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**STS 0001**

Schweizerischer Prüfstellendienst  
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Swiss testing service



Report:	<b><i>Electromagnetic Compatibility</i></b>	Report no:	<b><i>17-EL-0175.E01</i></b>
Test item description:	<b><i>NB800-LWWtSu: LTE, WLAN &amp; USB (Base) NB800-LWWtScSu: Base &amp; RS232/485 &amp; DIO NB800-LWWtSu2C: Base &amp; DualCAN</i></b>	Date of test:	<b><i>January 26 – February 20, 2018</i></b>
Applicant:	<b><i>NetModule AG Meriedweg 11 3172 Niederwangen bei Bern SWITZERLAND</i></b>	Model/Type reference:	<b><i>NB800-LWWtSu2C</i></b>
Manufacturer:	<b><i>NetModule AG Meriedweg 11 3172 Niederwangen bei Bern SWITZERLAND</i></b>	Serial no:	<b><i>00112B01D00B</i></b>
Trade mark:	<b><i>NetModule AG</i></b>		

Standards		Result
<b>UN ECE R10:2014</b>	Regulation No. 10 Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility	<b>PASS</b>

Test performed by  
*Mr. Peter Stillhard*  
EMC Test-Engineer

Reviewed by  
*Mr. Pascal Treichler*  
Head Albislab

*Peter Stillhard*

*P. Treichler*

**Zürich, 12.03.2018**

**(Issue Date)**

The present document results from tests on one specimen and does not prejudice to the conformity of all the manufactured products.

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# 1 Summary of Test Results (UN ECE R10)

Emission Tests for Electric Subassembly (ESA) according to Regulation UN ECE R10 :2014		
Test	Limit	Result
<b>Radiated E-Field</b> Appendix VII (Broadband disturbances, Quasi peak) Appendix VIII(Narrowband disturbances, Average) Test setup according to EN 55025 Measurement distance 1 m E-Field-Antenna 30 - 1000 MHz <i>EUT with all cables</i>	Broadband limits according to Regulation R10, chapter 6.5.2.1 and Appendix 6  Narrowband limits according to Regulation R10, chapter 6.6.2.1 and Appendix 7	<b>PASS</b>
<b>Conducted emission disturbances</b> Annex X (transient disturbances, Peak-Values) Test setup according to ISO 7637-2  <i>Power supply lines</i>	limits according to Regulation R10, chapter 6.7.1 and Annex 10, for 12 V- und 24 V-Systems	<b>N/A</b> <b>Note 1</b>

**Note 1: Not Applicable**, due to paragraph 8.5: Conducted emission: ESA's that are not switched, contain no switches or do not include inductive loads need not be tested for conducted emission and shall be deemed to comply with paragraph 6.9 of this Annex.

## Remark:

The Broadband and the narrowband limits of the radiated emission are not equal to the corresponding limits of EN 55025.

Immunity tests for Electric subassembly (ESA) according to Regulation UN ECE R10:2014			
Electric subassembly (ESA) may comply with the requirements of any combination of the following test methods at the manufacturers discretion provided that this results in the full frequency range with the following modulation methods are covered 20 – 800 MHz: Amplitude Modulation AM 80% (1 kHz) 800 – 2000 MHz: Pulse Modulation PM 217.34 Hz, Duty cycle 12.5%			
Test	Standard / Test level	Compliance Criteria	Result
Radiated electromagnetic field (Absorber-lined shielded enclosure) Appendix IX Test setup according to ISO 11452-2:2004 Distance of Antenna: 1 m; 20 - 2000 MHz Antenna vertical polarization  <b>EUT with all cables</b>	Limits according to Regulation R10, chapter 6.8.2.1 30 V/m in over 90% of the frequency band and 25 V/m over the whole band	<b>A</b>	<b>Pass</b>
BCI, Bulk current injection Appendix IX Test setup according to ISO 11452-4:2005 20 - 400 MHz  <b>EUT with all cables</b>	Limits according to Regulation R10, chapter 6.8.2.1 60 mA in over 90% of the frequency band and 50 mA over the whole band	<b>A</b>	<b>Note 2</b>
Stripline 150 mm Appendix IX Test setup according to ISO 11452-5:2005 20 - 400 MHz (expanded to 1000 MHz)  <b>EUT with all cables</b>	Limits according to Regulation R10, chapter 6.8.2.1 60 V/m in over 90% of the frequency band and 50 V/m over the whole band	<b>A</b>	<b>Pass</b>

**Note 2: The EUT has 'immunity-related functions', the tests have to be applied.**

Immunity Tests for Electric Subassembly (ESA) according to Regulation UN ECE R10 :2014		
Test	Limit	Result
<b>Supply lines</b>		
Test pulse No. 1	24 V Systems: Level III : -450 V	<b>PASS</b>
Test pulse No. 2a	24 V Systems: Level III : +37 V	<b>PASS</b>
Test pulse No. 2b	24 V Systems: Level III : +20 V	<b>PASS</b>
Test pulse No. 3a	24 V Systems: Level III : -150 V	<b>PASS</b>
Test pulse No. 3b	24 V Systems: Level III : +150 V	<b>PASS</b>
Test pulse No. 4	24 V Systems: Level III : -12 V	<b>PASS</b>

## 2 Applied Standards

EN 55025:2016 CISPR 25:2016	Radio disturbance characteristics for the protection of receivers used on board vehicles, boats and on devices – Limits and methods of measurement
ISO 7637-2:2011	Road vehicles — Electrical disturbances from conduction and coupling – Part 2: Electrical transient conduction along supply lines only
ISO 7637-3:2007	Road vehicles – Electrical disturbances from conduction and coupling – Part 3: Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines
ISO 11452-1:2015	Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 1: General principles and terminology
ISO 16750-2:2006	Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 2: Electrical loads
UN ECE R10:2014	Regulation No. 10 Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility

### 3 Abbreviations

Electromagnetic compatibility and radio spectrum matters:

AC	Alternating current
AFA	Adaptive Frequency Agility
AM	Amplitude Modulation
AV	Average
BW	Bandwidth
CDN	Coupling Decoupling Network
CW	Continuous Wave
d(t)	Relative voltage change characteristic
DAA	Detect And Avoid spectrum access technique
dB	Decibel
dBi	Gain in decibels relative to an isotropic antenna
DC	Direct current
DL	Downlink
dmax	Maximum relative voltage change
DSSS	Direct Sequence Spread Spectrum
e.i.r.p.	equivalent isotropic radiated power
EMC	ElectroMagnetic Compatibility
ERC	European Radiocommunication Committee
ESD	Electro Static Discharge
EUT	Equipment under Test
FHSS	Frequency Hopping Spread Spectrum
GBSAR	Ground Based Synthetic Aperture Radar
GRP	Ground reference plane
GTEM	Gigahertz Transverse ElectroMagnetic cell
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ISM	Industrial Scientific Medical (frequency band)
ITU-R	International Telecommunications Union, Radio Sector
ITU-T	International Telecommunications Union, Telecommunications Sector
L1,L2,L3	Phase
LBT	Listen Before Talk
LISN	Line impedance stabilization network
MDS	Absorbing measuring clamp
MU	Master Unit
N	Neutral
NRI	National Radio Interfaces
PE	Protective earth
PK	Peak
Pit	Long-term flicker indicator
PM	Pulse Modulation
Pst	Short-term flicker Indicator
R&TTE	Radio and Telecommunications Terminal Equipment
RF	Radio Frequency
RFID	Radio Frequency Identification
RU	Remote Unit
SCU	System Control Unit
SF-CW	Step Frequency Continuous Wave (spread spectrum)
SND/ND	Signal + Noise + Distortion divided by Noise + Distortion
SRD	Short Range Device
TEM	Transverse ElectroMagnetic cell
TETRA	Terrestrial Trunked Radio
Tx	Transmitter
UL	Uplink
UWB	Ultra Wide Band
VSWR	Voltage Standing Wave Ratio

General vocabulary: <http://www.electropedia.org>

## 4 Applicant

<i>Client name and address</i>	NetModule AG Meriedweg 11 3172 Niederwangen bei Bern SWITZERLAND
<i>Contact Person</i>	Michael Enz
<i>Telephone</i>	+41 31 985 25 93
<i>E-mail</i>	Michael.enz@netmodule.com



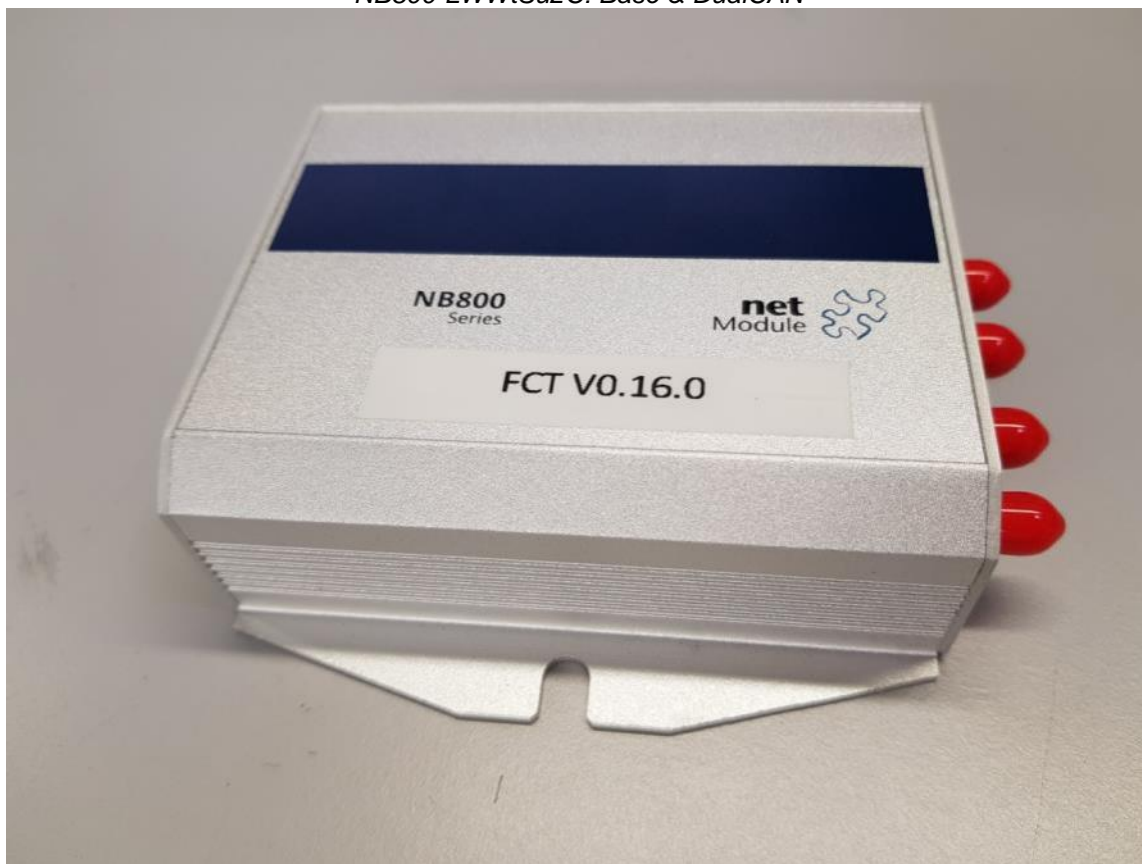
## 5 Equipment Under Test

### 5.1 Identification

Manufacturer name and address	NetModule AG Meriedweg 11 3172 Niederwangen bei Bern																							
Production country	SWITZERLAND																							
Trade mark	NetModule AG																							
Test item description	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN																							
Product description	(Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN																							
Model/type reference	NB800-LWWtSu2C																							
Serial number	00112B01D00B																							
Hardware identification	FCT v0.16.0																							
Software version	FCT v0.16.0																							
Highest frequency	<table><tr><td>CPU Core</td><td>600 MHz</td></tr><tr><td>Crystal Q100</td><td>25 MHz</td></tr><tr><td>CPU DDR3 RAM</td><td>400 MHz</td></tr><tr><td>USB</td><td>480 MHz</td></tr><tr><td>Ethernet</td><td>125 MHz</td></tr><tr><td>eMMC</td><td>48 MHz</td></tr><tr><td colspan="2"> </td></tr><tr><td>DC/DC Main N1400</td><td>750 kHz</td></tr><tr><td>DC/DC USB N1401</td><td>1 MHz</td></tr><tr><td>DC/DCGSM N900</td><td>1.5 MHz</td></tr><tr><td>PMIC U1500</td><td>2.4 MHz</td></tr></table>		CPU Core	600 MHz	Crystal Q100	25 MHz	CPU DDR3 RAM	400 MHz	USB	480 MHz	Ethernet	125 MHz	eMMC	48 MHz			DC/DC Main N1400	750 kHz	DC/DC USB N1401	1 MHz	DC/DCGSM N900	1.5 MHz	PMIC U1500	2.4 MHz
CPU Core	600 MHz																							
Crystal Q100	25 MHz																							
CPU DDR3 RAM	400 MHz																							
USB	480 MHz																							
Ethernet	125 MHz																							
eMMC	48 MHz																							
DC/DC Main N1400	750 kHz																							
DC/DC USB N1401	1 MHz																							
DC/DCGSM N900	1.5 MHz																							
PMIC U1500	2.4 MHz																							
Supply	12 - 24 VDC P= 5 W																							
Dimension	10.0 cm x 9.0 cm x 3.2 cm (lwxh)																							
Weight	<1000 g																							
Technical documentation	None. The equipment is completely identified by the above-mentioned information. NetModule AG assures the traceability of the documentation and is responsible for the product identification.																							

## 5.2 Pictures of the EUT

*NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO  
NB800-LWWtSu2C: Base & DualCAN*



*EUT*



EUT



EUT

*Marking Plate*

### 5.3 Ports

Port	Cable			Remarks
	Max. length	Type	Screen	
DC	≤ 30 m	2 wires	none	If not stated otherwise, powered with AC/DC power supply of Dr. Widmer
Ethernet 1	≤ 100 m	RJ45 cat 5e	yes	Connected to Test-PC
USB	≤ 3 m	USB	yes	Connected to USB memory stick (for radiated tests connectec with 3 m USB Standard cable) Connected to multiband-antenna
WLAN 1 (Main)	≤ 30 m	SMA ( Coax)	yes	Connected to multiband-antenna
WLAN 2 (Aux)	≤ 30 m	SMA ( Coax)	yes	Connected to multiband-antenna
Mobile 1 (Main) (GSM, UMTS, LTE)	≤ 30 m	SMA ( Coax)	yes	Connected to multiband-antenna
Mobile 2 (Aux) (GSM,UMTS, LTE)	≤ 30 m	SMA ( Coax)	yes	Connected to multiband-antenna
CAN1, CAN2	≤ 100 m		no	3 Wire

#### 5.3.1 Power Specification

Description	Manufacturers specifications
Connection	Plus, Minus
Rated voltage range	12 ...24 VDC
Input power	5 W

## 6 Test Conditions

### 6.1 Climatic conditions, location and date

Location	Date	Temp	Pressure [QFE]	Rel. humidity
Electrosuisse Albislab Albisriederstrasse 199 8047 Zürich SWITZERLAND	January 26, 2018	24 ± 3 °C	987 ± 30 hPa	31 ± 5 %
Continental Automotive Switzerland AG Industriestrasse 18 9464 Rüthi SWITZERLAND	February 20, 2018	22 ± 3 °C	982 ± 30 hPa	25 ± 5 %

### 6.2 Attendant Persons

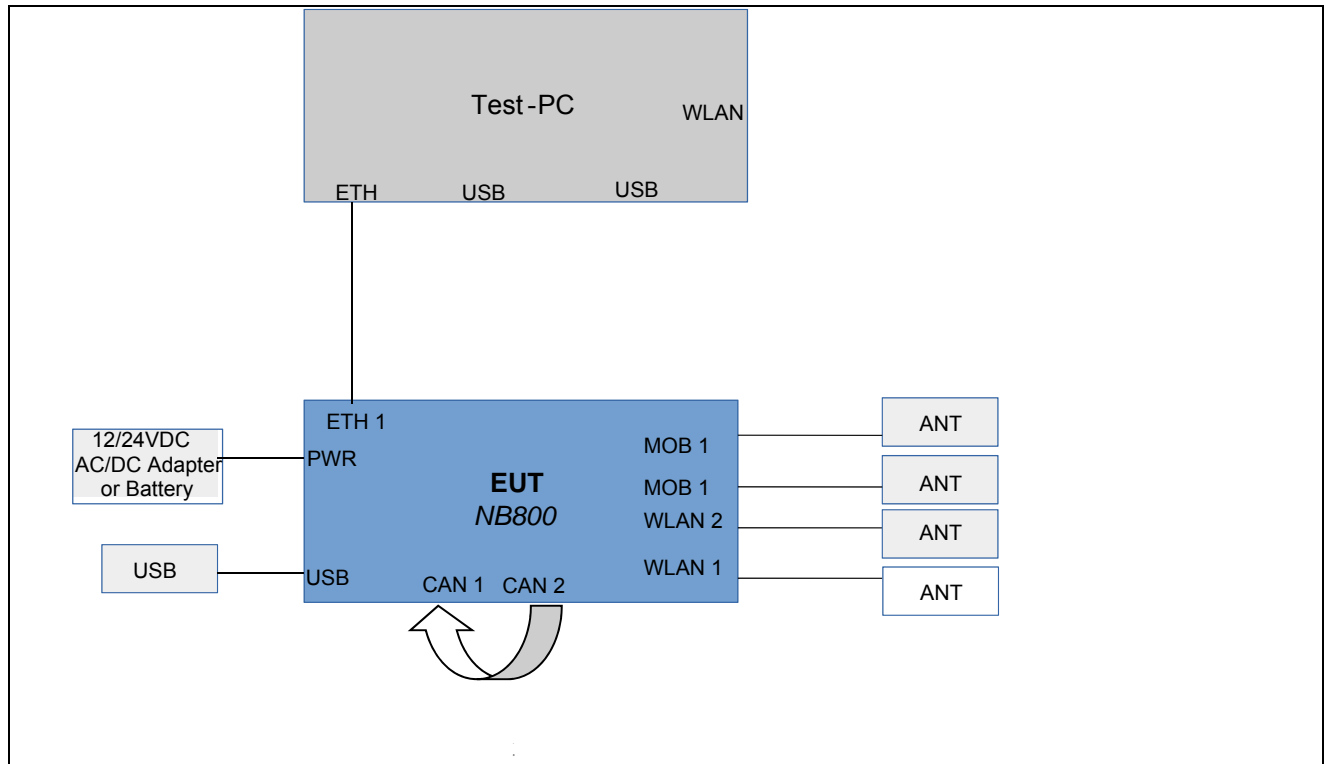
**Test Engineer(s):**

Mr. Peter Stillhard
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**Other(s):**

Name	Company
Nicolas Gugger	NetModule AG

### 6.3 Test Configuration



### 6.4 Operating Conditions

Power supply during tests 12 VDC or 24 VDC from battery  
....

### 6.5 Monitoring of the EUT

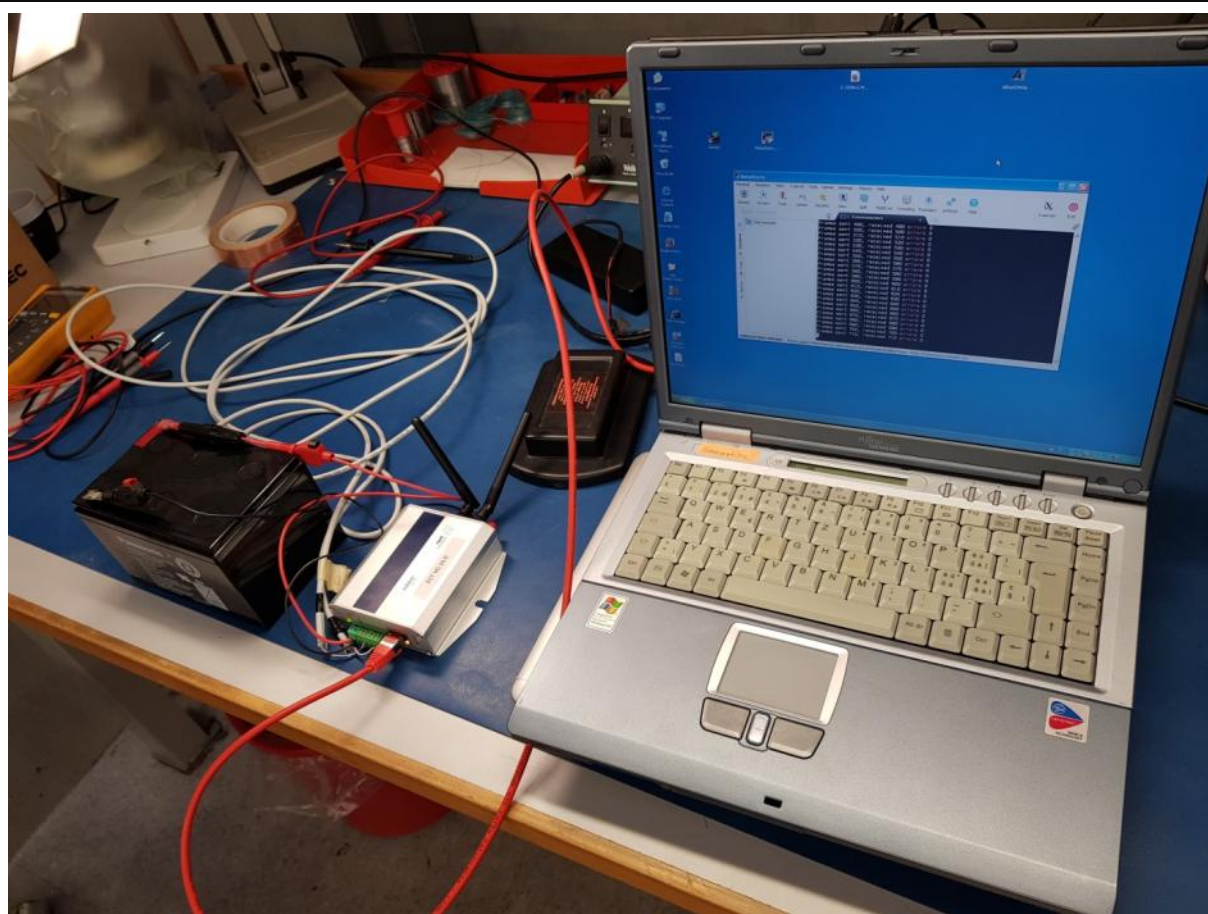
The performance of the EUT during the test is monitored as following:

Visual observation and observation of the teststing wich is allways sent and received.

### 6.6 Auxiliary Equipment

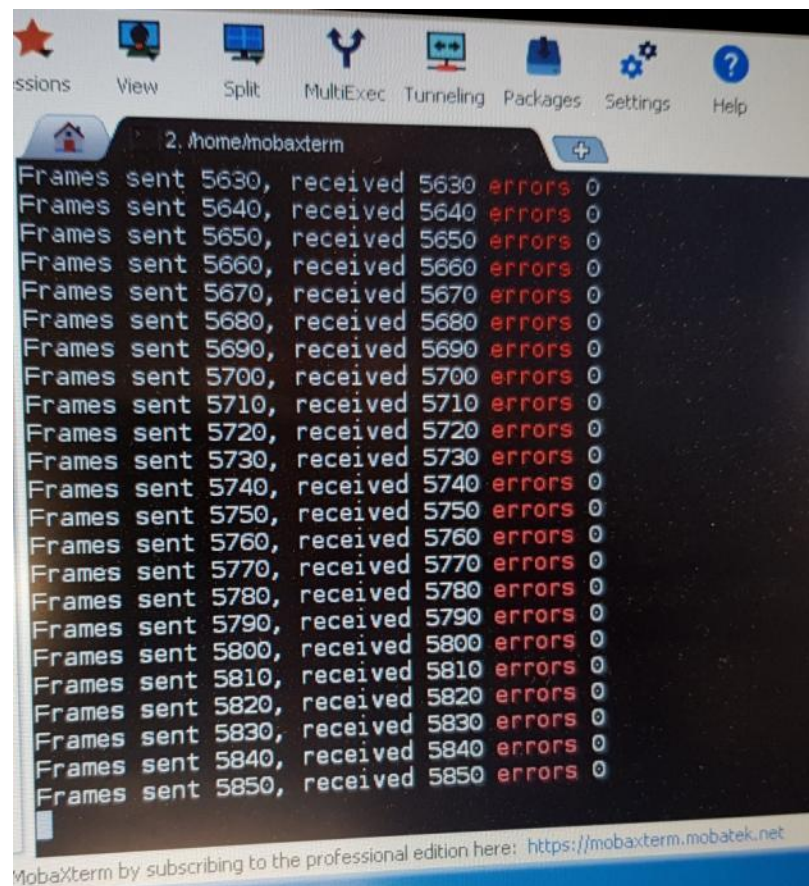
The following pieces of equipment are used for the monitoring of the EUT or are necessary for the EUT but they are not part of the EUT.

Product	Brand	Model No.	ID	Remarks
Laptop	Dell			
Laptop	Fujitsu Siemens	Lifebook E series		



*AE and EUT*





*supervision with terminal program*

## 6.7 Performance Criteria

Compliance criteria according to ISO 11452-1	
<b>A</b>	All functions of a device or system perform as designed during and after exposure to a disturbance.
<b>B</b>	All functions of a device or system perform as designed during exposure; however, one or more of them may go beyond the specified tolerance. All functions return automatically to within normal limits after exposure is removed. Memory functions shall remain class A.
<b>C</b>	One or more functions of a device or system do not perform as designed during exposure but return automatically to normal operation after exposure is removed.
<b>D</b>	One or more functions of a device or system do not perform as designed during exposure and do not return to normal operation until exposure is removed and the device or system is reset by a simple "operator/use" action.
<b>E</b>	One or more functions of a device or system do not perform as designed during and after exposure and cannot be returned to proper operation without repairing or replacing the device or system.

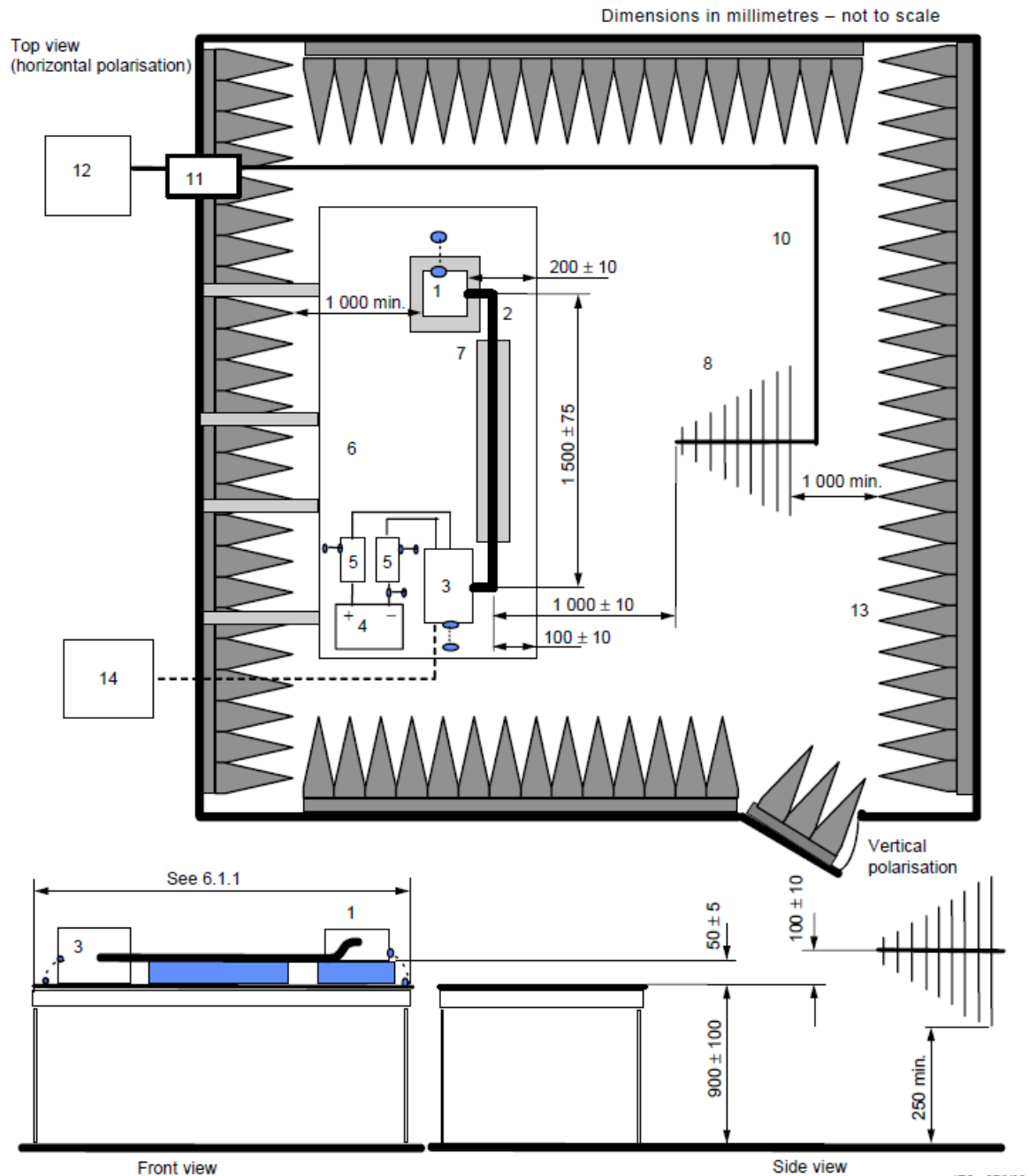
EUT specific compliance criteria	
<b>A</b>	The EUT shall operate in normal mode
<b>B</b>	After the test, the EUT shall operate as in normal mode, during the test one or more functions may be out of tolerance.
<b>C</b>	After the test, the EUT shall operate as in normal mode.
<b>D</b>	No specific requirement
<b>E</b>	No specific requirement

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

## 7 Emission Tests

### 7.1 Measurement of the Electromagnetic Field (Regulation R10, Annex 6 & 7)

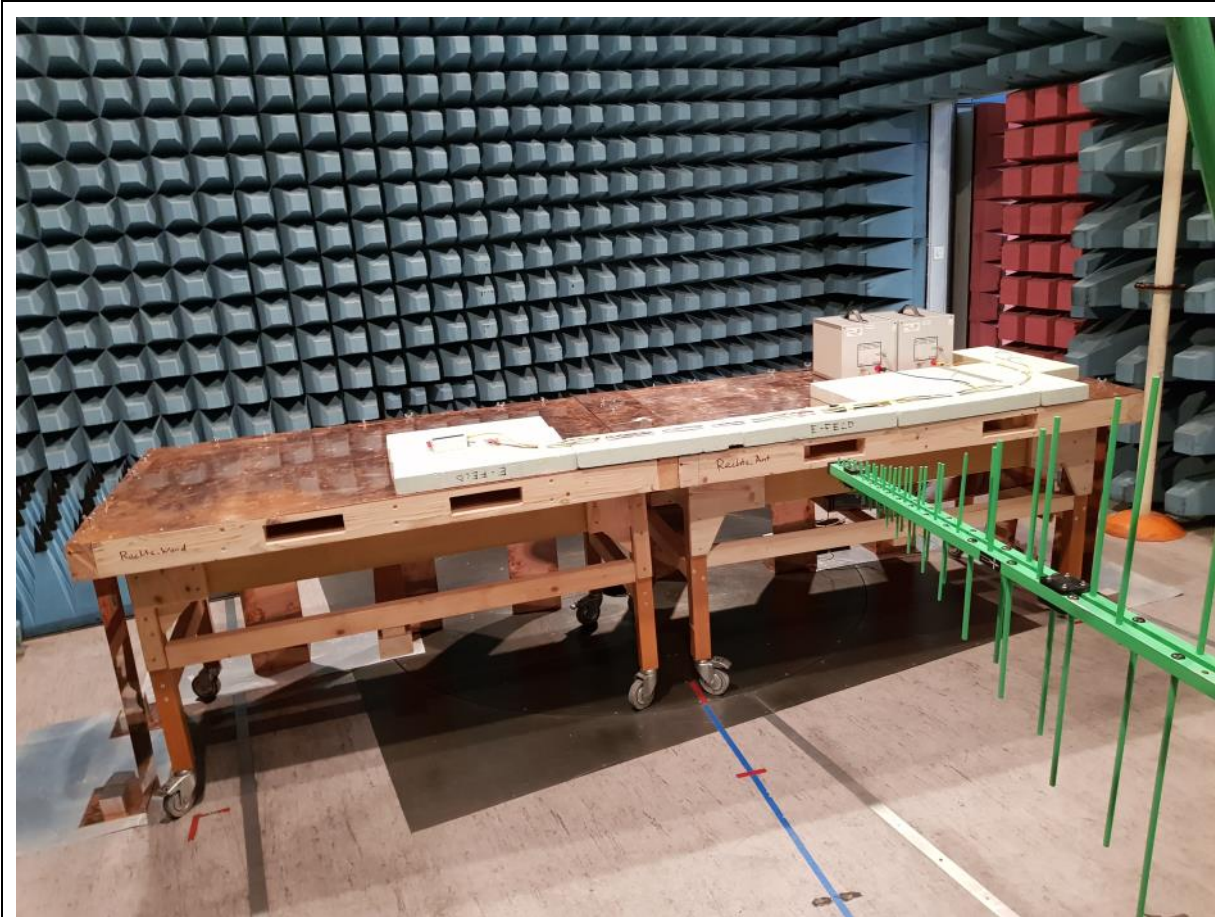
#### Measurement Setup



#### Key

- |   |   |
|---|---|
| 1 EUT (grounded locally if required in test plan)                       | 8 Log-periodic antenna  |
| 2 Test harness  |   |
| 3 Load simulator (placement and ground connection according to 6.4.2.5) | 10 High-quality coaxial cable e.g. double-shielded (50 $\Omega$ ) |
| 4 Power supply (location optional)                                      | 11 Bulkhead connector   |
| 5 Artificial network (AN)   | 12 Measuring instrument   |
| 6 Ground plane (bonded to shielded enclosure)                           | 13 RF absorber material   |
| 7 Low relative permittivity support ( $\epsilon_r \leq 1,4$ )           | 14 Stimulation and monitoring system                              |





**Photo 1: Measurement setup**



**Photo 2: Measurement setup**

### Test Equipment

<i>Device type</i>	<i>Brand</i>	<i>Type</i>	<i>ID</i>
EMI Receiver	Rohde & Schwarz	ESU8	OA 10193
Antenna LogPer	Chase	CBL 6112B	H9695
LISN 5 $\mu$ H/50 $\Omega$	Schwarzbeck	NNBM 8126-A 890	15.6632.01 15.6632.02

### Process of the Measurement

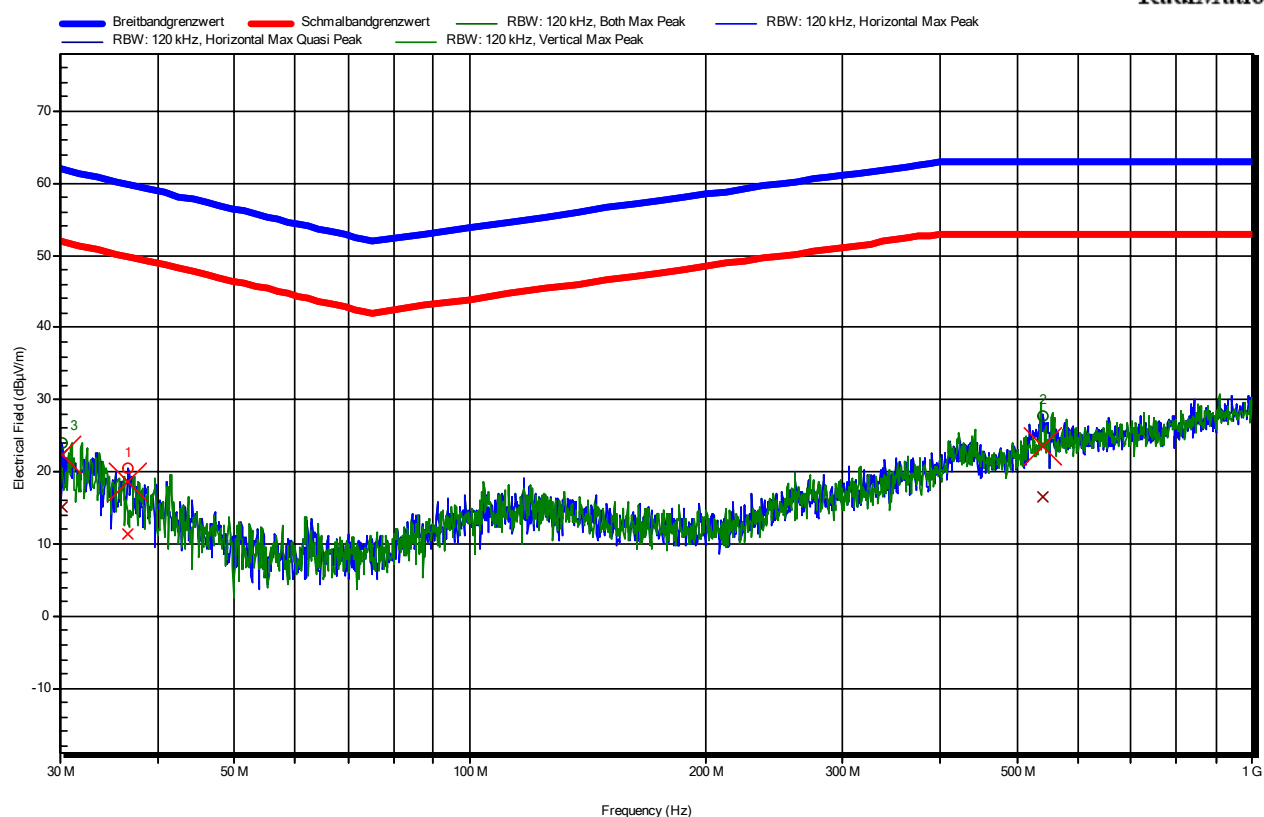
The measurement was carried out in a semi anechoic chamber with a distance of 1 m between antenna and the harness of the EUT. The EUT is placed on a metallic plane. For low DC resistance, every 0.3 m earth straps are placed to connect the metallic plane to the anechoic chamber. The power supply is connected to a LISN with 5  $\mu$ H / 50  $\Omega$  / 50 A. The radiated electromagnetic field was measured at a height of 1 m with the antenna on vertical and horizontal polarization.

The following diagrams shows the result of the Peak measurement. At each frequency point where the Peak value exceeds 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

Diagram 2

EUT	NB800		
Verdict, Test	PASS Test 2: ESW26_30M-1G Kfz		
Modification	None		
Cables, Notes	12 VDC, normal mode		
Mode of operation			
Test date, time	26.01.2018 09:43:56		
Antenna height	1 m - 1 m	Antenna polarization	Vertical/Horizontal
EUT position	0 Degree (stable)	Antenna distance	1 m
Measurement settings	Radimation Version: 2016.2.8, RBW: 120 kHz, VBW: Auto [1 MHz], Sweep time: Auto [20.1 ms], Step freq: Fixed step count: 20001 steps per Band, Attenuator: 0 dB, Internal preamp: 0 dB, Measure time: Auto [120 ms], Measurement equipment: RE_30M-2GHz_ESW26_Inp1_CBL6112B_Rec		

## RadiMation



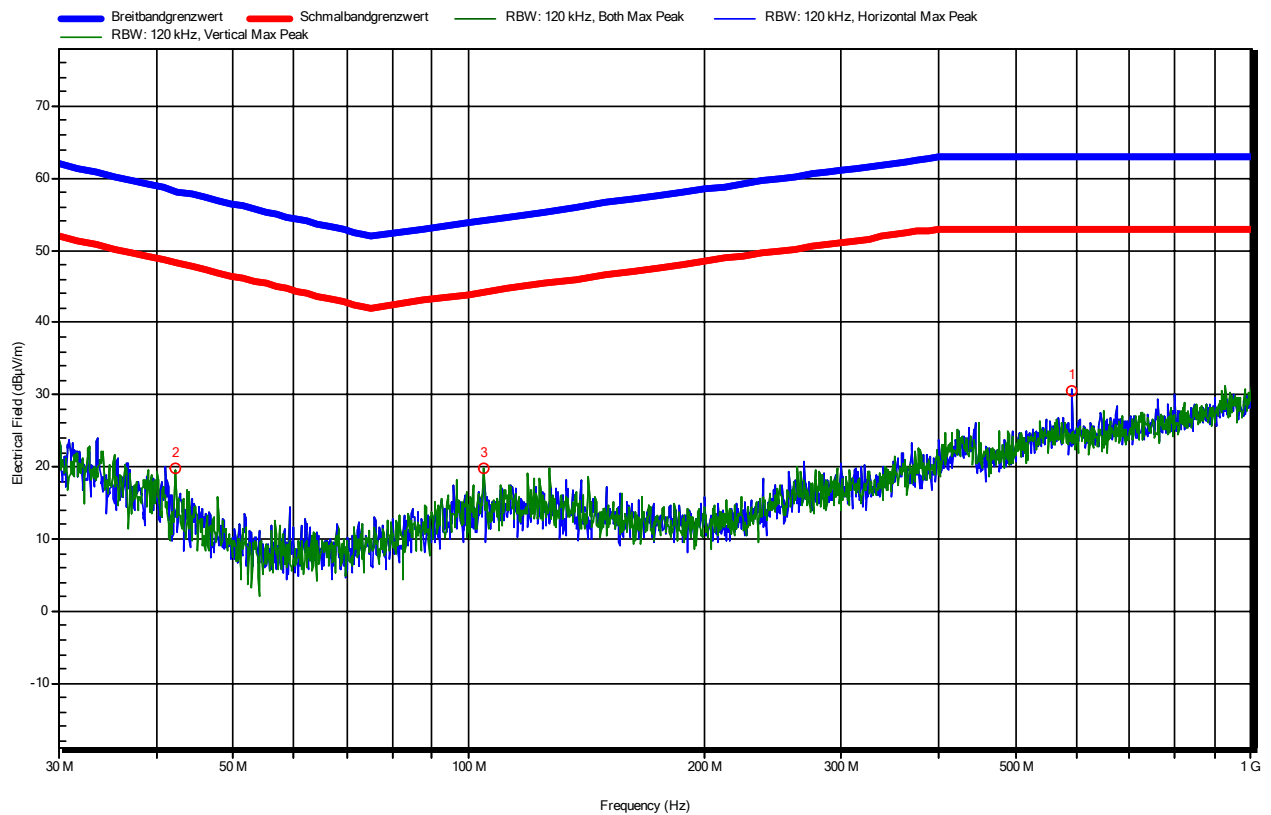
## Detected peaks

Peak Number	Frequency	Peak	Quasi-Peak	Quasi-Peak Difference	Average	Average Difference	Status	Angle	Height	Polarization
1	36.644 MHz	20.45 dBμV/m	18.6 dBμV/m	-41.22 dB	11.5 dBμV/m	-38.32 dB	Pass	0 Degree	1 m	Horizontal
2	539.324 MHz	27.79 dBμV/m	23.53 dBμV/m	-39.47 dB	16.46 dBμV/m	-36.54 dB	Pass	0 Degree	1 m	Horizontal
3	30.243 MHz	23.9 dBμV/m	22.37 dBμV/m	-39.54 dB	15.21 dBμV/m	-36.7 dB	Pass	0 Degree	1 m	Horizontal

## Diagram 1

<b>EUT</b>	NB800		
<b>Verdict, Test</b>	PASS Test 1: ESW26_30M-1G Kfz		
<b>Modification</b>	None		
<b>Cables, Notes</b>	24 VDC, normal mode		
<b>Mode of operation</b>			
<b>Test date, time</b>	26.01.2018 09:21:51		
<b>Antenna height</b>	1 m - 1 m	<b>Antenna polarization</b>	Vertical/Horizontal
<b>EUT position</b>	0 Degree (stable)	<b>Antenna distance</b>	1 m
<b>Measurement settings</b>	Radimation Version: 2016.2.8, RBW: 120 kHz, VBW: Auto [1 MHz], Sweep time: Auto [20.1 ms], Step freq: Fixed step count: 20001 steps per Band, Attenuator: 0 dB, Internal preamp: 0 dB, Measure time: Auto [120 ms], Measurement equipment: RE_30M-2GHz_ESW26_Inp1_CBL6112B_Rec		

## RadiMation



## Detected peaks

Peak Number	Frequency	Peak	Angle	Height	Polarization
1	590.66 MHz	30.58 dBμV/m	0 Degree	1 m	Horizontal
2	42.271 MHz	19.7 dBμV/m	0 Degree	1 m	Vertical
3	104.69 MHz	19.91 dBμV/m	0 Degree	1 m	Vertical

## 8 Immunity Tests

### 8.1 Immunity to Electromagnetic Fields - Stripline (ISO 11452-5)

*Introduction:* The aim of this test is to evaluate the performance of the equipment when in the presence of electromagnetic fields created by the transmission of radio or television, by cellular phones or by any other system producing electromagnetic radiation in continuous waves.

*Meas. uncertainty:* see chapter 9

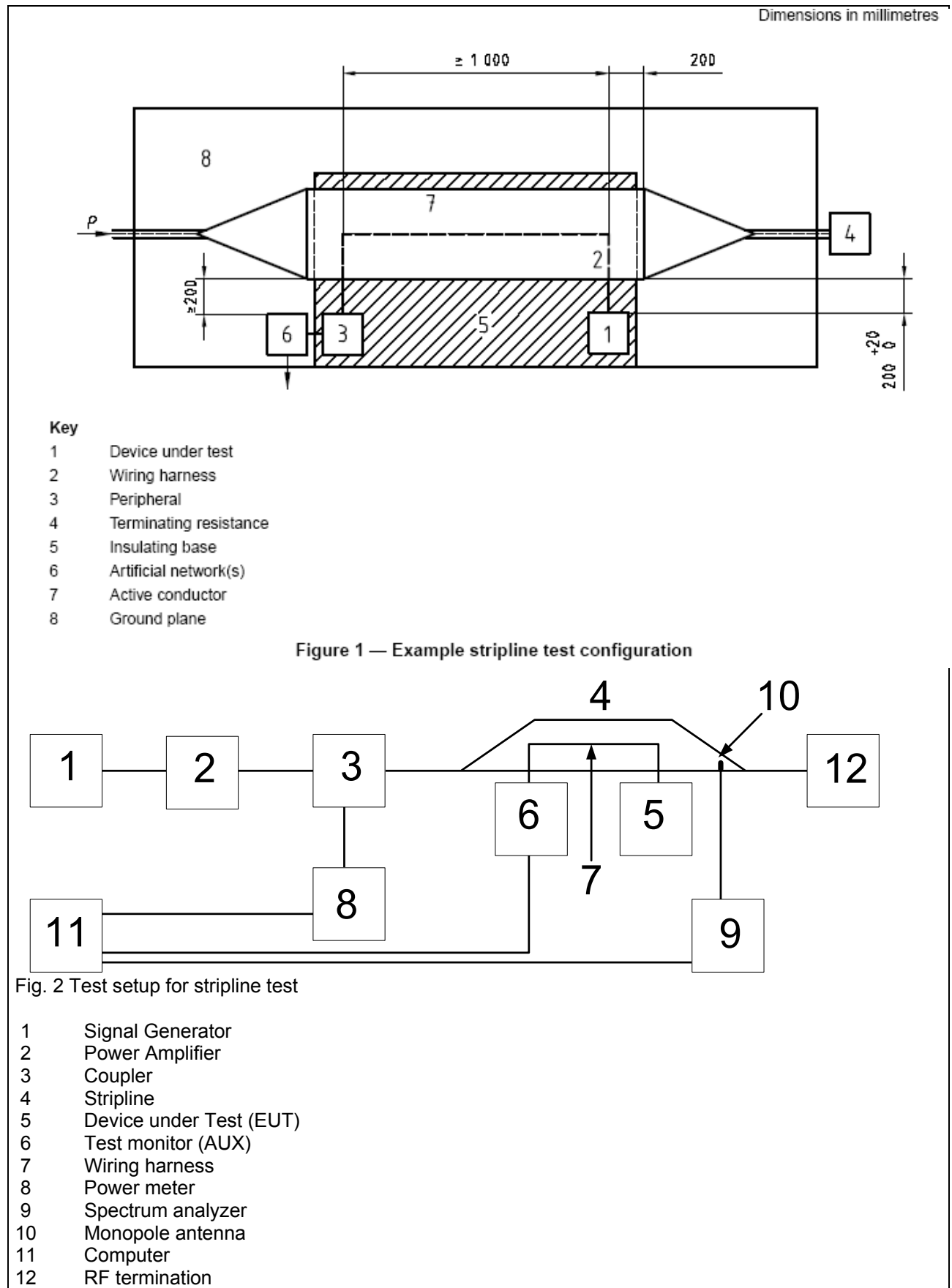
*Test method:* The field is coupled on the cables of the equipment under test with a strip-line antenna. The field is calibrated with the voltage applied to the strip-line and checked with an isotropic field probe. The frequency step and the modulation are adjusted according to the standard.

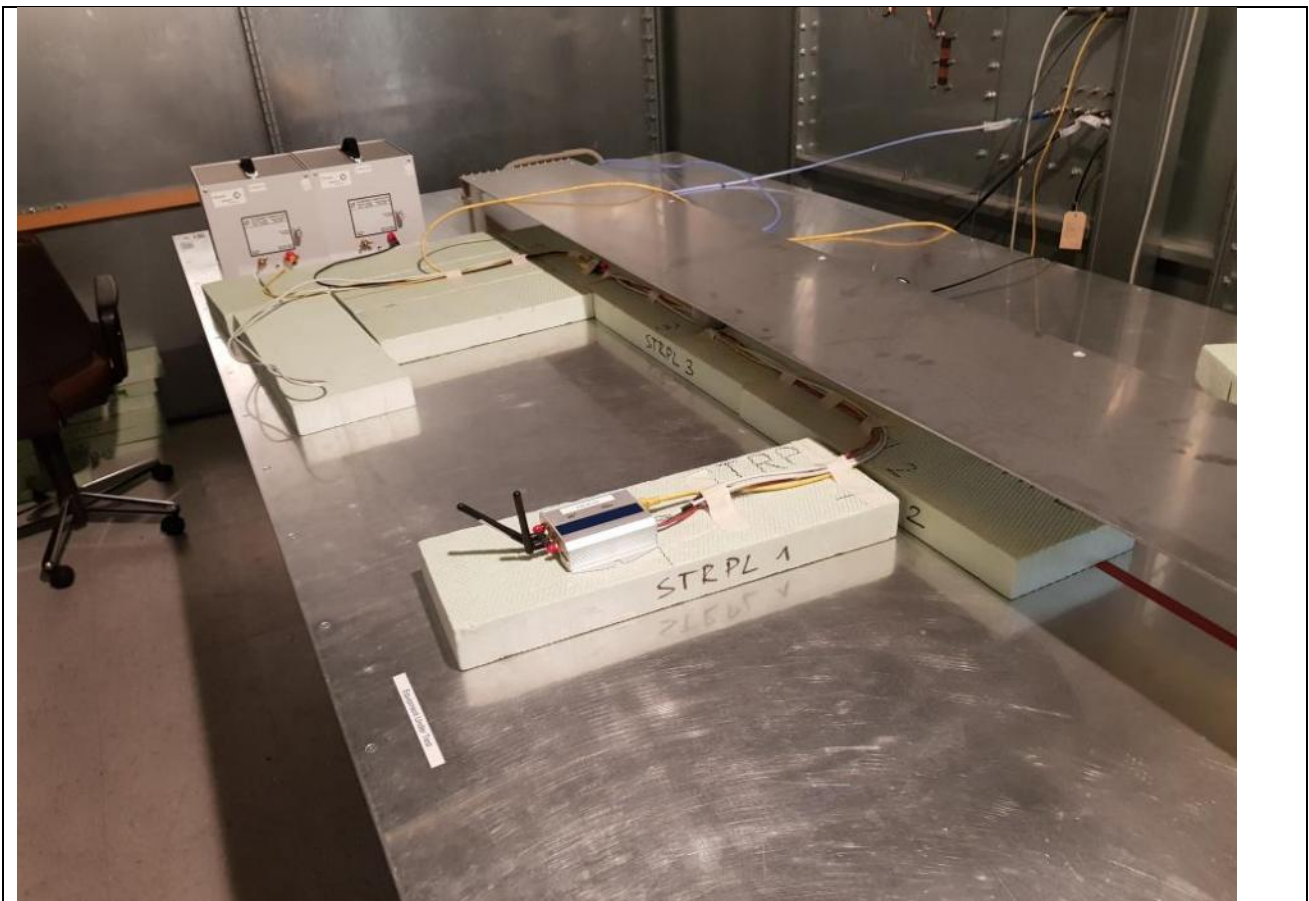
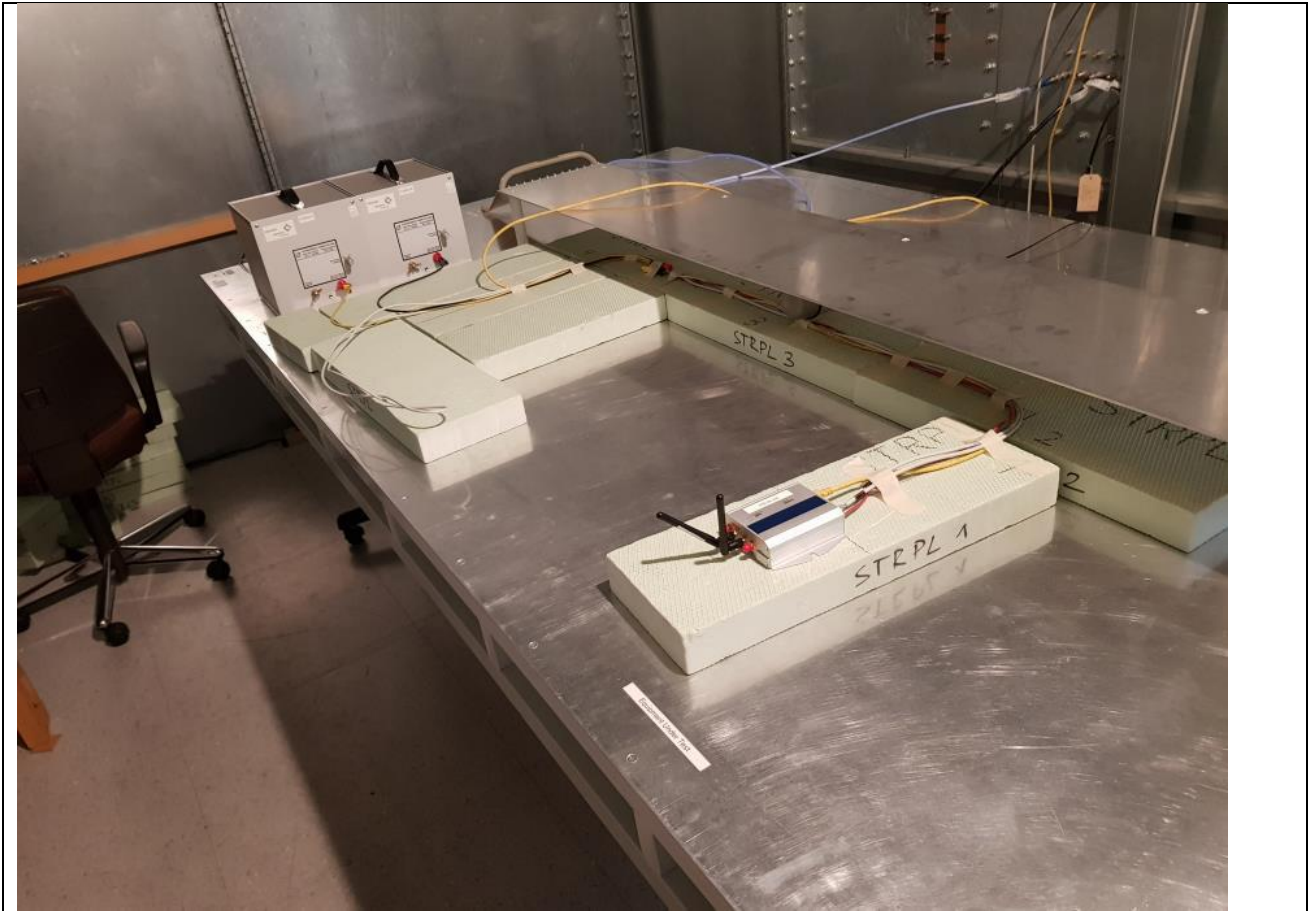
#### Test Equipment

Device Type	Brand	Type	ID
Signal Generator	Marconi	2023	GF7803
Coupler	Amplifier Research	DC3001	H8349
Amplifier 0.01 – 220 MHz	Amplifier Research	50A220	V6982
Amplifier 25 – 1000 MHz	Amplifier Research	100W1000M5A	V8169
Power Meter	Gigatronix	8541	IV9490
Field Probe	PMM	EP330	H9768
Stripline	Stimpfl	SL-3.2M	H10115



## Test Setup



**Photo of the Setup**

## Test Results

*Equipment:*

*Cables connected:* See chapter 5.3

*Operating mode:* See chapter 6.4

*Observation of EUT:* See chapter 6.5

*Test site:* laboratory

## Settings of the Test Equipment

<i>Frequency range:</i>	1 MHz - 30 MHz	<i>Dwell time:</i>	1 s
		<i>Amplitude modulation:</i>	80 % with 1 kHz
		<i>Frequency step:</i>	2%
	30 MHz – 200 MHz	<i>Dwell time:</i>	1 s
		<i>Amplitude modulation:</i>	80 % with 1 kHz
		<i>Frequency step:</i>	2%

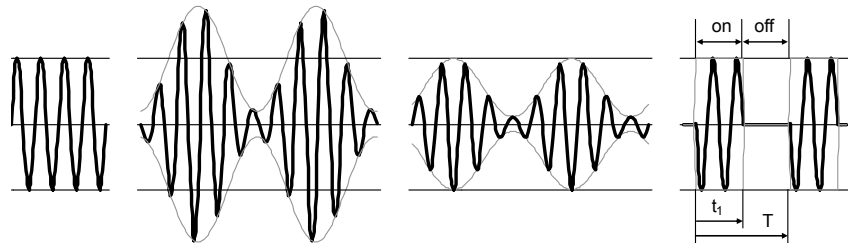
Modulation:

☐ CW

☐ AM (normal)

☒ AM (const. peak)

☐ PM



## Protocol of the Test

Frequency [MHz]	E [V/m]	Result, Observation Behavior of EUT	Fulfilled criterion	Verdict
0.1 – 30	100	no errors observed	A	Pass
30 – 1000	100	no errors observed	A	Pass

Note: Test level according customer requirement

## 8.2 Immunity to Electromagnetic Fields - Absorber-lined shielded enclosure (ISO 11452-5)

**Introduction:** The aim of this test is to evaluate the performance of the equipment when in the presence of electromagnetic fields created by the transmission of radio or television, by cellular phones or by any other system producing electromagnetic radiation in continuous waves.

**Meas. uncertainty:** see chapter 9

**Test method:** The field is emitted from the antennas placed in vertical and then in horizontal polarisation. The field is calibrated without the EUT using an isotropic probe.

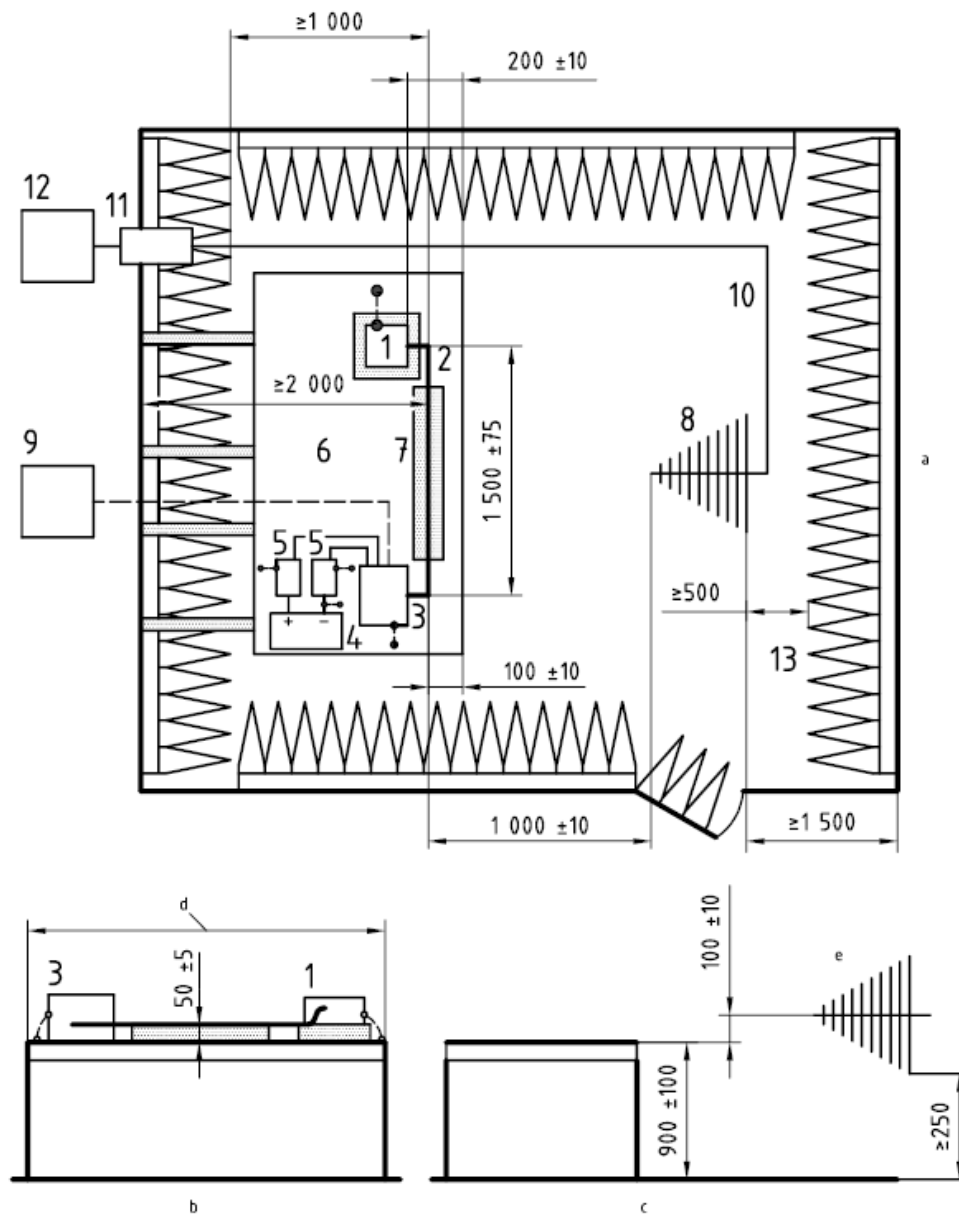
### Test Equipment

Device Type	Brand	Type	ID
Signal Generator	AnaPico	APSin 6010	13.6632.14
Amplifier 80 – 1000 MHz	Amplifier Research	750W1000	14.6632.04
Amplifier 1 – 6 GHz	Amplifier Research	50S1G6	14.6632.01
Antenna 80 – 1000 MHz	Amplifier Research	AT 6080	H10192
Antenna 0.8 – 6 GHz	Amplifier Research	AT 4002A	H9674
Field Sensor	Narda S.T.S	EP 601	14.6632.02

**Test Setup**

Setup 80 – 1000 MHz:

Dimensions in millimetres

**Key**

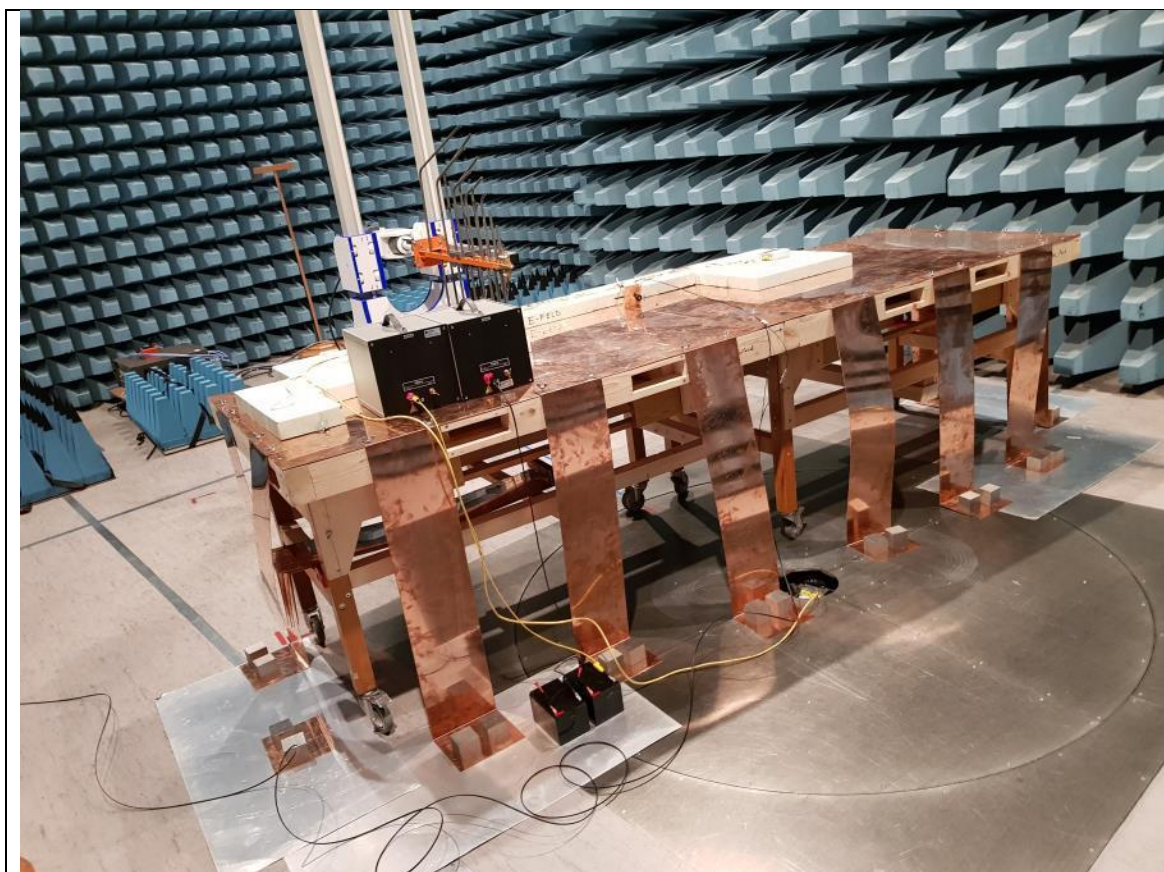
- |  |   |  |
|--|---|--|
| 1 DUT (grounded locally if required in test plan)                    | 6 ground plane (bonded to shielded enclosure)                 | 10 high quality double-shielded coaxial cable (50 Ω) |
| 2 test harness   | 7 low relative permittivity support ( $\epsilon_r \leq 1,4$ ) | 11 bulkhead connector                                |
| 3 load simulator (placement and ground: connection according to 7.5) | 8 log-periodic antenna  | 12 RF signal generator and amplifier                 |
| 4 power supply (location optional)                                   | 9 stimulation and monitoring system                           | 13 RF absorber material                              |
| 5 artificial network (AN)  |   |  |
- a Upper view (horizontal polarisation).  
b Front view.  
c Side view.  
d See 7.1.  
e Vertical polarization.





**Photo of the Setup**

Setup 80 – 1000 MHz:





## Setup 1 – 2 GHz:

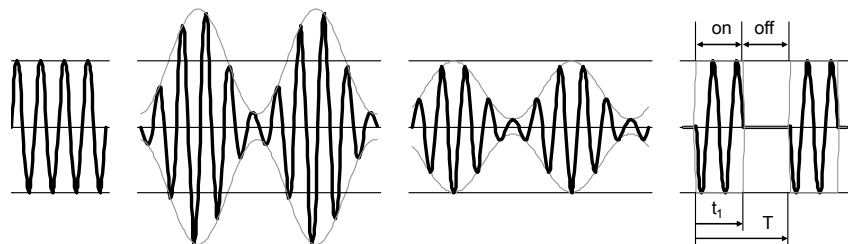




**Settings of the Test Equipment**

<i>Frequency range:</i>	80 - 1000 MHz	<i>Dwell time:</i>	1 s
		<i>Modulation:</i>	AM 80 % with 1 kHz
		<i>Frequency step:</i>	1 %
	800 - 1000 MHz	<i>Dwell time:</i>	1 s
		<i>Modulation:</i>	PM 217 Hz, 577 $\mu$ s
		<i>Frequency step:</i>	1 %
	1000 – 2000 MHz	<i>Dwell time:</i>	1 s
		<i>Modulation:</i>	PM 217 Hz, 577 $\mu$ s
		<i>Frequency step:</i>	1 %
	1200 – 1400 MHz	<i>Dwell time:</i>	1 s
		<i>Modulation:</i>	PM 300 Hz, 3 $\mu$ s
		<i>Frequency step:</i>	1 %

Modulation:

☐ CW☐ AM (normal)☒ AM (const. peak)☒ PM**Protocol of the Test**

Frequency [MHz]	E [V/m]	Polarization	Modulation	Result, Observation Behavior of EUT	Fulfilled criterion	Verdict
80 - 1000	100	horizontal	AM 1 kHz	no errors observed	A	Pass
	100	vertical	AM 1 kHz	no errors observed	A	Pass
800 - 1000	100	horizontal	PM 217 Hz, 577 $\mu$ s	no errors observed	A	Pass
	100	vertical	PM 217 Hz, 577 $\mu$ s	no errors observed	A	Pass
1000 - 2000	100	horizontal	PM 217 Hz, 577 $\mu$ s	no errors observed	A	Pass
	100	vertical	PM 217 Hz, 577 $\mu$ s	no errors observed	A	Pass
1200 - 1400	100	horizontal	PM 300 Hz, 3 $\mu$ s	no errors observed	A	Pass
	100	vertical	PM 300 Hz, 3 $\mu$ s	no errors observed	A	Pass

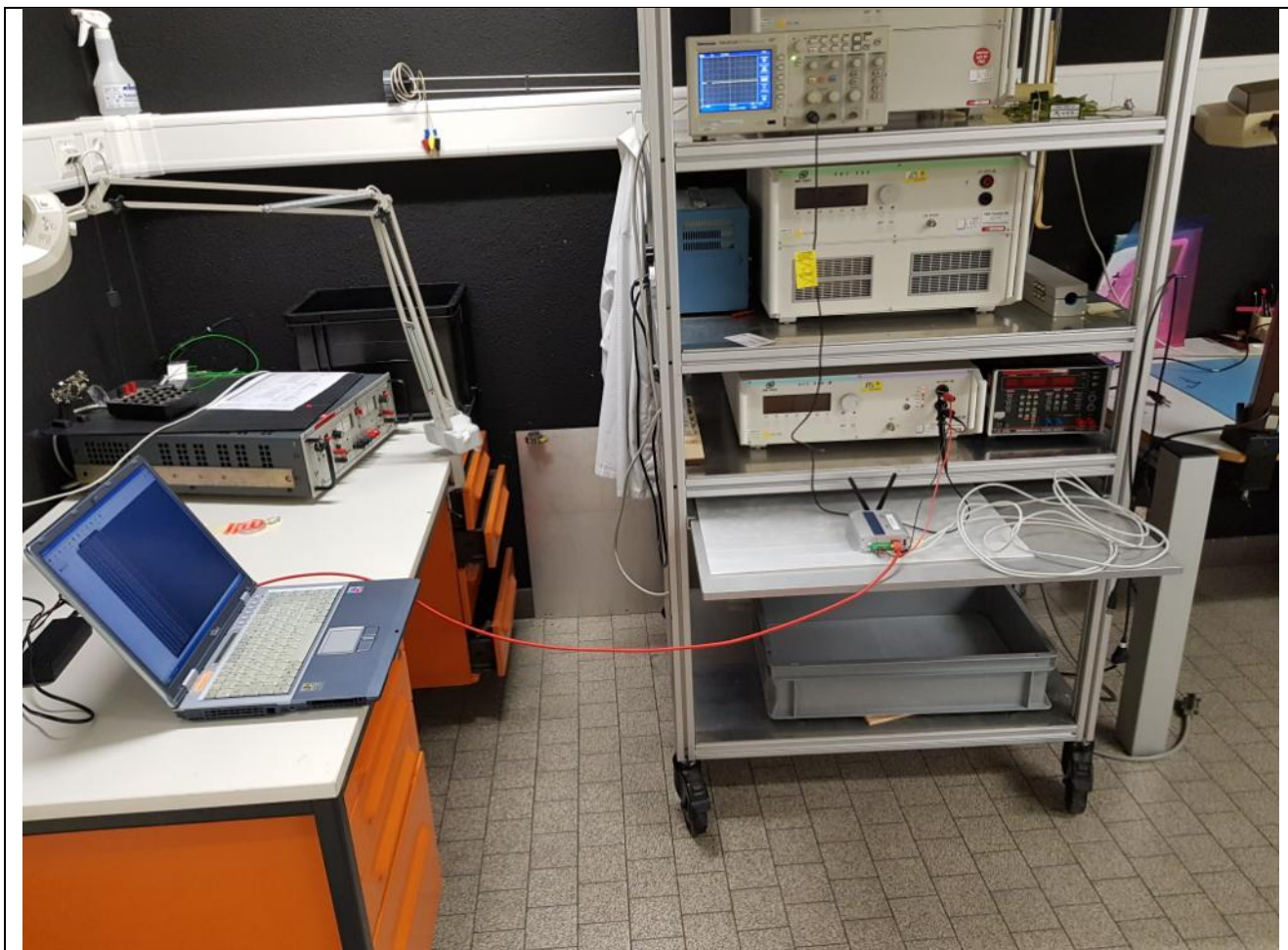
Note: Test level according customer requirement

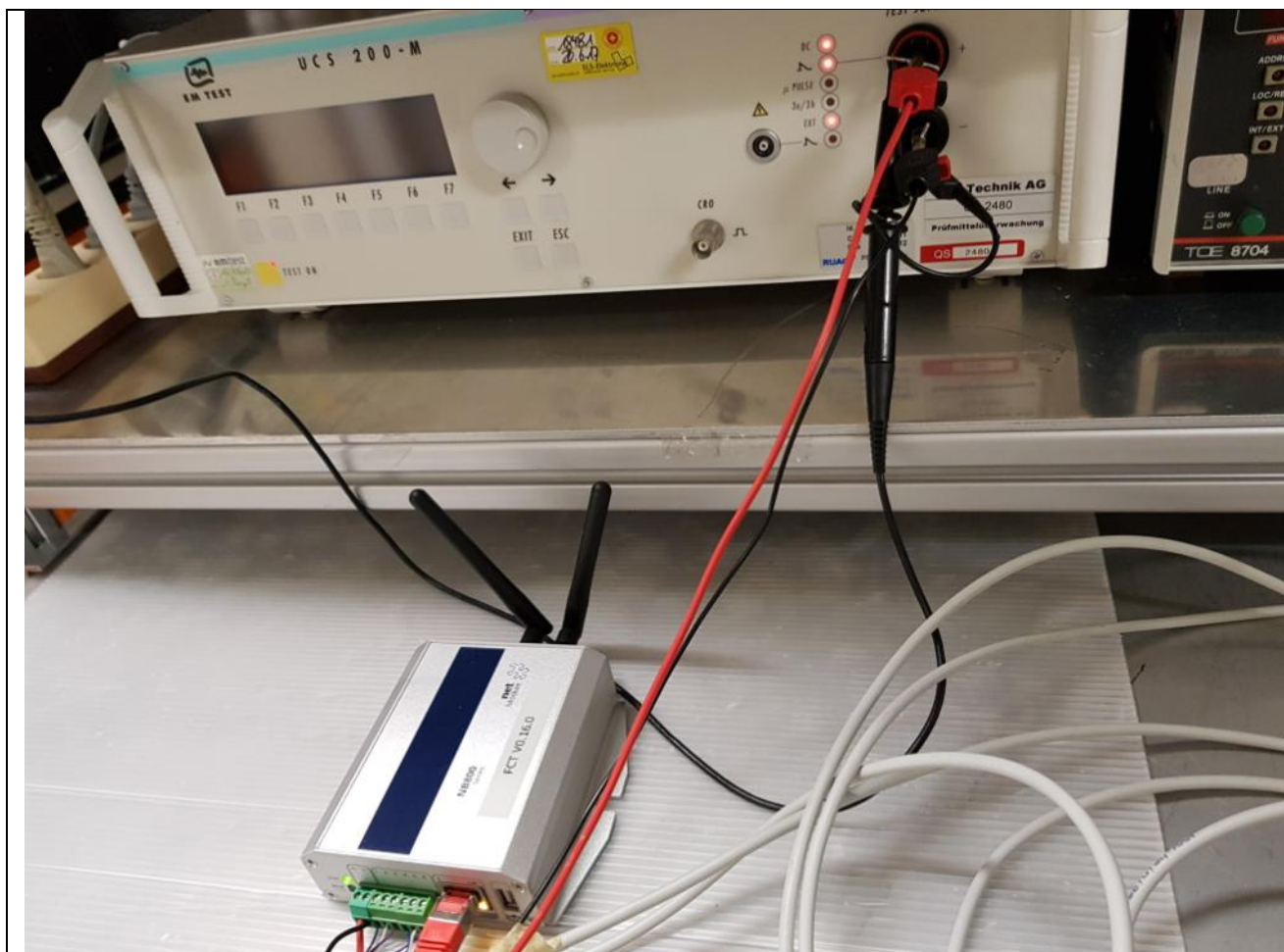
### 8.3 Impulse Tests (ISO 7637-2)

#### Test Setup

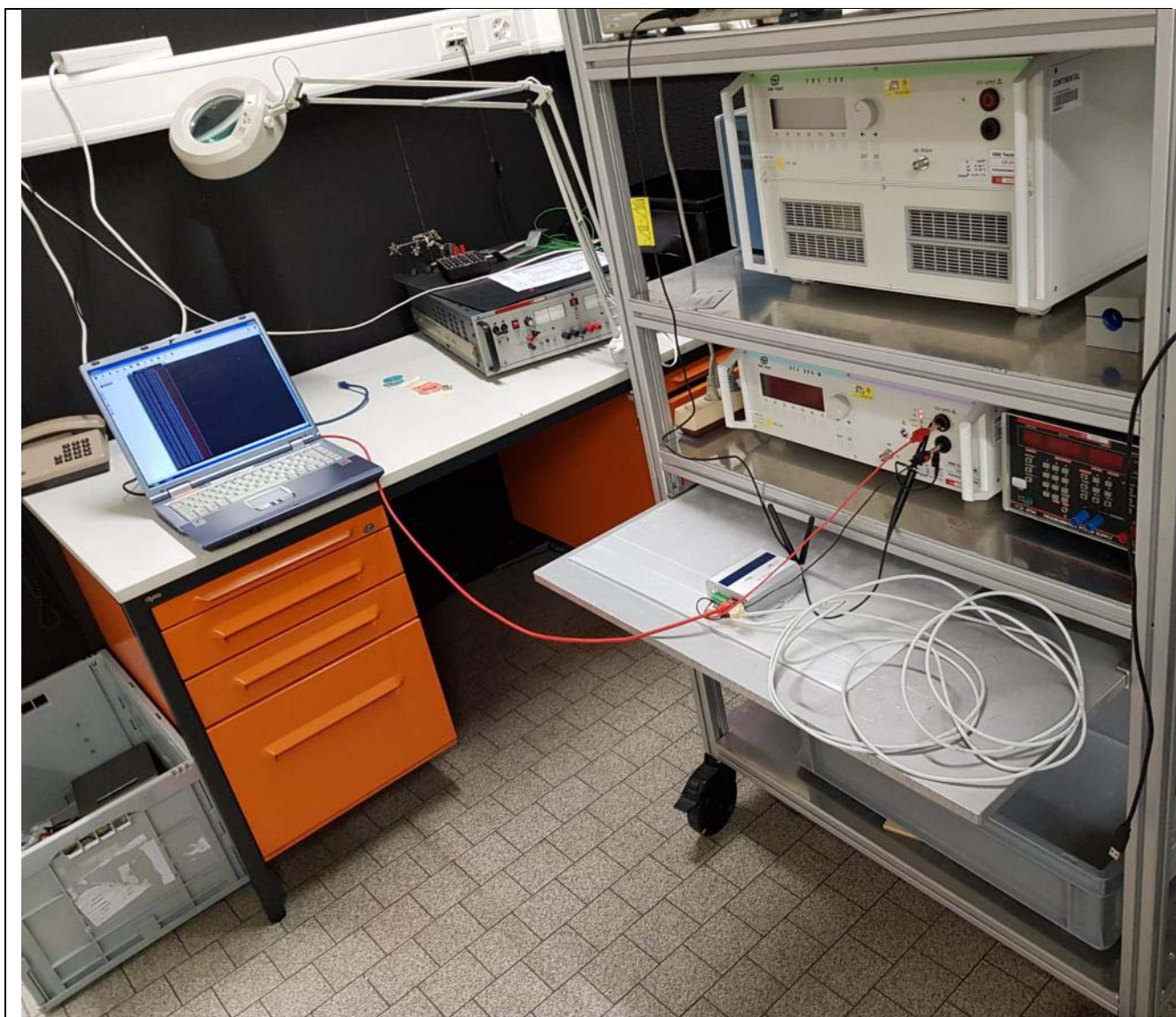
#### Measurement Equipment

<i>Equipment</i>	<i>Manufacturer</i>	<i>Type</i>	<i>Serial No.</i>	<i>Inv-No.</i>
Transient Generator	EM-Test	UCS200-M	06100108	QS2480
Voltage Drop Generator	EM-Test	VDS200	06100109	QS2479
Oscilloscope	Tektronix	TDS2012B	C040208	
Test Software	EM-Test		000029	









## Test Pulse 1

### Requirements

Electrical System	Test level ( $U_S$ )	Min. number of test pulses	Pulse repetition time		Compliance criteria
			min	max	
24 V	-450 V	500	0.5 s	5 s	Immunity-related functions: Class C Not immunity-related functions: Class D

### Measurement protocol

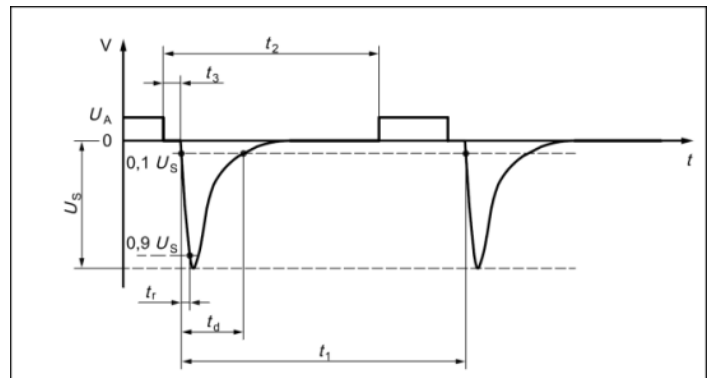
Client:	NetModule AG
EUT:	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN
Standard:	ISO 7637-2 : 2004
Application:	24 V System

### Settings

Pulse form:	ISO 7637-2 : 2004 : Pulse 1		
Test generator:	UCS200M	Software-No.:	000029
		Serial:	06100108
Ua (Alternator):	27.0 V	Current limiting:	15 A

### Pulse parameters

$U_S$ :	-75	-450	V
$t_1$ :	1.0	1.0	s
$t_2$ :	200	200	ms
$t_r$ :	1	3	$\mu$ s
$t_d$ :	2000	1000	$\mu$ s
$R_i$ :	10	10	Ohm
Number of events:	5000	5000	--
Test duration:	C	01:23:20	h



### Test result 24 V System

Number of pulses:	5000
Requirement:	Criteria C
Test result:	EUT makes a reset, in the protocol stands "Connection reset by 192.168.1.1" communication lost, after the test normal operation. Manual restart on the terminal program necessary, EUT conforms to the compliance criteria C

## Test Pulse 2a

### Requirements

Electrical System	Test level ( $U_S$ )	Min. number of test pulses	Pulse repetition time		Compliance criteria
			min	max	
24 V	+37 V	500 pulses	0.2 s	5 s	Immunity-related functions: Class B Not immunity-related functions: Class D

### Measurement protocol

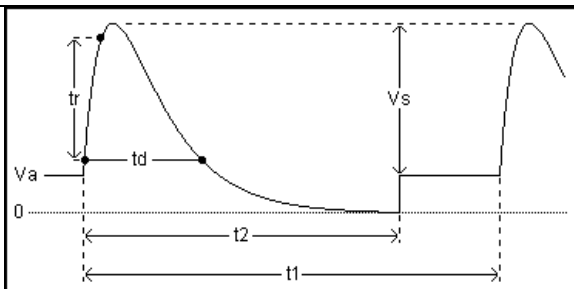
Client:	NetModule AG
EUT:	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN
Standard:	ISO 7637-2 : 2004
Application:	24 V System

### Settings

Pulse form:	ISO 7637-2 : 2004: Pulse 2a		
Test generator:	UCS200M	Software-No.:	000029
		Serial:	06100108
$U_a$ (Alternator):	27.0 V	Current limiting:	15 A

### Pulse parameters

$U_S$ :	+37	+37	V
$t_1$ :	0.2	0.2	s
$t_r$ :	1	1	$\mu$ s
$t_d$ :	50	50	$\mu$ s
$R_i$ :	2	2	Ohm
Events:	5000	5000	--
Duration:	00:16:40	00:16:40	h



### Test result 24 V System

Number of pulses:	5000
Requirement:	Criteria D
Test result:	No degradation noticed, EUT conforms to the compliance criteria A & D

## Test Pulse 2b

### Requirements

Electrical System	Test level ( $U_S$ )	Min. number of test pulses	Pulse repetition time		Compliance criteria
			min	max	
24 V	+20 V	10 pulses	0.5 s	5 s	Immunity-related functions: Class C Not immunity-related functions: Class D

### Measurement protocol

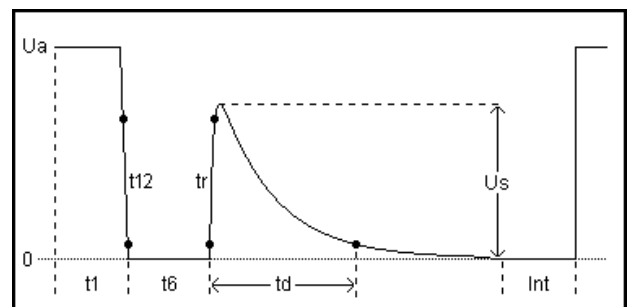
Client:	NetModule AG
EUT:	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN
Standard:	ISO 7637-2 : 2004
Application:	24 V System

### Settings

Pulse form:	ISO 7637-2 : 2004: Pulse 2b		
Test generator:	VDS200B	Software-No.:	000374
		Serial:	06100109
$U_a$ (Alternator):	27.0 V	Current limiting:	15 A

### Pulse parameters

$U_S$ :	10	20	V
$t_1$ :	5	5	s
$t_6$ :	1	1	ms
$t_d$ :	200	200	ms
$Int$ :	1.0	1.0	s
$R_i$ :	0.0	0.0	Ohm
$t_{12}$ :	1	1	ms
$t_r$ :	1	1	ms
Events:	10	10	--
Duration:	00:03:24	00:03:24	h



### Test result 24 V System

Number of pulses:	10
Requirement:	Criteria D
Test result:	EUT makes a reset, communication lost, after the test normal operation. Manual restart on the terminal program necessary, EUT conforms to the compliance criteria C

## Test Pulse 3a

### Requirements

Electrical System	Test level ( $U_s$ )	Min. number of test pulses	Pulse repetition time		Compliance criteria
			min	max	
24 V	-150 V	1 h	90 ms	100 ms	Immunity-related functions: Class A Not immunity-related functions: Class D

### Measurement protocol

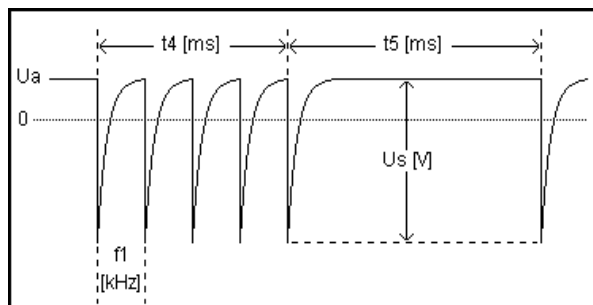
Client:	NetModule AG
EUT:	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN
Standard:	ISO 7637-2 : 2004
Application:	24 V System

### Settings

Pulse form:	ISO 7637-2 : 2004: Pulse 3a		
Test generator:	UCS200M	Software-No.:	000029
		Serial:	06100108
$U_a$ (Alternator):	27.0 V	Current limiting:	15 A

### Pulse parameters

$U_s$ :	-112	-150	V
$f1$ :	100	100	us
$t4$ :	10	10	ms
$t5$ :	90	90	ms
$tr$ :	5	5	ns
$td$ :	0.1	0.1	us
$Ri$ :	50	50	Ohm
Duration:	01:00:00	01:00:00	h



### Test result 24 V System

Test duration:	1 h
Requirement:	Criteria D
Test result:	No degradation noticed, EUT conforms to the compliance criteria A & D



## Test Pulse 3b

### Requirements

Electrical System	Test level ( $U_S$ )	Min. number of test pulses	Pulse repetition time		Compliance criteria
			min	max	
24 V	+150 V	1 h	90 ms	100 ms	Immunity-related functions: Class A Not immunity-related functions: Class D

### Measurement protocol

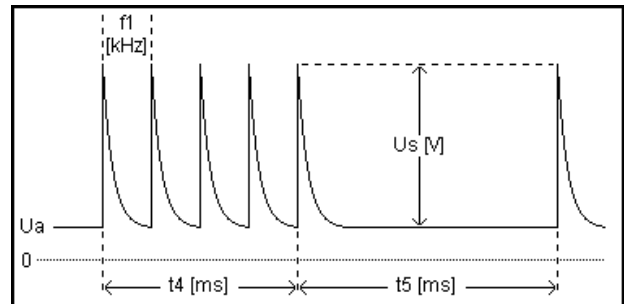
Client:	NetModule AG
EUT:	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN
Standard:	ISO 7637-2 : 2004
Application:	24 V System

### Settings

Pulse form:	ISO 7637-2 : 2004: Pulse 3b		
Test generator:	UCS200M	Software-No.:	000029
		Serial:	06100108
$U_a$ (Alternator):	27.0 V	Current limiting:	15 A

### Pulse parameters

$U_S$ :	+75	+150	V
$f_1$ :	100	100	us
$t_4$ :	10	10	ms
$t_5$ :	90	90	ms
$t_r$ :	5	5	ns
$t_d$ :	0.1	0.1	us
$R_i$ :	50	50	Ohm
Duration:	01:00:00	01:00:00	h



### Test result 24 V System

Test duration:	1 h
Requirement:	Criteria D
Test result:	No degradation noticed, EUT conforms to the compliance criteria A & D

**Test Pulse Nr. 4: tested as a 24 V System****Requirements**

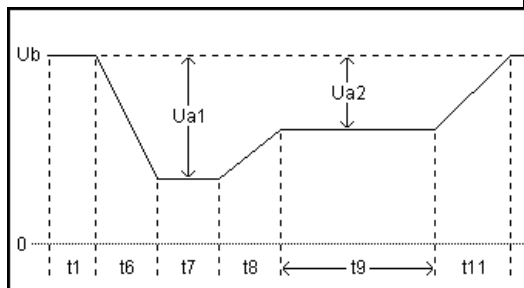
Electrical System	Test level ( $U_s$ )	Min. number of test pulses	Pulse repetition time		Compliance criteria
			min	max	
24 V	-12 V	10	90 ms	100 ms	Immunity-related functions: Class C Not immunity-related functions: Class D

**Measurement protocol**

Client:	NetModule AG
EUT:	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN
Standard:	ISO 7637-2 : 2004
Application:	24 V System

Settings:					
Pulse form:	ISO 7637-2 : 2004 : Pulse 4				
Test generator	VDS200B	Software-Nr.:	000374		
		Serial:	06100109		
Ub (Battery):	27	V	Current limiting:	15	A

Pulse parameters:				
Ua1:	-12	-6.0	V	
Ua2:	-5	-2.5	V	
t1:	1.0	1.0	s	
t6:	10	10	ms	
t7:	50	50	ms	
t8:	50	50	ms	
t9:	0.5	0.5	s	
t11:	10	10	ms	
Number of events:	10	10		
Test duration:		00:00:32	h	



Test result 24 V System	
Number of pulses:	10
Requirement:	Criteria D
Test result:	No degradation noticed, EUT conforms to the compliance criteria A & D

**Test Pulse Nr. 4: tested as 12 V-System****Requirements**

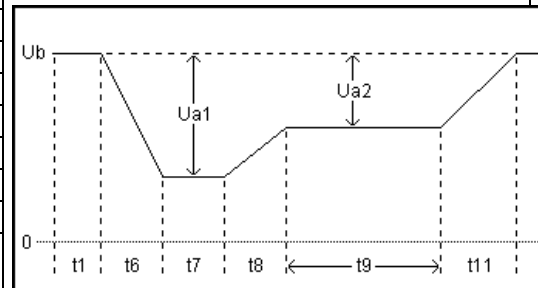
Electrical System	Test level ( $U_S$ )	Min. number of test pulses	Pulse repetition time		Compliance criteria
			min	max	
12 V	-6 V	10	90 ms	100 ms	Immunity-related functions: Class C Not immunity-related functions: Class D

**Measurement protocol**

Client:	NetModule AG
EUT:	NB800-LWWtSu: LTE, WLAN & USB (Base) NB800-LWWtScSu: Base & RS232/485 & DIO NB800-LWWtSu2C: Base & DualCAN
Standard:	ISO 7637-2 : 2004
Application:	12 V & 24 V System

Settings:					
Pulse form:	ISO 7637-2 : 2004 : Pulse 4				
Test generator	VDS200B	Software-Nr.:	000374		
		Serial:	06100109		
Ub (Battery):	13.5	V	Current limiting:	15	A

Pulse parameters:				
Ua1:	-12	-6.0	V	
Ua2:	-5	-2.5	V	
t1:	1.0	1.0	s	
t6:	10	10	ms	
t7:	50	50	ms	
t8:	50	50	ms	
t9:	0.5	0.5	s	
t11:	10	10	ms	
Number of events:	10	10		
Test duration:		00:00:32	h	



Test result 12 V System	
Number of pulses:	10
Requirement:	Criteria D
Test result:	No degradation noticed, EUT conforms to the compliance criteria A & D

## 9 Measurement Uncertainty

Conducted emission	Estimated uncertainty of the measurement results: (normal distribution, k=2)		± 2.8 dB
	Maximum uncertainty defined by the standard:		± 3.6 dB
Radiated emission	Estimated uncertainty of the measurement results for 30 – 230 MHz: (normal distribution, k=2)		± 3.4 dB
	Estimated uncertainty of the measurement results for 230 – 1000 MHz:(normal distribution, k=2)		± 2.2 dB
	Maximum uncertainty defined by the standard for 30 – 230 MHz:		± 5.2 dB
	Maximum uncertainty defined by the standard for 230 – 1000 MHz:		± 5.2 dB
	Estimated uncertainty of the measurement results for 1 – 6 GHz:(normal distribution, k=2)		± 4.8 dB
	Maximum uncertainty defined by the standard for 1 – 6 GHz:		± 5.2 dB
Electrostatic discharge	The measurement uncertainties are within the requirements of EN 61000-4-2 with a confidence level of 95 %.		/
Radiated immunity	The Uncertainty of measurement instrumentation is: (normal distribution, k=2)		± 2.4 dB
Fast transients	The measurement uncertainties are within the requirements of EN 61000-4-4 with a confidence level of 95 %.		/
Conducted radio frequency	The Uncertainty of measurement instrumentation is: (normal distribution, k=2)	CDN	± 1.51 dB
		EM clamp and direct injection	± 3.3 dB
		Current clamp	± 3.4 dB
Slow transients surge	The measurement uncertainties are within the requirements of EN 61000-4-5 with a confidence level of 95 %.		/
Power frequency magnetic field	The uncertainty of the measurement is: (normal distribution)		± 16 %
Voltage dips and interruptions	Output voltage $U_o$ : (normal distribution)		± 9.0 %
	Duration of the voltage interruption $t_e$ : (rectangular distribution)		± 5.0 %
	Phase $\phi_o$ :(rectangular distribution)		± 2.8 %
Voltage fluctuation	Output voltage $U_o$ : (normal distribution)		± 9 %