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## Test Report

Date

November 18, 2002

Prepared

FBM, Petter Gärdin

*EMC Test Engineer*

Ref. No

E014-TR 020200

Supersedes

Page

1 (14)

Title

### EMC Test 960 MHz – 5 GHz, 250 MHz Shielded antenna

#### Equipment under test (EUT):

Description: Ground Penetrating Radar System  
Manufacturer: Malå Geoscience  
Model name: 250 MHz Shielded antenna

#### Summary:

The EUT complied with the requirement of radiated emissions given in FCC 15.509, measured in the frequency range 960 – 5000 MHz.

#### Approved:

Per Larsson

*Ass. Laboratory Technical Manager*

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## 1 Introduction

The object of the test is to show compliance with the emission requirements of FCC Part 15 Subpart F.

Date of test: October 21,30, 2002

Location: AerotechTelub AB, Östersund

Test performed by: Petter Gärdin, AerotechTelub / FBM

Client: Malå Geoscience  
Skolgatan 11  
SE-93070 Malå  
Sweden

Client's observers: Bernth Johansson, Malå Geoscience

## 2 Test methods and results

### 2.1 Results

The test results in this report apply only for the tested specimen.

EMISSION REQUIREMENTS ACCORDING TO FCC Part 15 Subpart F					
Environmental phenomena	Test method	Requirement	Result	Comments	Test order
UWB definition		FCC 15.503 (a) 15.509(a)	PASS	$f_L$ 58 $f_C$ 201 $f_H$ 321	1
Peak emission at $f_M$	FCC 02-42	FCC 15.509 (f)	PASS	Margin 7.1 dB	2
Radiated emission	FCC 02-42	FCC 15.509 (d)	PASS	With peak detector	3
Radiated emission	FCC 02-42	FCC 15.509 (e)	PASS	With peak detector	4

## 3 Applicable documents

Measurements		
FCC Part 15	2002-07-22	Radio Frequency Devices
FCC 02-42	2002-04-22	Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems

## 4 Equipment under test (EUT)

### 4.1 Identification of equipment under test

Equipment under test (EUT):

Description: Ground Penetrating Radar System.

Manufacturer: Malå Geoscience

Model name: 250 MHz Shielded antenna.

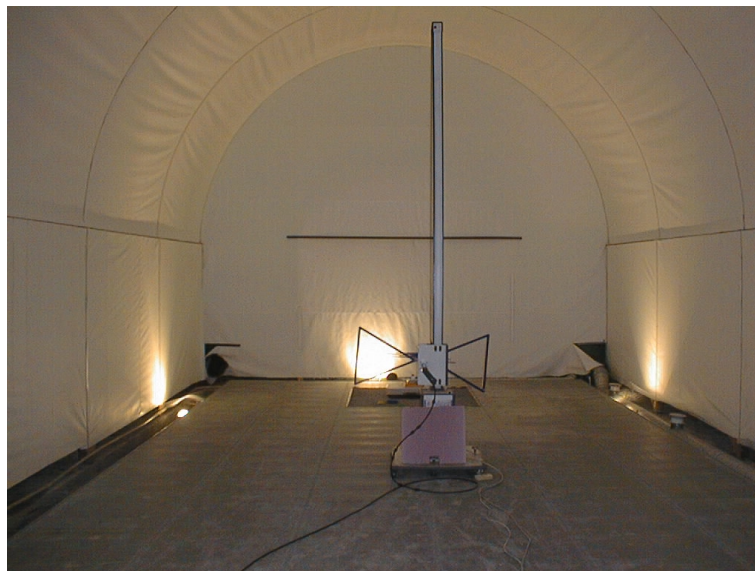
Build state: Production sample

Serial no: 4864

### 4.2 Test site

#### 4.2.1 Description

The measurements were all performed on a weather protected open area test site that was modified with a flat sand bed located in the ground plane. The sand bed is about 50 cm deep.



*Picture 1: Test Site*

The measurement distance antenna – EUT was 1 and 3 m. The measurement system and related equipment were placed next to the test site.

#### 4.2.2 Ambient signals

A number of ambient signals were detected in the different frequency ranges measurement was made, some of those are listed below.

Mobile telephones: 460 – 470 MHz, 937 – 945 MHz  
FM broadcasts: 87 – 108 MHz  
Television: 60 – 70 MHz, 650 – 800 MHz  
Radar system: 1.3 GHz

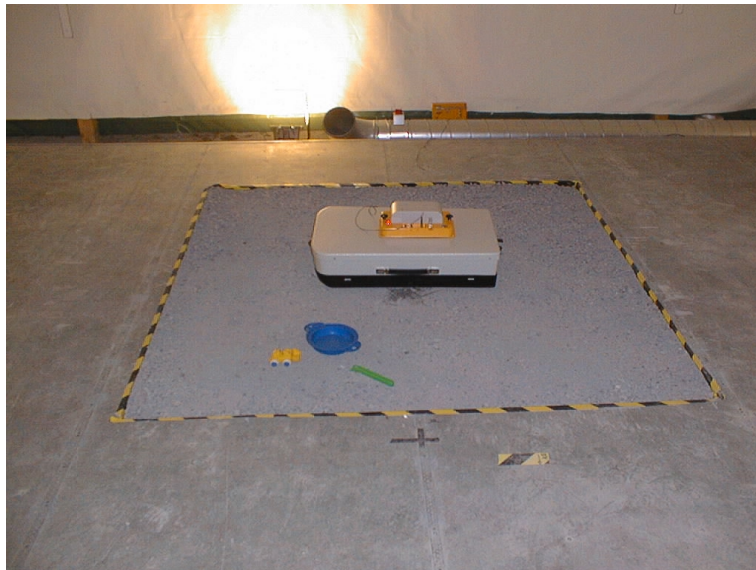
In addition many signals of short-term duration were found. Each measurement signal close to or above the limit was examined if ambient or related to the EUT.

#### 4.3 General configuration of EUT

The EUT was powered by a battery.

The EUT was connected with the control unit with a fiber optical cable.

The EUT was placed directly on the dry sand with no ground plane under it.



*Picture 2: EUT setup on sand bed*

#### 4.4 Operation of EUT during tests

The EUT was gathering data like in normal operation.

## 5 Emission

### 5.1 Measurement of radiated emission

#### 5.1.1 Requirements according to FCC 15.509 (d) and (e)

Radiated emission from the EUT shall not exceed the limit as specified below.

Frequency range	Limit	Limit*
960 – 1610 MHz	-65.3 dBm EIRP	29.9 dB $\mu$ V/m
1610 – 1990 MHz	-53.3 dBm EIRP	41.9 dB $\mu$ V/m
1990 – 10000 MHz	-51.3 dBm EIRP	43.9 dB $\mu$ V/m

Frequency range	Limit	Limit*
1164 – 1240 MHz	-75.3 dBm EIRP	19.9 dB $\mu$ V/m
1559 – 1610 MHz	-75.3 dBm EIRP	19.9 dB $\mu$ V/m

\* Converted to field strength level at 3 meters according to FCC 15.521 (g)

#### 5.1.2 Procedures

The radiated emission was measured on an Open Area Test Site (OATS) as described in 4.2.1 with 1 meters measuring distance.

According to the provisions of FCC 15.509 (d) and (e) the emissions should be compared with an average limit measured with a RMS detector.

These measurements were made with a peak detector.

The following resolution bandwidths and video bandwidths were used during the measurement

Frequency range	RBw	VBw
960 – 5000 MHz	1 MHz	3 MHz
1164 – 1240 MHz	1 kHz	1 kHz
1559 – 1610 MHz	1 kHz	1 kHz

Because the measurements were made at 1 meters distance a correction factor (9.5 dB) have been applied to the limits.

The measurements were made with the EUT in 8 different positions on the sand bed and the antenna position was changed as well as its polarization.

A sweep of the frequency range was made at each position and the resulting max field strength level was plotted.

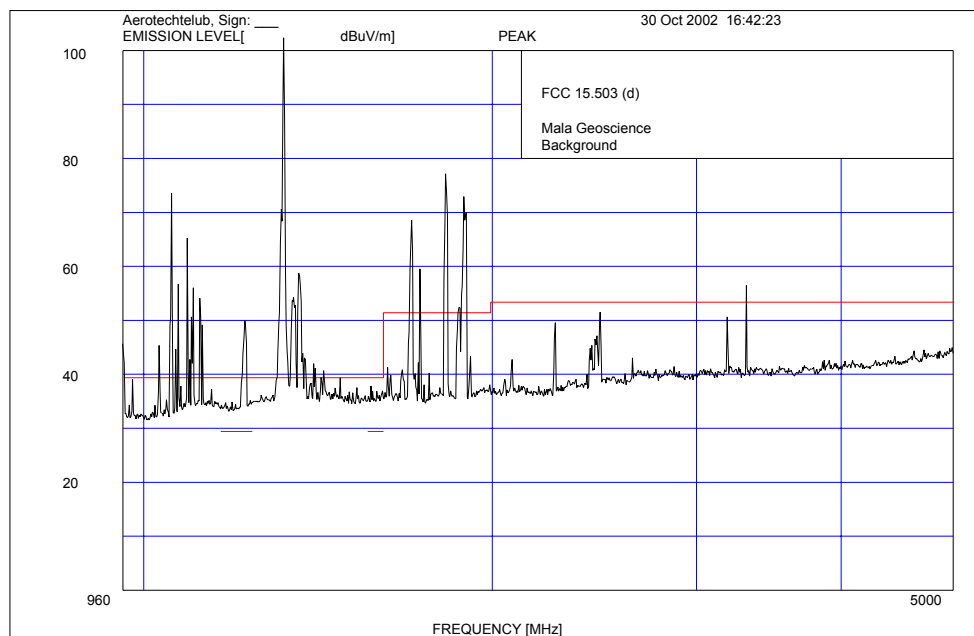
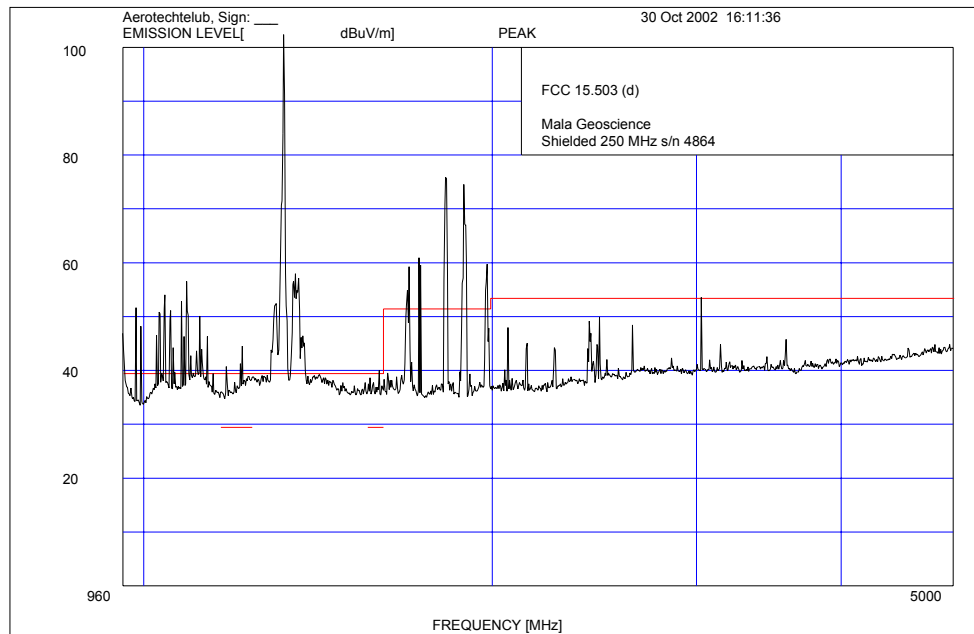
After the sweeps the max radiated field strength were controlled manually due to the high number of ambients.

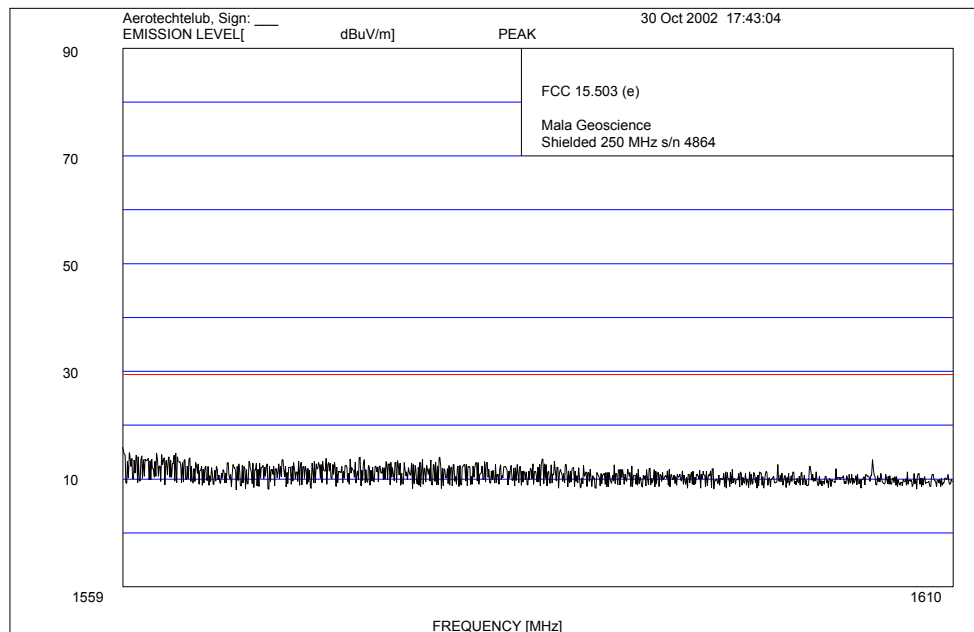
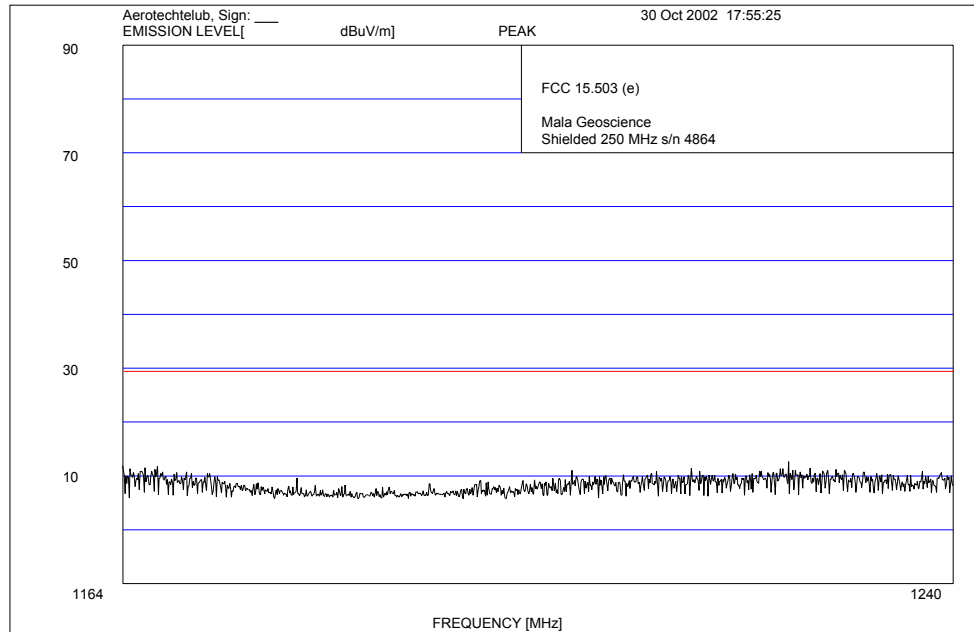
### **5.1.3 Results**

Given measured values are valid for the described arrangement and operation of the EUT.

The EUT complied with the requirement of radiated emission specified in FCC 15.509 (d) and (e) in the frequency range 960 – 5000 MHz when measured with a peak detector.







#### 5.1.4 Measurement uncertainty

For the test site used no calculations exists.

#### 5.1.5 Instrumentation

Hewlett Packard Spectrum analyzer	8566B	100 Hz - 22 GHz	2404A08864 / 2504A01320
Hewlett Packard Pre-amplifier	8449B	1 GHz - 26.5 GHz	3008A00103
Emco Double Ridge Waveguide	3115	1 GHz - 18 GHz	2800

## 5.2 Measurement of UWB bandwidth and peak emissions

### 5.2.1 Requirements according to FCC 15

#### 5.2.1.1 Definition according to FCC 15.503 (a)

The UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including antenna.

#### 5.2.1.2 Requirements according to FCC 15.509 (a)

The UWB bandwidth of an imaging system operating under the provisions of this section must be below 960 MHz.

#### 5.2.1.3 Requirements according to FCC 15.509 (f)

There is a limit on the peak level of emission contained within a 50 MHz bandwidth centered on  $f_M$ . That limit is 0 dBm EIRP. According to the provisions in 15.521 the limit is converted to field strength level in 3 MHz bandwidth.

### 5.2.2 Procedures

The equipment was placed on the test site described under paragraph 4.2.1 and the radiated emission was measured at 3 meters.

The measurements were made with the EUT in 8 different positions on the sand bed and the antenna position was changed as well as its polarization resulting in 32 different sweeps of the frequency range.

The diagrams show the peak field strength from these sweeps.

At the peak of emission ( $f_M$ ) the emissions was manually measured with a resolution bandwidth of 3 MHz.

### 5.2.3 Results

Given measured values are valid for the described arrangement and operation of the EUT.

The EUT complied with the requirement in FCC 15.509 (a) and (f).

#### According to 15.509 (a)

From the diagrams below the following data was gathered and calculated.

Frequency of highest emission  $f_M$ : 201 MHz

Upper boundary  $f_H$ : 321 MHz

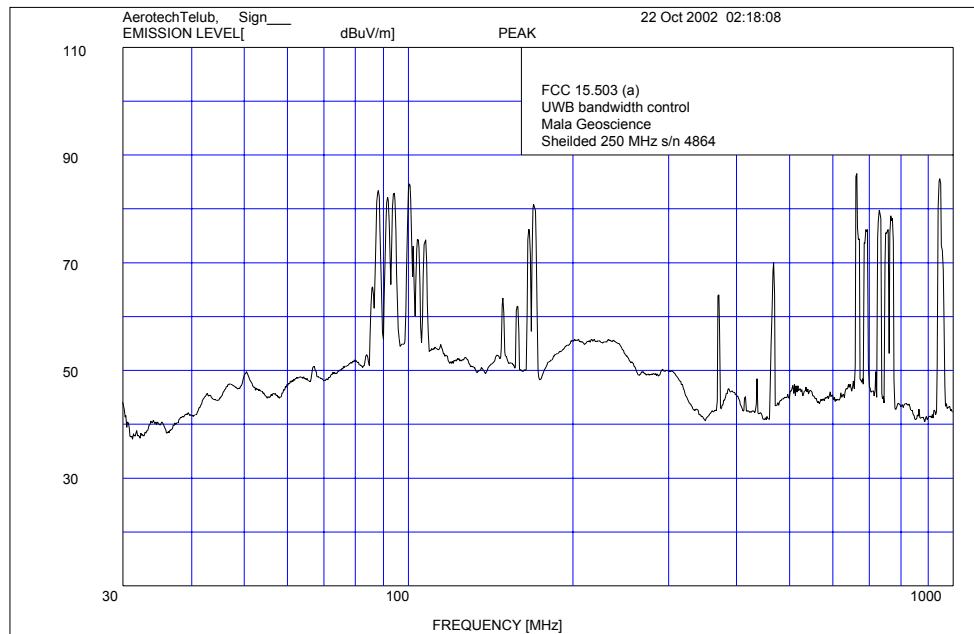
Lower boundary  $f_L$ : 58 MHz

Center frequency  $f_C$ : 189.5 MHz

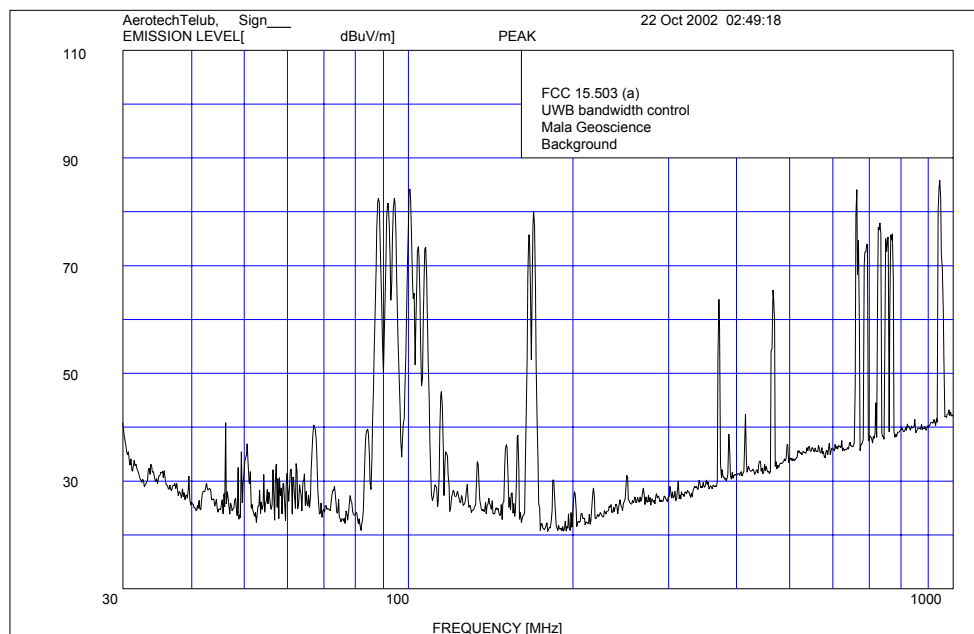
Fractional bandwidth: 1.38

#### According to 15.509 (f)

Emission at  $f_M$ :  
Radiated emission 63.7 dB $\mu$ V/m  
Limit 70.8 dB $\mu$ V/m  
Margin 7.1 dB



## Background



#### 5.2.4 Instrumentation

Hewlett Packard Spectrum analyzer	8566B	100 Hz - 22 GHz	2404A08864 / 2504A01320
Chase Bilog antenna	CBL6111A	30 - 1000 MHz	1164