4200	V	32.99	-5.52	27.47	30.00	- 2.53	
156.4700	V	31.23	-4.39	26.84	30.00	- 3.16	
440.8400	V	31.73	-0.18	31.55	37.00	- 5.45	
445.6400	V	31.54	-0.01	31.53	37.00	- 5.47	
455.1400	V	31.06	0.20	31.26	37.00	- 5.74	
1000.0000	V	22.34	9.67	32.01	37.00	- 4.99	

Remark :

- (1) Reading in which marked as QP or Peak means measurements by using are Quasi-Peak Mode or Peak Mode with Detector BW=120 kHz; SPA setting in RBW=120 kHz, VBW =120 kHz, Swp. Time = 0.3 sec./ MHz.
- (2) All readings are Peak unless otherwise stated QP in column of Note. Peak denotes that the Peak reading compliance with the QP Limits and then QP Mode measurement didn't perform.
- (3) Measuring frequency range from 30 MHz to 1000 MHz.
- (4) If the peak scan value is under the limit for more than 20dB, the signal will not show in table.



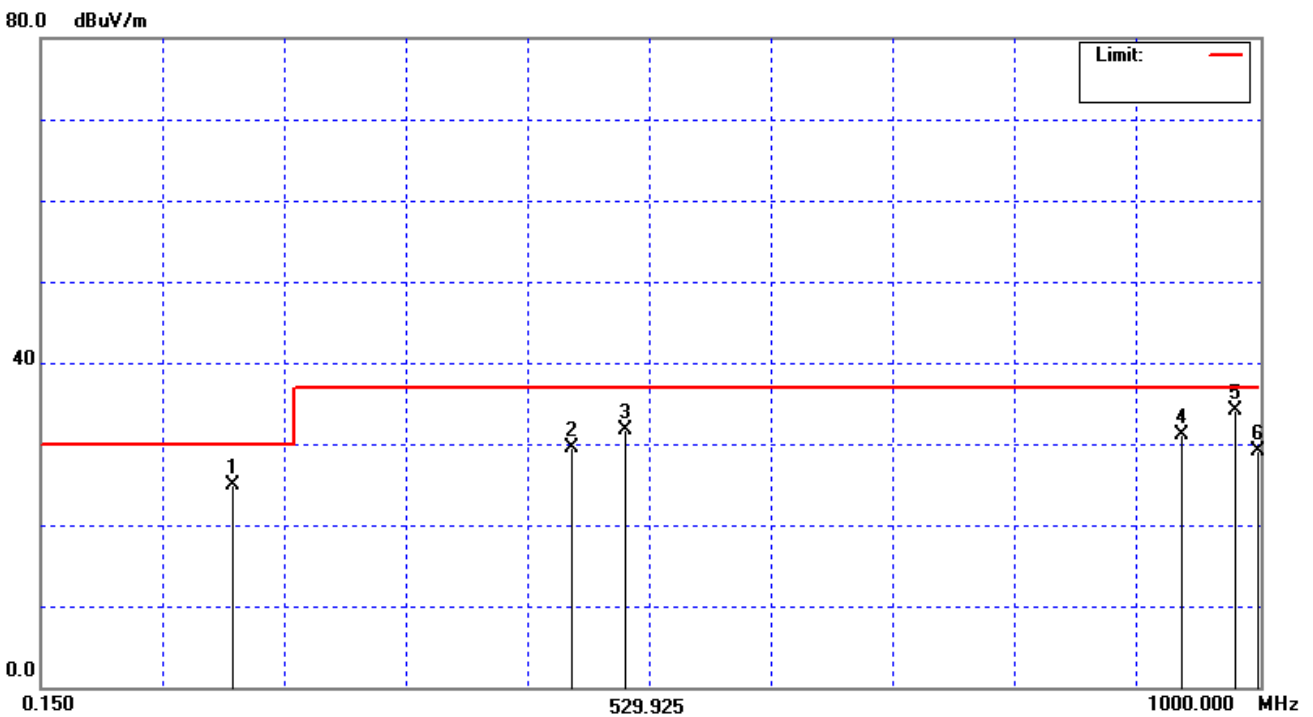


E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	20°C	Relative Humidity :	86%
Test Voltage :	DC 12V		
Test Mode :	FULL SYSTEM(MANDO-301)		

Freq. (MHz)	Polarization H/V	Reading Level (dBuV)	Correct Factor(dB)	Measurement (dBuV/m)	Limit(Quasi-Peak) (dBuV/m)	Margin (dB)	Note
156.3000	H	29.30	-4.40	24.90	30.00	- 5.10	
435.8900	H	29.83	-0.35	29.48	37.00	- 7.52	
479.1920	H	31.10	0.51	31.61	37.00	- 5.39	
936.5840	H	22.29	8.73	31.02	37.00	- 5.98	
981.0200	H	24.75	9.45	34.20	37.00	- 2.80	
1000.0000	H	19.48	9.67	29.15	37.00	- 7.85	

Remark :

- (1) Reading in which marked as QP or Peak means measurements by using are Quasi-Peak Mode or Peak Mode with Detector BW=120 kHz; SPA setting in RBW=120 kHz, VBW =120 kHz, Swp. Time = 0.3 sec./ MHz.
- (2) All readings are Peak unless otherwise stated QP in column of Note. Peak denotes that the Peak reading compliance with the QP Limits and then QP Mode measurement didn't perform.
- (3) Measuring frequency range from 30 MHz to 1000 MHz.
- (4) If the peak scan value is under the limit for more than 20dB, the signal will not show in table.





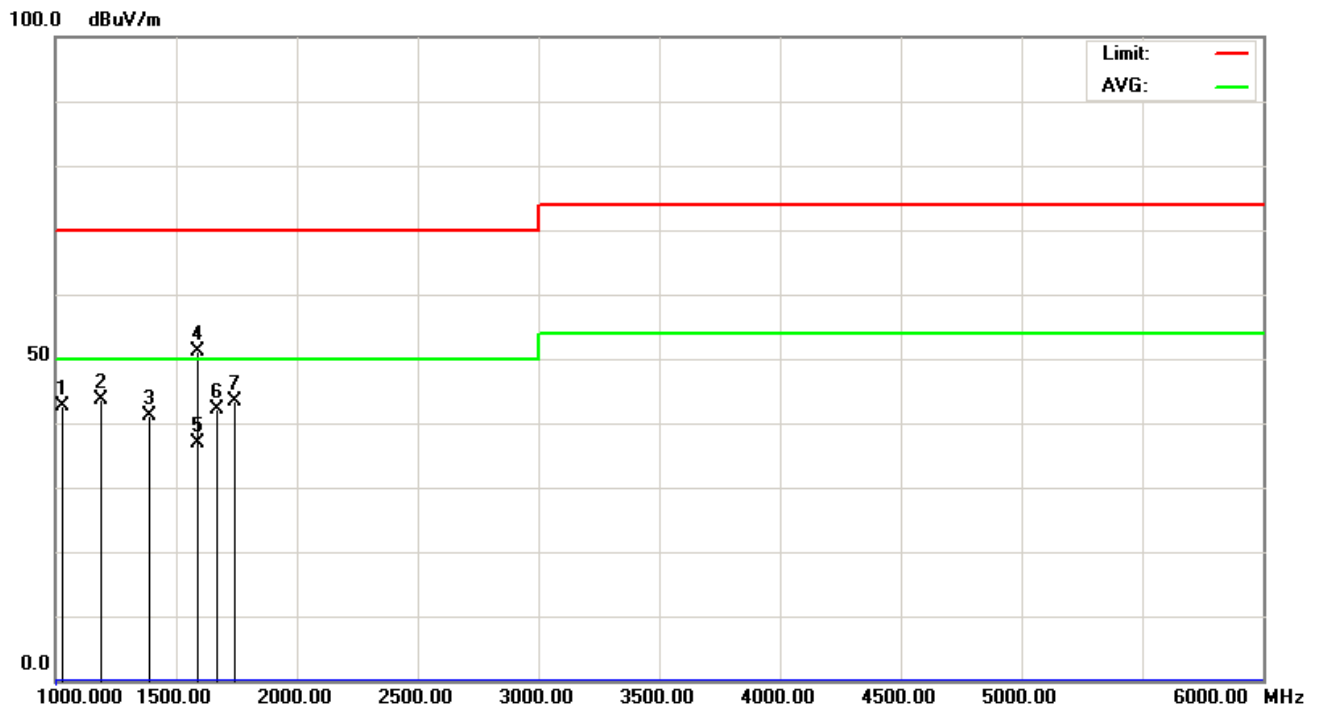
**4.1.8 TEST RESULTS-ABOVE 1000MHZ**

E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	25°C	Relative Humidity :	31%
Test Voltage :	DC 12V		
Test Mode :	FULL SYSTEM(MANDO-301)		

Freq. (MHz)	Polarization H/V	Reading Level(dBuV)		Correct Factor(dB)	Measurement(dBuV/m)		Limit(dBuV/m)		Margin (dB)	Note
		Peak	AV		Peak	AV	Peak	AV		
1030.000	V	51.17	*	-8.45	42.72	*	70.00	50.00	- 27.28	Peak
1190.000	V	51.52	*	-7.85	43.67	*	70.00	50.00	- 26.33	Peak
1390.000	V	48.10	*	-7.09	41.01	*	70.00	50.00	- 28.99	Peak
1590.000	V	57.45	43.22	-6.41	51.04	36.81	70.00	50.00	- 13.19	AV
1670.000	V	48.35	*	-6.17	42.18	*	70.00	50.00	- 27.82	Peak
1740.000	V	49.45	*	-5.96	43.49	*	70.00	50.00	- 26.51	Peak

Remark :

- (1) Reading in which marked as PK means measurements by using are Peak Mode with instrument setting in RBW= 1 MHz, VBW= 1 MHz, Swp. Time = Auto.  
Reading in which marked as AV means measurements by using are Average Mode with instrument setting in RBW= 1 MHz, VBW= 10 Hz, Swp. Time = Auto.
- (2) All readings are PK Mode value unless otherwise stated AVG in column of Note. If the PK Mode Measured value compliance with the PK Limits and lower than AVG Limits, the EUT shall be deemed to meet both PK & AVG Limits and then only PK Mode was measured, but AVG Mode didn't perform. In this case, a " \* " marked in AVG Mode column of Interference Voltage Measured.
- (3) In the "Note" column, Peak means the margin value of Peak is higher than Average and the "Margin" column shows the margin value of Peak; AV means the margin value of Average is higher than Peak and the "Margin" column shows the margin value of Average.



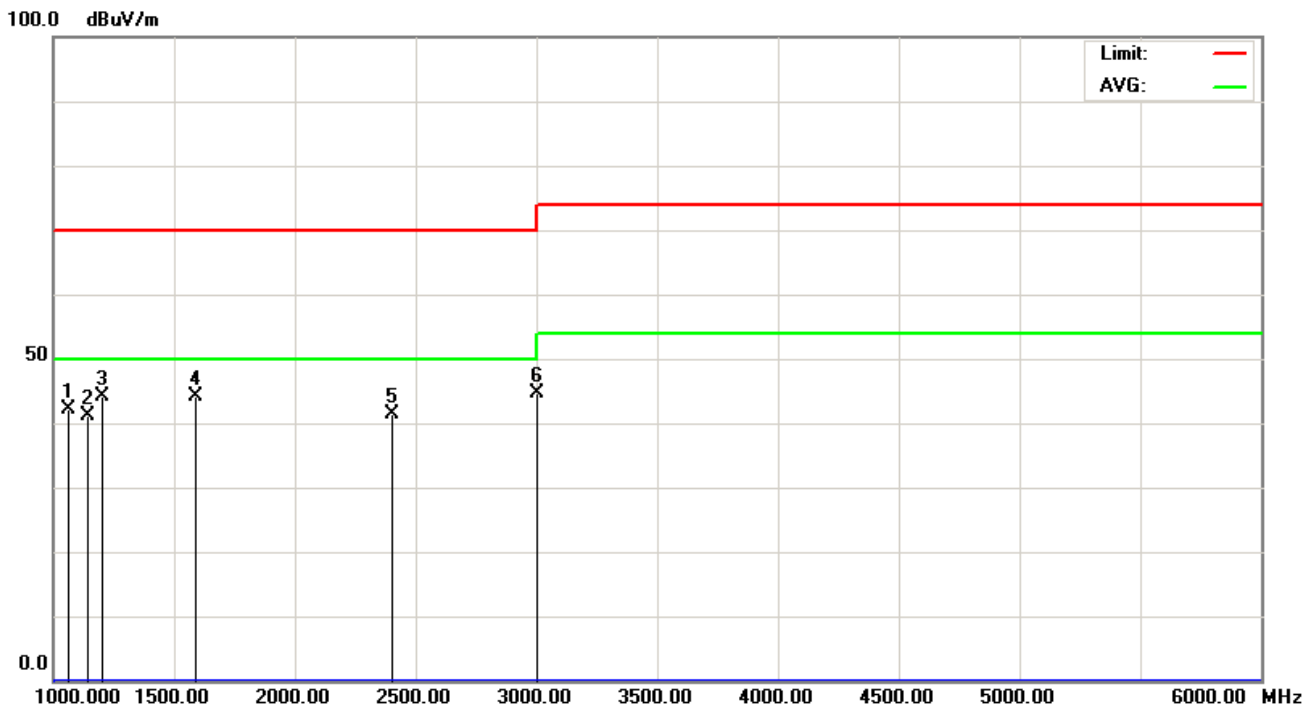


E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	25°C	Relative Humidity :	31%
Test Voltage :	DC 12V		
Test Mode :	FULL SYSTEM(MANDO-301)		

Freq. (MHz)	Polarization H/V	Reading Level(dBuV)		Correct Factor(dB)	Measurement(dBuV/m)		Limit(dBuV/m)		Margin (dB)	Note
		Peak	AV		Peak	AV	Peak	AV		
1060.000	H	50.54	*	-8.33	42.21	*	70.00	50.00	- 27.79	Peak
1140.000	H	49.18	*	-8.03	41.15	*	70.00	50.00	- 28.85	Peak
1200.000	H	51.86	*	-7.81	44.05	*	70.00	50.00	- 25.95	Peak
1590.000	H	50.54	*	-6.41	44.13	*	70.00	50.00	- 25.87	Peak
2400.000	H	45.18	*	-3.78	41.40	*	70.00	50.00	- 28.60	Peak
3000.000	H	46.78	*	-2.21	44.57	*	70.00	50.00	- 25.43	Peak

Remark :

- (1) Reading in which marked as PK means measurements by using are Peak Mode with instrument setting in RBW= 1 MHz, VBW= 1 MHz, Swp. Time = Auto.  
Reading in which marked as AV means measurements by using are Average Mode with instrument setting in RBW= 1 MHz, VBW= 10 Hz, Swp. Time = Auto.
- (2) All readings are PK Mode value unless otherwise stated AVG in column of Note. If the PK Mode Measured value compliance with the PK Limits and lower than AVG Limits, the EUT shall be deemed to meet both PK & AVG Limits and then only PK Mode was measured, but AVG Mode didn't perform. In this case, a " \* " marked in AVG Mode column of Interference Voltage Measured.
- (3) In the "Note" column, Peak means the margin value of Peak is higher than Average and the "Margin" column shows the margin value of Peak; AV means the margin value of Average is higher than Peak and the "Margin" column shows the margin value of Average.





**5. EMC IMMUNITY TEST**

**5.1 STANDARD COMPLIANCE/SERVIRITY LEVEL/CRITERIA**

Tests Standard No.	TEST SPECIFICATION Level	Test Mode Test Ports	Perform. Criteria	Remark
1. ESD IEC/EN 61000-4-2	8 kV air discharge 4 kV contact discharge	Direct Mode	B	
	4 kV HCP discharge 4 kV VCP discharge	Indirect Mode	B	
2. RS IEC/EN 61000-4-3	80 MHz - 1000 MHz & 1400 MHz - 2700 MHz 3 V/m(rms), 1 kHz, 80%, AM modulated	Enclosure	A	
3. EFT/Burst IEC/EN 61000-4-4	1.0kV(peak) 5/50ns Tr/Th 5 kHz Repetition Freq.	Power Supply Port	B	
	0.5 kV(peak) 5/50ns Tr/Th 5 kHz Repetition Freq.	CTL/Signal Data Line Port	B	
4 Injected Current IEC/EN 61000-4-6	0.15 MHz to 80 MHz 3V(rms), 1 kHz 80%, AM Modulated 150Ω source impedance	CTL/Signal Port	A	
		AC Power Port	A	N/A
		DC Power Port	A	

\* Remark:

N/A : denotes test is not applicable in this Test Report



**5.2 GENERAL PERFORMANCE CRITERIA**

According to ETSI EN 301 489-3 standard, the general performance criteria as following:

<b>Class 1 SRD Equipment</b>		
<b>Criteria</b>	<b>During Test</b>	<b>After Test</b>
<b>Criteria A</b>	Operate as intended. No loss of function. For equipment type II the minimum performance shall be 12 dB SINAD. No unintentional responses.	Operate as intended. No loss of function. For equipment type II the communication link shall be maintained. No degradation of performance. No loss of stored data or user programmable functions.
<b>Criteria B</b>	May be loss of function (one or more). No unintentional responses.	Operate as intended. Lost function(s) shall be self-recoverable. No degradation of performance. No loss of stored data or user programmable functions.
<b>Class 2 SRD Equipment</b>		
<b>Criteria</b>	<b>During Test</b>	<b>After Test</b>
<b>Criteria A</b>	Operate as intended. No loss of function. For equipment type II the minimum performance shall be 12 dB SINAD. No unintentional responses.	Operate as intended. No loss of function. For equipment type II the communication link shall be maintained. No degradation of performance. No loss of stored data or user programmable functions.
<b>Criteria B</b>	May be loss of function (one or more). No unintentional responses.	Operate as intended. Lost function(s) shall be self-recoverable. No degradation of performance. No loss of stored data or user programmable functions.
<b>Class 3 SRD Equipment</b>		
<b>Criteria</b>	<b>During Test</b>	<b>After Test</b>
<b>Criteria A, B</b>	May be loss of function (one or more). No unintentional responses.	Operate as intended. For equipment type II the communication link may be lost, but shall be recoverable by user. No degradation of performance. Lost function(s) shall be self-recoverable.

**5.3 THE REQUIREMENT OF PERFORMANCE CRITERIA**

1.	Performance criteria for continuous phenomena applied to transmitters (CT)	Criterion A of the applicable class shall apply
2.	Performance criteria for transient phenomena applied to transmitters (TT)	Criterion B of the applicable class shall apply
3.	Performance criteria for continuous phenomena applied to receivers (CR)	Criterion A of the applicable class shall apply
4.	Performance criteria for transient phenomena applied to transmitters (TR)	Criterion B of the applicable class shall apply



**5.4 GENERAL PERFORMANCE CRITERIA TEST SETUP**

The EUT tested system was configured as the statements of **4.1.6** Unless otherwise a special operating condition is specified in the follows during the testing.



5.5 ESD TESTING

5.5.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-2
Discharge Impedance:	330 ohm / 150 pF
Required Performance	B
Discharge Voltage:	Air Discharge : 2 kV / 4 kV / 8 kV (Direct) Contact Discharge : 2 kV / 4 kV (Direct/Indirect)
Polarity:	Positive & Negative
Number of Discharge:	Air Discharge: min. 20 times at each test point Contact Discharge: min. 200 times in total
Discharge Mode:	Single Discharge
Discharge Period:	1 second minimum

5.5.2 MEASUREMENT INSTRUMENTS

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	ESD Simulator	TESEQ	NSG 437	429	Apr. 05. 2012

Remark: " N/A" denotes No Model Name / Serial No. and No Calibration specified.

5.5.3 TEST PROCEDURE

The test generator necessary to perform direct and indirect application of discharges to the EUT in the following manner:

- a. Contact discharge was applied to conductive surfaces (Direct) and coupling planes (Indirect) of the EUT.

During the test, it was performed with single discharges. For the single discharge time between successive single discharges was at least 1 second. The EUT shall be exposed to at least 200 discharges, 100 each at negative and positive polarity, at a minimum of four test points. One of the test points shall be subjected to at least 50 indirect discharges to the center of the front edge of the horizontal coupling plane. The remaining three test points shall each receive at least 50 direct contact discharges.

If no direct contact test points are available, then at least 200 indirect discharges shall be applied in the indirect mode. Test shall be performed at a maximum repetition rate of one discharge per second.

Vertical Coupling Plane (VCP):

The coupling plane, of dimensions 0.5m x 0.5m, is placed parallel to, and positioned at a distance 0.1m from, the EUT, with the Discharge Electrode touching the coupling plane.

The four faces of the EUT will be performed with electrostatic discharge.

Horizontal Coupling Plane (HCP):

The coupling plane is placed under to the EUT. The generator shall be positioned vertically at a distance of 0.1m from the EUT, with the Discharge Electrode touching the coupling plane.

The four faces of the EUT will be performed with electrostatic discharge.

- b. Air discharges at insulation surfaces of the EUT.

It was at least ten single discharges with positive and negative at the same selected point.

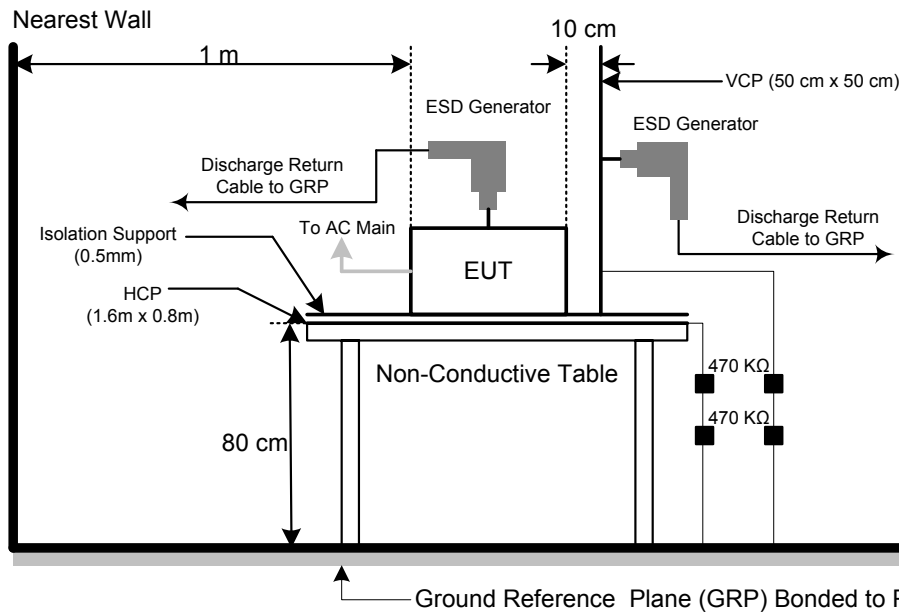
- c. For the actual test configuration, please refer to the related Item –EUT Test Photos.



**5.5.4 DEVIATION FROM TEST STANDARD**

No deviation

**5.5.5 TEST SETUP**



Note:

**TABLE-TOP EQUIPMENT**

The configuration consisted of a wooden table 0.8 meters high standing on the Ground Reference Plane. The GRP consisted of a sheet of aluminum at least 0.25mm thick, and 2.5 meters square connected to the protective grounding system. A Horizontal Coupling Plane (1.6m x 0.8m) was placed on the table and attached to the GRP by means of a cable with 940k total impedance. The equipment under test, was installed in a representative system as described in section 7 of IEC /EN 61000-4-2, and its cables were placed on the HCP and isolated by an insulating support of 0.5mm thickness. A distance of 1-meter minimum was provided between the EUT and the walls of the laboratory and any other metallic structure.

**FLOOR-STANDING EQUIPMENT**

The equipment under test was installed in a representative system as described in section 7 of IEC/EN 61000-4-2, and its cables were isolated from the Ground Reference Plane by an insulating support of 0.1-meter thickness. The GRP consisted of a sheet of aluminum that is at least 0.25mm thick, and 2.5 meters square connected to the protective grounding system and extended at least 0.5 meters from the EUT on all sides.



**5.5.6 TEST RESULTS**

E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	22°C	Relative Humidity :	45%
Pressure :	1025 hPa	Test Voltage :	DC 12V
Test Mode :	FULL SYSTEM(MANDO-301)		

Mode	Air Discharge								Contact Discharge							
	2 kV		4 kV		8 kV		15 kV		2 kV		4 kV		6 kV		8 kV	
Location	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N
1	A	A	A	A	A	A			A	A	A	A				
2	A	A	A	A	A	A			A	A	A	A				
3	A	A	A	A	A	A			A	A	A	A				
4									A	A	A	A				
5									A	A	A	A				
6									A	A	A	A				
7									A	A	A	A				
8									A	A	A	A				
9									A	A	A	A				
10									A	A	A	A				
11									A	A	A	A				
12									A	A	A	A				
13									A	A	A	A				
14									A	A	A	A				
15									A	A	A	A				
16									A	A	A	A				
17									A	A	A	A				
18									A	A	A	A				
19									A	A	A	A				
20									A	A	A	A				
21									A	A	A	A				
22									A	A	A	A				
23									A	A	A	A				
24									A	A	A	A				
Criteria	<b>B</b>								<b>B</b>							
Result	<b>A</b>								<b>A</b>							
Judgment	<b>PASS</b>								<b>PASS</b>							

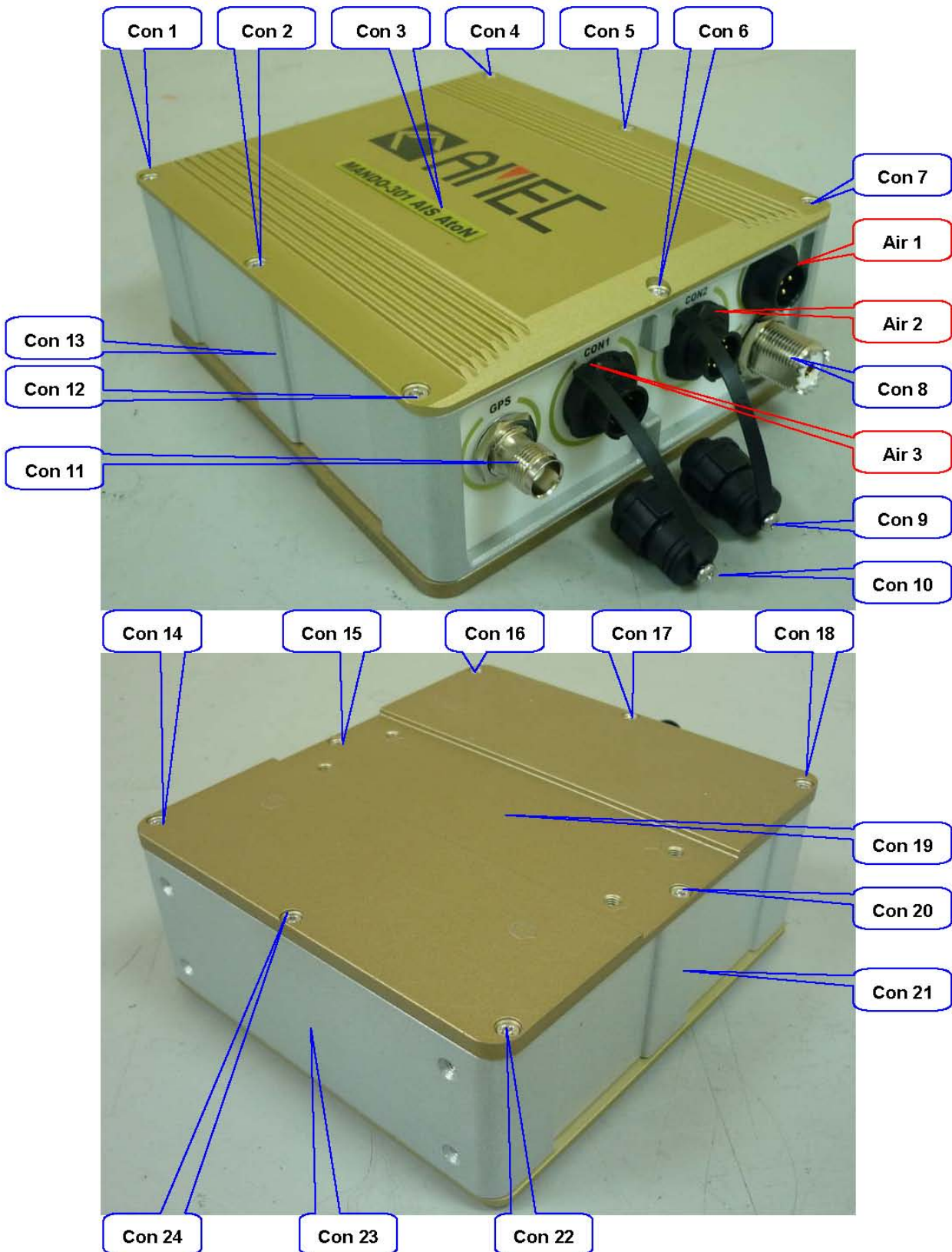


Mode	HCP Discharge								VCP Discharge							
	2 kV		4 kV		6 kV		8 kV		2 kV		4 kV		6 kV		8 kV	
Location	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N
1	A	A	A	A					A	A	A	A				
2	A	A	A	A					A	A	A	A				
3	A	A	A	A					A	A	A	A				
4	A	A	A	A					A	A	A	A				
Criteria	<b>B</b>								<b>B</b>							
Result	<b>A</b>								<b>A</b>							
Judgment	<b>PASS</b>								<b>PASS</b>							

**Note:**

- 1) P/N denotes the Positive/Negative polarity of the output voltage.
- 2) Test condition:  
Direct / Indirect (HCP/VCP) discharges: Minimum 25 times (Positive/Negative) at each point. Air discharges: Minimum 10 times (Positive/Negative) at each point.
- 3) Test location(s) in which discharge (Air and contact discharge) to be applied illustrated by photos shown in next page(s)
- 4) The Indirect (HCP/VCP) discharges description of test point as following:  
1.left side 2.right side 3.front side 4.rear side
- 5) N/A - denotes test is not applicable in this test report
- 6) Criteria A: There was no change operated with initial operating during the test.
- 7) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
- 8) Criteria C: The system shut down during the test.

5.5.7 PHOTO(S) SHOWN THE LOCATION(S) OF ESD EVALUATED





5.6 RS TESTING

5.6.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-3
Required Performance	A
Frequency Range:	80 MHz - 1000 MHz & 1400MHz - 2700MHz
Field Strength:	3 V/m
Modulation:	1 kHz Sine Wave, 80%, AM Modulation
Frequency Step:	1% of fundamental
Polarity of Antenna:	Horizontal and Vertical
Test Distance:	3 m
Antenna Height:	1.5 m
Dwell Time:	at least 3 seconds

5.6.2 MEASUREMENT INSTRUMENTS

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Signal Generator	R&S	SMT06	832080/007	Aug. 2, 2011
2	Log-Bicon Antenna	Schwarzbeck	VULB 9161	4022	Jun. 03, 2012
3	Power Amplifier	AR	150W1000M1	320946	Jun. 03, 2012
4	Microwave Horn Antenna	AR	AT4002A	321467	Jun. 03, 2012
5	Power Amplifier	AR	25S1G4A	308598	Jun. 03, 2012
6	Measurement Software	AR	SW1006 (Version 1.22)	321779	N/A

Remark: " N/A" denotes No Model Name / Serial No. and No Calibration specified.

5.6.3 TEST PROCEDURE

The EUT and support equipment, which are placed on a table that is 0.8 meter above ground and the testing was performed in a fully-anechoic chamber.

The testing distance from antenna to the EUT was 3 meters.

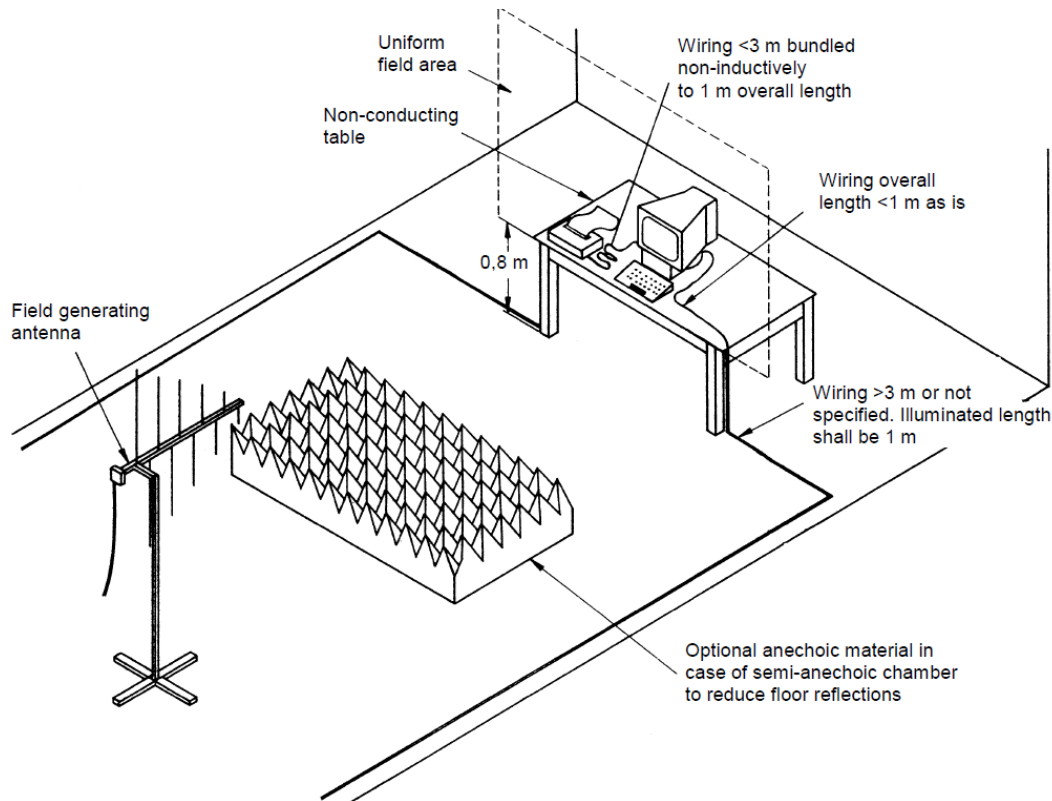
The other condition as following manner:

- a. The field strength level was 3 V/m.
- b. The frequency range is swept from 80 MHz to 1000 MHz and 1400MHz - 2700MHz, with the signal 80%amplitude modulated with a 1kHz sine wave. The rate of sweep did not exceed 1.5x 10<sup>-3</sup> decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.
- c. Sweep Frequency 900 MHz, with the Duty Cycle:1/8 and Modulation: Pulse 217 Hz(if applicable)
- d. The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.
- e. The test was performed with the EUT exposed to both vertically and horizontally polarized fields on each of the four sides.
- f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

5.6.4 DEVIATION FROM TEST STANDARD

No deviation

**5.6.5 TEST SETUP**



**Note:**

**TABLE-TOP EQUIPMENT**

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive table 0.8 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

**FLOOR-STANDING EQUIPMENT**

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive wood support 0.1 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.



**5.6.6 TEST RESULTS**

E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	22°C	Relative Humidity :	45%
Test Voltage :	DC 12V		
Test Mode :	FULL SYSTEM(MANDO-301)		

Frequency Range (MHz)	RF Field Position	R.F. Field Strength	Azimuth	Perform . Criteria	Results	Judgme nt
80 - 1000	H / V	3 V/m (rms) AM Modulated 1 kHz, 80%	0	<b>A</b>	<b>A</b>	<b>PASS</b>
			90			
			180			
			270			

Frequency Range (MHz)	RF Field Position	R.F. Field Strength	Azimuth	Perform . Criteria	Results	Judgme nt
1400 - 2700	H / V	3 V/m (rms) AM Modulated 1 kHz, 80%	0	<b>A</b>	<b>A</b>	<b>PASS</b>
			90			
			180			
			270			

**Note:**

- 1) P/N denotes the Positive/Negative polarity of the output voltage.
- 2) N/A - denotes test is not applicable in this test report.
- 3) Criteria A: There was no change operated with initial operating during the test.
- 4) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
- 5) Criteria C: The system shut down during the test.





5.7 EFT/BURST TESTING

5.7.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-4
Required Performance	B
Test Voltage :	Power Line: 1 kV Signal/Control Line: 0.5 kV
Polarity:	Positive & Negative
Impulse Frequency:	5 kHz
Impulse Wave shape :	5/50 ns
Burst Duration:	15 ms
Burst Period:	300 ms
Test Duration:	Not less than 1 min.

5.7.2 MEASUREMENT INSTRUMENTS

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	EMC Immunity Test System	Thermo	EMCPRO PLUS	0502176	Mar. 9, 2012
2	Capacitive Clamp	Thermo	CCL	0502218	N/A
3	Measurement Software	KeyTek	CEWare32 (Version 4.00)	N/A	N/A

Remark: " N/A" denotes No Model Name / Serial No. and No Calibration specified.

5.7.3 TEST PROCEDURE

The EUT and support equipment(s) are placed on a table that is 0.8 meter high above a metal ground plane and should be located 0.1 m+/- 0.01m high above the Ground Reference Plane (1m\*1m min. and 0.65mm thick min).

The other condition as following manner:

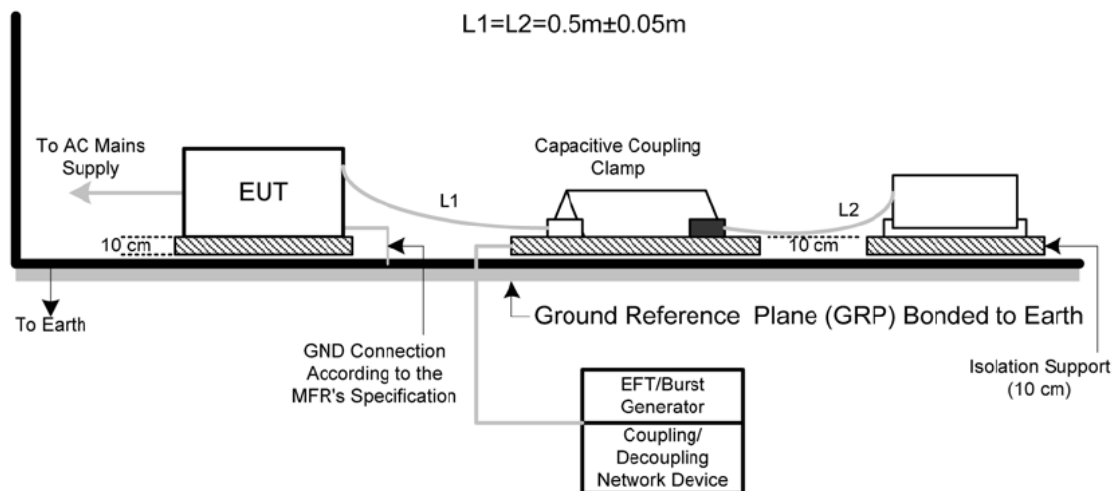
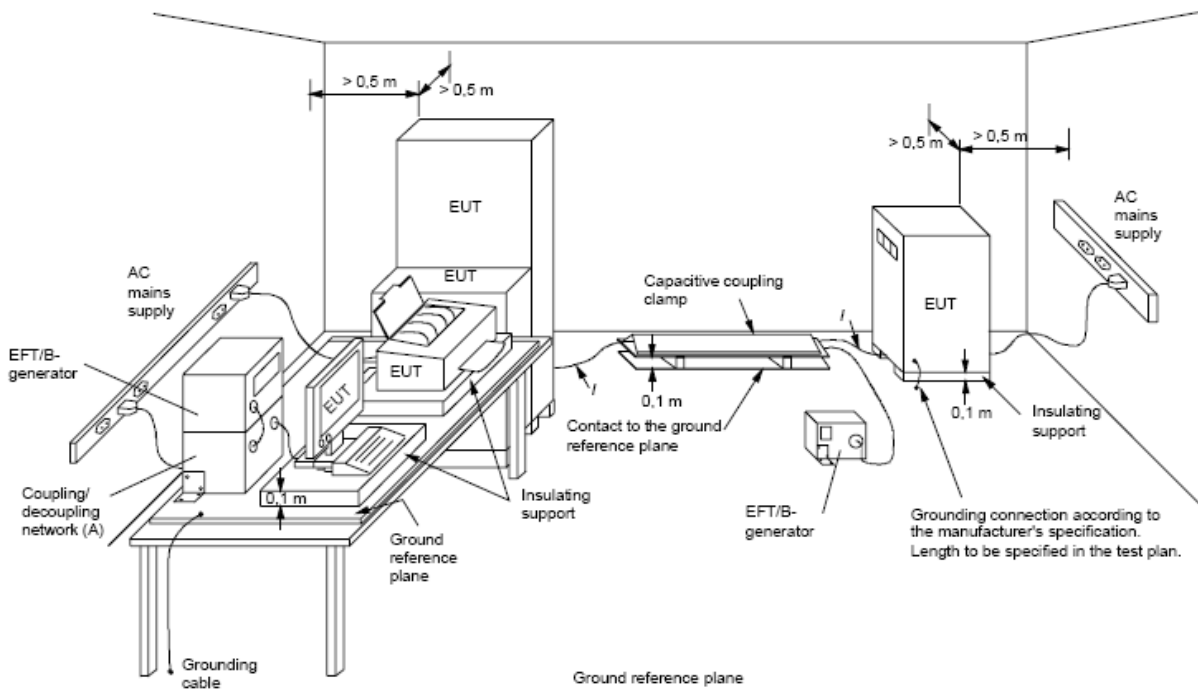
- a. The length of power cord between the coupling device and the EUT should not exceed 1 meter.
- b. Both positive and negative polarity discharges were applied.
- c. The duration time of each test sequential was 1 minute
- d. For the actual test configuration, please refer to the related Item –EUT Test Photos.

5.7.4 DEVIATION FROM TEST STANDARD

No deviation



**5.7.5 TEST SETUP**



Note:

**TABLE-TOP EQUIPMENT**

The configuration consisted of a wooden table (0.8m high) standing on the Ground Reference Plane and should be located 0.1 m+/- 0.01m above the Ground Reference Plane. The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5m square) connected to the protective grounding system. A minimum distance of 0.5m was provided between the EUT and the walls of the laboratory or any other metallic structure.

**FLOOR-STANDING EQUIPMENT**

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-4 and its cables, were isolated from the Ground Reference Plane by an insulating support that is 0.1-meter thick. The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5m square) connected to the protective grounding system.



**5.7.6 TEST RESULTS**

E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	22°C	Relative Humidity :	45%
Test Voltage :	DC 12V		
Test Mode :	FULL SYSTEM(MANDO-301)		

Mode	( ) AC Power Line		( X ) DC Power Line		( X ) Signal/Control Line	
Test Level	1kV		0.5kV		0.5kV	
Port(s)	Polarity	Results	Polarity	Results	Polarity	Results
Line (L)	P		P	A	P	
	N		N	A	N	
Neutral (N)	P		P	A	P	
	N		N	A	N	
Ground (PE)	P		P	N/A	P	
	N		N	N/A	N	
Signal/Control Line	P		P		P	A
	N		N		N	A
Criteria	<b>B</b>		<b>B</b>		<b>B</b>	
Result	<b>N/A</b>		<b>A</b>		<b>A</b>	
Judgment	<b>N/A</b>		<b>PASS</b>		<b>PASS</b>	

Note:

- 1) P/N denotes the Positive/Negative polarity of the output voltage.
- 2) N/A - denotes test is not applicable in this test report
- 3) Criteria A: There was no change operated with initial operating during the test.
- 4) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
- 5) Criteria C: The system shut down during the test.
- 6) For DC input, L means positive pole & N means negative pole



5.8 INJECTION CURRENT TESTING

5.8.1 TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-6
Required Performance	A
Frequency Range:	0.15 MHz - 80 MHz
Field Strength:	3 Vr.m.s.
Modulation:	1 kHz Sine Wave, 80%, AM Modulation
Frequency Step:	1% of fundamental
Dwell Time:	at least 3 seconds

5.8.2 MEASUREMENT INSTRUMENTS

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Signal Generator	IFR	2023A	202301/368	Apr. 06, 2012
2	Power Amplifier	AR	75A250AM1	0320709	Sep. 22, 2011
3	EM Clamp	FCC	F-203I-23MM	504	Jun. 14, 2011
4	CDN(M2)	FCC	FCC-801-M2/M3-16A	100266	May. 18, 2013
5	50Ω BNC TYPE Terminator	N/A	N/A	08	Jun. 01, 2013
6	Measurement Software	AR	SW1006 (Version 1.13)	321778	N/A

Remark: " N/A" denotes No Model Name / Serial No. and No Calibration specified.

5.8.3 TEST PROCEDURE

The EUT and support equipment, are placed on a table that is 0.8 meter above a metal ground plane measured 1m\*1m min. and 0.65mm thick min.

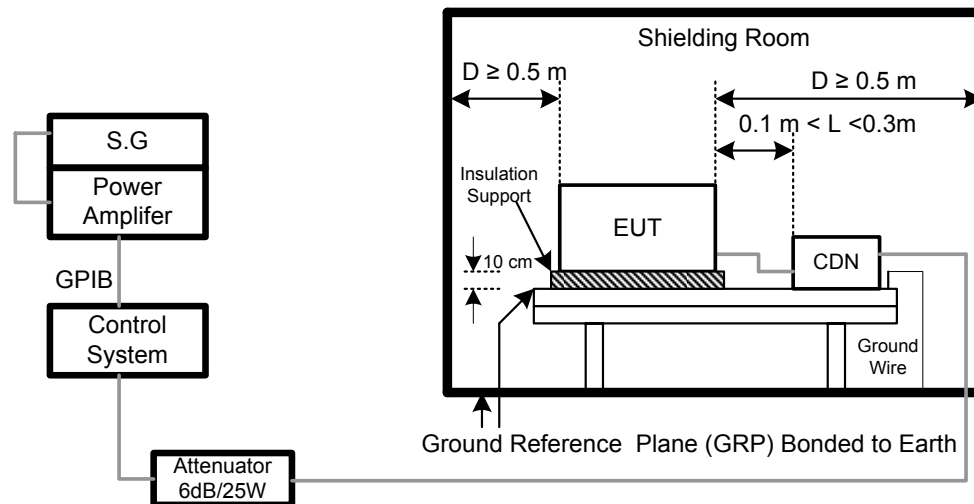
The other condition as following manner:

- a. The field strength level was 3V.
- b. The frequency range is swept from 150 kHz to 80 MHz, with the signal 80%amplitude modulated with a 1 kHz sine wave. The rate of sweep did not exceed 1.5x 10-3 decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.
- c. The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.
- d. For the actual test configuration, please refer to the related Item –EUT Test Photos.

5.8.4 DEVIATION FROM TEST STANDARD

No deviation

### 5.8.5 TEST SETUP



For the actual test configuration, please refer to the related Item –EUT Test Photos.

**NOTE:**

**FLOOR-STANDING EQUIPMENT**

The equipment to be tested is placed on an insulating support of 0.1 meters height above a ground reference plane. All relevant cables shall be provided with the appropriate coupling and decoupling devices at a distance between 0.1 meters and 0.3 meters from the projected geometry of the EUT on the ground reference plane.



**5.8.6 TEST RESULTS**

E.U.T :	AIS Aids to Navigation (AtoN)	Model Name :	MANDO-301
Temperature :	22°C	Relative Humidity :	45%
Test Voltage :	DC 12V		
Test Mode :	FULL SYSTEM(MANDO-301)		

Test Ports (Mode)	Freq. Range ( MHz)	Field Strength	Perform. Criteria	Results	Judgment
Input/ Output AC. Power Port	0.15 - 80	3V(rms) AM Modulated 1000Hz, 80%	A	N/A	N/A
Input/ Output DC. Power Port			A	A	PASS
Signal Line (Data)			A	A	PASS
Signal Line (RS-232)			A	A	PASS
Signal Line (ANT)			A	A	PASS

**Note:**

- 1) N/A - denotes test is not applicable in this Test Report.
- 2) Criteria A: There was no change operated with initial operating during the test.
- 3) Criteria B: The EUT function loss during the test, but self-recoverable after the test.
- 4) Criteria C: The system shut down during the test.

**6. EUT TEST PHOTO**

**Radiated Measurement Photos  
BETWEEN 30MHZ AND 1000MHZ**





**Radiated Measurement Photos**

**ABOVE 1000MHZ**

