telefication bv
The Netherlands
Chamber of Commerce
09076358
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telefication

Test report
99475920

based on:
EN 60945, issue 4 : 2002-11

Class A Shipborne AIS equipment
McMurdo
M2

Contents

This report comprises of five modules. The total number of pages exclusive of the pages enclosed in the additional information module is: 78.

Main module

1 Introduction

This report contains the result of tests performed by:

Telefication bv
Edisonstraat 12a
6902 PK Zevenaar
The Netherlands

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Ordering party:

Company name	:	McMurdo Ltd
Address	:	Silver Point, Airpoint Service Road
Zipcode	:	P03 5PB
City/town	:	Portsmouth
Country	:	United Kingdom
Date of order	:	12 August 2003

2 Product

A sample of the following product was submitted for testing:

Product category	:	Universal Automatic Identification System	
Manufacturer	:	McMurdo	
Trade mark	:	McMurdo	
Type designation	:	M2 (complete system)	
Transponder	:	Hardware version	: see hardware list
		Software version	: see software list
		Serial number	: Sample 03
MKD	:	Hardware version	: see hardware list
		Software version	: see software list
		Serial number	: Sample 01

3 Test schedule

The test was carried out at the following locations:

- Telefication, Zevenaar
- Thales, Hengelo (vibration tests only)

The tests were carried out between:

- 5 July 2004 and 4 October 2004

4 Product documentation

For production of this report the following product documentation was used:

Description	**Identification**	**Date**
Installation manual	35-060N, iss.0	27 September 2004
User manual	35-061N	27 September 2004
Block diagram transponder, RF electronics	LM040407176, rev 1.5, sheet No. 1	29 July 2004
Schematics transponder RF electronics	LM040407176, rev 1.5, sheet No. 2 to 10	29 July 2004
Schematics Baseband electronics	LN040407174, rev. 517, sheet 1 to 6	23 April 2004

The above mentioned documentation will be filed at Telefication for a period of 10 years following the issue of this report.

5 Hardware list

The table below shows the release version of hardware at date of testing.

Transponder	Module	Hardware Nr.
	RF pcb	35-421, rev 3.0
	Screw Terminal pcb	35-401, rev 1.0
	Baseband pcb	35-411, rev 3.0
	GPS module	Manf.: U-BLOX, mod.: TIM-LC
MKD	Display PCB	35-201, rev 1.0
	Interconnect pcb	35-211, rev 1.0

6 Software list

The table below shows the software release version of the various processes.

Transponder	Software module	Software file
	System software	Kontiki-032.hex
	FPGA software	Kontiki-fpga014.mcs
MKD	System software	29lv160b, V 0.5.0

7 List of ports

The equipment under test is equipped with the following ports:

Port name	number of ports	Screened cable mandatory	Electrical specification
DC input	1	~~yes~~ / no / ~~na~~	DC voltage 24 volt
VHF antenna	1	yes / ~~no / na~~	Conducted VHF RF
GPS Receiver	1	yes / ~~no / na~~	1.5GHz RF
61162-2 ports: Main, Display, Pilot/Auxiliary , Long range, data/pwr, RTCM, Sensor1, Sensor2, Sensor3, Sensor4	9	yes / ~~no / na~~	RS422, NMEA0183 RTCM104
Alarm Relay output	1	~~yes~~ / no / ~~na~~	Open circuit
--	--	--	--

8 Observations and comments

This test report is complementary to Telefication test report 99475930

The system consists out of 2 parts, the Transponder M2 and the MKD.

All tests were carried out at Telefication except for the vibration tests which were done at the accredited Environmental Competence Centre of Thales BV, Hengelo, the Netherlands.

The environmental class of the presented equipment was determined to be class B (protected).

For the performance check used with the environmental tests, the EUT was set into autonomous mode and tests were carried out as specified in EN61993-2 clause 14.1.1.

For the performance check used with the EMC immunity tests, the EUT was set-up to interrogate an ancillary transponder to send its static information (message nr. 5). The presentation interface of the EUT was monitored for sentences which could indicate loss of performance.
All unexpected behaviour of the EUT was monitored for loss of performance, in particular the following:

1 The reporting rate behaviour of the unit under test
2 The sentences on the Mains PI port of the unit under test, especially
3 for ALR and TXT messages which could indicate loss of performance
4 The sentences output of the ancillary radio to monitor VDM messages from the unit under test;
5 The MKD information displayed;
6 GPS information utilization;
7 The DC power consumption;
8 Undesirable VDL transmissions.

9 Uncertainty of measurement

The reported expanded uncertainty of measurement stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for normal distribution corresponds to a coverage factor probability of approximately 95%.

10 Technical specifications

The applicant supplied the following technical specifications.

Power supply requirements	24 volt DC
Power consumption	55 watt (max)
Default frequencies	AIS-1 : 161.975 MHz AIS-2 : 162.025 MHz DSC : 156.525 MHz (channel 70)
Operating temperature	-15°C to +55°C
Storage temperature	-20°C to +70°C
GNSS receiver	Build-in GPS receiver
AIS/DSC transmitter RF power output	Low power : 2 Watt High Power : 12.5 Watt
Operating frequency range	156.025 - 162.025 MHz
Antenna output impedance (VDL link)	50 Ω
TDMA receiver sensitivity	PER < 10% @ - 107dBm
TDMA channel spacing	12.5 and 25 kHz
TDMA modulation	according ITU-R M.1371 SOTDMA
TDMA data rate	9600 bits/s
Frequency stability VDL link	In conformance with IEC 61993-2
DSC receiver sensitivity	BER $<10^{-4}$ at -107 dBm
DSC frequency range	156.025 - 162.5 MHz
DSC Channel spacing	25 kHz
DSC Modulation and demodulation	AFSK 1300/2100 Hz pre/de-emphasis, modulation index = 2

11 Summary

The product is intended for use in the following application area:

Universal Automatic Identification System

The sample was tested according to the following specifications:

EN 60945, issue 4 : 2002-11:	Clause 7	Excessive conditions
	Clause 8	Environmental
	Clause 9	Electromagnetic emission
	Clause 10	Electromagnetic immunity
	Clause 11	Special purpose
	Clause 12	Safety precautions
	Clause 13	Maintenance
	Clause 15	Marking and identification

Remarks:
No compass safe distance test (11.2) was performed
No corrosion test (8.12) was performed.

12 Conclusions

The sample of the product showed **NO NON-COMPLIANCES** to the specification stated in chapter 11 of this report.

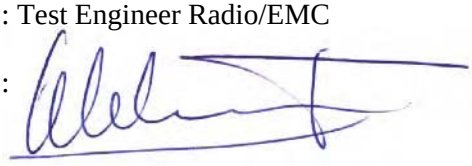
The results of the test as stated in this report are exclusively applicable to the product item as identified in this report. Telefication bv does not accept any responsibility for the results stated in this report, with respect to the properties of product items not involved in these tests.

All tests are performed by:

name : H.H. Lodewijk

function : Test Engineer Radio/EMC

signature :

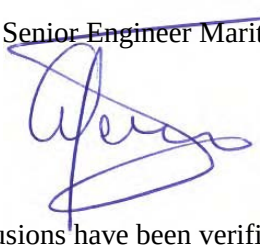


Review of test methods and report by:

name : M.W. Jansen

function : Senior Engineer Maritime

signature :



The above conclusions have been verified by the following signatory:

date : 21 October 2004

name : J.P. van de Poll

function : Co-ordinator Test Group

signature :

Test results module

1 Power supply – Methods of testing and test results according to EN60945 clause 7

1.1 Extreme power supply

EN 60945 reference : 7.1

Environment	Normal power supply	Extreme power supply	Result
Dry heat	Performance test	Performance check	P
Damp heat	Performance check	--	P
Low temperature	Performance test	Performance check	P
Normal temperature	Performance test	Performance test	P

The tests were carried out as specified in clause 8.

1.2 Excessive conditions

EN 60945 reference : 7.2

	Observation of the operational check	Result
a)	The equipment is designed to withstand an excessive voltage of **33 Volt**. During the test, the protection circuitry was activated at a test voltage of **35 Volt**	P
b)	The equipment was exposed to a power supply misconnection (reversed polarity) for the duration of 5 minutes with a voltage of 50 volt. No resetting of protection components was necessary and a confidence check was carried out.	P

1.3 Power supply short-term variation

EN 60945 reference : 7.3

For test results refer to clause 10.7

1.4 Power supply failure

EN 60945 reference : 7.3

For test results refer to clause 10.8

2 Durability and resistance to environmental conditions according to EN60945 clause 8

According to EN 60945:2002 fourth edition the following tests were performed:

Summary

Sub clause	Category	Test	Phenomena	
8.1	a b c d		Pre test and visual inspection	P
8.2	a c d a b c	Storage Functional	Dry heat 70°C Dry heat 55°C	NA P
8.3	a b c	Functional	Damp heat 40°C 95% relative humidity	P
8.4	a a b c	Storage Functional Functional Functional	Low temperature -30°C Low temperature -20°C Low temperature -15°C Low temperature -25°C	NA NA P NA
8.5	A		Thermal shock 70°C -> 25°C	NA
8.6	a a		Drop on hard surface 1.00 m Drop into water 20 m	NA
8.7	a b c d		Vibration 2 - 13.6Hz 1mm, 13.6 - 100Hz 7m/s^2, resonance 2h	P
8.8	C		Rain 100 l/m, 30 minutes	NA
8.9	C		Immersion 600kPa 12h Immersion 100kPa 5min. Temporary immersion 1m 5min.	NA
8.10	A		Solar radiation 1120W/m^2 80h	NA
8.11	a		Oil resistance immersion 3h	NA
8.12	a b c d	Corrosion	Salt mist 5% NaCl 2h -> 40°C 95% humidity 7 days	NP

Category:

a	=	portable	c	=	exposed
b	=	protected	d	=	submerged

P	=	Pass	NA	=	Not applicable
NP	=	Not performed			

2.1 General (8.1)

EN 60945 reference : 8.1

A pre-test was carried out to verify the correct operation of the equipment. A performance check was carried out and the equipment was operational according to the product standard EN 61993-2.

The test software used are listed below:

Test Software	**Version or serial number**	**dated**
Sailsoft, NMEA protocol simulation software	1.7.0	June 2003

2.2 Dry heat functional test

EN 60945 reference : 8.2
Basic standard : IEC 60068-2-2

Temperature : 55°C
Duration : 10-16h
EUT : Transponder unit and MKD unit
Power supply : DC

Power supply variation	**Voltage (V)**	**Result**
Normal Power supply	24	P
High voltage +30%	31.2	P
Low voltage -10%	21.6	P

Comments : The performance check was carried out with the EUT switched on and the EUT was kept operational for sixteen hours. During the performance check the EUT operated in accordance with its equipment standard.

2.3 Damp heat functional test

EN 60945 reference : 8.3
Basic standard : IEC 60068-2-30

Temperature : 40°C
Relative humidity : 95%
Duration : 10-16h
EUT : Transponder unit and MKD unit
Power supply : DC

Power supply variation	**Voltage (V)**	**Result**
Normal Power supply	24	P
High voltage +30%	31.2	P
Low voltage -10%	21.6	P

Comments : The performance check was carried out 30 minutes after the EUT was switched on and the EUT was kept operational for two hours. During the performance check the EUT operated in accordance with its equipment standard.

2.4 Low temperature functional test

EN 60945 reference : 8.4
Basic standard : IEC 60068-2-1

Temperature : -15°C
Duration : 10-16h
EUT : Transponder unit and MKD unit
Power supply : DC

Power supply variation	**Voltage (V)**	**Result**
Normal Power supply	24	P
High voltage +30%	31.2	P
Low voltage -10%	21.6	P

Comments : The performance check was performed with the EUT switched on and the EUT was kept operational for two hours. During the performance test and checks the EUT operated in accordance with its equipment standard.

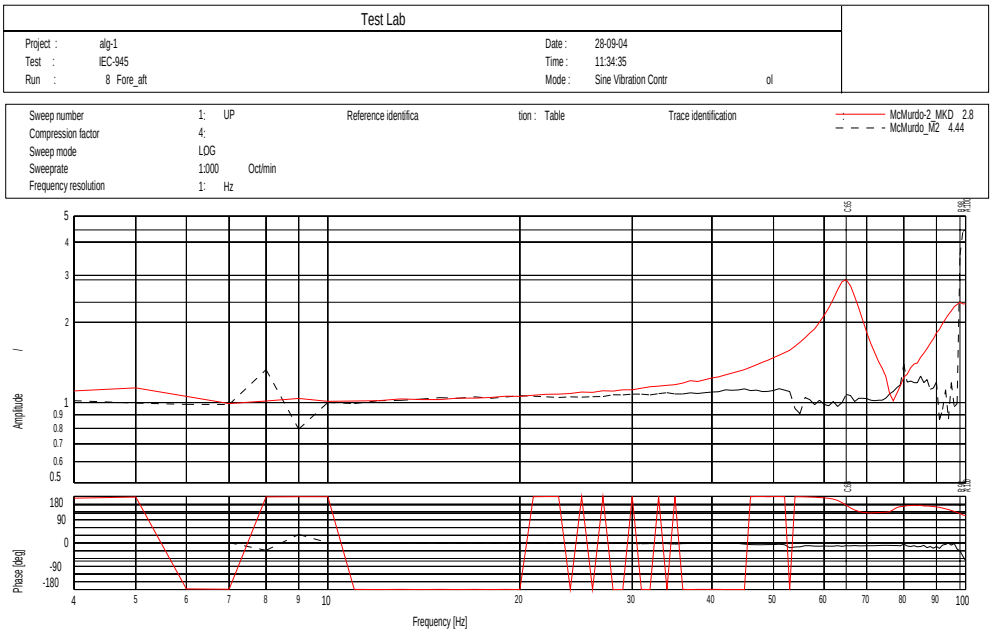
2.5 Vibration

EN 60945 reference : 8.7
Basic standard : IEC 60068-2-6
EUT : Transponder unit and MKD unit
Endurance test : 2 hours at 30 Hz if no resonance (Q>5) occurs

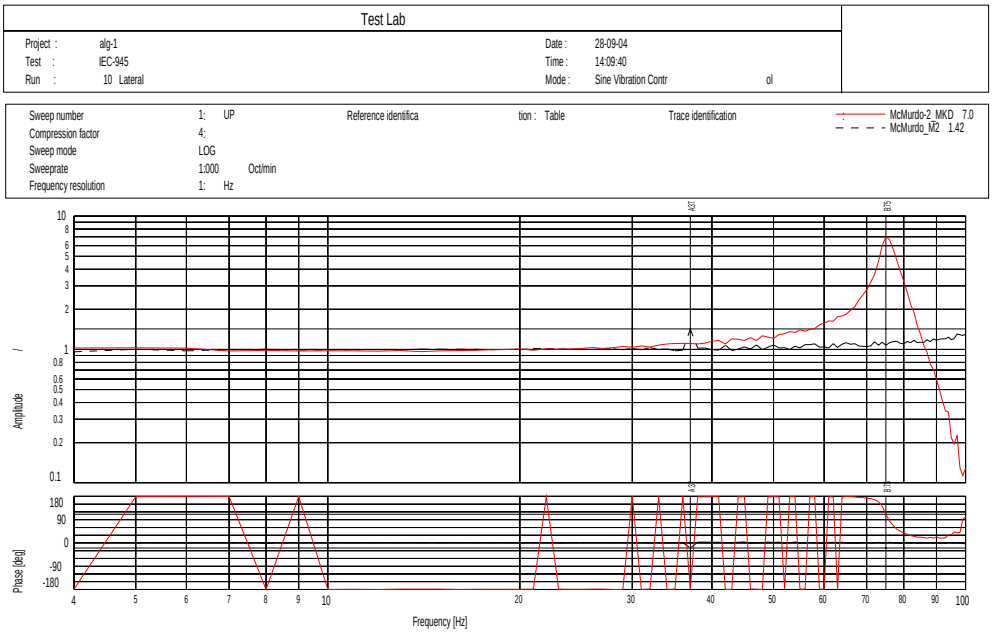
Horizontal vibration direction 1 test					
EUT	Frequency (Hz)	Acceleration table (m/s^2)	Acceleration EUT (m/s^2)	Q	Result
Transponder	5-100	7.0	-	< 5	P
Display	5-100	7.0	-	< 5	P
Horizontal vibration direction 2 test					
EUT	Frequency (Hz)	Acceleration table (m/s^2)	Acceleration EUT (m/s^2)	Q	Result
Transponder	5-100	7.0	-	< 5	P
Display	78	7.0	49	7.0	P
Vertical vibration direction test					
EUT	Frequency (Hz)	Acceleration table (m/s^2)	Acceleration EUT (m/s^2)	Q	Result
Transponder	5-100	7.0	-	< 5	P
Display	5-100	7.0	-	< 5	P

Comments : Performance checks were carried out during each endurance test period and before the end of each endurance period.
There was no degradation of performance during and after the test.
At frequencies where resonance occurred, an endurance test was carried out.
If no resonance occurred than an endurance test was carried out at 30 Hz.
For all test : test time = 2 hours

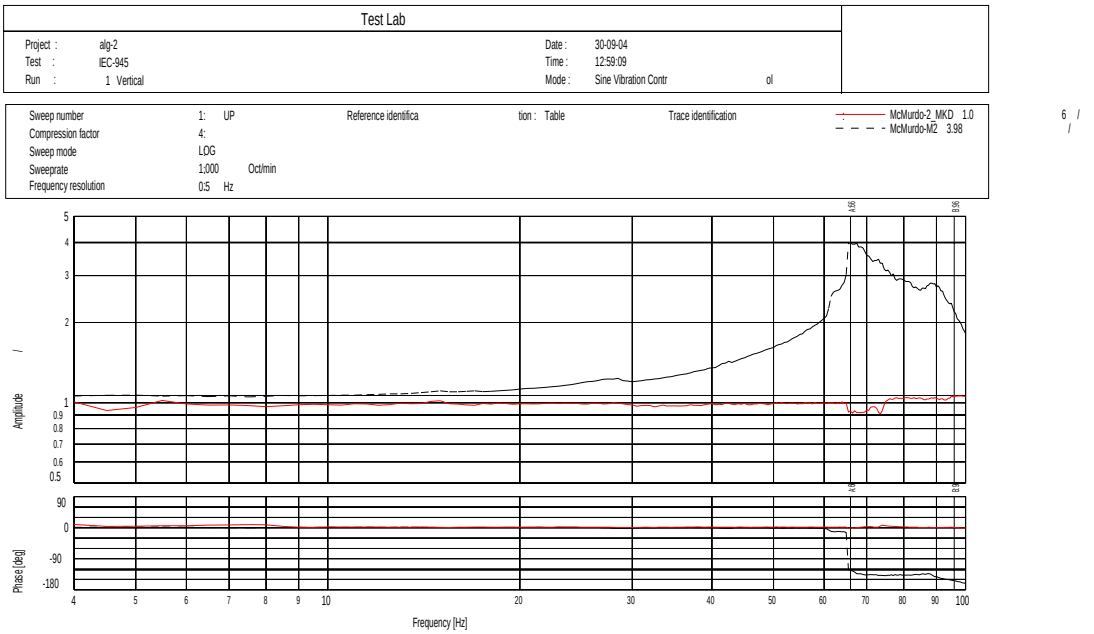
Horizontal direction-1 :



Horizontal direction-2 :



Vertical direction :



Performed vibration test:

Test run No.	Direction	Test frequency	Duration	Comment
1	Horizontal 1	30 Hz	2 h	MKD and transponder
2	Horizontal 2	75 Hz	2 h	MKD
3	Horizontal 2	30 Hz	2 h	Transponder
4	Vertical	30	2 h	MKD and transponder

Test equipment used at vibration testing.
This equipment is the property of Thales BV, Environmental Competence Centre , Hengelo

Item	Type	Manufacturer
Vibration control computer	HP 9000 type 715/64 (software revision 3.8)	Hewlett Packard
Vibration control front-end	Type 35654	Hewlett Packard
Shaker	Type 894-440	Ling Dynamic
Acceleration sensor	Type 4384	Brüel & Kjaer
Amplifier	Type 5011	Kistler

3 Electromagnetic emission clause 9

3.1 Summary

According to EN 60945 :2002 the following tests were performed:

Port	Sub clause	Category	Phenomenon	Result
DC-input	9.2	b c d	Conducted emissions	P
AC-input	9.2	b c d	Conducted emissions	NA
Enclosure	9.3	a b c	Radiated emissions	P

Result:
P = pass NA = not applicable
F = fail NP = not performed

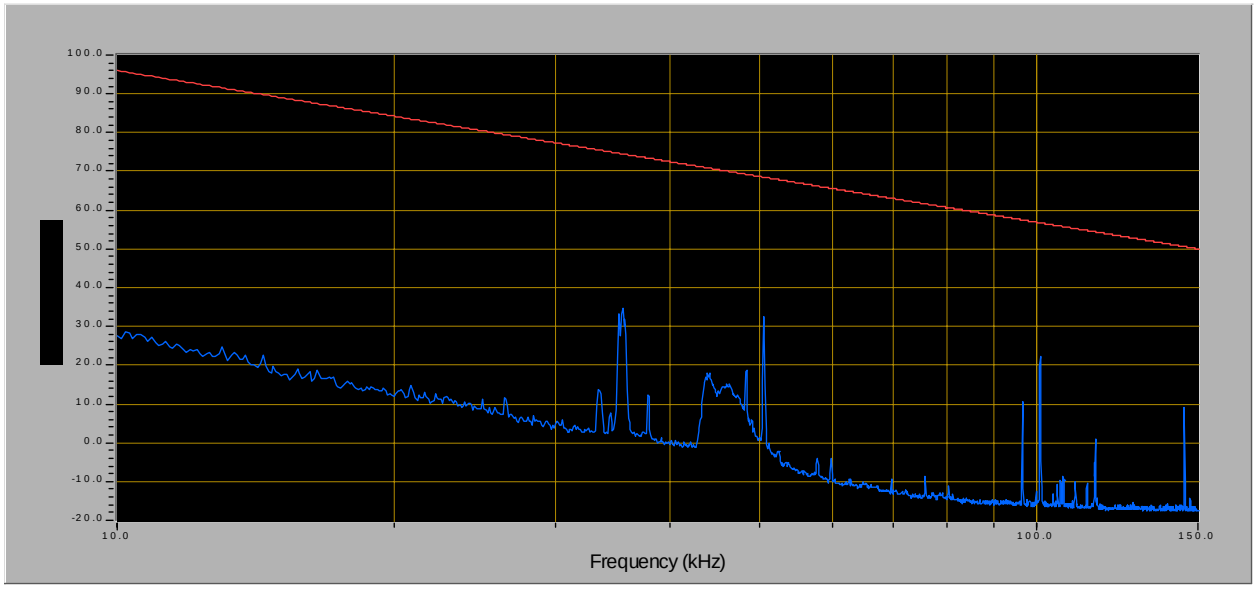
Category:
a = portable c = exposed
b = protected d = submerged

3.2 Conducted emissions 10 kHz - 150 kHz

EN 60945 reference	:	9.2
Basic standard	:	CISPR 16-1
Port	:	DC-input, 24Vdc
Frequency range	:	10 kHz - 150 kHz
Measurement bandwidth	:	200 Hz
Length power cable	:	0.3 m
EUT	:	Transponder unit and MKD unit in receive condition.

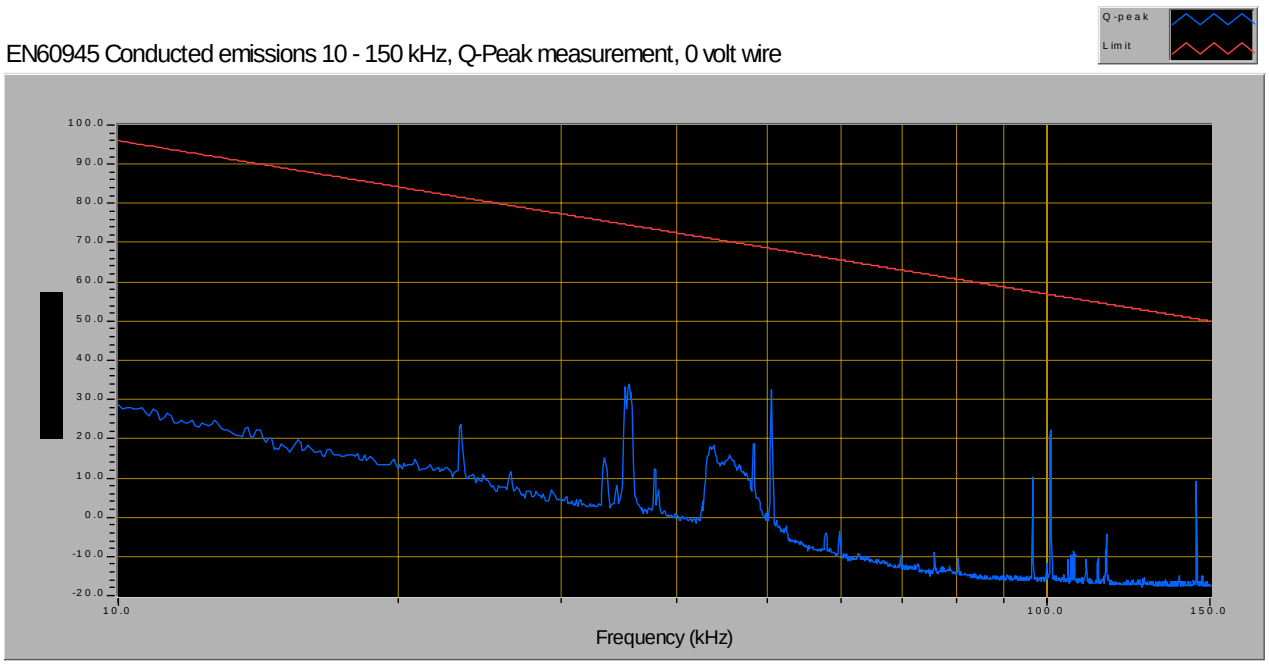
Test result :

EN60945 Conducted emissions 10 - 150 kHz, Q-Peak measurement, 24 volt wire



Levels in dBµV

EN60945 Conducted emissions 10 - 150 kHz, Q-Peak measurement, 0 volt wire



Levels in dBµV

Measurement uncertainty	3.7 dB
Limit: 96 dBµV @ 10 kHz descending to 50 dBµV @ 150 kHz	

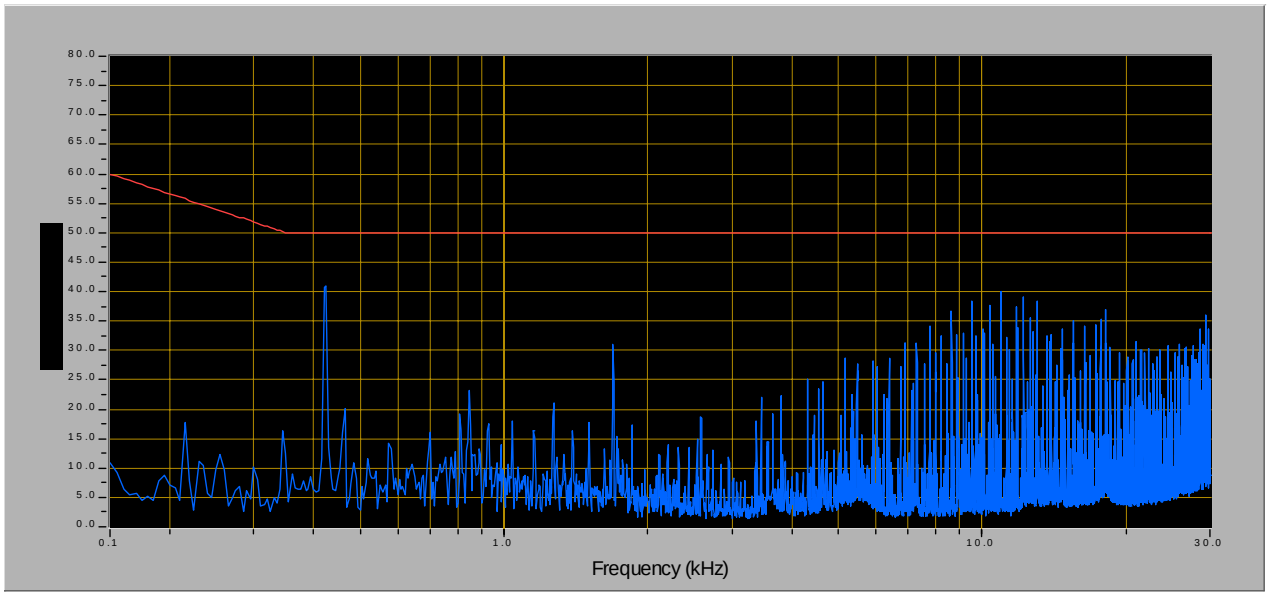
Test equipment used: (Item numbers)	24, 25, 26, 76

3.3 Conducted emissions 150 kHz - 30 MHz

EN 60945 reference	:	9.2
Basic standard	:	CISPR 16-1
Port	:	DC-input, 24Vdc
Frequency range	:	150 kHz - 30 Mhz
Measurement bandwidth	:	10 kHz
Length power cable	:	0.5 m
EUT	:	Transponder unit and MKD unit in receive condition.

Test result :

EN60945 Conducted emissions 150 kHz - 30 MHz, Q-Peak measurement, 24 volt wire

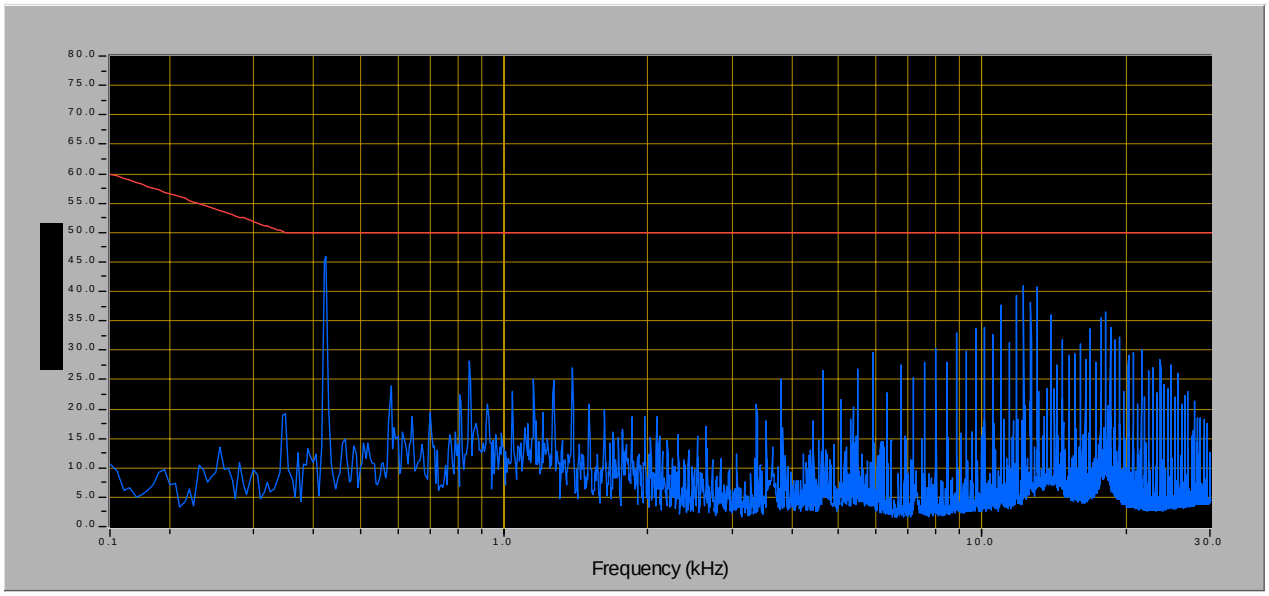


Levels in dBµV

Frequency (MHz)	Level (dBµV)	Result
0.425	40.9	P
*	*	P
--	--	
Measurement uncertainty	3.7 dB	
Limit: 60 dBµV @ 150 kHz descending to 50 dBµV @ 350 kHz 350 kHz < 50 dBµV > 30 MHz		

** all other frequencies more that 10 dB below the limit.*

EN60945 Conducted emissions 150 kHz - 30 MHz, Q-Peak measurement, 0 volt wire



Levels in dBµV

Frequency (MHz)	Level (dBµV)	Result
0.425	45.8	P
*	*	P
--	--	
Measurement uncertainty	3.7 dB	
Limit: 60 dBµV @ 150 kHz descending to 50 dBµV @ 350 kHz 350 kHz < 50 dBµV > 30 MHz		

** all other frequencies more that 10 dB below the limit.*

Test equipment used: (Item numbers)	24, 25, 26, 76

3.4 Radiated emissions 150 kHz - 30 MHz

EN 60945 reference	:	9.3
Basic standard	:	CISPR 16-1
Frequency range	:	150 kHz - 30 MHz
Measurement bandwidth	:	10 kHz
EUT	:	Transponder unit and MKD unit

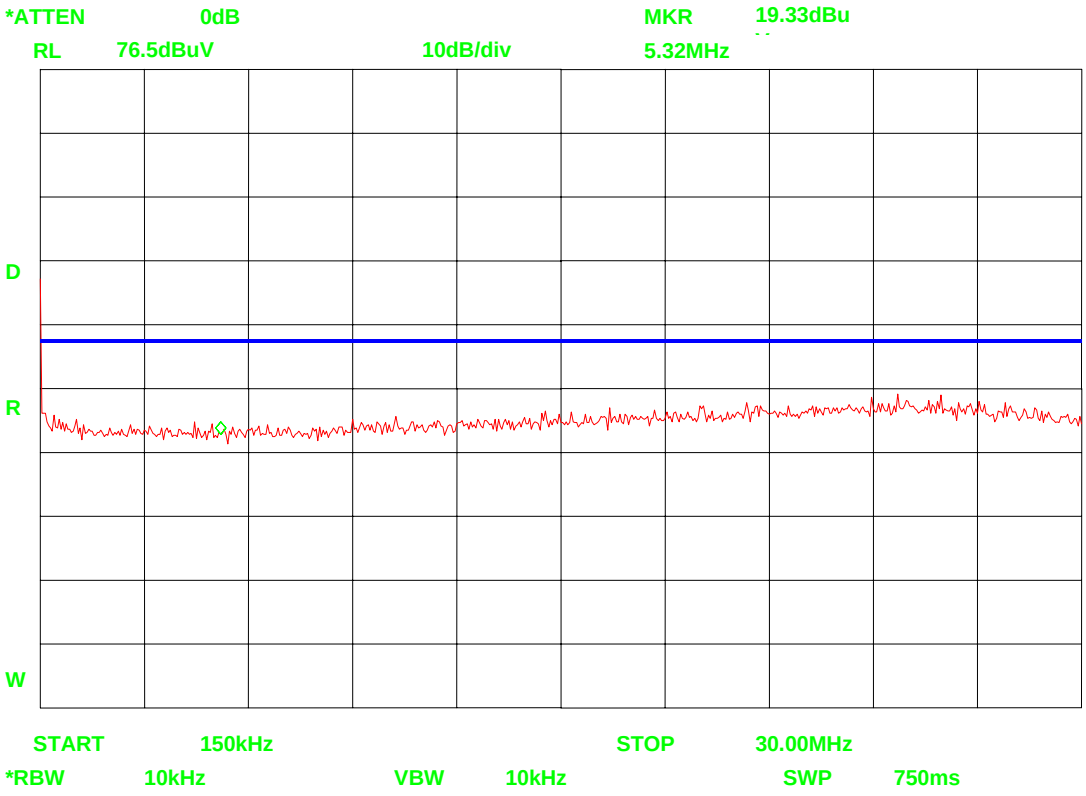
Field measurement results were obtained with a Large Loop Antenna (H-field).

Frequency (kHz)	**Level (dBµV)**	**Result**
*	*	P
--	--	
--	--	
--	--	
Measurement uncertainty	+1.9 / -2.1 dB	
Limit: 80 dBµV/m @ 150 kHz descending to 52 dBµV/m @ 300 kHz 52 dBµV @ 300 kHz descending to 34 dBµV/m @ 30 MHz		

* All emissions > 10 dB below the limit

Test equipment used: (Item numbers)	68, 76, 83

3.4.1 Plot radiated emissions 150 kHz - 30 MHz



Limit line shows limit at 30 MHz

3.5 Radiated emissions 30 MHz - 1 GHz

EN 60945 reference	:	9.3
Basic standard	:	CISPR 16-1
Frequency range	:	30 MHz - 1 GHz
Measurement bandwidth	:	100 kHz
Distance ant. EUT	:	3m
EUT	:	Transponder unit and MKD unit

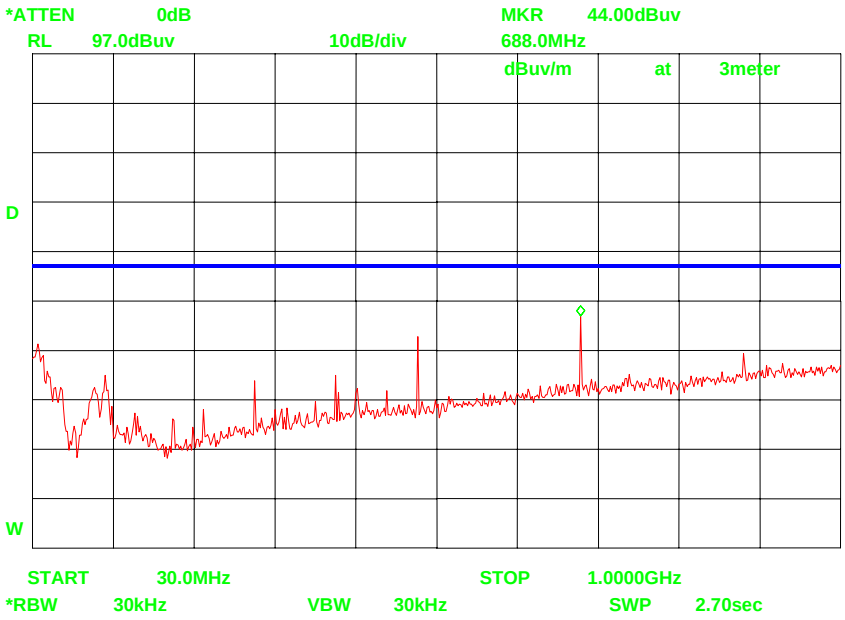
Field measurement results were obtained with a Log-periodic antenna.

Frequency (MHz)	**Level (dBµV)**	**Polarization**	**Result**
688.0	44.0	V	P
*	--	--	--
--	--	--	--
--	--	--	--
Measurement uncertainty	3.3 dB		
Limit: 54 dBµV/m			

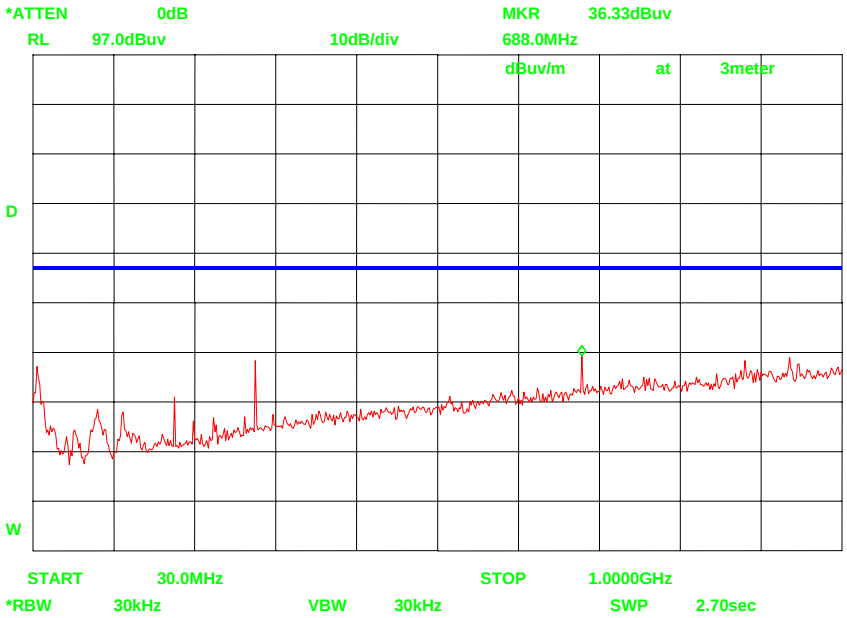
* All other emissions > 10 dB below the limit

Test equipment used: (Item numbers)	12, 28, 32, 69, 76

3.5.1 Plot radiated emissions 30 MHz - 1000 MHz Vertical



3.5.2 Plot radiated emissions 30 MHz - 1000 MHz Horizontal



3.6 Radiated emissions 156 MHz - 165 MHz

EN 60945 reference	:	9.3
Basic standard	:	CISPR 16-1
Frequency range	:	156 MHz - 165 MHz
Measurement bandwidth	:	10 kHz
Distance ant. EUT	:	3m
EUT	:	Transponder unit and MKD unit.

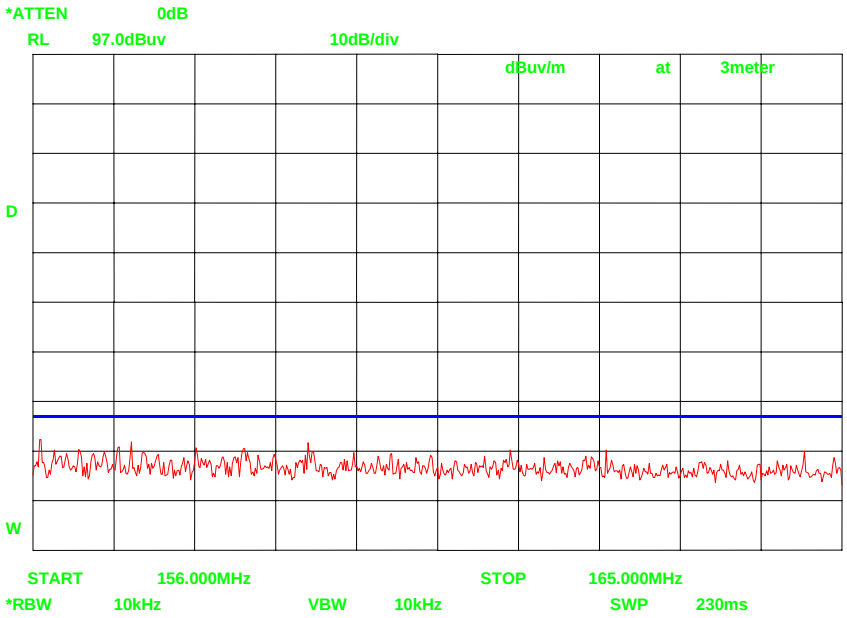
Field measurement results were obtained with a Log-periodic antenna.

Frequency (MHz)	**Level (dBµV)**	**Polarization**	**Result**
*	*	H/V	P
--		--	--
--		--	--
--		--	--
Measurement uncertainty	3.3 dB		
Limit: 24 dBµV/m			

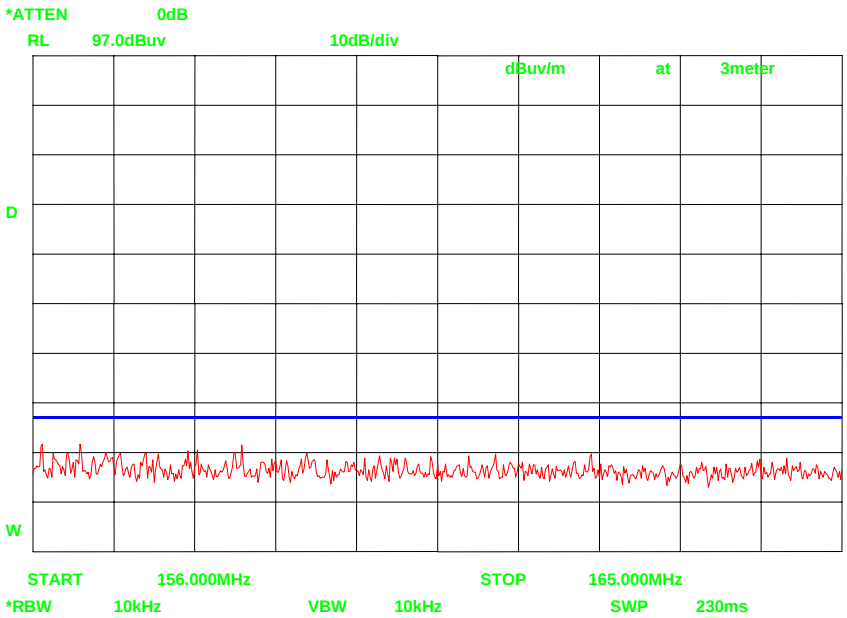
* All emissions > 10 dB below the limit

Test equipment used: (Item numbers)	12, 28, 32, 69, 76

3.6.1 Plot radiated emissions 156 - 165 MHz Vertical



3.6.2 Plot radiated emissions 156 - 165 MHz Horizontal



3.7 Radiated emissions 1 GHz - 2 GHz

EN 60945 reference	:	9.3
Basic standard	:	CISPR 16-1
Frequency range	:	1 GHz - 2 GHz
Measurement bandwidth	:	100 kHz
Distance ant. EUT	:	3m
EUT	:	Transponder unit and MKD unit.

Field measurement results were obtained with a broadband horn antenna @ 3 meter distance.

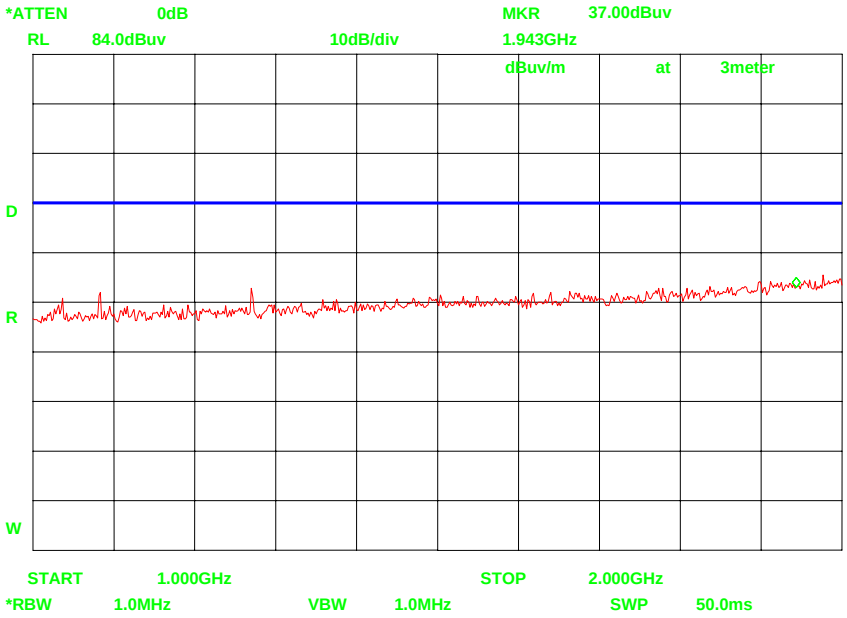
Frequency (MHz)	**Level (dBµV)**	**Polarization**	**Result**
1082	45.9	H/V	P
1943	52.4	H/V	P
*	*	--	--
--		--	--
Measurement uncertainty	6.0 dB		
Limit: 54 dBµV/m			

* No other emissions were found.

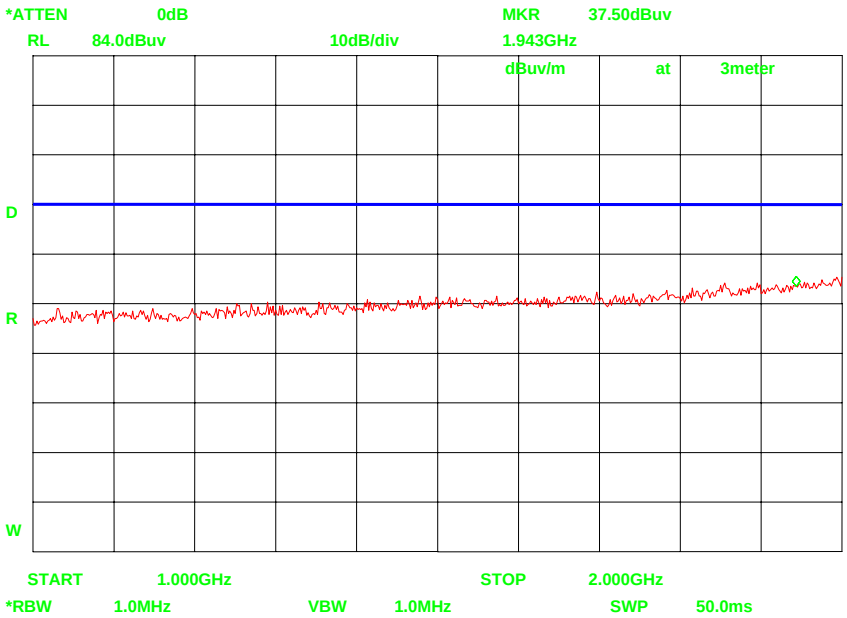
Signals were measured as EUT radiated power in dBm EIRP and corrected with +95.2dB/m

Test equipment used: (Item numbers)	54, 75, 76

3.7.1 Plot radiated emissions 1 - 2 GHz Vertical



3.7.2 Plot radiated emissions 1 - 2 GHz Horizontal



4 Immunity to electromagnetic environment clause 10

4.1 Summary

According to EN 60945:2002 the following tests were performed:

Port	Subclause Category	Phenomena	Performance criterion	Result
AC-input	10.3 b c d	Conducted RF common mode 0.01-80.00 MHz, AM80% 400Hz	A	NA
DC-input	10.3 b c d	Conducted RF common mode 0.01-80.00 MHz, AM80% 400Hz	A	P
Signal/control line(s)	10.3 b c d	Conducted RF common mode 0.15-80.00 MHz, AM80% 400Hz	A	P
Enclosure	10.4 a b c	RF-field 10 V/m, AM80% 400Hz 80 - 2000 MHz	A	P
AC-input	10.5 b c d	EFT +/- 2 kV common mode	B	NA
DC-input	10.5 b c d	EFT +/- 1 kV common mode	B	P
Signal/control line(s)	10.5 b c d	EFT +/- 1 kV common mode	B	P
AC-input	10.6 b c d	Surges 1 kV line-earth 0.5 kV line-line	B	NA
AC-input	10.7 b c d	Power supply short-term variation volt. +/-20%, freq. +/-10%	B	NA
AC-input	10.8 b c d	Power supply failure, 60sec common mode	C	NA
DC-input	10.8 b c d	Power supply failure, 60sec common mode	C	P
Enclosure	10.9 a b c	ESD, 6 kV contact, 8 kV air	B	P

Result:
P = pass NA = not applicable
F = fail NP = not performed

Category:
a = portable c = exposed
b = protected d = submerged

4.2 Immunity to conducted radio frequency disturbance (10.3)

EN 60945 reference	:	10.3
Basic standard	:	EN 61000-4-6
Port	:	DC input, Sensor-3, Main, VHF antenna, MKD
Frequency range	:	150 kHz - 80 MHz
Test level	:	3 Volt (Sweep), 10 Volt (Spot frequencies)
Modulation	:	AM, 400Hz / 80%
Dwell time	:	5 seconds
Sweep rate	:	1.5 x 10^{-3} decades / s
Performance criterion	:	A, ref. par 10.1 of EN 60945

Frequency (MHz)	Port	Coupl. dev.	Test Level (V_{rms})	Comments	Result
Range 0.15 - 80.00 1 % frequency steps	DC input	CDN-2	3V	1	P
Range 0.15 - 80.00 Spot frequencies	DC input	CDN-2	10V	1, 4	P
Range 0.15 - 80.00 1 % frequency steps	MKD	Clamp	3V	1	P
Range 0.15 - 80.00 Spot frequencies	MKD	Clamp	10V	1, 4	P
Range 0.15 - 80.00 1 % frequency steps	Main	Clamp	3V	1	P
Range 0.15 - 80.00 Spot frequencies	Main	Clamp	10V	1, 4	P
Range 0.15 - 80.00 1 % frequency steps	GPS RF input	CDN-S	3V	1	P
Range 0.15 - 80.00 Spot frequencies	GPS RF input	CDN-S	10V	1, 4	P
Range 0.15 - 80.00 1 % frequency steps	Alarm	Clamp	3V	1	P
Range 0.15 - 80.00 Spot frequencies	Alarm	Clamp	10V	1, 4	P
Range 0.15 - 80.00 1 % frequency steps	Sensor 3	ESH3-Z4	3V	1	P
Range 0.15 - 80.00 Spot frequencies	Sensor 3	ESH3-Z4	10V	1, 4	P

Comments:
1. There is no degradation of performance of the EUT during and after the test.
2. There is no degradation of performance of the EUT after the test.
3. The degradation of performance during the test is permissible and within the limits specified by the manufacturer.
4. The 10 volt test is performed on the following frequencies: 2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22 and 25 MHz.

Measurement uncertainty : +/- 1.3 dB
The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approx. 95%, but excluding the effect of measurement system repeatability.

Test equipment used: (Item numbers)	38, 39, 42, 43, 44, 46, 50, 51, 64, 88, 90, 91

4.3 Immunity to Radiated radio frequency disturbance (10.4)

EN 60945 reference	:	10.4
Basic standard	:	EN 61000-4-3
Port	:	Enclosure
Frequency range	:	80 MHz - 2 GHz
Test level	:	10 Volt/m
Modulation	:	AM, 400Hz / 80%
Dwell time	:	5 seconds
Sweep rate	:	$<1.5 \times 10^{-3}$ decades / s (80 MHz - 1GHz) $<0.5 \times 10^{-3}$ (1 - 2 GHz)
Calculated exclusion band	:	147.9 - 170.1 MHz (5% Fh)
Performance criterion	:	A, ref. par 10.1 of EN 60945

Frequency (MHz)	Test Level (V/m)	Polarisation H/V	Comments	Result
Range 80 - 1000 1 % frequency steps	10	H/V	1	P
Range 1000 - 2000 1 % frequency steps	10	H/V	1	P

Comments:
1. There is no degradation of performance of the EUT during and after the test.
2. There is no degradation of performance of the EUT after the test.
3. The degradation of performance during the test is permissible and within the limits specified by the manufacturer.
4. --

Measurement uncertainty : +/- 1.8 dB
The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approx. 95%, but excluding the effect of measurement system repeatability.

Test equipment used: (Item numbers)	11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 32, 54, 84, 85, 86, 87, 89, 90

4.4 Immunity to Fast Transients (10.5)

EN 60945 reference	:	10.5
Basic standard	:	EN 61000-4-4
Port	:	Signal ports
Atmospheric pressure	:	between 86 kPa and 106 kPa
Temperature	:	24 °C
Relative humidity	:	47 %
Performance criterion	:	B, ref. par 10.1 of EN 60945

Port	Coupl. dev.	Test Volt. (kV)	Polarity +/-	Comments	Result
Main	Clamp	1	+/-	1, 2	P
MKD	Clamp	1	+/-	1, 2	P
Sensor 3	Clamp	1	+/-	1, 2	P
VHF VDL RF	Clamp	1	+/-	1, 2	P
GPS RF input	Clamp	1	+/-	1, 2	P
Alarm	Clamp	1	+/-	1, 2	P
--	--	--	--	--	--
--	--	--	--	--	--

Comments:
1.There is no change of actual operating mode or loss of stored data (messages) after the test.
2.There is no degradation of performance of the EUT after the test.
3.The degradation of performance after the test is permissible and within the limits specified by the manufacturer.
4.--

Measurement uncertainty : It has been demonstrated that EFT generator and its coupling networks meet the specified requirements in the standard with at least a 95% confidence.

Test equipment used: (Item numbers)	1, 2, 3, 4, 90

4.5 Immunity to Power supply failure (10.8)

EN 60945 reference	:	10.8
Basic standard	:	EN 61000-4-11
Port	:	DC supply
Atmospheric pressure	:	between 86 kPa and 106 kPa
Temperature	:	24 °C
Relative humidity	:	47 %
Nominal voltage	:	24 volt
Performance criterion	:	B, ref. par 10.1 of EN 60945

Test			Performance criterion	Comments	Result
nr.	supply	time			
1	break	60 s	C	1	P
2	break	60 s	C	1	P
3	break	60 s	C	1	P
4	--	--	--	--	--
5	--	--	--	--	--
6	--	--	--	--	--

Comments:
1.There is no corruption of operational software or loss of essential data (messages) after the test.
2.There is no degradation of performance of the EUT after the test.
3.The degradation of performance after the test is permissible and within the limits specified by the manufacturer.
4.--

Measurement uncertainty : Not applicable

Test equipment used: (Item numbers)	48, 90

4.6 Immunity to electrostatic discharge, contact (10.9)

EN 60945 reference : 10.9
Basic standard : EN 61000-4-2
Atmospheric pressure : between 86 kPa and 106 kPa
Temperature : 24 °C
Relative humidity : 47 %
Performance criterion : B, ref. par 10.1 of EN 60945

Position	Test Volt. (kV)	Number of Discharges	Polarity +/-	Comments	Result
Transponder unit Front &Rear sides, metal screws, mounting bracket	6	10	+	1,2	P
	6	10	-	1, 2	P
MKD mounting bracket	6	10	+	1, 2	P
	6	10	-	1, 2	P
MKD sub-D connector cap	6	10	+	1, 2	P
	6	10	-	1, 2	P
--	--	--	--	--	--
	--	--	--	--	--

Comments:
1.There is no corruption of operational software or loss of essential data (messages) after the test.
2.There is no degradation of performance of the EUT after the test.
3.The degradation of performance after the test is permissible and within the limits specified by the manufacturer.
4.--

Measurement uncertainty : It has been demonstrated that the ESD generator meets the specified requirements in the standard with at least a 95% confidence.

Test equipment used: (Item numbers)	5, 6, 90

4.7 Immunity to electrostatic discharge, Air (10.9)

EN 60945 reference : 10.9
Basic standard : EN 61000-4-2
Atmospheric pressure : between 86 kPa and 106 kPa
Temperature : 24 °C
Relative humidity : 47 %
Performance criterion : B, ref. par 10.1 of EN 60945

Position	Test Volt. (kV)	Number of Discharges	Polarity +/-	Comments	Result
Transponder unit, Leds on front	8	0	+	1	P
	8	0	-	1	P
Display Unit, Plastic cover LCD	8	0	+	1	P
	8	0	-	1	P
Display unit, Push buttons and LED	8	0	+	1	P
	8	0	-	1	P
--	--	--	--	--	--
	--	--	--	--	--
--	--	--	--	--	--
	--	--	--	--	--
	--	--	--	--	--

Comments:
1.There is no corruption of operational software or loss of essential data (messages) after the test.
2.There is no degradation of performance of the EUT after the test.
3.The degradation of performance after the test is permissible and within the limits specified by the manufacturer.
4.--

Measurement uncertainty : It has been demonstrated that the ESD generator meets the specified requirements in the standard with at least a 95 % confidence.

Test equipment used: (Item numbers)	5, 7, 90

4.8 Immunity to electrostatic discharge, Coupling plane (10.9)

EN 60945 reference : 10.9
Basic standard : EN 61000-4-2
Atmospheric pressure : between 86 kPa and 106 kPa
Temperature : 24 °C
Relative humidity : 47 %
Performance criterion : B, ref. par 10.1 of EN 60945

Position	Test Volt. (kV)	Number of Discharges	Polarity +/-	Comments	Result
Display Unit, Plastic cover LCD	6	10	+	1	P
	6	10	-	1	P
--	--	--	--	--	--
	--	--	--	--	--
--	--	--	--	--	--
	--	--	--	--	--
	--	--	--	--	--

Comments:
1.There is no corruption of operational software or loss of essential data (messages) after the test.
2.There is no degradation of performance of the EUT after the test.
3.The degradation of performance after the test is permissible and within the limits specified by the manufacturer.
4.--

Measurement uncertainty : It has been demonstrated that the ESD generator meets the specified requirements in the standard with at least a 95 % confidence.

Test equipment used: (Item numbers)	5, 7, 90

5 Special purpose tests according to EN 60945 clause 11

According to EN 60945: 2002 fourth edition the following checks were performed:

Summary

Subclause	Performance requirement	Result
11.1	Acoustic noise and signals	P
11.2	Compass safe distance	NP

Results:
P : = pass
F : = fail
NA : = not applicable
NP : = not performed

5.1 Acoustic noise and signals

EN 60945 reference : 11.1
EUT : transponder unit and MKD unit

Acoustic parameter	Observation	Result
Acoustic noise power	The product is not capable of generating any significant noise. Therefore this test has not been performed and the test result is deemed to be positive	P
Acoustic noise power of an alarm	Between 75 dB(A) and 85 dB(A)	NA

5.2 Compass safe distance

EN 60945 reference : 11.2
Basic standard : ISO/R 694 and IEC 61000-4-8

Unit	Compass safe distance standard	Compass safe distance Steering	Result
Transponder unit and MKD unit	--	--	NP

Comment: On request of the applicant this test was excluded.

6 Safety precautions according to EN 60945 clause 12

According to EN 60945:2002 fourth edition the following checks were carried out:

Summary

Subclause	Performance requirement	Result
12.1	Protection against accidental access to dangerous voltages	P
12.2	Electromagnetic radio frequency radiation	P
12.3	Emission from visual display	NA
12.4	X-radiation	NA

Results:
P : = pass
F : = fail
NA : = not applicable
NP : = not performed

6.1 Protection against accidental access to dangerous voltages

EN 60945 reference : 12.1
Basic standard : IEC 60529, IEC 60071-2
EUT : Transponder unit and MKD unit

Observation	Result
There are no openings in the EUT where the test probe can reach hazardous parts	P

6.2 Safety rules to Electromagnetic radio frequency radiation

EN 60945 reference : 12.2
Basic standard : --
EUT : Transponder unit and MKD unit

Test	Result
Calculation of the safe distance to the radiating device	P

Remark:
Calculations for a power density of 10W/m^2 show that this density can be found on a 40 cm distance from the aerial when the transmitter is operated on its high power setting and a 0dBd antenna is used (attenuation of coax not included).

Used formula:

$$P = \frac{P_{T(eirp)}}{4\pi.r^2}$$

6.3 Maintenance according to EN 60945 clause 13

According to EN 60945:2002 fourth edition the following checks were performed:

Observation	Result
The EUT is so designed that the main units can be replaced readily, on-board repair is possible without elaborate recalibration or readjustment.	P
The EUT is so constructed that it is readily accessible for inspection and maintenance purposes.	P

Results:
P : = pass
F : = fail
NA : = not applicable
NP : = not performed

7 Equipment manuals according to EN 60945 clause 14

According to EN 60945:2002 fourth edition the following checks were performed:

Observation	Result
The equipment manuals are not checked according to the equipment standard EN 60945 clause 14 and EN 61993-2 clause 4.3	NP

Comment: On request of the applicant this test was excluded.

Results:
P : = pass
F : = fail
NA : = not applicable
NP : = not performed

8 Marking and identification according to EN 60945 clause 15

According to EN 60945:2002 fourth edition the following checks were performed:

Observation	Result
The equipment is marked with the following identification: a) Identification of the manufacturer. b) Equipment type identification. c) Serial number of the unit.	P

Results:
P : = pass
F : = fail
NA : = not applicable
NP : = not performed

Used test equipment module

This module contains the total list of test equipment used.

The following measurement equipment is used at Telefication:

Ref	Description	Ident.	Manufacturer	Model
1	EFT generator	TE 00760	Keytek	E411
2	EFT/surge coupler	TE 00759	Keytek	E4551
3	Capacitive clamp	TE 00761	Keytek	CCL-4/S
4	Controller (A07)	TE 00023	Keytek	E103
5	ESD simulator	TE 00516	Keytek	MZ-15/EC
6	ESD air discharge tip	TE 00755	Keytek	TPA-2
7	ESD contact discharge tip	TE 00709	Keytek	TPC-2
8	Surge comb. wave generator	TE 00757	Keytek	E501A
9	Surge telecom wave gen.	TE 00022	Keytek	E502A
10	Surge coupler/decoupler	TE 00758	Keytek	E571
11	Logper/bow-tie antenna (Anec)	TE 00700	EMCO	3143
12	Biconical antenna	TE	Schwarzbeck	BBA 9106
13	RF amplifier	TE 00750	Kalmus	737FC
14	RF generator	TE 00474	Adret	7200A
15	Isotropic field sensor	TE 00748	Holaday	HI-4422
16	Fiber optic RS232 interface	--	Holaday	HI-4413G
17	System readout	TE 00749	Holaday	HI-4416
18	Antenna tower	--	HD	AS 620p
19	Turntable	--	HD	DS 412
20	Turntable controller	--	HD	HD 050
21	RF voltmeter	TE 00707	Boonton	9200B
22	40 dB coupler	TE 00752	Kalmus	DC100HHR
23	RF probe (2x)	TE 00753 TE 00754	Boonton	952001B
24	Artificial mains network	TE 00208	R & S	ESH2-Z5

Ref	Description	Ident.	Manufacturer	Model
25	Test receiver	TE 00205	R & S	ESH3
26	Pulse limiter	TE 00227	R & S	ESH3-Z2
27	Spectrum analyzer	TE 00094 TE 00095	R & S	FSB Display
28	Test receiver	TE 00091	R & S	ESV(P)
29	Antenna mast	--	EMCO	1070
30	Turn table	--	EMCO	1060-2M
31	Absorbing clamp	TE 00777	R & S	MDS 21
32	Anechoic chamber	--	Euroshield	RFD-F-100
33	Open Area Test Site	--	Telefication	--
34	Power/Arb waveform source	TE 00711	Keytek	EP72
35	Reference impedance	TE 00712	Keytek	ERI-1
36	Power analyzer	TE 00763	Xitron Technologies	2501AH
37	AC power simulator	TE 00762	Kikusui	PCR4000L
38	RF Signal generator 5.4 GHz	TE 00379	Marconi	2042
39	RF amplifier	TE 00515	Amplifier Research	25A250A
40	T-network	TE 00026	R & S	ESH3-Z4
41	--	--	--	--
42	Power meter	TE 00414	R & S	NRVS
43	Measurement probe	TE 00415	R & S	URV5-Z4
44	Attenuator 6 dB	TE 00514	Narda	766-6
45	Pulse generator	TE 00225	HP	8012 B
46	Coaxial coupl./dec. network	TE 00766	Telefication	CDN-S1
47	Voltage swell/DIP/interrupt source	TE 00710	Keytek	EP62

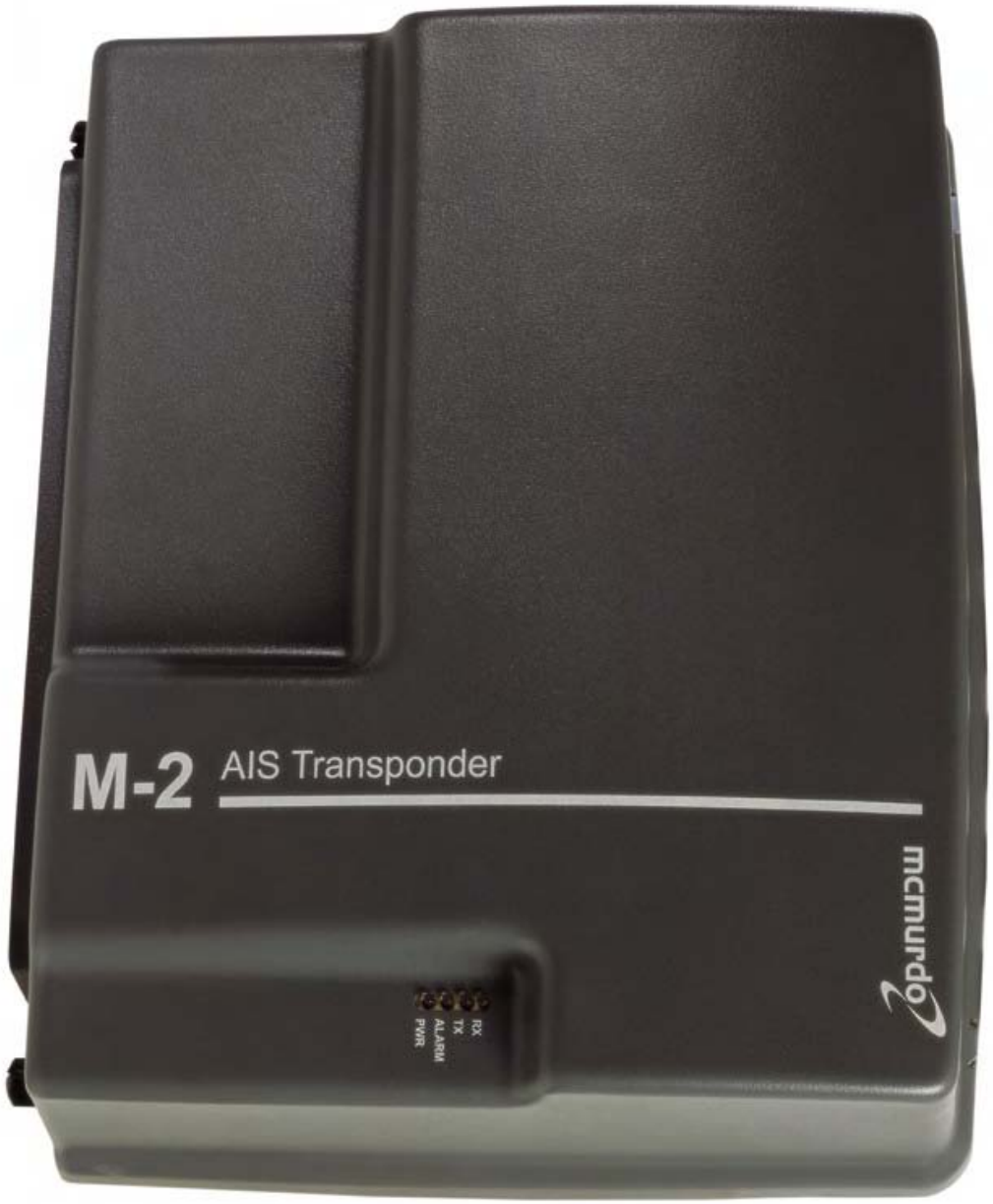
Ref	Description	Ident.	Manufacturer	Model
48	Digital multi-meter	TE 00329	Fluke	Fluke 87
49	--	--	--	--
50	EM clamp	TE 00764	Lüthi	EM101
51	Ferrite tube	TE 00765	Lüthi	FTC101
52	Distortion meter	TE 00416	HP	HP 8903 B
53	Artificial Mains Network	TE	Telefication	JOZ191194
54	Double Ridged Guide Antenna	TE 00532	EMCO	3115
55	Log periodic antenna	TE 00744	EMCO	3147
56	Modulation analyzer	TE 00412	R & S	FAM
57	Audio amplifier	TE 00517	Solar Electronics	6552-1A
58	Acoustic Pipe Coupler	TE 00775	Telefication	JOZ110395
59	Antenna	--	Kathrein	K 51164
60	Pulse modulator	TE 00708	Schaffner	CPM9830
61	RF power amplifier	TE 00714	Schaffner	CBA9546
62	Adjustable transformer	--	KSL	RU8
63	100 µF decoupling capacitor	TE 00769	Telefication	JOZ
64	Mains coupling/decoupling Network	TE 00767	Telefication	CDN-M2/M3
65	Coupling/decoupling device for screened cables	TE 00771	MEB	CDN-S25
66	Audio isolation transformer	TE 00772	Solar	6220-2
67	Current probe	TE 00773	Eaton	93686-2
68	Triple loop antenna	TE 01066	Telefication	--
69	Pre-amplifier	TE 00344	R&S	ESV-Z3

Ref	Description	Ident.	Manufacturer	Model
70	800 mm strip line	--	Telefication	--
71	Measurement probe	TE 00009	R & S	URV5-Z2
72	Standard gain horn antenna	TE 00602	Scientific Atlanta	12-1.7
73	Frequency doubler	TE 00569	HP	11721A
74	Microwave amplifier	TE 00124	HP	8349A
75	Preamplifier	TE 00092	HP	8449B
76	Spectrum analyzer	TE 00481	HP	8563E
77	Controller (A010)	TE 00713	Keytek	E103
78	Arbitrary waveform generator	TE 00144	HP	33120A
79	Power supply	TE 00362	Kepco	BOP100
80	Oscilloscope	TE 00129	Nicolet	Pro34
81	Coupling/decoupling network	TE 00796	Schaffner	ISN T444
82	Environmental chamber	TE 00741	CTS	C-40/350
83	Pre-amplifier 0.01 - 30 MHz, 20dB	TE 00036	JOZ	20dB
84	RF Power amplifier 1 - 2 GHz, 30 Watt	TE 00714	Schaffner	GRF5046
85	DC Power supply	TE 00170	Delta	SM 7020
86	Power supply 0 - 100 volt, 1 Ampere	TE 01057	HP	HP6634A
87	RF signal generator 5.4 GHz	TE 00427	Marconi	2042
88	CDN 4 wire (2x2) balanced	TE 00201	R & S	EZ10
89	CDN screened 25 wire	TE 00771	MEB	S25
90	DC Power supply	TE 00849	Delta	SM 6020
91	Oscilloscope	TE 00090	Tektronix	2430A

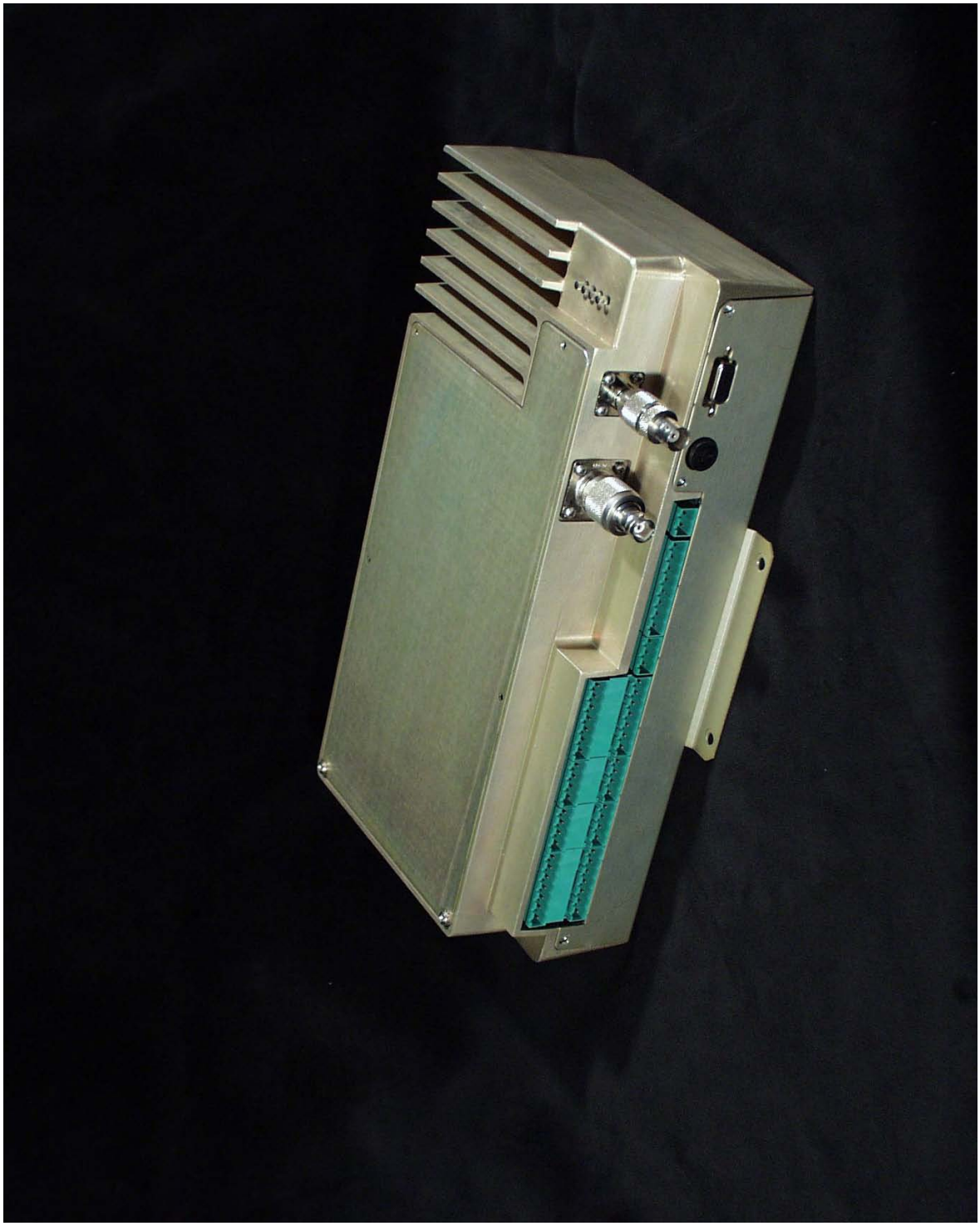
Photographs module

List of Photographs

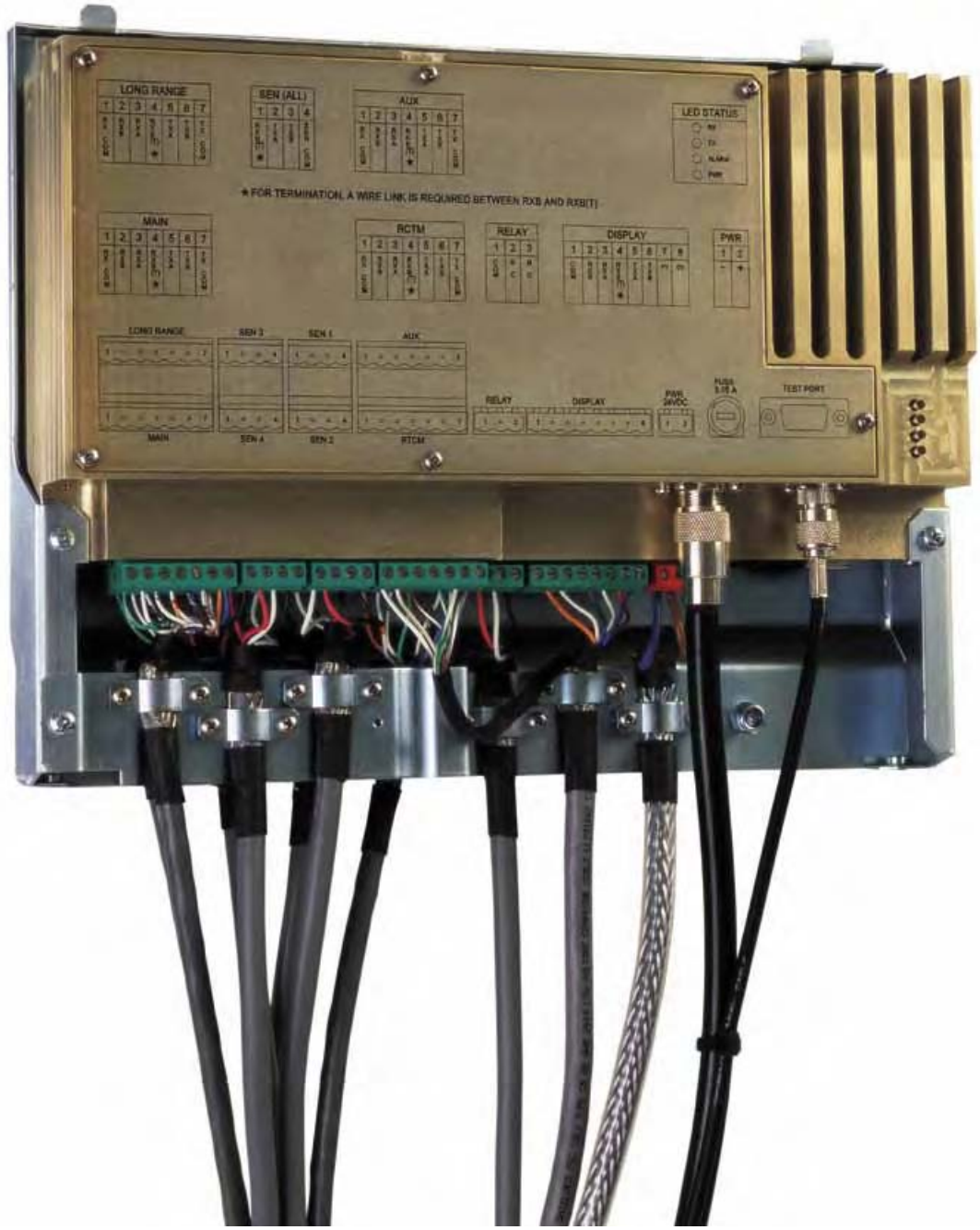
Photograph 1: *Assembled view M2 transponder*



Photograph 2: *M2 transponder without plastic enclosure*

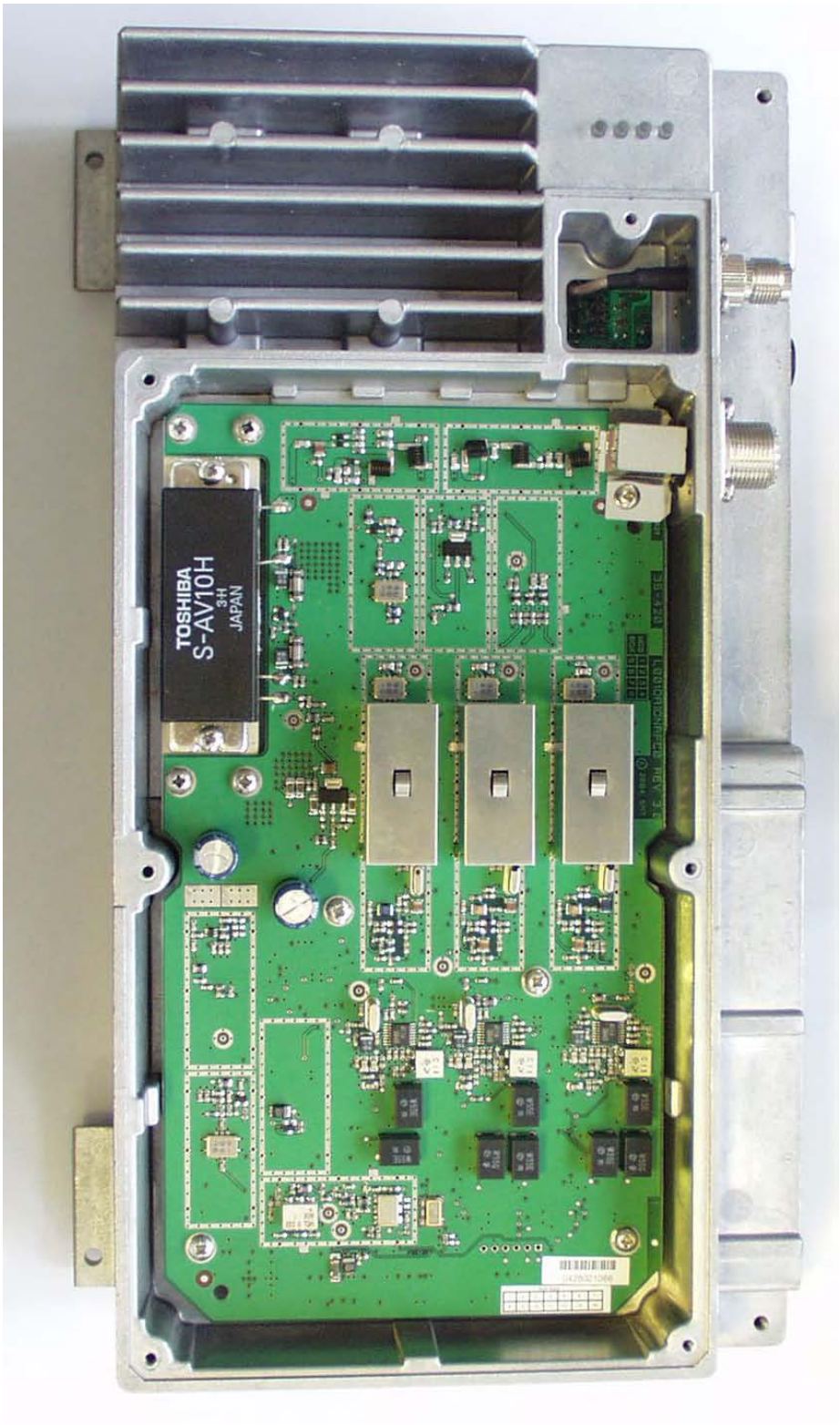


Photograph 3: *Cabling assembly overview*

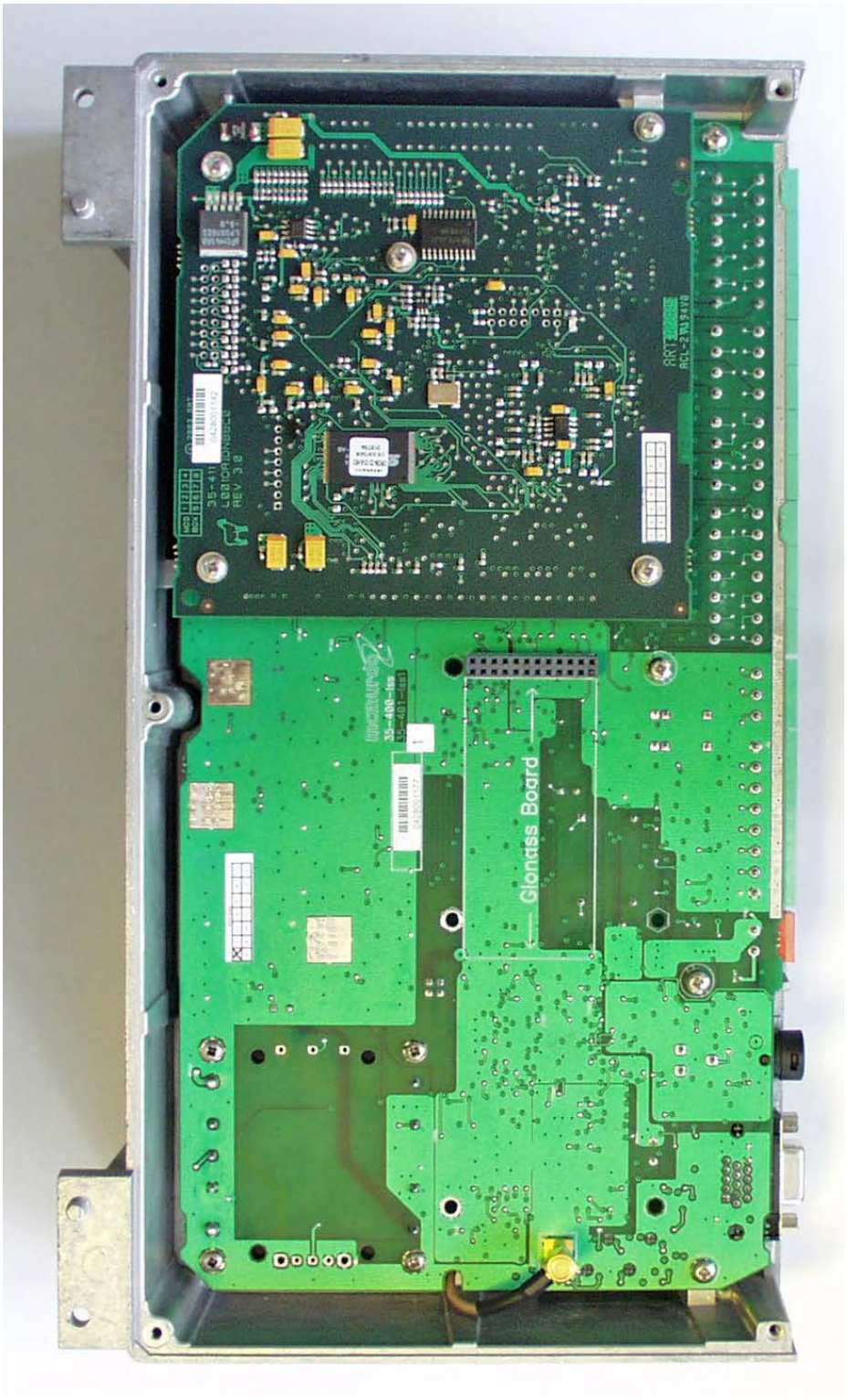


Photograph 4: *Label*

Photograph 5: *Opened enclosure RF side*



Photograph 6: *Opened enclosure, logic board and connection board side*

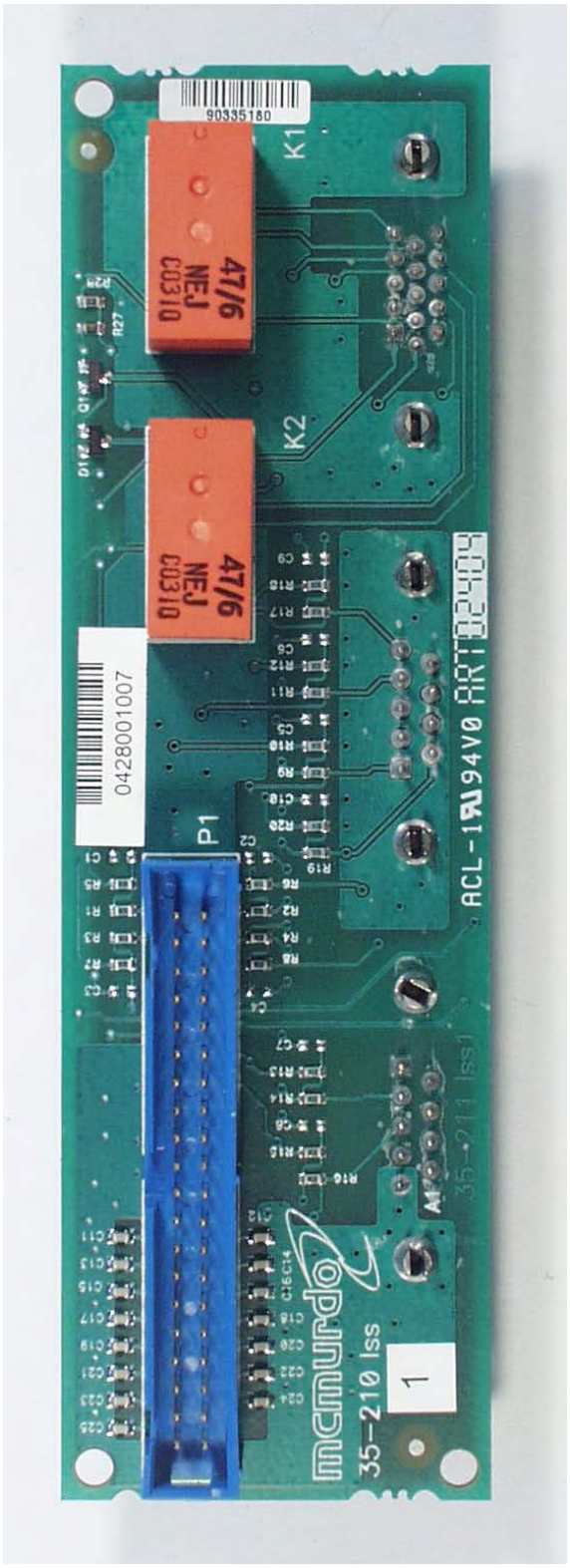


Photograph 7: *General view MKD*

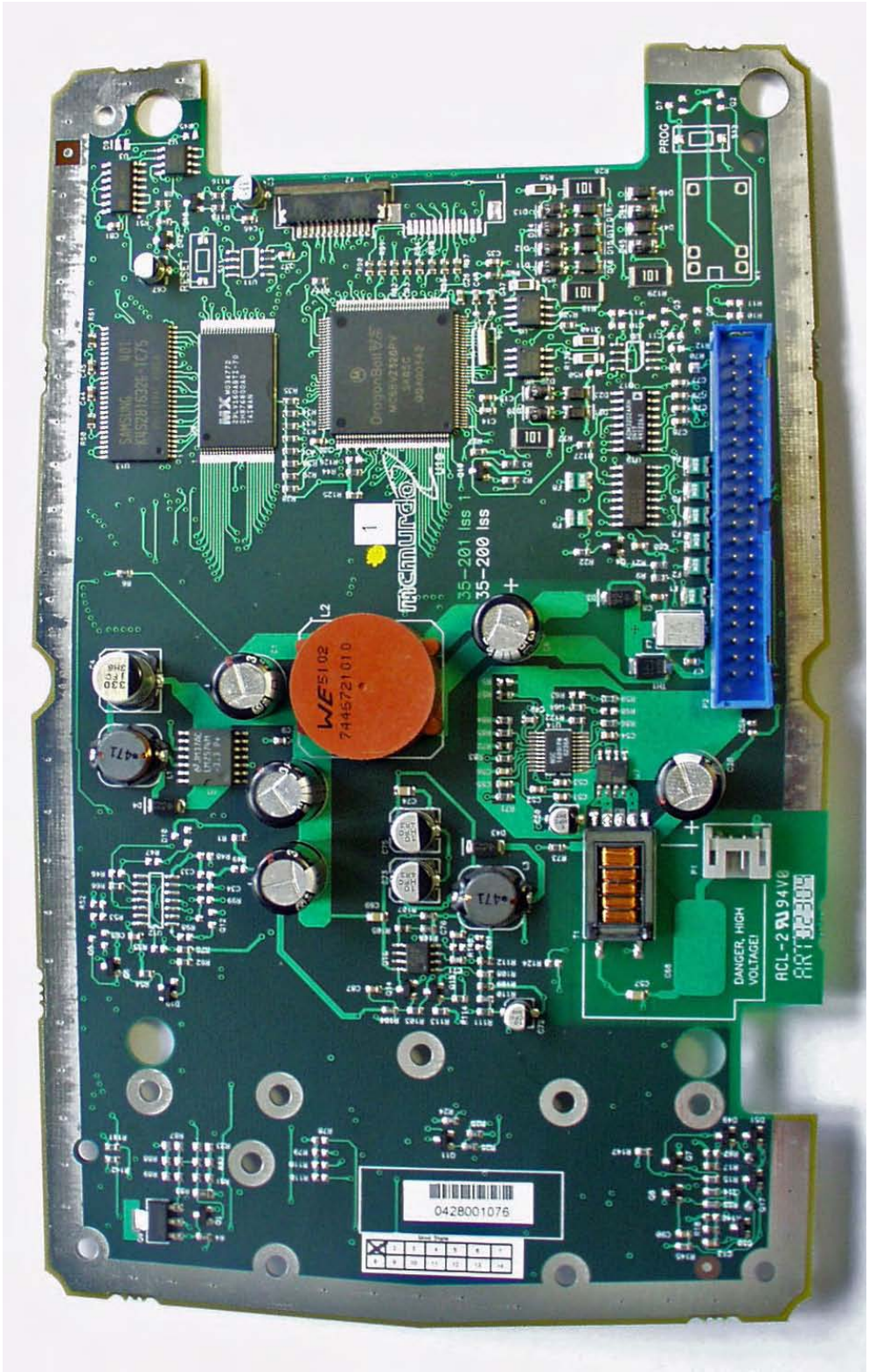
Photograph 8: *Rear side MKD*

Photograph 9: *MKD, opened enclosure*

Photograph 10: *MKD, Connection board*



Photograph 11: *MKD, opened enclosure*

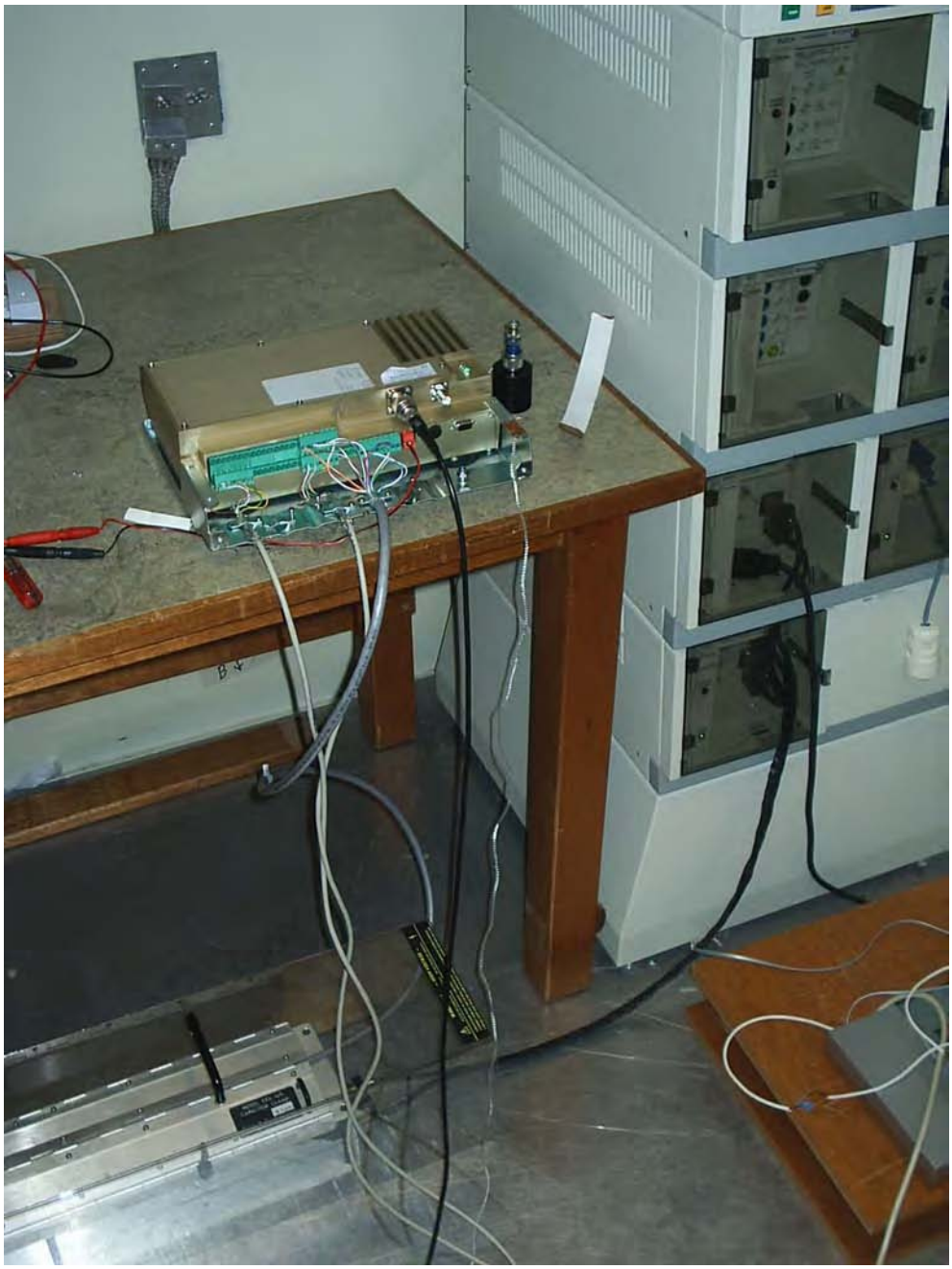


Photograph 12: *Radiated emissions 150 kHz - 30 MHz*

Photograph 13: *Radiated emissions*

Photograph 14: *EFT Test Set-up(1)*

Photograph 15: *EFT Test Set-up(1)*

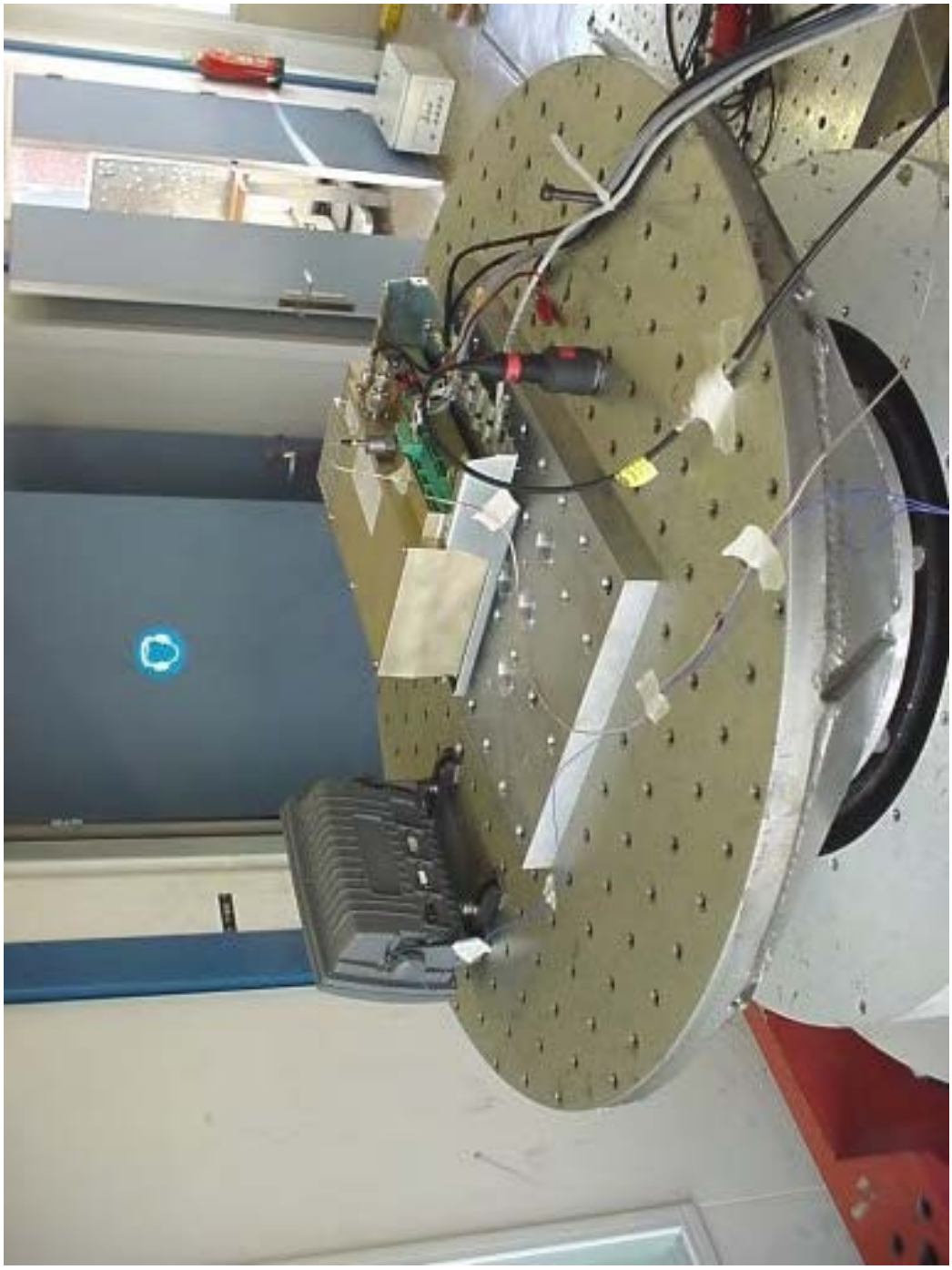


Photograph 16: *Radiated immunity*

Photograph 17: *Vibration testing (1)*

Photograph 18: *Vibration testing (2)*

Photograph 19: *Vibration testing (3)*



Photograph 20: *Marking and identification Transponder*

Additional information module

This module contains no pages of information provided by the applicant.