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STS 014

FCC Registration Number: 0018535302

## EMC Test Report

Number, Revision: PB PST 2505, Revision 2

Date: November 23rd, 2010

Client: Leica Geosystems AG  
 Heinrich-Wild-Strasse  
 CH-9435 Heerbrugg

Equipment under Test: Tornado CS15

Magnitude of Test: EMC-Tests according to the 2004/108/EC harmonized standards:



- EN 61000-6-2: 2005 (Immunity for industrial environments)
- EN 61000-6-3: 2007 (Emission for residential, commercial and light-industrial)
- ETSI EN 301 489-1 V1.8.1 (Part 1: Common technical requirements)
- ETSI EN 301 489-7 V1.3.1 (Part 7: Specific conditions for GSM and DCS)
- ETSI EN 301 489-17 V2.1.1 (Part 17: Specific conditions for Broadband Data Transmission Systems)
- FCC requirements Subpart B of CFR 47 – Part 15 : 2008 for Class B

Result of Test: **The equipment under test (EUT) is in conformance to all requirements mentioned above.**

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Distribution List: Client (Original), PST2, Archive

Function	Department	Name	Signature	Date
Test engineer	PST2	Daniel Rufer		23.11.10
Technical Manager	PST2	U. von Känel		23.11.2010

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## Table of contents

<b>1</b>	<b>GENERAL</b>	<b>3</b>
1.1	TEST LABORATORY	3
1.2	CLIENT	3
1.3	EQUIPMENT UNDER TEST (EUT)	3
1.4	CHARACTERISTICS OF THE EUT	5
1.4.1	<i>Short Description of the EUT</i>	5
1.4.2	<i>Interfaces and operating conditions</i>	5
1.4.3	<i>Operating conditions of the EUT for the tests (active condition)</i>	6
1.4.4	<i>Clock frequencies in the EUT</i>	6
1.5	TEST REQUIREMENTS AND RESULTS	7
1.5.1	<i>References</i>	7
1.5.2	<i>Assembly of test requirements and results</i>	8
1.5.3	<i>Compliance criteria for immunity tests</i>	10
1.5.4	<i>Exclusion bands</i>	10
1.5.5	<i>Test environment</i>	10
1.6	TEST REPORT SUMMARY	10
1.7	MODIFICATIONS	10
1.8	COMMENTS	10
<b>2</b>	<b>TESTS</b>	<b>11</b>
2.1	EMISSION	11
2.1.1	<i>Measurement of the Electromagnetic Field</i>	11
2.2	IMMUNITY	15
2.2.1	<i>Electrostatic Discharge (ESD) (EN 61000-4-2)</i>	15
2.2.2	<i>Radiated Electromagnetic Field (EN 61000-4-3)</i>	18

# 1 General

## 1.1 Test Laboratory

Albis Technologies Ltd - Certification Laboratory

Head of Certification Laboratory:

Technical Manager:

Test site:

Mr. A. Gnehm

Mr. U. von Känel

Certification Laboratory Albis Technologies Ltd.

Albisriederstrasse 199

CH-8047 Zürich

## 1.2 Client

Address:

Leica Geosystems AG

Heinrich-Wild-StrasseLeica Geosystems AG

CH-9435 Heerbrugg

Contact Person:

Mr. Hanspeter Schär

Phone number +41(0)71 727 3563

## 1.3 Equipment Under Test (EUT)

Supplier:

same address as client

Manufacturer:

same address as client

### Identification:

Type:

Tornado CS15

Serial. No.

1500183

Device number:

013

Leica Art. No.

781600

Firmware

FW 2.97 (1357)



Photo 1: EUT Tornado CS15

**Auxiliary equipment AE for all measurements and tests:**

Power Supply EUT	GlobTek, Inc. GT-41052-1512 12VDC / 1.25 A
GPS-Sensor	GS15
GPS-Antenna	Leica AX1203+
Pre-Amplifier	Mini-Circuits ZFBT-4R2G-FT
RCS Radio	Leica TCPS28R
GSM Antenna	GAT3
LogPer Antenna	Schwarzbeck USLP9142

Method of sampling:	1 of 1 EUT delivered by client
State of the EUT	Prototype
Delivery date of EUT	July 19, 2010
Date of tests	July 16 until 29, 2010

## 1.4 Characteristics of the EUT

### 1.4.1 Short Description of the EUT

The EUT is a rugged IP67 (waterproof, etc.) handheld computer with keyboard and display. It is equipped with acoustic interface (microphone and loudspeaker) and three different radio systems in the 2.4 GHz ISM band:

- Wireless LAN
- Bluetooth
- RCS (2.4 GHz spread spectrum OEM module)

The EUT is also equipped with an GSM/UMTS Module from TELIT UC864-G.

The EUT may be equipped with two different types of connector modules, both containing a USB Host interface, power jack (12 VDC in) and contacts for a docking station.

The EUT is powered by batteries or by a standard power supply adapter.

The EUT may be used outdoors.

The EUT is intended to be used in geodesy applications.

### 1.4.2 Interfaces and operating conditions

Port Type	Description
AC Power Port	None
DC Power Port	12 V power in from standard AC/DC power adapter
Signal Ports	USB 2.0 / USB-Host HS / Type A connector USB 2.0 / USB-OTG HS / Lemo connector
Telecommunication Ports	None
Earth Connection	None
Enclosure	Plastic Housing

### Power Consumption

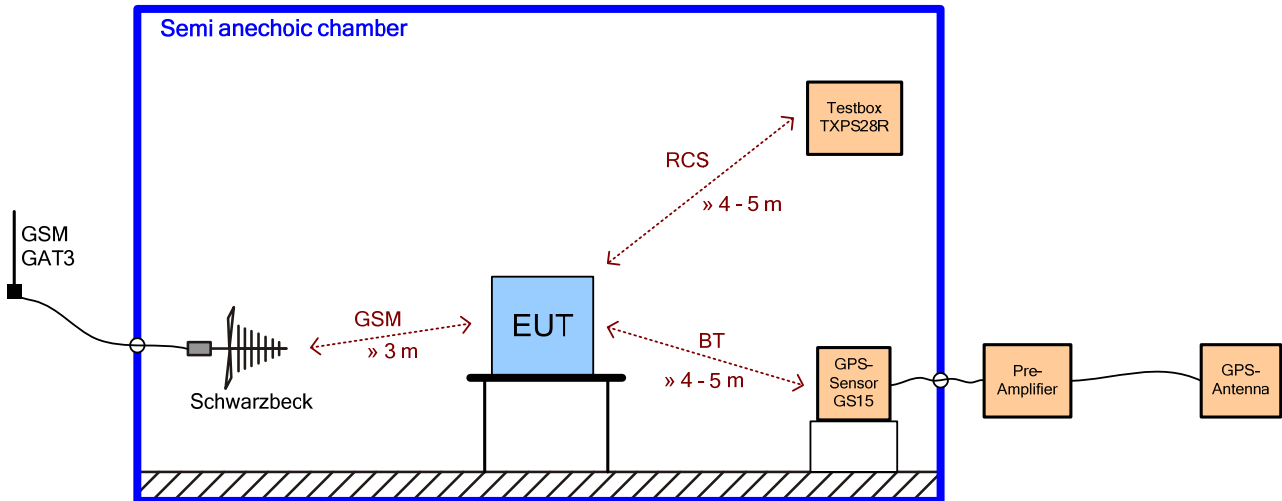
Mode	Definition	Power Consumption
On	The appliance is connected to a power source and fulfils a main function, including the provision of signals to supported devices	< 1 A

### 1.4.3 Operating conditions of the EUT for the tests (active condition)

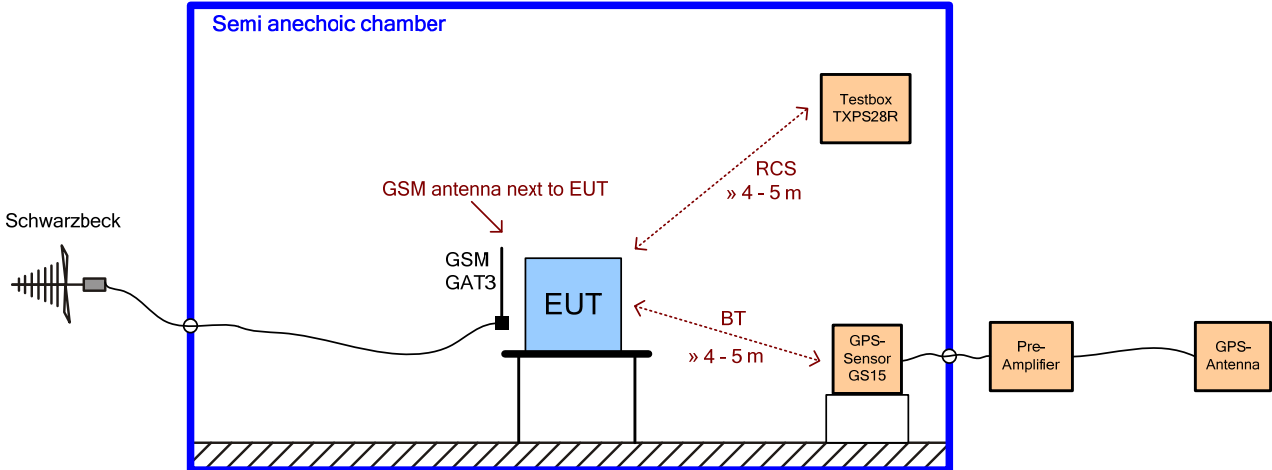
The EUT is performing simultaneous data communication over three types of wireless interfaces:

- Bluetooth Connection to receive position data from GPS Receiver GS15
  - GSM connection to receive correction data from a reference GPS Receiver
  - loopback connection from RCS Module to external Radio TCPS28R
- and data transmission from SD-Card over USB-OTG to Laptop with ActiveSync connection

#### Setup RE:



#### Setup RI:



### 1.4.4 Clock frequencies in the EUT

Component, Part	Frequency
SD-RAM clock	133 MHz
CPU main clock	26 MHz
Display clock	26.6 MHz
USB system clock	60 MHz

## 1.5 Test requirements and results

### 1.5.1 References

Standard	Description
ETSI EN 301 489-1: V1.8.1 (2008)	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
ETSI EN 301 489-7: V1.3.1 (2005)	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
ETSI EN 301 489-17: V2.1.1 (2009)	Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment; Part 17: Specific conditions for Broadband Data Transmission Systems
EN 61000-6-2: 2005	Electromagnetic compatibility (EMC) - Generic standards - Immunity for industrial environments
EN 61000-6-3: 2007	Electromagnetic compatibility (EMC) - Generic standards - Emission standard for residential, commercial and light-industrial environments
EN 55022: 2006 + A1:2007	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
EN 61000-3-2: 2006	Electromagnetic compatibility (EMC) - Limits - Limits for harmonic current emissions (equipment input current < 16 A per phase)
EN 61000-3-3:2008	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current < 16 A per phase and not subjected to conditional connection
EN 61000-4-2:2009	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test
EN 61000-4-3:2006 + A1:2008	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-4: 2004	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
EN 61000-4-5: 2006	Electromagnetic Compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
EN 61000-4-6:2009	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques; Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-4-8:1993 + A1:2001	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques; Power frequency magnetic field immunity test
EN 61000-4-11: 2004	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests
FCC Part 15 : 2008	FCC requirements Subpart B of CFR 47 – Part 15 : 2008 for Class B

## 1.5.2 Assembly of test requirements and results

Emission requirements according to 2004/108/EC harmonized standards EN 61000-6-3 Electromagnetic compatibility (EMC) - Generic standards Emission standard for residential, commercial and light-industrial environments		
Test	Standard / Limit	Result
<b>Stationary interference voltage on the operational voltage terminals</b> V-Network 0.15 – 30 MHz <b>AC mains port</b>	EN 55022 Class B, Chap. 5.1, Tab. 2	<b>Not tested</b> Note 1
<b>Current harmonics on the operational voltage terminals</b> <b>AC mains port</b>	EN 61000-3-2 Class A	<b>Not tested</b> Note 1
<b>Voltage fluctuations and flicker on the operational voltage terminals</b> <b>AC mains port</b>	EN 61000-3-3	<b>Not tested</b> Note 1
<b>Radiated E-Field, horizontal and vertical polarized</b> E-Field-Antennas 30 – 1000 MHz <b>EUT with all cables</b>	EN 55022 Class B, Chap. 6, Tab. 6	<b>PASS</b>

### Notes:

- 1) Tested in Pb2259



Immunity requirements according to 2004/108/EC harmonized standard EN 61000-6-2 Generic immunity standard for industrial environments			
Test	Standard / Test level	Compliance Criteria	Result
<b>Electrostatic discharge (ESD)</b> – indirect on coupling plane with contact discharge – direct on case with air and contact discharge <b>EUT with all cables</b>	EN 61000-4-2  <b>4 kV Cont. / 8 kV Air</b>	<b>B</b>	<b>PASS</b>
<b>Radiated electromagnetic field</b> 80 – 1000 MHz, 80%AM (1 kHz) <b>EUT with all cables</b>	EN 61000-4-3  <b>10 V/m</b>	<b>A</b>	<b>PASS</b>
<b>Radiated electromagnetic field</b> 1.4 – 2.0 GHz, 80 % AM (1 kHz) 2.0 – 2.7 GHz, 80 % AM (1 kHz) <b>EUT with all cables</b>	EN 61000-4-3  <b>3 V/m</b> <b>1 V/m</b>	<b>A</b> <b>A</b>	<b>PASS</b> <b>PASS</b>
<b>Fast Transients (Burst)</b> Common Mode, 5/50 ns, Repetition frequency 5 kHz <b>AC mains port</b> <b>Signal ports (L &gt; 3 m)</b>	EN 61000-4-4  <b>2 kV</b> <b>1 kV</b>	<b>B</b> <b>B</b>	<b>Not tested</b> Note 1
<b>Slow transients (Surges)</b> Pulse form 1.2/50 µs <b>AC mains port</b> <b>Signal ports (L &gt; 30 m)</b> <b>Screened signal lines</b>	EN 61000-4-5  <b>1 kV (L → N),</b> <b>2 kV (L, N → PE)</b> <b>1 kV (L → PE)</b> <b>1 kV (Screen → PE)</b>	<b>B</b> <b>B</b> <b>B</b> <b>B</b>	<b>Not tested</b> Note 1
<b>Conducted radio frequency</b> 150 kHz - 80 MHz, 1 kHz 80% AM, 150Ω source imp. <b>AC mains port</b> <b>Signal ports (L &gt; 3 m)</b>	EN 61000-4-6  <b>10 V</b> <b>10 V</b>	<b>A</b> <b>A</b>	<b>Not tested</b> Note 1
<b>Power frequency magnetic field immunity test</b> <b>EUT with all cables</b>	EN 61000-4-8  <b>30 A/m</b>	<b>A</b>	<b>Not tested</b> Note 1
<b>Voltage dips and short interruptions</b> Voltage reduction, duration  <b>AC mains port</b>	EN 61000-4-11  <b>0%, 20ms/</b> <b>40%, 200ms/</b> <b>70%, 500ms/</b> <b>0%, 5s</b>	<b>B</b> <b>C</b> <b>C</b> <b>C</b>	<b>Not tested</b> Note 1

**Notes:**

- 1) Tested in Pb2259

### 1.5.3 Compliance criteria for immunity tests

Compliance criteria according to EN 61000-6-2	
<b>A</b>	The EUT shall continue to operate as intended. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the EUT is used as intended.
<b>B</b>	The EUT shall continue to operate as intended after the test. During the test, degradation of performance is however allowed.
<b>C</b>	Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

EUT specific compliance criteria	
<b>A</b>	The data communication over all interfaces including wireless is not stopped and without errors
<b>B</b>	After the test, the EUT shall operate as in normal mode
<b>C</b>	No specific requirement

In any case, the EUT should not be damaged by the tests!

### 1.5.4 Exclusion bands

#### GSM according to ETSI EN 301 489-7

Downlink (Receiver)	935 – 960 MHz	- 6 / + 5 %	878.9 – 1008.0 MHz
	1805 – 1880 MHz	- 6 / + 5 %	1696.7 – 1974.0 MHz
Uplink (Transmitter)	890 – 915 MHz	± 600 kHz	889.4 – 915.6 MHz
	1710 – 1785 MHz	± 600 kHz	1709.4 – 1785.6 MHz

#### RCS, WLAN and Bluetooth according to ETSI EN 301 489-17

WLAN	2.400 – 2.4835 GHz	± 5 %	2.5200 – 2.60768 GHz
Bluetooth	2.402 – 2.4800 GHz	± 5 %	2.2819 – 2.60400 GHz

### 1.5.5 Test environment

Variable	Requirement	Actual values during the test	Complied
Mains	207 – 253 VAC	220 – 240 VAC	Yes
Temperature	15 – 35 °C	22 – 26 °C	Yes
Relative humidity (RH)	25 – 75 %	50 – 60 %	Yes
Air pressure	860 – 1060 hPa	960 – 970 hPa	Yes

Remark: For ESD test see requirements and actual values in the test description.

## 1.6 Test report summary

The EUT mentioned in chapter 1.3 with the modifications according to chapter 1.7 is in conformance with the EMC requirements indicated in the chapter 1.5.

## 1.7 Modifications

None

## 1.8 Comments

The test report applies exclusively to the EUT specified in chapter 1.3 of this document.

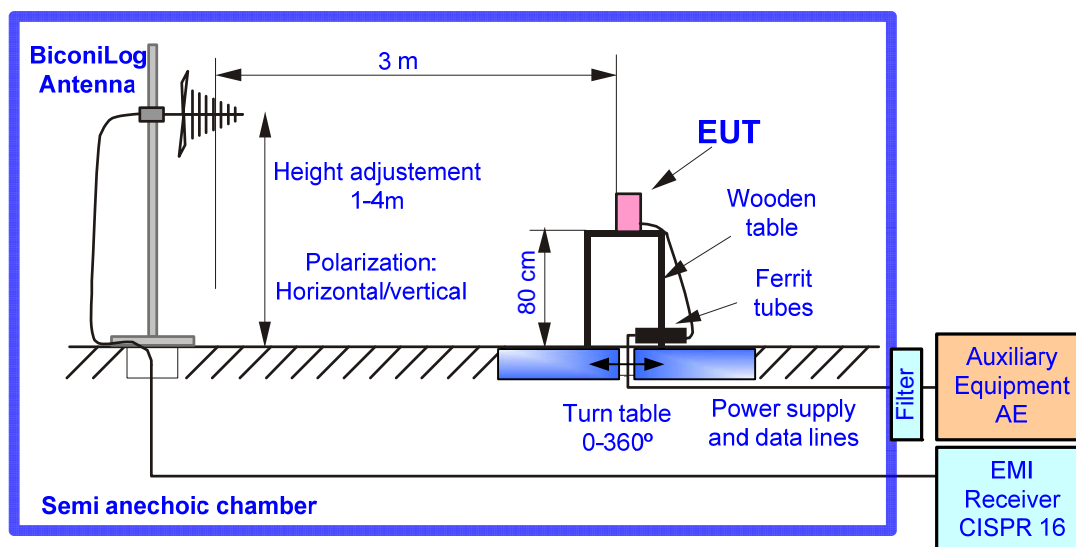
The EUT has been already tested in Pb2259. The current report contains additional tests with activated GSM module.

## 2 Tests

### 2.1 Emission

#### 2.1.1 Measurement of the Electromagnetic Field

##### Measurement setup



The boundary of the EUT is defined by an imaginary cylinder with its centre in the middle of the turntable encompassing all intersystem ITE components under test and all ITE intersystem cables. The horizontal distance between cylinder and antenna is 3 m. For the correct arrangement of the measurement see EN 55022.

##### Test equipment

Device Type	Brand	Type	ID
Antenna	Chase	CBL 6112B	H9728
Spectrum Analyzer	Rohde & Schwarz	ESU 8	OA10193
Coaxial Cables	Huber & Suhner	--	H10010-H10011-H10012-H10013
Antenna tower & turn table	Maturo	MS32	--

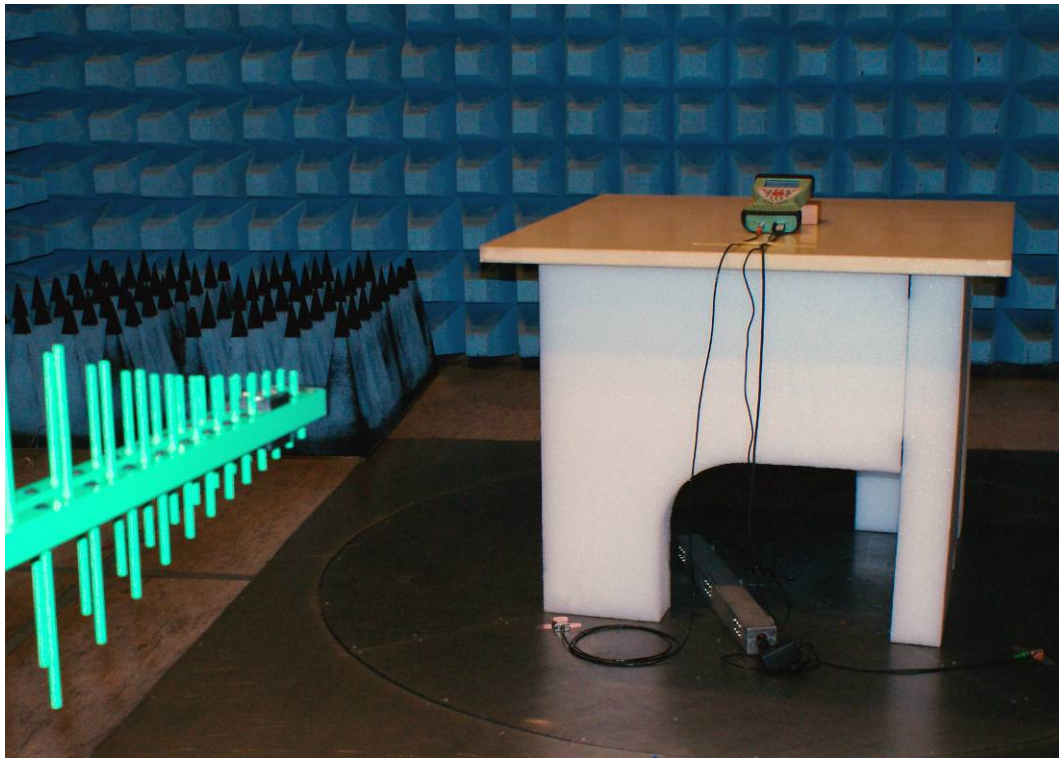
##### Process of the measurement

The radiated electromagnetic field is measured around the EUT at a height of 1 m to 4 m with the antenna on vertical and horizontal polarization.

The following diagrams show the result of the Peak measurement and the Quasi-Peak limit. At the six highest disturbances, where the Peak value exceeds the 12 dB margin to the Quasi-Peak limit, a measurement with the Quasi-Peak detector is carried out and the result is listed in the table below the diagram. Because of the shortened measurement distance (3 m instead of 10 m) the limit line is converted according to the actual distance of 3 m by adding 10 dB to the limit.

##### Result of the measurement

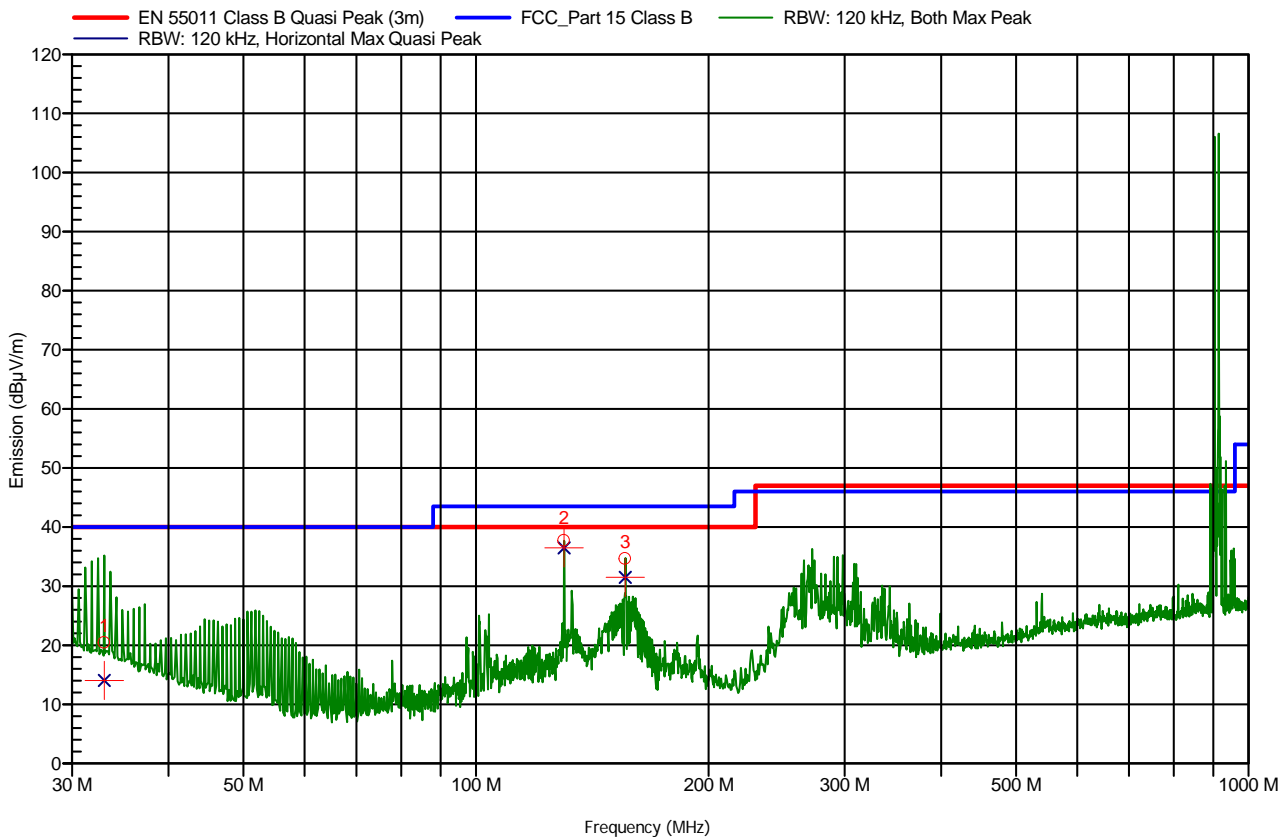
The EUT is in conformance with the requirements.



**Photo 2: Measurement setup for radiated Emission**

**Measurement protocol**

<b>EUT</b>	Tornado CS15		
<b>Verdict, Test</b>	PASS Test 15: ESU8_30M-1G EN 55011 Class B 3m Antenna 1-4m 360Grad		
<b>Modification</b>	None		
<b>Cables, Notes</b>	--		
<b>Mode of operation</b>	see chapter 1.4.3		
<b>Test date, time</b>	July 16, 2010, 17:26:09		
<b>Antenna height</b>	100 cm - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 359 Degree (rotating)	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	RBW: 120 kHz, VBW: Auto [500 kHz], Sweep time: Auto [120 ms], Step freq: Fixed step count: 2 * 1e+3 steps per Band, Attenuator: 0 dB, Internal preamp: 20 dB, Measure time: Auto [120 ms], Measurement equipment: RE_30M-2GHz_ESU8_Inp1_CBL6112B_Rec		

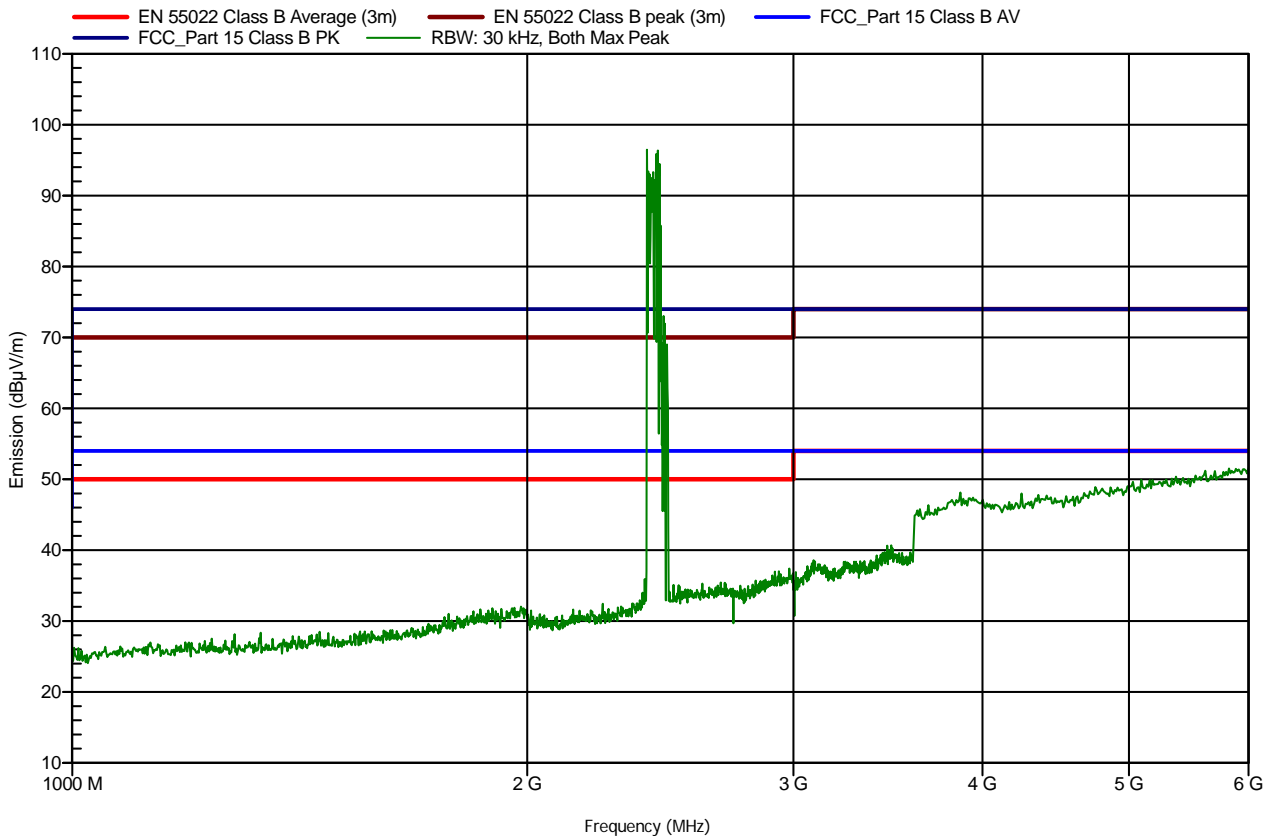


Note: Exclusion band according to chapter 1.5.4

**Detected peaks**

Nr	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Status	Angle	Height	Polarization
1	33.029 MHz	20.42 dBµV/m	14.03 dBµV/m	-25.97 dB	Pass	275 Degree	3 m	Horizontal
2	130 MHz	37.69 dBµV/m	36.47 dBµV/m	-3.53 dB	Pass	263 Degree	2 m	Horizontal
3	156.01 MHz	34.62 dBµV/m	31.49 dBµV/m	-8.51 dB	Pass	67 Degree	2 m	Horizontal

<b>EUT</b>	Tornado CS15		
<b>Verdict, Test</b>	PASS Test 10: ESU8_1G-6G EN 55022 Class B 3m Antenna 1-4m 4steps		
<b>Modification</b>	None		
<b>Cables, Notes</b>	--		
<b>Mode of operation</b>	see chapter 1.4.3		
<b>Test date, time</b>	July 16, 2010, 14:50:23		
<b>Antenna height</b>	100 cm - 4 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree to 359 Degree (rotating)	<b>Antenna distance</b>	3 m
<b>Measurement settings</b>	RBW: 30 kHz, VBW: Auto [30 kHz], Sweep time: Auto [0 ms], Step freq: Fixed step count: 2 * 1e+3 steps per Band, Attenuator: 0 dB, Internal preamp: 0 dB, Measure time: Auto [120 ms], Measurement equipment: RE_1-8GHz_ESU8_Inp1_Rec_EMCO3115		



Note: Exclusion band according to chapter 1.5.4

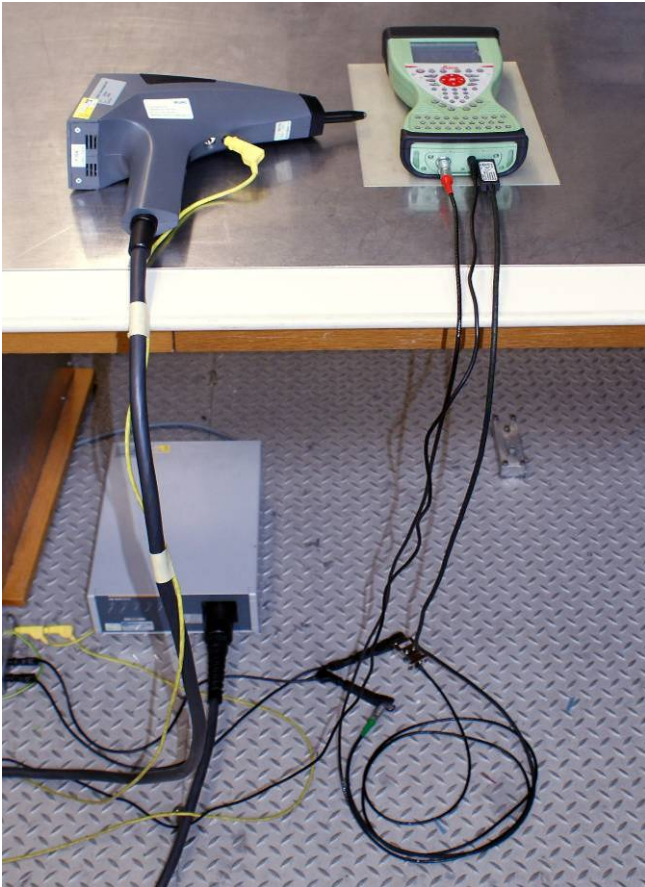
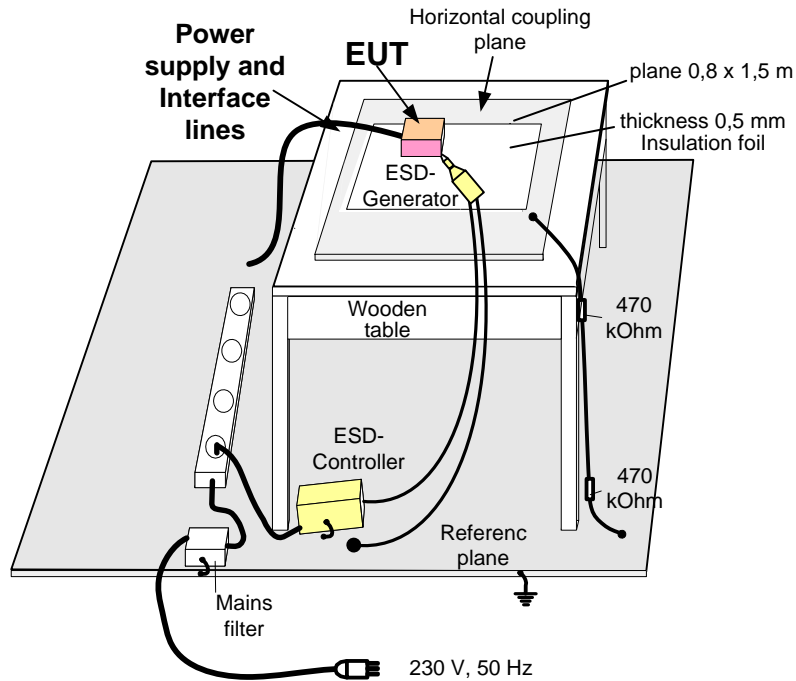
**Detected peaks**

None

## 2.2 Immunity

### 2.2.1 Electrostatic Discharge (ESD) (EN 61000-4-2)

#### Test setup for tabletop equipment



**Photo 3: Setup of the ESD Test**

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## Environment

Variable	Requirement	Actual values during the test	Complied
Mains	207 – 253 VAC	207 – 253 VAC	Yes
Temperature	15 – 35 °C	24 °C	Yes
Relative humidity (RH)	30 – 60 %	55 %	Yes
Air pressure	860 – 1060 hPa	965 hPa	Yes

## Test equipment

Device Type	Brand	Type	ID
ESD Generator	EM-Test	ESD 30N	PE10238

<b>EUT:</b>	Tornado CS15		
<b>Connected:</b>	All cables		
<b>Operating mode:</b>	Active condition, see chap. 1.4.3		
<b>Compliance criteria (see chap. 1.5.3):</b>	<b>Voltage:</b>	<b>EN 61000-6-2:</b>	<b>Compliance Criterion:</b>
	Indirect contact discharge	± 4 kV	B
	Contact discharge	± 4 kV	B
	Air discharge	± 8 kV	B
<b>Function surveillance:</b>	Visual observation		

## Protocol of the test

<b>Mode of operation:</b>	Active condition, see chap. 1.4.3
<b>Indirect contact discharge:</b>	<b>Performance of the EUT:</b>
<b>Points of discharges:</b>	On horizontal coupling plane
± 2 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 4 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 6 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 8 kV (Note 1)	No degradation noticed, EUT is in conformance to the compliance criteria A

<b>Mode of operation:</b>	Active condition, see chap. 1.4.3
<b>Contact discharge:</b>	<b>Performance of the EUT:</b>
<b>Points of discharges:</b>	On conductive metal parts of the EUT: metallic parts of the connectors
± 2 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 4 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 6 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 8 kV (Note 1)	No degradation noticed, EUT is in conformance to the compliance criteria A

<b>Mode of operation:</b>	Active condition, see chap. 1.4.3
<b>Direct air discharge:</b>	<b>Performance of the EUT:</b>
<b>Points of discharges:</b>	On non conductive parts of the EUT: case
± 2 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 4 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 6 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 8 kV	No degradation noticed, EUT is in conformance to the compliance criteria A
± 10 kV (Note 1)	No degradation noticed, EUT is in conformance to the compliance criteria A
± 12 kV (Note 1)	No degradation noticed, EUT is in conformance to the compliance criteria A
± 15 kV (Note 1)	No degradation noticed, EUT is in conformance to the compliance criteria A

Notes:

- 1) Over-testing requested by customer



### Uncertainty of measurement

Voltage level: (rectangular distribution)

1 digit

I<sub>max</sub> first current peak: (rectangular distribution)

± 10 %

Rise time t<sub>r</sub> of the discharge current with discharge relay: (rectangular distribution)

± 17,6 %

The uncertainty does not affect the compliance to the requirement.

### Result of the test

The EUT is **in conformance** with the requirements.

## 2.2.2 Radiated Electromagnetic Field (EN 61000-4-3)

### Test setup

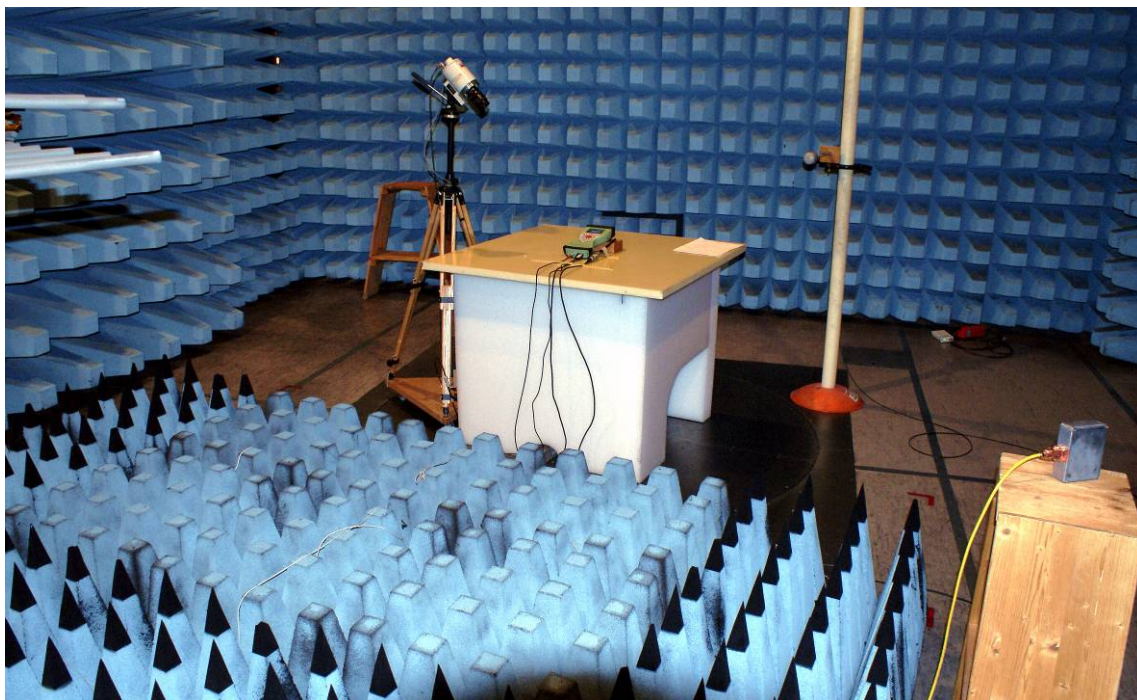
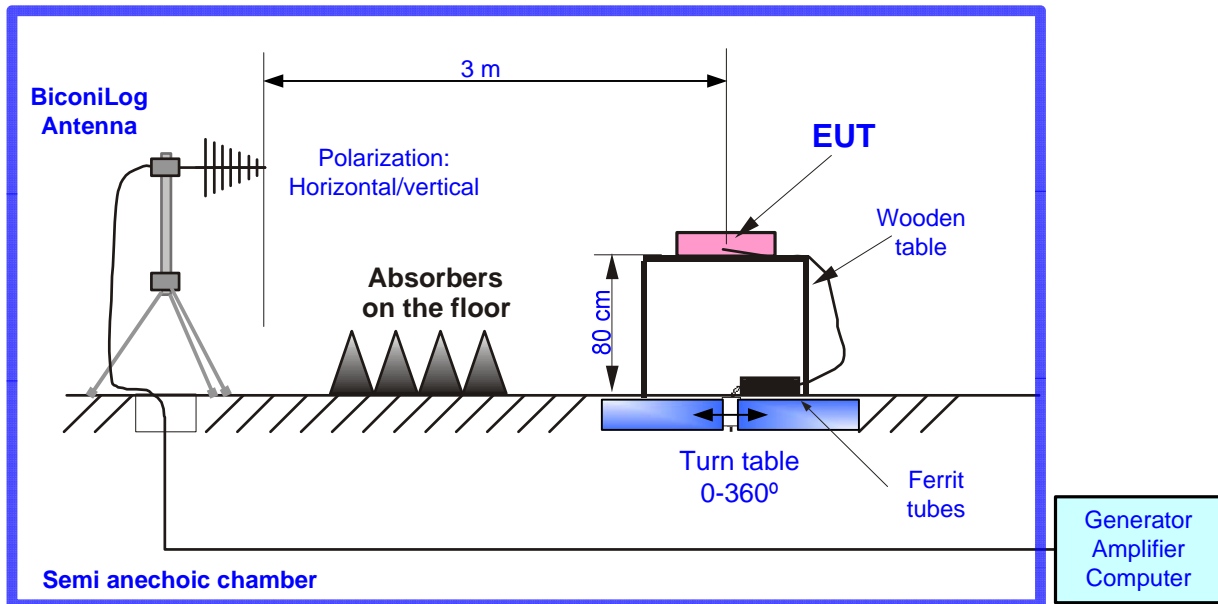


Photo 4: Measurement setup for radiated Immunity

### Test equipment

Device Type	Brand	Type	ID
Signal Generator	Rohde & Schwarz	SML 03	GF9921
Amplifier 80 – 1000 MHz	Amplifier Research	100W1000BM1	V8169
Amplifier 1 – 3 GHz	Amplifier Research	50S1G4	V9671
Antenna	Amplifier Research	AT 6080	H10192
Field Sensor	PMM	OR03 + EP330	H9676

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<b>EUT:</b>	Tornado CS15		
<b>Connected:</b>	All cables		
<b>Test setup:</b>	EUT is on the table 80 cm above ground plane		
<b>Operating mode:</b>	Active condition, see chap. 1.4.3		
<b>Compliance criteria (see chap. 1.5.3):</b>	<b>Field strength:</b>	<b>EN 61000-6-2:</b>	<b>Compliance Criterion:</b>
	10 V/m	80 – 1000 MHz	A
	3 V/m	1.4 – 2.0 GHz	A
	1 V/m	2.0 – 2.7 GHz	A
<b>Function surveillance:</b>	Visual observation		

<b>Settings of the test equipment</b>			
<b>Frequency range:</b>	80 – 1000 MHz 1.4 – 2.7 GHz	<b>Height of the antenna:</b>	1.62 m / 1.48 m 1.32 m
<b>Frequency step:</b>	1 %	<b>Amplitude modulation:</b>	80 % with 1 kHz
<b>Polarization:</b>	Horizontal, Vertical	<b>Dwell time:</b>	1 s
<b>Side of EUT to antenna:</b>	Front, Rear, Left, Right		

### Protocol of the test

<b>Mode of operation:</b>	Active condition, see chap. 1.4.3		
<b>Frequency range:</b>	<b>Test Voltage:</b>	<b>Performance of the EUT:</b>	
80 – 1000 MHz	10 V/m	No degradation noticed, EUT conforms to the compliance criteria A	
1.0 – 3.0 GHz	10 V/m	No degradation noticed, EUT conforms to the compliance criteria A	

### Uncertainty of measurement

The uncertainty of measurement is: (normal distribution, k=2)

± 26 %

The uncertainty does not affect the compliance to the requirement.

### Result of the test

The EUT is **in conformance** with the requirements.