



EMC Test Report

| | |
|-----------------------|---|
| Number, Revision: | 14-EL-0068.E02 |
| Date: | 2015-01-30 |
| Client: | NetModule AG, Meriedweg 11 3172 Niederwangen bei Bern |
| Equipment under Test: | NB2700 and NB2710 |
| Magnitude of Test: | EMC tests according to Regulation UN ECE R10: 2011 The EUT is an Electric subassembly (ESA) with no immunity related functions. Any tests according to immunity as defined in this directive are not required. |
| Result of Test: | The equipment under test (EUT) conforms to all requirements mentioned above. This ESA can be used on any vehicle type. |
| Author: | P. Stillhard |
| Telephone: | +41 44 956 1463 |

| Function | Department | Name | Signature | Date |
|-----------------------|------------|------------------|------------------------|------------|
| Test engineer | IH-EAL | P. Stillhard | <i>Peter Stillhard</i> | 2015-01-30 |
| Review | IH-EAL | Pascal Treichler | <i>P. Treichler</i> | 2015-01-30 |
| Head of Business Unit | IH-ELM | Urs von Känel | <i>U. Känel</i> | 2015-01-30 |

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|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
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1 General

1.1 Test Laboratory

| | |
|-------------------|--|
| Test site: | Electrosuisse Albislab Albisriederstrasse 199 CH-8047 Zürich |
| Head of Albislab: | Mr. Pascal Treichler |

1.2 Client

| | |
|-----------------|---|
| Address: | NetModule AG Meriedweg 11 3172 Niederwangen bei Bern |
| Contact person: | Mr. Thomas Siegrist Phone number +41 (52) 209 00 41 Thomas.Siegrist@netmodule.com |

1.3 Equipment under test (EUT)

| | |
|-------------------|------------------------|
| Supplier: | same address as client |
| | |
| Factory location: | same address as client |

| | |
|------------------------|-----------------------------|
| Identification: | |
| Type: | NB2700 and NB2710 |
| Serial: | 00112B00889F / 00112B00888F |





Photo 2: EUT 2



Photo 3: Marking plate EUT 1

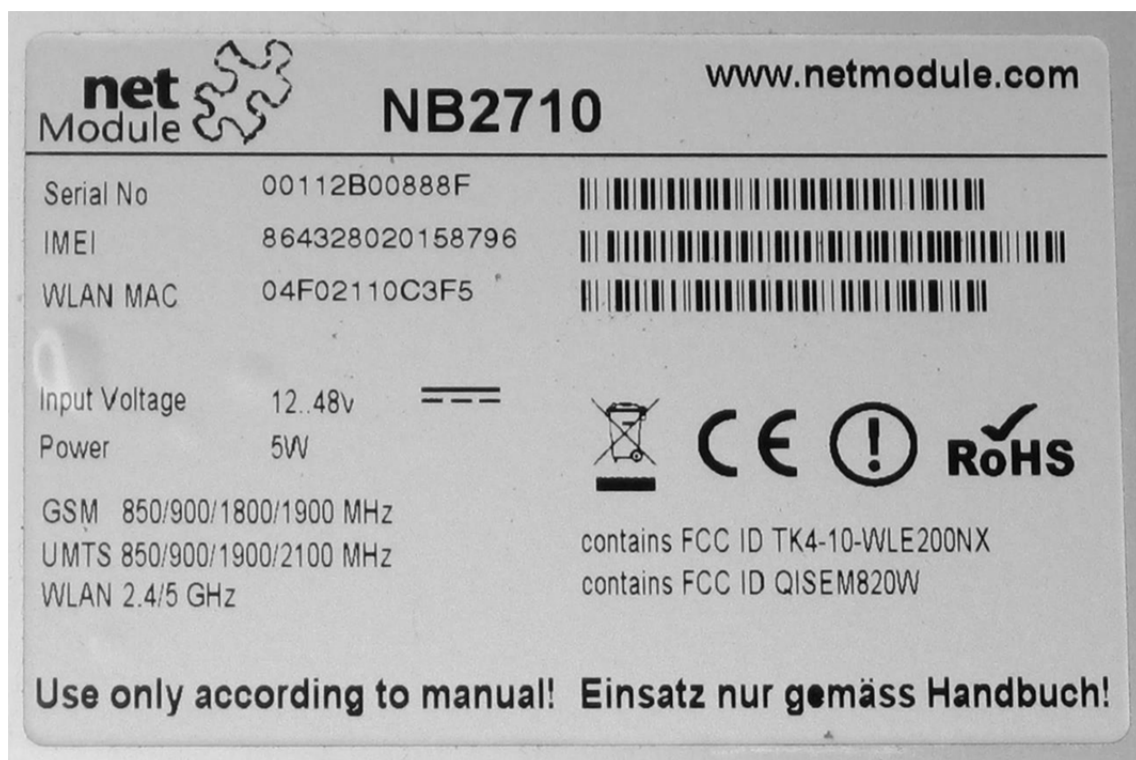


Photo 4: Marking plate EUT 2

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1.4 Characteristics of the EUT

1.4.1 Short Description of the EUT

The EUT Testing system is a Vehicle Router with Mobile, WLAN & GPS interface. It is built for this purpose in vehicles and powered from the board net.

There were two tested versions:

NB2710-LWA-GV (EUT 1)

NB2710-UWC-G (EUT 2)

They are part of a whole family of routers. The measurements are representative for the whole family, which is described below:

All covered NB2700 variants contain the same main board (PCB), have the same case and the same form factor. The same applies to the NB2710 variants.

They can host up to two (NB2700) or three (NB2710) communication modules. These modules can even include a GPS module. There can be up to 5 (NB2700) or 7 (NB2710) antenna connectors.

The wireless communication modules applied have been CE and FCC certified in an independent way of the Tested Equipment.

'H₁...H_n' is a sequence of the following letters that identify the communication modules included:

R: none, router only

Ed: 2G = GPRS/EDGE

U: 3G+ = 2G+UMTS/HSPA/HSPA+

L: 4G = 3G+ + LTE

Ca: CDMA450

W: WLAN a/b/g/n Client & Access Point

A: Audio in/out

C: CAN-bus

Sa: RS-485 (on the same module as CAN)

I: IBIS-bus

S: RS-232 (on the same module as IBIS)

... (more to follow)

'S₁...S_n' indicate the software options activated:

G: GPS

V: Voice gateway

The following NB2700/NB2710 variants are currently available or planned:

| NB2700 variants: | NB2710 variants: |
|------------------|------------------|
| NB2700-R | NB2710-UA-V |
| NB2700-W | NB2710-UWA-GV |
| NB2700-Ca | NB2710-2UW |
| NB2700-U | NB2710-2UW-G |
| NB2700-U-G | NB2710-LSa |
| NB2700-UW | NB2710-LWA-GV |
| NB2700-UW-G | NB2710-LWC-G |
| NB2700-2U | NB2710-LWI-G |
| NB2700-2U-G | NB2710-2LW |
| NB2700-L | NB2710-2LW-G |
| NB2700-L-G | |
| NB2700-LW | |
| NB2700-LW-G | |
| NB2700-2L | |
| NB2700-2L-G | |

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1.4.2 Power supply and Interface cables

EUT 1:

| Port | Cable | | | Remark |
|--------------------------|-------------|-------------|--------|--|
| | Max. length | Type | Screen | |
| DC Supply | Not defined | 2 wires | No | If not stated otherwise, powered with AC/DC adapter |
| Ethernet 1 | < 100m | RJ45 cat 5e | Yes | Connected to Test-PC |
| Ethernet 2 | < 100m | RJ45 cat 5e | Yes | If not stated otherwise, no cable connected |
| Ethernet 3 | < 100m | RJ45 cat 5e | Yes | If not stated otherwise, no cable connected |
| Ethernet 4 | < 100m | RJ45 cat 5e | Yes | If not stated otherwise, no cable connected |
| RS232 | < 10 m | 3 wire | Yes | Connected to Test-PC |
| USB | < 3m | USB | Yes | Connected to USB memory stick (for radiated tests connected with 3 m USB standard cable) |
| 2x Digital inputs | < 30 m | 2 wire | No | Cables connected |
| 2x Outputs (relays) | < 30 m | 2 wire | No | Cables connected |
| WLAN1 | < 30 m | SMA (Coax) | Yes | Connected to multiband-antenna |
| Mob1 (GSM, UMTS, LTE) | < 30 m | SMA (Coax) | Yes | Connected to multiband-antenna |
| GPS | < 30 m | SMA (Coax) | Yes | Connected to multiband-antenna |
| Audio | < 10 m | RJ45 cat 5e | Yes | Connected to Loopback cable (3m) |

EUT 2:

| Port | Cable | | | Remark |
|--------------------------|-------------|-------------|--------|--|
| | Max. length | Type | Screen | |
| DC Supply | Not defined | 2 wires | No | If not stated otherwise, powered with AC/DC adapter |
| Ethernet 1 | < 100m | RJ45 cat 5e | Yes | Connected to Test-PC |
| Ethernet 2 | < 100m | RJ45 cat 5e | Yes | If not stated otherwise, no cable connected |
| Ethernet 3 | < 100m | RJ45 cat 5e | Yes | If not stated otherwise, no cable connected |
| Ethernet 4 | < 100m | RJ45 cat 5e | Yes | If not stated otherwise, no cable connected |
| RS232 | < 10 m | 3 wire | Yes | Connected to Test-PC |
| USB | < 3m | USB | Yes | Connected to USB memory stick (for radiated tests connected with 3 m USB standard cable) |
| 2x Digital inputs | < 30 m | 2 wire | No | Cables connected |
| 2x Outputs (relays) | < 30 m | 2 wire | No | Cables connected |
| WLAN1 | < 30 m | SMA (Coax) | Yes | Connected to multiband-antenna |
| Mob1 (GSM, UMTS, LTE) | < 30 m | SMA (Coax) | Yes | Connected to multiband-antenna |
| GPS | < 30 m | SMA (Coax) | Yes | Connected to multiband-antenna |
| CAN | < 1000 m | RJ45 cat 5e | Yes | Connected to Test-PC (with CAN-to-USB Adapter) |

| | | |
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1.4.3 Power specification

| Description | Manufacturers specifications |
|---------------------|------------------------------|
| Connection | Plus, Minus |
| Rated voltage range | 12 VDC / 24 VDC |
| Input power | <10W |

1.4.4 Operating conditions of the EUT for the tests (active condition)

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

General:

Monitor of all Ping-outputs on the Test-PC

EUT 1: NB2710-LWA-GV:

SIP connection (SIP Softphone „PhonerLite“) to EUT. (partly)

EUT: Audio-In & Out on SIP configured. Audio In and Audio Out via Loopback-cable connected.

Via SIP Phone: send music and check if music will be returned.

EUT 2: NB2710-UVC-G:

CAN connection between EUT and Test-PC. EUT and Test-PC send CAN messages (1s cycle)

The following measurement setups were used:

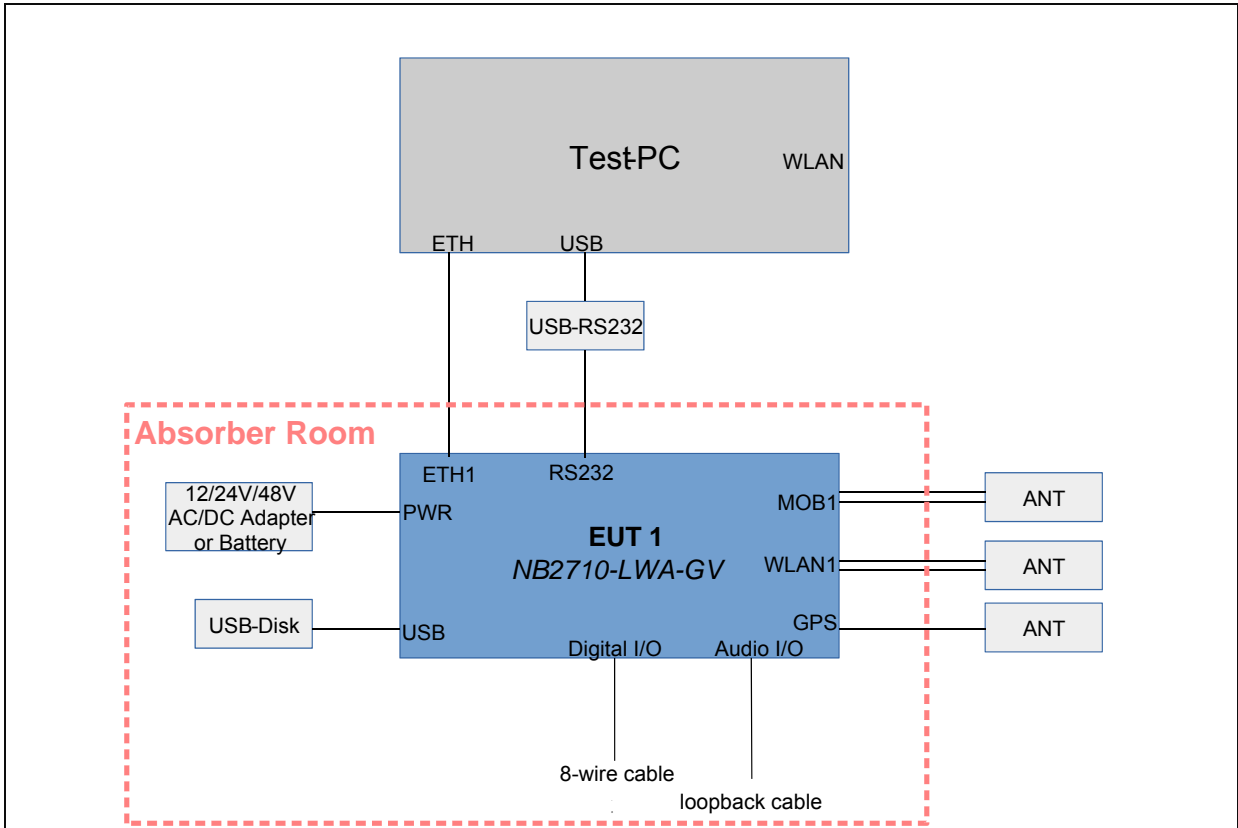


Photo 5: Measurement set up EUT 1

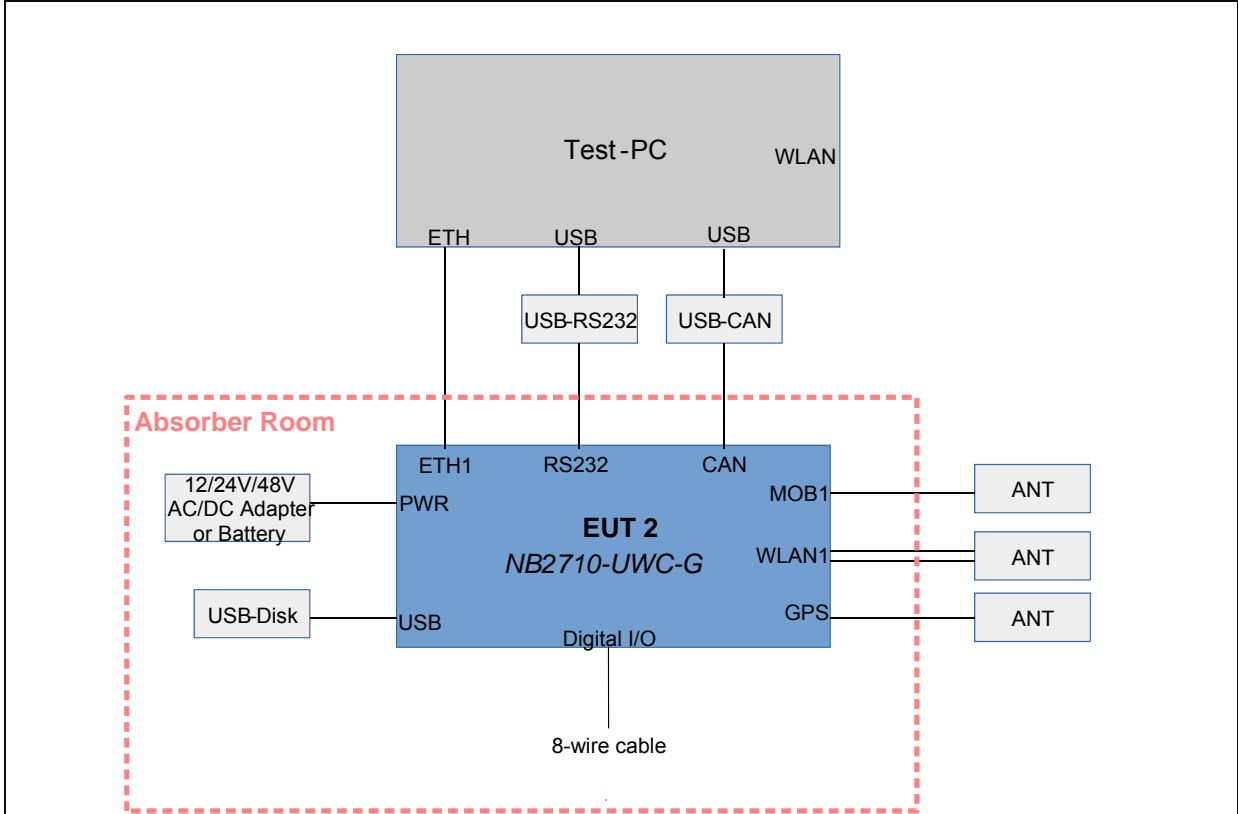


Photo 6: Measurement set up EUT 2

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EUT 1 : NB2710-LWA-GV:

- 1 Ethernet connection established to Test-PC
- 1 RS232 connection established to Test-PC
- 1 GSM/UMTS/LTE Antenna (2 cables)
- 1 WLAN Antenna (2 cables)
- 1 GPS Antenna (1 cable)
- Digital I/O cable (floating)
- Audio-cable (RJ-45) with Loopback
- USB cable with USB Memory Stick
- 1 SIM card

EUT 2 : NB2710-UWC-G:

- 1 Ethernet connection established to Test-PC
- 1 RS232 connection established to Test-PC
- 1 GSM/UMTS/LTE Antenna (1 cable)
- 1 WLAN Antenna (2 cables)
- 1 GPS Antenna (1 cable)
- Digital I/O cable (floating)
- CAN-cable (RJ-45) to Test-PC
- USB cable with USB Memory Stick
- 1 SIM card

1.4.5 Clock frequencies in the EUT

Not relevant for this type of equipment

1.5 Supporting equipment used during test

The following auxiliary equipment AUX 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.: | Serial: | Remark: |
|----------------------|--------|----------------------|---------------|-----------|
| Test-PC / Notebook | Dell | E5540 | 1PF9M12 | |
| USB-to-CAN Adapter | IXXAT | USB-to-CAN compact | HW243428 | |
| USB-to-RS232 Adapter | n/a | U232-P9(2.4) | 0608SP030727 | |
| USB Disk | n/a | | | |
| Audio Loopback Cable | n/a | | | |
| WWAN Antenna | n/a | Antenna-Roof-2L DL-9 | A140812300036 | |
| GPS Antenna | n/a | | | |
| WLAN Antenna | | Antenna-Roof-2W | | |
| Power supply | | | | See tests |

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1.6 Test specifications and results

1.6.1 References

| Standard | Description |
|------------------|---|
| EN 55025:2008 | Radio disturbance characteristics for the protection of receivers used on board vehicles, boats and on devices – Limits and methods of measurement |
| ISO 7637-2:2004 | Road vehicles — Electrical disturbances from conduction and coupling —Part 2: Electrical transient conduction along supply lines only |
| ISO 11452-1:2005 | Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General principles and terminology |
| ISO 11452-2:2004 | Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 2: Absorber-lined shielded enclosure |
| ISO 11452-4:2005 | Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 4: Bulk current injection (BCI) |
| ISO 11452-5:2005 | Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 5: Stripline |
| UN ECE R10:2011 | Regulation No. 10 Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility |

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1.6.2 Assembly of test specifications and results

EUT 1 and EUT 2:

| Emission tests for Electric subassembly (ESA) according to Regulation UN ECE R10:2011 | | |
|---|---|---------------------------------|
| Test | Limit | Result |
| Radiated E-Field Appendix VII (Broadband disturbances, Quasi peak) Appendix VIII (Narrowband disturbances, Average) Test set-up according to EN 55025:2003 Measurement distance 1m; E-Field-Antenna 30 - 1000 MHz EUT with all cables | Broadband limits according to Regulation R10, chapter 6.5.2.1 Narrowband limits according to Regulation R10, chapter 6.6.2.1 | PASS |
| Conducted emission disturbances Annex X (transient disturbances, Peak-Values) Test set-up according to ISO 7637-2:2004 Power supply lines | limits according to Regulation R10, chapter 6.9.1, for 12 V- und 24 V-Systems | N/A Note 1 |

Note 1: Not Applicable, due to chapter 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 EN55025.

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EUT 1:

| Immunity tests for Electric subassembly (ESA) according to Regulation UN ECE R10:2011 | | | |
|--|--|---------------------|---------------------------------|
| 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% (1kHz) 800 – 2000 MHz: Pulse Modulation PM 217.34 Hz, Duty cycle 12.5% | | | |
| Test | Norm / Test level | Compliance Criteria | Result |
| Radiated electromagnetic field (Absorber-lined shielded enclosure) Appendix IX Test set-up according to EN ISO 11452-2:2004 Distance of Antenna: 1m; 20 - 2000 MHz Antenna vertical polarization EUT with all cables | Limits according to Regulation R10, chapter 6.7.2.1 30 V/m in over 90% of the frequency band and 25 V/m over the whole band | A | N/A Note 2 |
| BCI, Bulk current injection Appendix IX Test set-up according to EN ISO 11452-4:2005 20 - 400 MHz EUT with all cables | Limits according to Regulation R10, chapter 6.7.2.1 60 mA in over 90% of the frequency band and 50 mA over the whole band | A | N/A Note 2 |
| Stripline 150 mm Appendix IX Test set-up according to EN ISO 11452-5:2005 20 - 400 MHz (expanded to 1000 MHz) EUT with all cables | Limits according to Regulation R10, chapter 6.7.2.1 60 V/m in over 90% of the frequency band and 50 V/m over the whole band | A | N/A Note 2 |

Note 2: The EUT has no 'immunity-related functions', the test has not to be applied. Due to Chap. 6.10.2: Vehicles which do not have electrical/electronic systems with 'immunity related functions' need not be tested for immunity to radiated disturbances and shall be deemed to comply with paragraph 6.4 and with Annex 6 to Regulation R10.

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EUT 1:

| Immunity tests for Electric subassembly (ESA) according to Regulation UN ECE R10:2011 | | | |
|--|--|---------------------|-----------------|
| Test | Norm / Test level | | Test Result |
| Immunity to transient disturbances conducted along supply lines Annex X Test setup according to EN ISO 7637-2:2004 | Limits according to Regulation R10, chapter 6.8.1 | | |
| Test pulse Nr. 1 | 12 V Sys. -75 V | 24 V Sys. -450 V | Crit.1 cl. C |
| Test pulse Nr. 2a | +37 V | +37 V | Crit.2 cl. D |
| Test pulse Nr. 2b | +10 V | +20 V | |
| Test pulse Nr. 3a | -112 V | -150 V | |
| Test pulse Nr. 3b | +75 V | +150 V | |
| Test pulse Nr. 4 | -6 V | -12 V | |
| Test pulse Nr. 5 | --- | | |
| Supply lines and connections to supply lines | *) for ESA which must not be operational during engine start phases. | | |

note 3: Test not required by Commission Regulation R10

| | | |
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EUT 2:

| Immunity tests for Electric subassembly (ESA) according to Regulation UN ECE R10:2011 | | | |
|--|--|---------------------|----------------------------------|
| 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% (1kHz) 800 – 2000 MHz: Pulse Modulation PM 217.34 Hz, Duty cycle 12.5% | | | |
| Test | Norm / Test level | Compliance Criteria | Result |
| Radiated electromagnetic field (Absorber-lined shielded enclosure) Appendix IX Test set-up according to EN ISO 11452-2:2004 Distance of Antenna: 1m; 20 - 2000 MHz Antenna vertical polarization EUT with all cables | Limits according to Regulation R10, chapter 6.7.2.1 30 V/m in over 90% of the frequency band and 25 V/m over the whole band | A | Note 2 PASS |
| BCI, Bulk current injection Appendix IX Test set-up according to EN ISO 11452-4:2005 20 - 400 MHz EUT with all cables | Limits according to Regulation R10, chapter 6.7.2.1 60 mA in over 90% of the frequency band and 50 mA over the whole band | A | N/A Note 3 |
| Stripline 150 mm Appendix IX Test set-up according to EN ISO 11452-5:2005 20 - 400 MHz (expanded to 1000 MHz) EUT with all cables | Limits according to Regulation R10, chapter 6.7.2.1 60 V/m in over 90% of the frequency band and 50 V/m over the whole band | A | Note 2 PASS |

Note 2: EUT 2 itself has no immunity related function, but it can be connected via CAN bus to a device with immunity related function. Therefore criteria A has to be fulfilled.

Note 3: covered by stripline test

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EUT 2:

| Immunity tests for Electric subassembly (ESA) according to Regulation UN ECE R10:2011 | | | |
|--|--|---------------------|-----------------|
| Test | Norm / Test level | | Test Result |
| Immunity to transient disturbances conducted along supply lines Annex X Test setup according to EN ISO 7637-2:2004 | Limits according to Regulation R10, chapter 6.8.1 | | Note 2 |
| Test pulse Nr. 1 | 12 V Sys. -75 V | 24 V Sys. -450 V | Crit.1 cl. C |
| | | Crit.2 cl. D | C |
| Test pulse Nr. 2a | +37 V | +37 V | cl. B |
| Test pulse Nr. 2b | +10 V | +20 V | cl. C |
| Test pulse Nr. 3a | -112 V | -150 V | cl. A |
| Test pulse Nr. 3b | +75 V | +150 V | cl. A |
| Test pulse Nr. 4 | -6 V | -12 V | cl. B/C*) |
| Test pulse Nr. 5 | --- | | |
| Supply lines and connections to supply lines | *) for ESA which must not be operational during engine start phases. | | |
| | | | PASS |
| | | | PASS |
| | | | PASS |
| | | | PASS |
| | | | PASS |
| | | | N/A |
| | | | note 3 |

Note 2: EUT 2 itself has no immunity related function, but it can be connected via CAN bus to a device with immunity related function. Therefore the stronger criteria have to be fulfilled.

note 3: Test not required by Commission Regulation R10

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1.6.3 Compliance criteria for immunity tests

| Compliance criteria according to ISO 11452-1 | |
|--|---|
| A | All functions of a device or system perform as designed during and after exposure to a disturbance. |
| 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. |
| C | 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. |
| D | 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. |
| E | 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 | |
|----------------------------------|---|
| A | The EUT shall operate in normal mode |
| B | After the test, the EUT shall operate as in normal mode, during the test one or more functions may be out of tolerance. |
| C | After the test, the EUT shall operate as in normal mode. |
| D | No specific requirement |
| E | No specific requirement |

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

1.6.4 Test environment

| Variable | Requirement | Actual values during the test | Complied |
|------------------------|----------------------|-------------------------------|----------|
| Mains | | 12.5 VDC / 25 VDC | Yes |
| Temperature | 15° C – 35° C | 24° C | Yes |
| Relative humidity (RH) | 25 % - 75 % | 25 % - 75 % | Yes |
| Air pressure | 860 mbar – 1060 mbar | 980 mbar – 1035 mbar | Yes |

1.7 Date of tests / sampling method

| | |
|----------------------|--|
| Method of sampling: | 1 of 1 EUT delivered by client |
| State of the EUT | serial |
| Delivery date of EUT | October 20, 2014 October 27, 2014 November 5, 2014 January 22, 2015 |
| Date of tests | October 20 – 21, 2014 October 27 – 28, 2014 November 5 – 7, 2014 January 22, 2015 |

| | | |
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1.8 Test report summary

The EUT mentioned in chapter 1.3 with the modifications according to chapter 1.9 is in conformance with the EMC requirements indicated in the chapter 1.6.

1.9 Modifications

after Ferrite Ls105 (330R@100MHz, 2.5A) a LC-Filter has been implemented:

C: electrolytic capacitor, 33 uF, 100 V, 450 mR

L: Inductor, 3.3 uH, 3.3 A, 27 mR

1.10 Comments

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

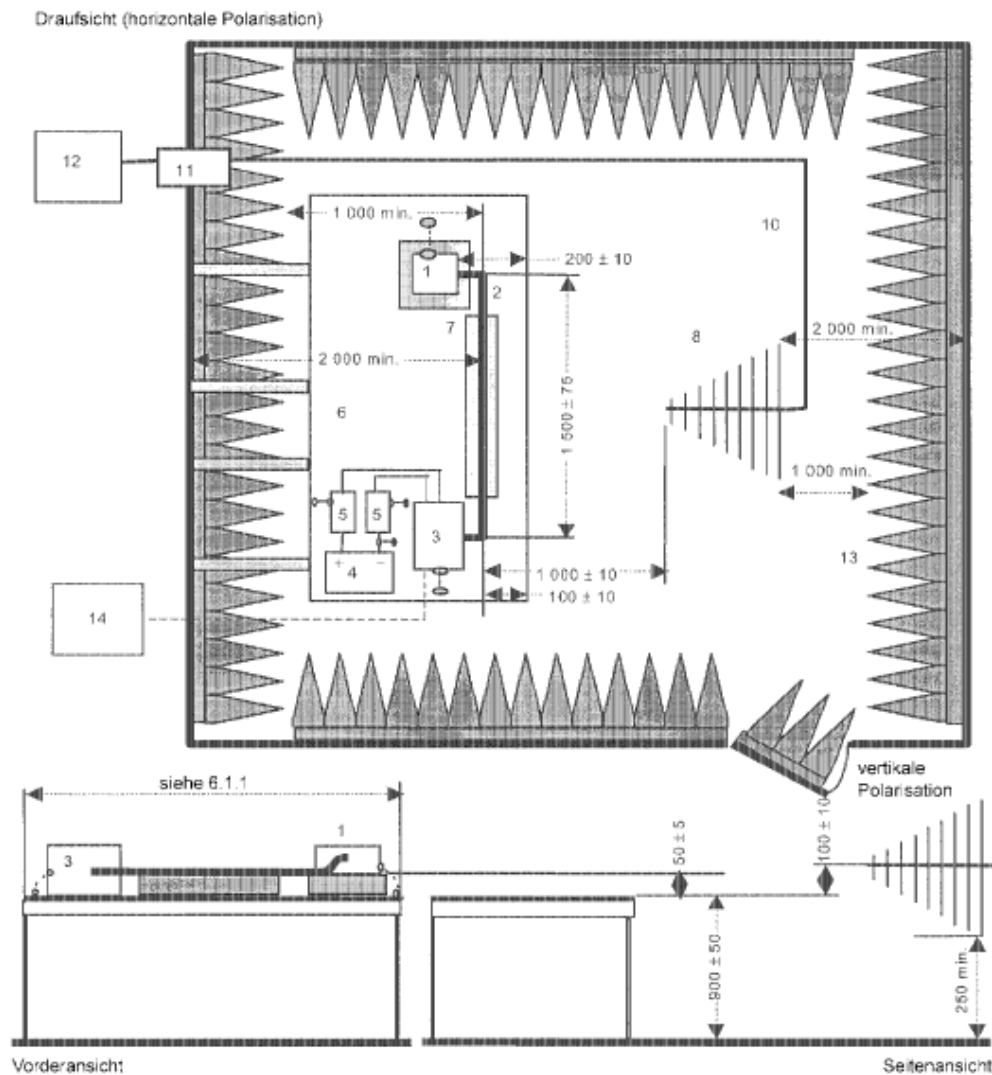
2 Test

2.1 Emission

2.1.1 Measurement of the electromagnetic field (Regulation R10, Annex 7 und 8)

Measurement set-up

Maße in mm



Legende

- | | |
|---|---|
| 1 Prüfling (direkt mit Masse verbunden, wenn dies im Prüfplan gefordert wird) | 8 logarithmisch-periodische Antenne |
| 2 Prüfkabelbaum | - - |
| 3 Lastsimulator (Anordnung und Masseverbindung entsprechend 6.4.2.5) | 10 doppelt geschirmtes Koaxialkabel hoher Qualität (50 Ω) |
| 4 Spannungsversorgung (Anordnung freigestellt) | 11 Durchführungsanschluss |
| 5 Netznachbildung (BAN) | 12 Messinstrument |
| 6 Masseplatte (mit der Wand des Schirmraums verbunden) | 13 HF-Absorbermaterial |
| 7 Unterlage mit niedriger relativer Permittivität ($\epsilon_r \leq 1,4$) | 14 Anregungs- und Überwachungssystem |

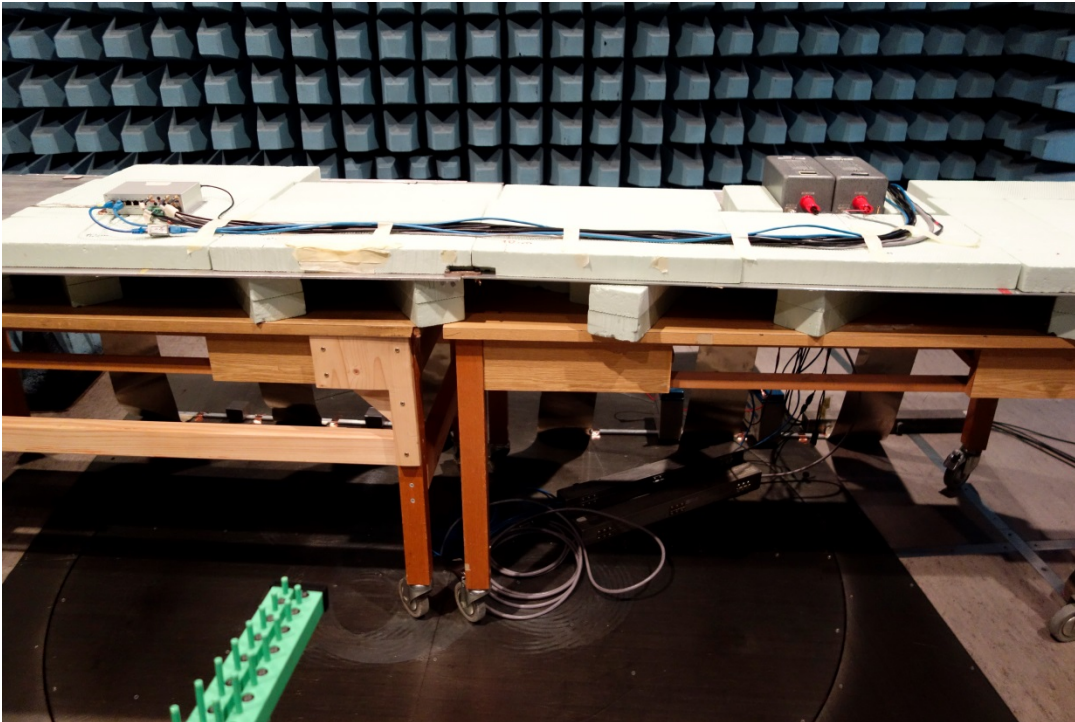


Photo 7: Measurement set-up for radiated Emission

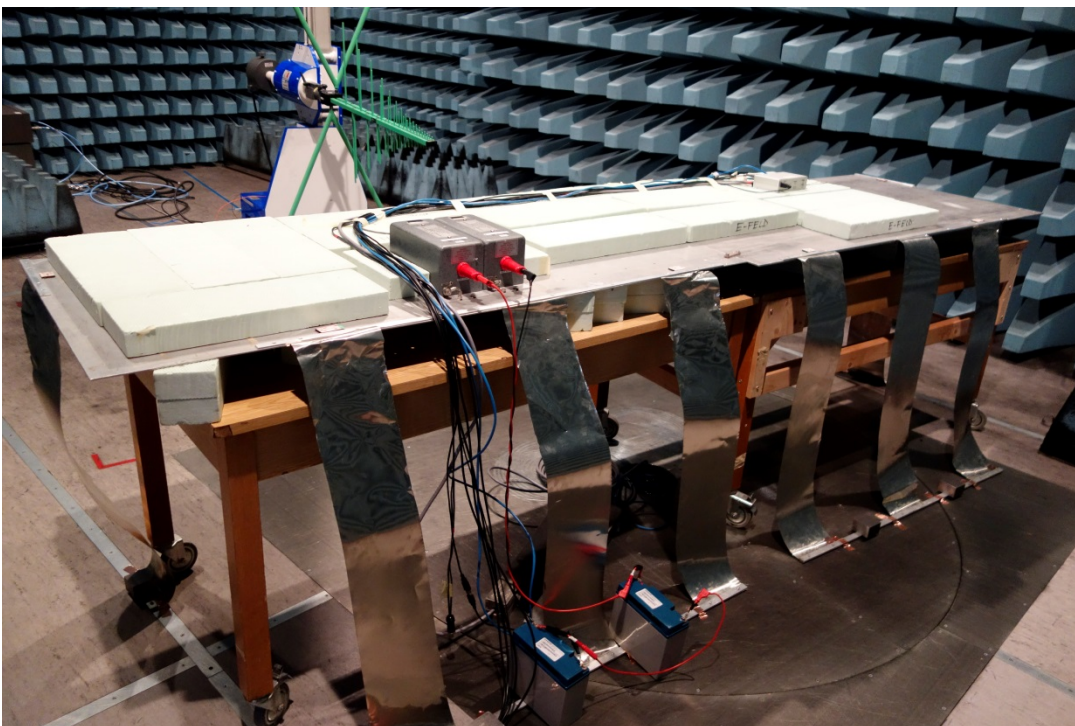


Photo 8: Measurement set-up for radiated Emission

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test equipment

| Device Type | Description | Brand | Type | ID |
|--------------------------|---|-----------------|---------------|-----------------------------|
| Antenna | H9728 BiLog Chase CBL 6112B | Chase | CBL 6112B | H9728 |
| Cable preamp -> analyser | RE <8 GHz Receiver---Ant H10010---H10013 | Huber&Suhner | Koaxial Cable | H10010-H10011-H10012-H10013 |
| Antenna tower | Maturo MC32 Tower | Maturo | MC32 | |
| Spectrum analyser | Rohde & Schwarz ESU 8 Input 1 Time Domain (LAN) | Rohde & Schwarz | ESU 8 | OA10193 |
| Turn table | Maturo MC32 Table | Maturo | MC32 | |
| LISN | LISN 5µH/50Ω | SOLAR | LISN-6338 | PE3745 |

Process of the measurement

The measurement was carried out in a semi anechoic chamber with a distance of 1 m between antenna and the harm of the EUT. The EUT is placed on a metallic plane. For low DC resistance, every 0.3m earth straps are placed to connect the metallic plane to the anechoic chamber. The power supply is connected to a LISN with 5µH/50Ω/50Amp. The radiated electromagnetic field was measured at a height of 1 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 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

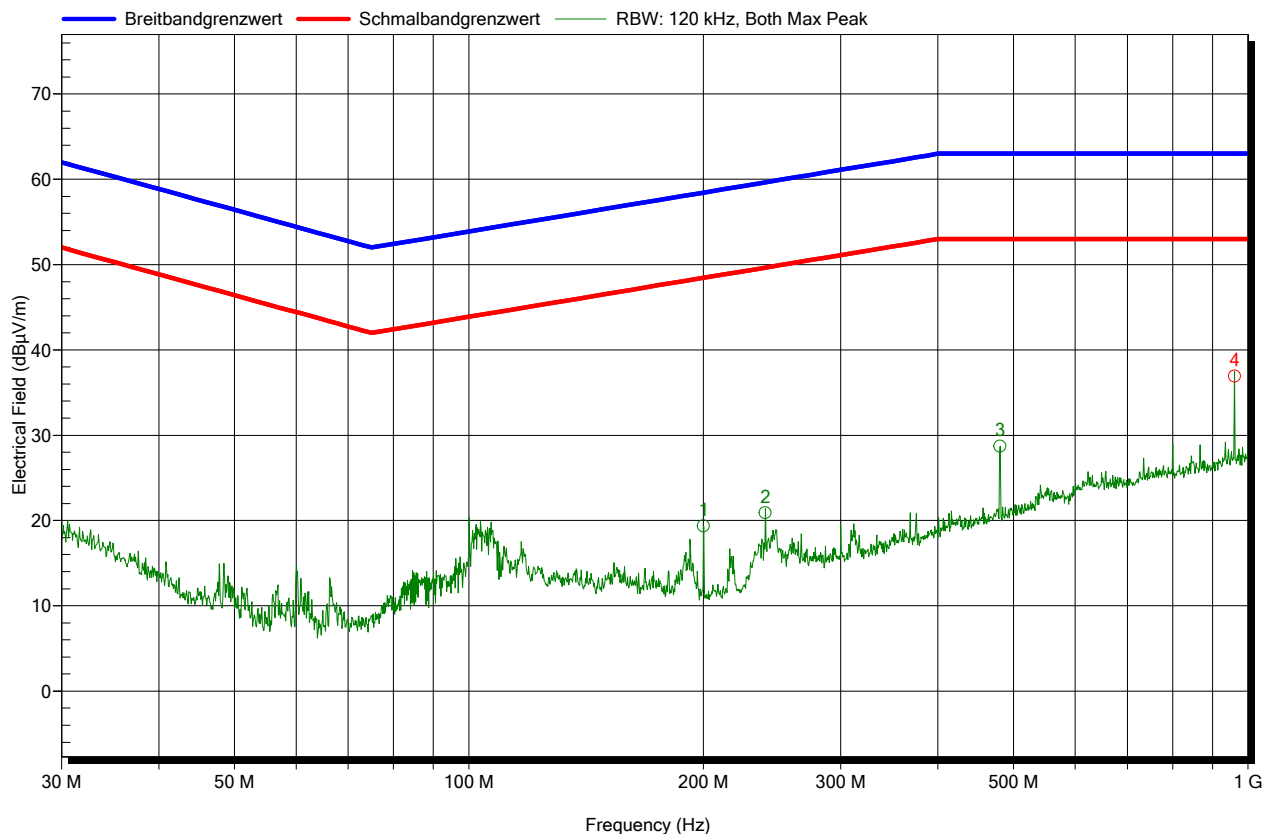
| | | |
|------------|-------------------------------------|--|
| Bandwidths | Peak Resolution Bandwidth 120kHz | Quasi-Peak detector QP-Bandwidth 120kHz |
|------------|-------------------------------------|--|

Result of the measurement

The EUT is in conformance with the specification.

Measurement 1

| | | | |
|-----------------------------|--|-----------------------------|---------------------|
| EUT | EUT 1 : NB2710 LWA-GV | | |
| Verdict, Test | Test 43: ESU8_30M-1G KFZ05/83EG Antenne 1m 0 Grad | | |
| Modification | None | | |
| Cables, Notes | All cables, see chapter 1.4.2 | | |
| Mode of operation | Normal mode, see chapter 1.4.4, supplied with 12 VDC | | |
| Test date, time | 21 October 2014, 09:25:13 | | |
| Antenna height | 1 m | Antenna polarization | Vertical/Horizontal |
| EUT position | 0 Degree (stable) | Antenna distance | 1 m |
| Measurement settings | Radimation Version: 2014.1.7, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 30 kHz steps, Attenuator: 0 dB, Internal preamp: 20 dB, Measure time: Auto [0 ns] | | |



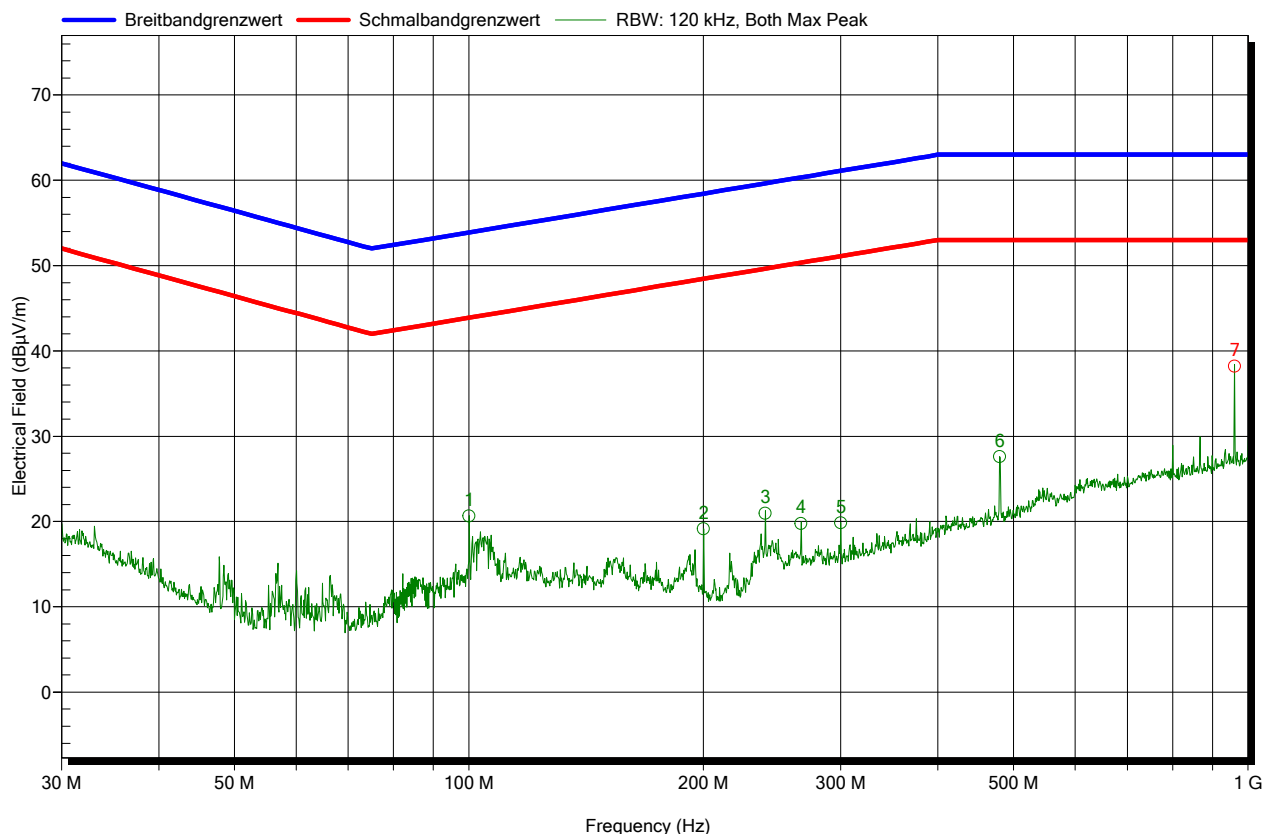
Detected peaks

| Peak Number | Frequency | Peak | Angle | Height | Polarization |
|-------------|------------|--------------|----------|--------|--------------|
| 1 | 199.98 MHz | 19.38 dBµV/m | 0 Degree | 1 m | Vertical |
| 2 | 240 MHz | 20.93 dBµV/m | 0 Degree | 1 m | Vertical |
| 3 | 480.09 MHz | 28.71 dBµV/m | 0 Degree | 1 m | Vertical |
| 4 | 960.12 MHz | 36.94 dBµV/m | 0 Degree | 1 m | Vertical |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Measurement 2

| | | | |
|-----------------------------|--|-----------------------------|---------------------|
| EUT | EUT 1 : NB2710 LWA-GV | | |
| Verdict, Test | Test 44: ESU8_30M-1G KFZ05/83EG Antenne 1m 0 Grad | | |
| Modification | None | | |
| Cables, Notes | All cables, see chapter 1.4.2 | | |
| Mode of operation | Normal mode, see chapter 1.4.4, supplied with 24 VDC | | |
| Test date, time | 21 October 2014, 09:42:39 | | |
| Antenna height | 1 m | Antenna polarization | Vertical/Horizontal |
| EUT position | 0 Degree (stable) | Antenna distance | 1 m |
| Measurement settings | Radimation Version: 2014.1.7, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 30 kHz steps, Attenuator: 0 dB, Internal preamp: 20 dB, Measure time: Auto [0 ns] | | |



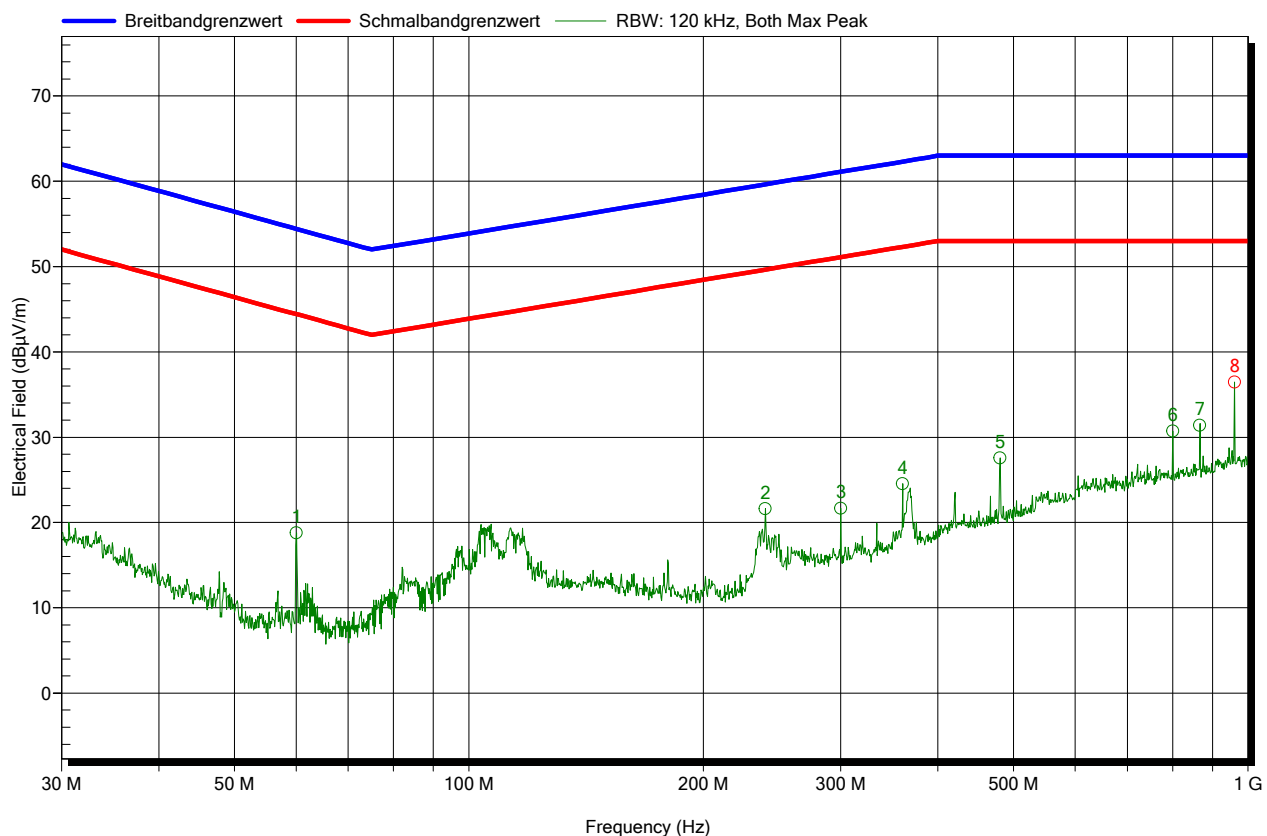
Detected peaks

| Peak Number | Frequency | Peak | Angle | Height | Polarization |
|-------------|------------|--------------|----------|--------|--------------|
| 1 | 99.99 MHz | 20.65 dBµV/m | 0 Degree | 1 m | Vertical |
| 2 | 199.98 MHz | 19.14 dBµV/m | 0 Degree | 1 m | Vertical |
| 3 | 240 MHz | 20.97 dBµV/m | 0 Degree | 1 m | Vertical |
| 4 | 266.67 MHz | 19.78 dBµV/m | 0 Degree | 1 m | Vertical |
| 5 | 300 MHz | 19.87 dBµV/m | 0 Degree | 1 m | Vertical |
| 6 | 479.76 MHz | 27.61 dBµV/m | 0 Degree | 1 m | Vertical |
| 7 | 960.15 MHz | 38.19 dBµV/m | 0 Degree | 1 m | Vertical |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Measurement 3

| | | | |
|-----------------------------|--|-----------------------------|---------------------|
| EUT | EUT 2 : NB2710 UWC-G | | |
| Verdict, Test | Test 46: ESU8_30M-1G KFZ05/83EG Antenne 1m 0 Grad | | |
| Modification | None | | |
| Cables, Notes | All cables, see chapter 1.4.2 | | |
| Mode of operation | Normal mode, see chapter 1.4.4, supplied with 12 VDC | | |
| Test date, time | 21 October 2014, 10:01:50 | | |
| Antenna height | 1 m | Antenna polarization | Vertical/Horizontal |
| EUT position | 0 Degree (stable) | Antenna distance | 1 m |
| Measurement settings | Radimation Version: 2014.1.7, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 30 kHz steps, Attenuator: 0 dB, Internal preamp: 20 dB, Measure time: Auto [0 ns] | | |



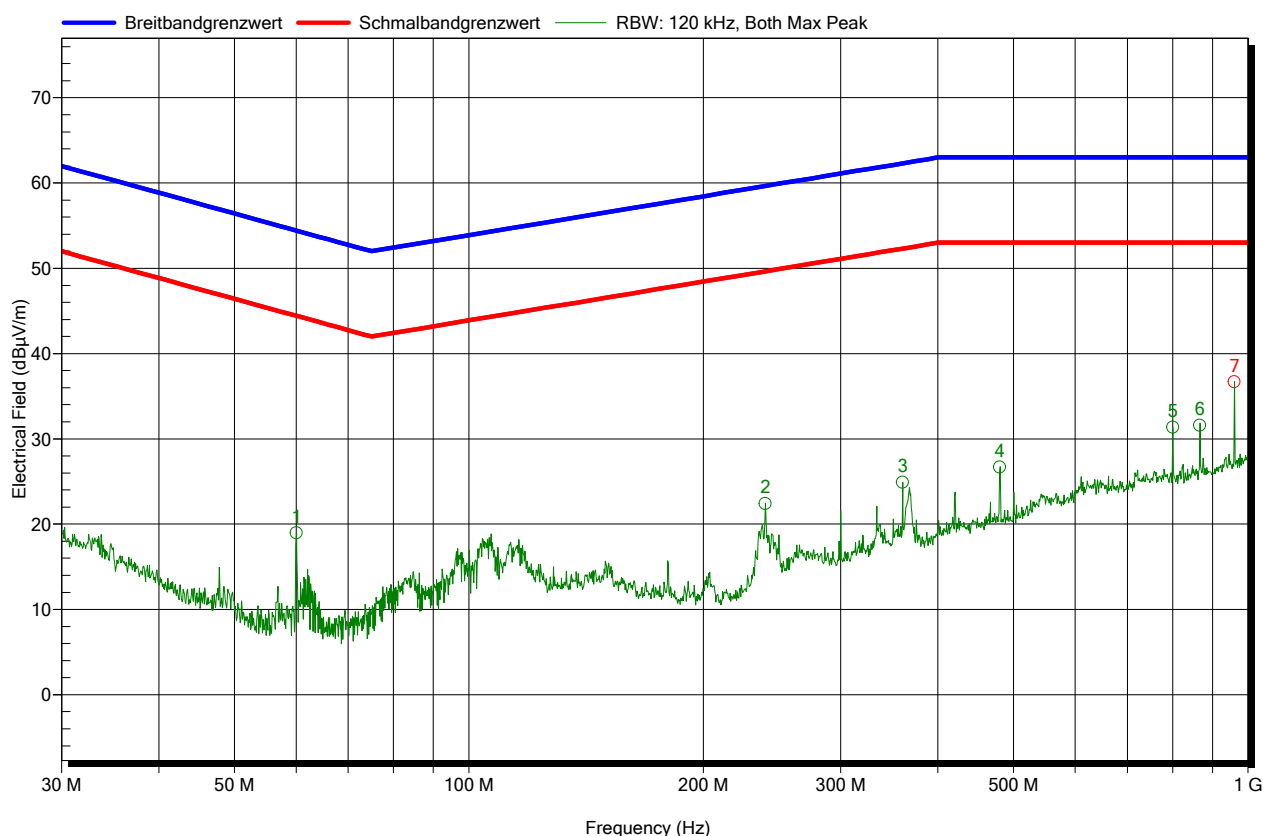
Detected peaks

| Peak Number | Frequency | Peak | Angle | Height | Polarization |
|-------------|------------|--------------|----------|--------|--------------|
| 1 | 60 MHz | 18.8 dBμV/m | 0 Degree | 1 m | Vertical |
| 2 | 240 MHz | 21.63 dBμV/m | 0 Degree | 1 m | Horizontal |
| 3 | 300 MHz | 21.66 dBμV/m | 0 Degree | 1 m | Horizontal |
| 4 | 360 MHz | 24.55 dBμV/m | 0 Degree | 1 m | Vertical |
| 5 | 480.09 MHz | 27.55 dBμV/m | 0 Degree | 1 m | Horizontal |
| 6 | 799.98 MHz | 30.74 dBμV/m | 0 Degree | 1 m | Vertical |
| 7 | 866.67 MHz | 31.42 dBμV/m | 0 Degree | 1 m | Vertical |
| 8 | 960.21 MHz | 36.47 dBμV/m | 0 Degree | 1 m | Horizontal |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Measurement 4

| | | | |
|-----------------------------|--|-----------------------------|---------------------|
| EUT | EUT 2 : NB2710 UWC-G | | |
| Verdict, Test | Test 45: ESU8_30M-1G KFZ05/83EG Antenne 1m 0 Grad | | |
| Modification | None | | |
| Cables, Notes | All cables, see chapter 1.4.2 | | |
| Mode of operation | Normal mode, see chapter 1.4.4, supplied with 24 VDC | | |
| Test date, time | 21 October 2014, 09:56:28 | | |
| Antenna height | 1 m | Antenna polarization | Vertical/Horizontal |
| EUT position | 0 Degree (stable) | Antenna distance | 1 m |
| Measurement settings | Radimation Version: 2014.1.7, RBW: 120 kHz, VBW: Auto [120 kHz], Sweep time: Auto [120 ms], Step freq: Linear: 30 kHz steps, Attenuator: 0 dB, Internal preamp: 20 dB, Measure time: Auto [0 ns] | | |



Detected peaks

| Peak Number | Frequency | Peak | Angle | Height | Polarization |
|-------------|------------|--------------|----------|--------|--------------|
| 1 | 60 MHz | 18.99 dBµV/m | 0 Degree | 1 m | Vertical |
| 2 | 240 MHz | 22.42 dBµV/m | 0 Degree | 1 m | Horizontal |
| 3 | 360 MHz | 24.91 dBµV/m | 0 Degree | 1 m | Vertical |
| 4 | 480.06 MHz | 26.71 dBµV/m | 0 Degree | 1 m | Horizontal |
| 5 | 799.98 MHz | 31.38 dBµV/m | 0 Degree | 1 m | Vertical |
| 6 | 866.64 MHz | 31.6 dBµV/m | 0 Degree | 1 m | Vertical |
| 7 | 959.52 MHz | 36.69 dBµV/m | 0 Degree | 1 m | Horizontal |

Uncertainty of Measurement Instrumentation

Estimated uncertainty of the measurement results for 30MHz – 230MHz: (normal distribution, k=2) ± 3.4 dB
Estimated uncertainty of the measurement results for 230MHz – 1GHz: (normal distribution, k=2) ± 2.2 dB

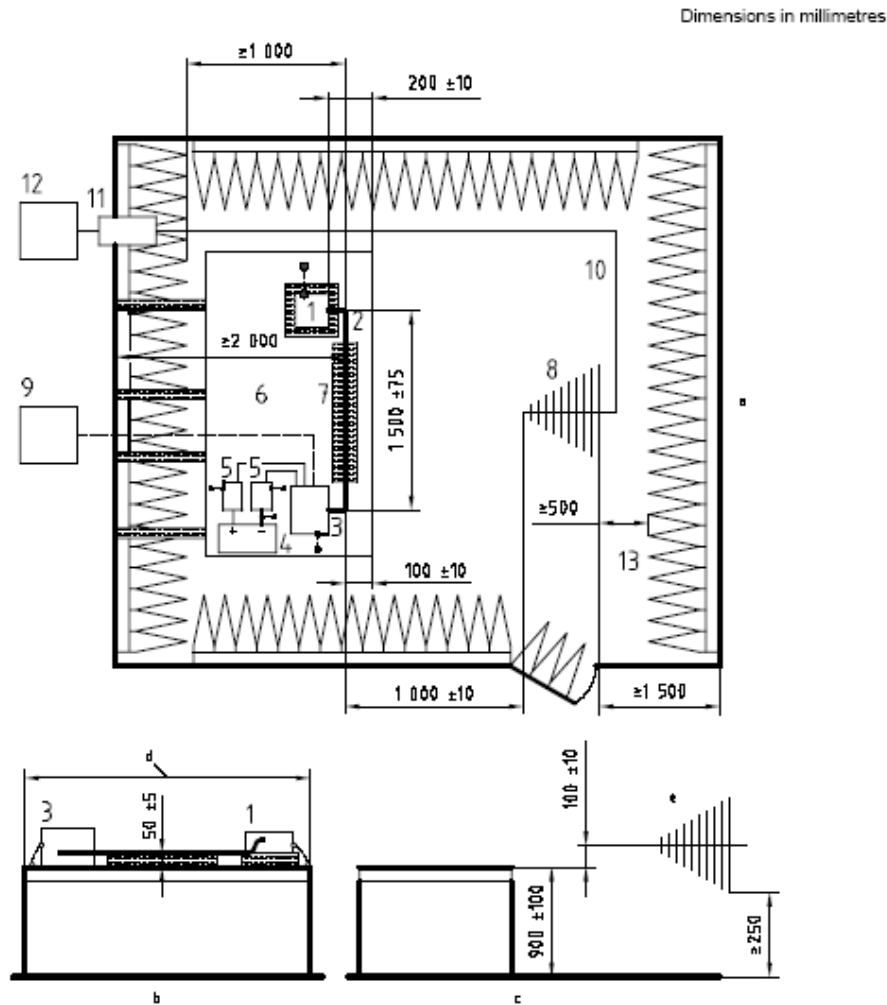
Maximum uncertainty defined by the standard for 30MHz – 230MHz: $\pm 5,2$ dB
Maximum uncertainty defined by the standard for 230MHz – 1GHz: $\pm 5,2$ dB

The measurement instrumentation uncertainty does not affect the compliance to the specification limits.

2.2 Immunity

2.2.1 Radiated Field Measurement (EN ISO 11452-2)

Test set-up according to ISO 11452-2:



| | | | |
|---|--|----|---|
| 1 | DUT (grounded locally if required in test plan) | 7 | low relative permittivity support ($\epsilon_r \leq 1,4$) |
| 2 | test harness | 8 | horn antenna |
| 3 | load simulator (placement and ground: connection according to 7.5) | 9 | stimulation and monitoring system |
| 4 | power supply (location optional) | 10 | high quality double-shielded coaxial cable (50 Ω) |
| 5 | artificial network (AN) | 11 | bulkhead connector |
| 6 | ground plane (bonded to shielded enclosure) | 12 | RF signal generator and amplifier |
| | | 13 | RF absorber material |

a Upper view (horizontal polarisation).
b Front view.
c Side view.
d See 7.1.
e Vertical polarization.

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|



Photo 9: Measurement set-up for radiated Immunity, Log-periodic-antenna

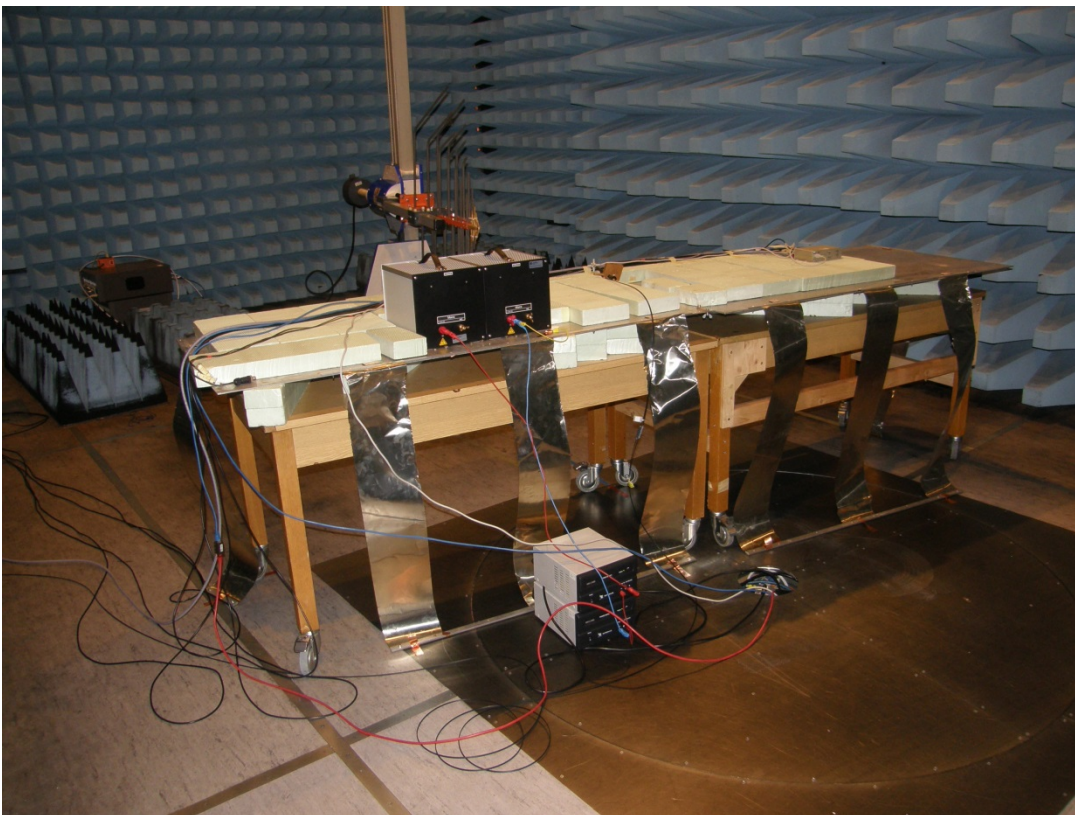


Photo 10: Measurement set-up for radiated Immunity, Log-periodic-antenna



Photo 11: Measurement set-up for radiated Immunity, Horn antenna, for immunity above 1 GHz

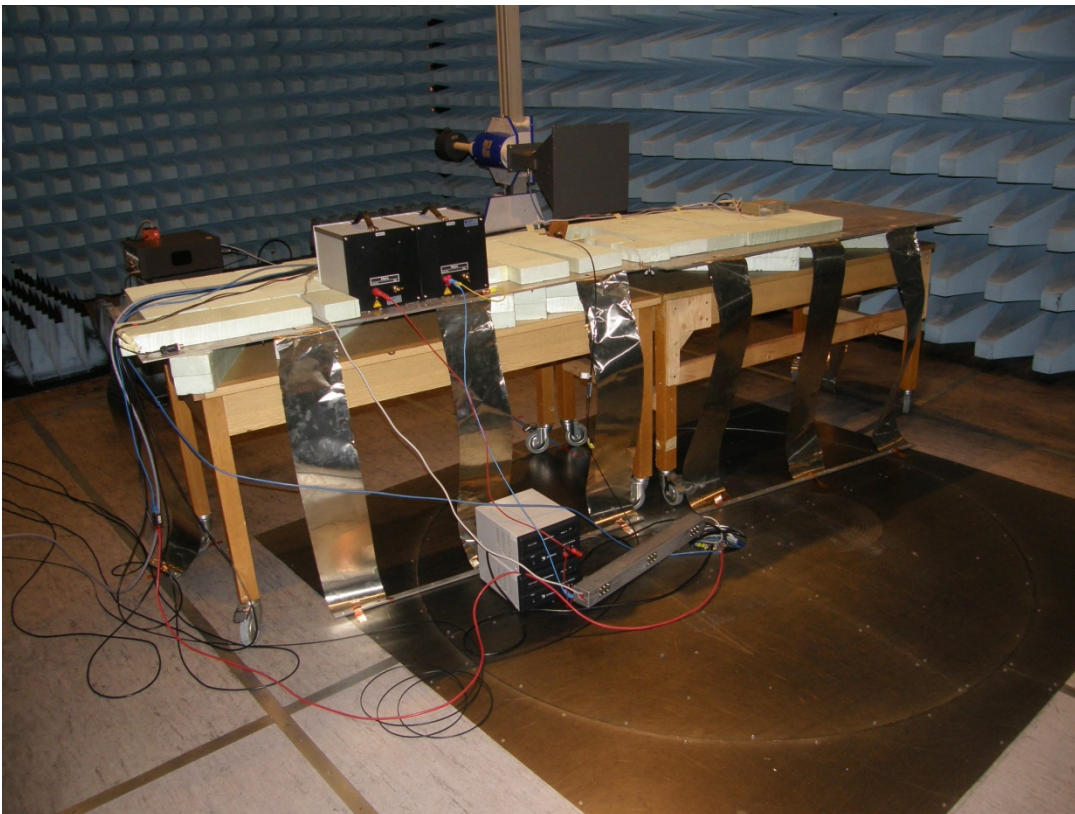


Photo 12: Measurement set-up for radiated Immunity, Horn antenna, for immunity above 1 GHz

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test equipment

| Device Type | Description | Brand | Type | ID |
|------------------|---------------------------|--------------------|-------------|------------|
| Signal generator | AnaPico APSIN 6010 | AnaPico | APSIN 6010 | 13.6632.14 |
| Amplifier: | AR 750W1000 | Amplifier Research | AR 750W1000 | 14.6632.04 |
| Antenna: | AT 6080 H10192 | Amplifier Research | AT 6080 | H10192 |
| Antenna | AT4002A | Amplifier Research | AT4002A | H9673 |
| Amplifier: | Amplifier Research 50S1G6 | Amplifier Research | AR 50S1G6 | 13.6632.13 |
| Field sensor 1 | 146632.02 PMM EP601 | PMM | EP601 | 146632.02 |

| | | | |
|---|---|---|------------------------------|
| EUT: | EUT 2 : NB2710 UWC-G | | |
| Connected: | All cables | | |
| Test set-up: | EUT is on the metallic table 95 cm above ground plane | | |
| Operating mode: | Active condition, see chap. 1.4.4 | | |
| Compliance criteria (see chap. 1.6.3): | Field strength: | ISO 11452-2: with test levels according to Directive 72/245/EEC last update directive 2006/28/EC | Compliance Criterion: |
| | 30 V/m | 20 MHz – 800 MHz, 80% AM, 1 kHz | A |
| | 30 V/m | 0.8 GHz – 2 GHz, PM 217Hz, 12.5% Duty | A |
| Function surveillance: | Visual observation | | |

| Settings of the test equipment | | | |
|--------------------------------|-------------------|-------------------------------|-----------------|
| Frequency range: | 80 MHz - 1000 MHz | Height of the antenna: | 1.05 m |
| Frequency step: | 1 % | Amplitude modulation: | 80 % with 1 kHz |
| Polarisation: | Vertical | Dwell time: | 1 s |
| Side of EUT to antenna: | Front | | |

Measurement 1:

| | | | |
|---------------------------|-----------------------------------|---|--|
| Mode of operation: | Active condition, see chap. 1.4.4 | | |
| Frequency range: | Test Voltage: | Performance of the EUT: | |
| 80 – 1000 MHz | 50 V/m | No degradation noticed, EUT conforms to the compliance criteria A | |

| Settings of the test equipment | | | |
|--------------------------------|----------------------|-------------------------------|---------------------|
| Frequency range: | 0.8 GHz – 2.0 GHz | Height of the antenna: | 1.05 m |
| Frequency step: | 1 % | Pulse modulation: | 217 Hz, 12.5 % Duty |
| Polarisation: | Horizontal, vertical | Dwell time: | 1 s |
| Side of EUT to antenna: | Front | | |

Measurement 2:

| | | | |
|---------------------------|-----------------------------------|---|--|
| Mode of operation: | Active condition, see chap. 1.4.4 | | |
| Frequency range: | Test Voltage: | Performance of the EUT: | |
| 0.8 GHz – 2.0 GHz | 50 V/m | No degradation noticed, EUT conforms to the compliance criteria A | |
| 0.8 GHz – 2.0 GHz | 100 V/m | No degradation noticed, EUT conforms to the compliance criteria A | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Uncertainty of Measurement

The uncertainty of measurement is: (normal distribution, k=2) ± 26 %

The uncertainty does not affect the compliance to the specification.

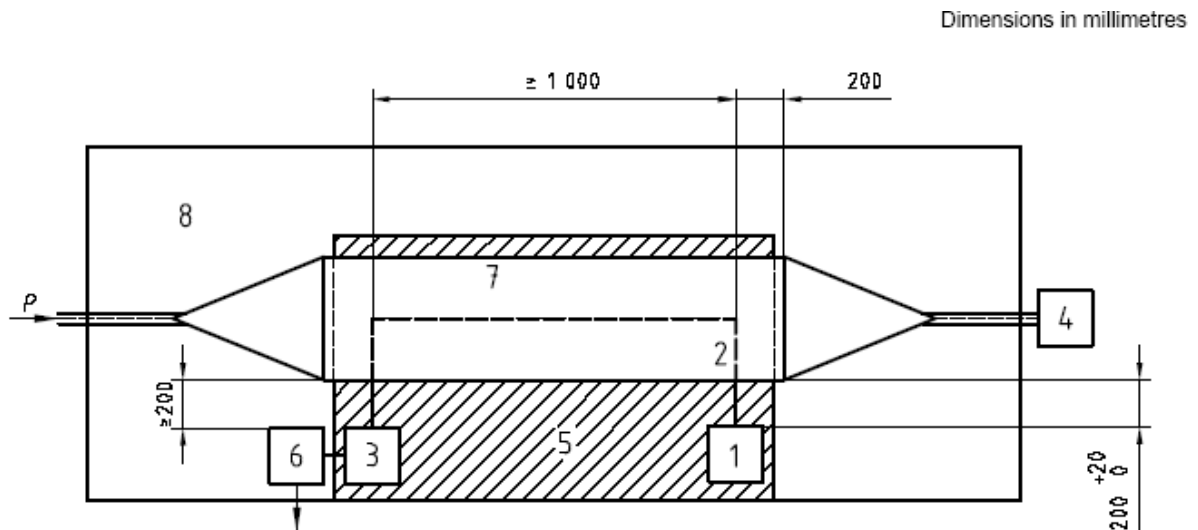
Result of the test

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

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

2.2.2 Stripline (EN ISO 11452-5)

Test set-up:



Key

- 1 Device under test
- 2 Wiring harness
- 3 Peripheral
- 4 Terminating resistance
- 5 Insulating base
- 6 Artificial network(s)
- 7 Active conductor
- 8 Ground plane

Figure 1 — Example stripline test configuration

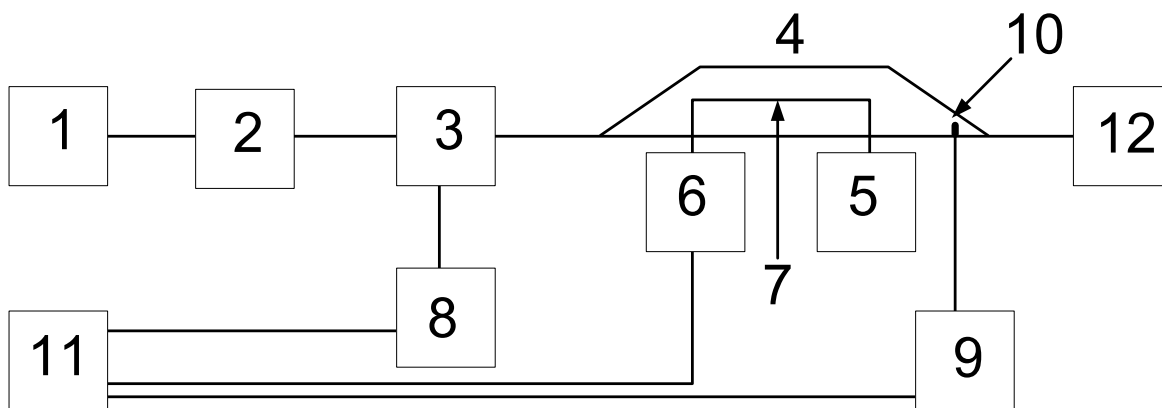


Fig. 2 Test setup for stripline test

- 1 Signal Generator
- 2 Power Amplifier
- 3 Coupler
- 4 Stripline
- 5 Device under Test (EUT)
- 6 Test monitor (AUX)
- 7 Wiring harness
- 8 Power meter
- 9 Spectrum analyzer
- 10 Monopole antenna
- 11 Computer
- 12 RF termination

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|



Photo 13: Set-up for the Stripline test

Test equipment

| Device Type | Description | Brand | Type | ID |
|--------------------------|---------------------------------------|--------------------|---------------------------------|------------------------|
| Field sensor 1 | H9768 PMM OR03 + EP330 | PMM | OR03 + EP330 | H9768 |
| Amplifier | V8169 Amplifier Research 100W1000M5A | Amplifier Research | 100W1000M5A | V8169 |
| Signal generator | Rohde & Schwarz SME 03 | Rohde & Schwarz | SME 03 | |
| Cable coupler -> antenna | RI <6 GHz Coupler-Ant H10015---H10017 | Huber Su- hner | Sucoflex 106 | H10015, H10016, H10017 |
| Antenna tower | Manual Tower | | Manual Controlled Antenna Tower | |
| Spectrum analyser | OA9715 HP 8546A 20M-2.9G | Hewlett Packard | 8546A | OA9715 |
| Coupler | H8322 Amplifier Research DC3001M2 | Amplifier Research | DC3001A | H8322 |
| Antenna | H10115 Stimpfl SL-3.2M | Stimpfl | SL-3.2M | H10115 |
| Turn table | Manual Controlled Turn Table | | Manual Controlled Turn Table | |
| Forward power meter | OL8386 Gigatronic 8542C+80401A Ch A | Gigatronic | 8542 Channel A | OL8386 |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

| | | | |
|---|-----------------------------------|---|------------------------------|
| EUT: | EUT 2 : NB2710 UWC-G | | |
| Connected: | All cables | | |
| Operating mode: | Active condition, see chap. 1.4.4 | | |
| Compliance criteria (see chap. 1.6.3): | Field strength: | ISO 11452-2: with test levels according to Directive 72/245/EEC last update directive 2006/28/EC | Compliance Criterion: |
| | 60 V/m | 20 MHz – 800 MHz, 80% AM, 1 kHz | A |
| | 60 V/m | 0.8GHz – 1 GHz, 217 Hz with 12.5% Duty | A |
| Function surveillance: | Visual observation | | |

Protocol of the test:

| Settings of the test equipment | | | |
|--------------------------------|------------------|-------------------------------|-----------------|
| Frequency range: | 0.1 MHz - 30 MHz | Height of the antenna: | 0.15 m |
| Frequency step: | 5 % | Amplitude modulation: | 80 % with 1 kHz |
| Polarisation: | vertical | Dwell time: | 1 s |
| Side of EUT to antenna: | Front | | |

| Settings of the test equipment | | | |
|--------------------------------|-------------------|-------------------------------|-----------------|
| Frequency range: | 30 MHz - 1000 MHz | Height of the antenna: | 0.15 m |
| Frequency step: | 2 % | Pulse modulation: | 80 % with 1 kHz |
| Polarisation: | vertical | Dwell time: | 1 s |
| Side of EUT to antenna: | Front | | |

Measurement 1:

| | | | |
|---------------------------|-----------------------------------|---|--|
| Mode of operation: | Active condition, see chap. 1.4.4 | | |
| Frequency range: | Test Voltage: | Performance of the EUT: | |
| 0.1 – 30 MHz | 100 V/m | No degradation noticed, EUT conforms to the compliance criteria A | |
| 30 – 1000 MHz | 100 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 specification.

Result of the test

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

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

2.2.3 Impulse tests (ISO 7637-2), EUT 1 as 12 V system

Test set-up



Measurement equipment

| Equipment | Manufacturer | Type | Serial Nr. | Inv-Nr. |
|------------------------|--------------|----------|------------|---------|
| Load Dump Generator | EM-Test | LD200 | 06100107 | QS2481 |
| Transient Generator | EM-Test | UCS200-M | 06100108 | QS2480 |
| Voltage Drop Generator | EM-Test | VDS200 | 06100109 | QS2479 |
| Oscilloscope | Tektronix | TDS350 | B010167 | QS2453 |
| Oscilloscope | Tektronix | TDS2012B | C040208 | QS2546 |
| | | | | |
| Test Software | EM-Test | | 000029 | |

Test Pulse Nr. 1:

Requirements

| Test level (U _s) | Min. number of test pulses | Pulse repetition time | | Compliance criteria |
|---------------------------------|-------------------------------|--------------------------|------|--|
| | | min | max. | |
| -75 V | 5000 pulses | 0.5 s | 5 s | Immunity-related functions: Class C Not immunity-related functions: Class D |

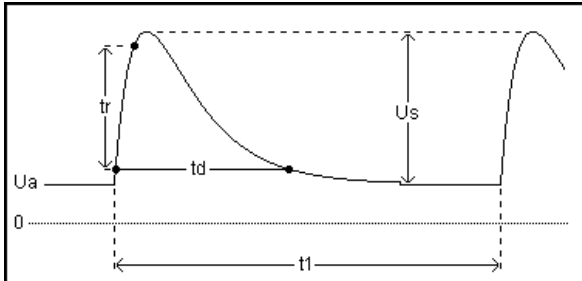
| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Measurement protocol

| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 15:45 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2011 |
| Application: | 12 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 96 kPa |

| Settings: | | | |
|------------------|-----------------------------|---------------|------------------------|
| Pulse form: | ISO 7637-2 : 2011 : Pulse 1 | | |
| Test generator: | UCS200M | Software-Nr.: | 000029 |
| | | Serial: | 06100108 |
| Ua (Alternator): | 13.5 | V | Current limiting: 15 A |

| Pulse parameters: | | |
|-------------------|----------|----|
| Us: | -75 | V |
| t1: | 1.0 | s |
| t2: | 200 | ms |
| tr: | 1 | us |
| td: | 2000 | us |
| Coupling: | Battery | |
| Number of events: | 5000 | |
| Test duration: | 01:23:20 | h |



The graph illustrates a pulse waveform. The vertical axis represents voltage, with a zero line indicated by a horizontal dotted line. The pulse starts at a baseline voltage U_a , rises to a peak voltage U_s (indicated by a dashed line), and then decays back to the baseline. The rise time t_r is the time interval from the start of the rise to the peak. The delay time t_d is the time interval from the start of the pulse to the point where the voltage has decayed to a level just above the baseline. The pulse width t_1 is the total time duration of the pulse, from its start to its end. The baseline voltage U_a is shown as a horizontal line segment before and after the pulse. The zero line is a horizontal dotted line below the baseline.

| Test result: | | |
|-------------------|--|--|
| Number of pulses: | 5000 | |
| Requirement: | Criteria D | |
| Test result: | The EUT shuts down, ethernet communication lost, after the test restart without any operation, communication over ethernet already o.k., EUT conforms to the compliance criteria C & D | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 2a:

Requirements

| Test level (U_s) | Min. number of test pulses | Pulse repetition time | | Compliance criteria |
|-------------------------|-------------------------------|--------------------------|------|--|
| | | min | max. | |
| +37 V | 5000 pulses | 0.2 s | 5 s | Immunity-related functions: Class B Not immunity-related functions: Class D |

Measurement protocol

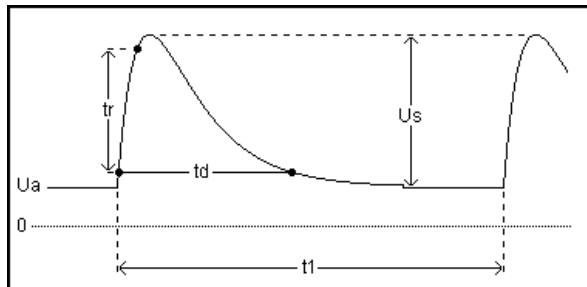
| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 12:16 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 12 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 1012 mbar |

Settings:

| | | | | | |
|------------------|------------------------------|---|-------------------|----------|---|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 2a | | | | |
| Test generator | UCS200M | | Software-Nr.: | 000029 | |
| | | | Serial: | 06100108 | |
| Ua (Alternator): | 13.5 | V | Current limiting: | 15 | A |

Pulse parameters:

| | | |
|-------------------|----------|-----|
| Us: | +37 | V |
| t1: | 0.5 | s |
| tr: | 1 | us |
| td: | 50 | us |
| Ri: | 2 | Ohm |
| Coupling: | Battery | |
| Number of events: | 5000 | |
| Test duration: | 00:41:40 | h |



Test result:

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

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 3a:

Requirements

| Test level (U_s) | Min. test time | Burst cycle | | Compliance criteria |
|-------------------------|-------------------|-------------|--------|--|
| | | min | max. | |
| -112 V | 1 h | 90 ms | 100 ms | Immunity-related functions: Class A Not immunity-related functions: Class D |

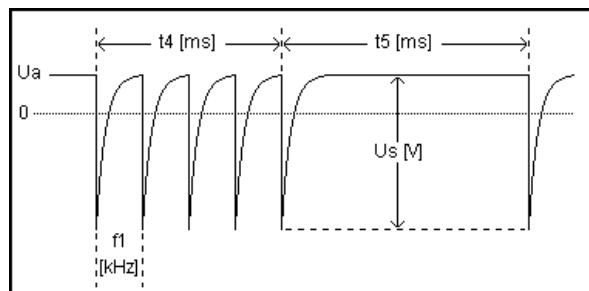
| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 13:18 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 12 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 1012 mbar |

Settings:

| | | | | |
|------------------|------------------------------|---------------|-------------------|------|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 3a | | | |
| Test generator | UCS200M | Software-Nr.: | 000029 | |
| | | Serial: | 06100108 | |
| Ua (Alternator): | 13.5 | V | Current limiting: | 15 A |

Pulse parameters:

| | | |
|----------------|---------|-----|
| Us: | -112 | V |
| f1: | 10 | kHz |
| t4: | 10 | ms |
| t5: | 90 | ms |
| tr: | 5 | ns |
| td: | 100 | ns |
| Ri: | 50 | Ohm |
| Coupling: | Battery | |
| Test duration: | 1 | h |



Test result:

| | | | |
|----------------|---|---|--|
| Test duration: | 01:00:01 | h | |
| Requirement: | Criteria D | | |
| Test result: | No degradation noticed, EUT conforms to the compliance criteria A & D | | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 3b:

Requirements

| Test level (U_s) | Min. test time | Burst cycle | | Compliance criteria |
|-------------------------|-------------------|-------------|--------|--|
| | | min | max. | |
| +75 V | 1 h | 90 ms | 100 ms | Immunity-related functions: Class A Not immunity-related functions: Class D |

| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 14:20 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 12 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 1012 mbar |

| Settings: | | | | | |
|------------------|------------------------------|---|-------------------|----------|---|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 3b | | | | |
| Test generator | UCS200M | | Software-Nr.: | 000029 | |
| | | | Serial: | 06100108 | |
| Ua (Alternator): | 13.5 | V | Current limiting: | 15 | A |

| Pulse parameters: | | |
|-------------------|---------|-----|
| Us: | +75 | V |
| f1: | 10 | kHz |
| t4: | 10 | ms |
| t5: | 90 | ms |
| tr: | 5 | ns |
| td: | 100 | ns |
| Ri: | 50 | Ohm |
| Coupling: | Battery | |
| Test duration: | 1 | h |

| Test result: | | | |
|----------------|---|---|--|
| Test duration: | 01:00:01 | h | |
| Requirement: | Criteria D | | |
| Test result: | No degradation noticed, EUT conforms to the compliance criteria A & D | | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 4:

Requirements

| Test level (U _s) | Min. number of test pulses | Pulse repetition time | | Compliance criteria |
|---------------------------------|-------------------------------|--------------------------|------|--|
| | | min | max. | |
| -6 V | 1 pulse | --- | --- | Immunity-related functions: Class C Not immunity-related functions: Class D |

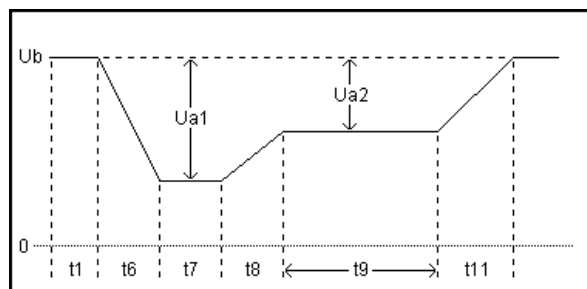
| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 16:05 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 12 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 1012 mbar |

Settings:

| | | | | |
|---------------------------|-----------------------------|---------------|-------------------|------|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 4 | | | |
| Test generator | VDS200B | Software-Nr.: | 000374 | |
| | | Serial: | 06100109 | |
| U _b (Battery): | 12.0 | V | Current limiting: | 15 A |

Pulse parameters:

| | | |
|-------------------|----------|----|
| U _{a1} : | -6.0 | V |
| U _{a2} : | -2.5 | V |
| t ₁ : | 1.0 | s |
| t ₆ : | 5 | ms |
| t ₇ : | 15 | ms |
| t ₈ : | 50 | ms |
| t ₉ : | 0.5 | s |
| t ₁₁ : | 5 | ms |
| Number of events: | 1 | |
| Test duration: | 00:00:02 | h |



| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

| Test result: | | |
|-------------------|--|--|
| Number of pulses: | 10 | |
| Requirement: | Criteria D | |
| Test result: | The EUT shuts down, ethernet communication lost, after the test restart without any operation, communication over ethernet already o.k., EUT conforms to the compliance criteria C & D | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

2.2.4 Impulse tests (ISO 7637-2), EUT 2 as 24 V system

Test set-up



Measurement equipment

| Equipment | Manufacturer | Type | Serial Nr. | Inv-Nr. |
|------------------------|--------------|----------|------------|---------|
| Load Dump Generator | EM-Test | LD200 | 06100107 | QS2481 |
| Transient Generator | EM-Test | UCS200-M | 06100108 | QS2480 |
| Voltage Drop Generator | EM-Test | VDS200 | 06100109 | QS2479 |
| Oscilloscope | Tektronix | TDS350 | B010167 | QS2453 |
| Oscilloscope | Tektronix | TDS2012B | C040208 | |
| | | | | |
| Test Software | EM-Test | | 000029 | |

Test Pulse Nr. 1:

Requirements

| Test level (U_s) | Min. number of test pulses | Pulse repetition time | | Compliance criteria |
|-------------------------|-------------------------------|--------------------------|------|--|
| | | min | max. | |
| -450 V | 5000 pulses | 0.5 s | 5 s | Immunity-related functions: Class C Not immunity-related functions: Class D |

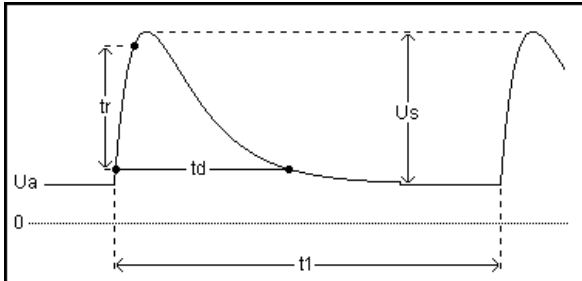
| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Measurement protocol

| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 11:50 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2011 |
| Application: | 24 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 96 kPa |

| Settings: | | | |
|------------------|-----------------------------|---------------|------------------------|
| Pulse form: | ISO 7637-2 : 2011 : Pulse 1 | | |
| Test generator: | UCS200M | Software-Nr.: | 000029 |
| | | Serial: | 06100108 |
| Ua (Alternator): | 27.0 | V | Current limiting: 15 A |

| Pulse parameters: | | |
|-------------------|----------|----|
| Us: | -450 | V |
| t1: | 1.0 | s |
| t2: | 200 | ms |
| tr: | 3 | us |
| td: | 1000 | us |
| Coupling: | Battery | |
| Number of events: | 5000 | |
| Test duration: | 01:23:20 | h |



The graph illustrates a pulse waveform with the following parameters:

- tr**: Rise time, indicated by a vertical double-headed arrow from the baseline to the peak.
- td**: Delay time, indicated by a horizontal double-headed arrow from the start of the pulse to the point where the voltage has decayed to the level of the baseline.
- Us**: Peak voltage, indicated by a vertical double-headed arrow from the baseline to the peak.
- Ua**: Alternator voltage, indicated by a horizontal line at the level of the baseline.
- 0**: Zero line, indicated by a horizontal dotted line.
- t1**: Pulse width, indicated by a horizontal double-headed arrow from the start of the pulse to the end of the pulse.

| Test result: | | |
|-------------------|--|--|
| Number of pulses: | 5000 | |
| Requirement: | Criteria C | |
| Test result: | The EUT shuts down, ethernet communication lost, after the test restart without any operation, communication over ethernet already o.k., EUT conforms to the compliance criteria C | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 2a:

Requirements

| Test level (U _s) | Min. number of test pulses | Pulse repetition time | | Compliance criteria |
|---------------------------------|-------------------------------|--------------------------|------|--|
| | | min | max. | |
| +37 V | 5000 pulses | 0.2 s | 5 s | Immunity-related functions: Class B Not immunity-related functions: Class D |

Measurement protocol

| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 08:18 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 24 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 96 kPa |

Settings:

| | | | | | |
|------------------------------|------------------------------|---------------|-------------------|----|---|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 2a | | | | |
| Test generator: | UCS200M | Software-Nr.: | 000029 | | |
| | | Serial: | 06100108 | | |
| U _a (Alternator): | 27.0 | V | Current limiting: | 15 | A |

Pulse parameters:

| | | |
|-------------------|----------|-----|
| Us: | +37 | V |
| t1: | 0.2 | s |
| tr: | 1 | us |
| td: | 50 | us |
| Ri: | 2 | Ohm |
| Coupling: | Battery | |
| Number of events: | 5000 | |
| Test duration: | 00:16:40 | h |

Test result:

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

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 2b:

Requirements

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

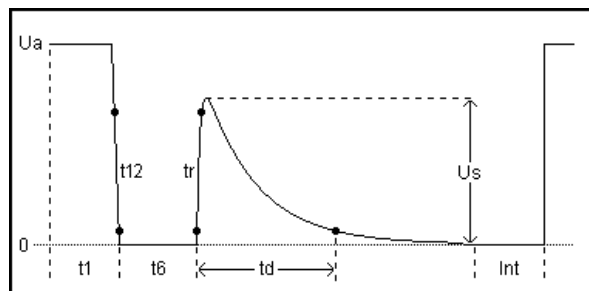
| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 11:55 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 24 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 96 kPa |

Settings:

| | | | | |
|------------------|------------------------------|---------------|-------------------|------|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 2b | | | |
| Test generator: | VDS200B | Software-Nr.: | 000374 | |
| | | Serial: | 06100109 | |
| Ua (Alternator): | 27.0 | V | Current limiting: | 15 A |

Pulse parameters:

| | | |
|-------------------|----------|-----|
| Us: | 20.0 | V |
| t1: | 5 | s |
| t6: | 1 | ms |
| td: | 200 | ms |
| Int: | 1 | s |
| Ri: | 0.00 | Ohm |
| t12: | 1 | ms |
| tr: | 1 | ms |
| Number of events: | 10 | |
| Test duration: | 00:01:08 | h |



Test result:

| | |
|-------------------|--|
| Number of pulses: | 10 |
| Requirement: | Criteria C |
| Test result: | The EUT shuts down, ethernet communication lost, after the test restart without any operation, communication over ethernet already o.k., EUT conforms to the compliance criteria C |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 3a:

Requirements

| Test level (U_s) | Min. test time | Burst cycle | | Compliance criteria |
|-------------------------|-------------------|-------------|--------|--|
| | | min | max. | |
| -150 V | 1 h | 90 ms | 100 ms | Immunity-related functions: Class A Not immunity-related functions: Class D |

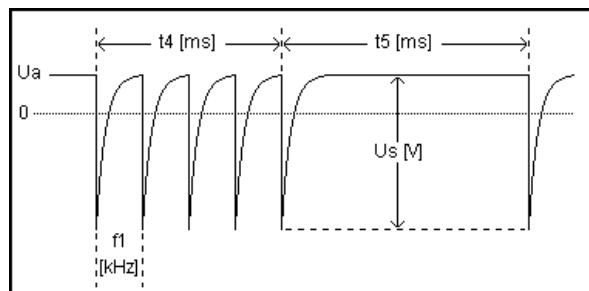
| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 09:20 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 24 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 96 kPa |

Settings:

| | | | | |
|------------------|------------------------------|---------------|-------------------|------|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 3a | | | |
| Test generator: | UCS200M | Software-Nr.: | 000029 | |
| | | Serial: | 06100108 | |
| Ua (Alternator): | 27.0 | V | Current limiting: | 15 A |

Pulse parameters:

| | | |
|----------------|---------|-----|
| Us: | -150 | V |
| f1: | 10 | kHz |
| t4: | 10 | ms |
| t5: | 90 | ms |
| tr: | 5 | ns |
| td: | 100 | ns |
| Ri: | 50 | Ohm |
| Coupling: | Battery | |
| Test duration: | 1 | h |



Test result:

| | | | |
|----------------|---|---|--|
| Test duration: | 01:00:01 | h | |
| Requirement: | Criteria A | | |
| Test result: | No degradation noticed, EUT conforms to the compliance criteria A | | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

Test Pulse Nr. 3b:

Requirements

| Test level (U_s) | Min. test time | Burst cycle | | Compliance criteria |
|-------------------------|-------------------|-------------|--------|--|
| | | min | max. | |
| +150 V | 1 h | 90 ms | 100 ms | Immunity-related functions: Class A Not immunity-related functions: Class D |

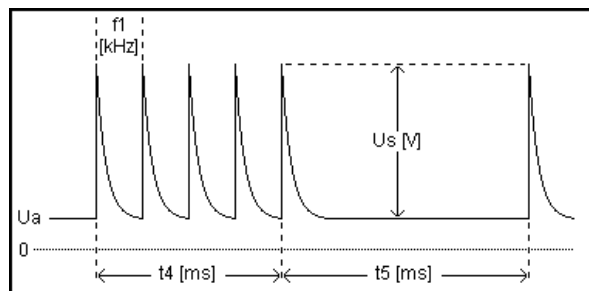
| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 10:25 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 24 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 96 kPa |

Settings:

| | | | | |
|------------------|------------------------------|---------------|-------------------|------|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 3b | | | |
| Test generator: | UCS200M | Software-Nr.: | 000029 | |
| | | Serial: | 06100108 | |
| Ua (Alternator): | 27.0 | V | Current limiting: | 15 A |

Pulse parameters:

| | | |
|----------------|---------|-----|
| Us: | +150 | V |
| f1: | 10 | kHz |
| t4: | 10 | ms |
| t5: | 90 | ms |
| tr: | 5 | ns |
| td: | 100 | ns |
| Ri: | 50 | Ohm |
| Coupling: | Battery | |
| Test duration: | 1 | h |



Test result:

| | | | |
|----------------|---|---|--|
| Test duration: | 01:00:01 | h | |
| Requirement: | Criteria A | | |
| Test result: | No degradation noticed, EUT conforms to the compliance criteria A | | |

| | | |
|---------------|------------------------|----------------|
| Electrosuisse | EUT: NB2700 and NB2710 | 14-EL-0068.E02 |
|---------------|------------------------|----------------|

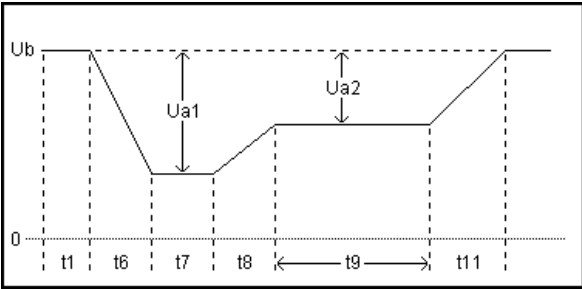
Test Pulse Nr. 4:

Requirements

| Test level (U _s) | Min. number of test pulses | Pulse repetition time | | Compliance criteria |
|---------------------------------|-------------------------------|--------------------------|------|--|
| | | min | max. | |
| -12 V | 1 pulse | --- | --- | Immunity-related functions: Class C Not immunity-related functions: Class D |

| | |
|-------------------------|-----------------------------------|
| Subcontractor: | Electrosuisse Albislab |
| Report: | 14-EL-0068.E02 |
| Date of test: | 11-11-2014, 11:58 |
| Test engineer: | Peter Stillhard |
| Client: | NetModule AG, Mr. Thomas Siegrist |
| EUT: | NB2700 and NB2710 |
| Standard: | ISO 7637-2 : 2004 |
| Application: | 24 V System |
| Temperature: | 22 °C |
| Relative humidity (RH): | 49 % |
| Pressure: | 96 kPa |

| Settings: | | | | |
|---------------------------|-----------------------------|---------------|-------------------|------|
| Pulse form: | ISO 7637-2 : 2004 : Pulse 4 | | | |
| Test generator: | VDS200B | Software-Nr.: | 000374 | |
| Coupling: | UCS200M | Serial: | 06100109 | |
| U _b (Battery): | 24.0 | V | Current limiting: | 15 A |

| Pulse parameters: | | | | |
|-------------------|----------|----|--|--|
| U _{a1} : | -12.0 | V |  | |
| U _{a2} : | -5.0 | V | | |
| t1: | 1.0 | s | | |
| t6: | 10 | ms | | |
| t7: | 50 | ms | | |
| t8: | 50 | ms | | |
| t9: | 0.5 | s | | |
| t11: | 10 | ms | | |
| Ereignisse: | 10 | | | |
| Testdauer: | 00:00:30 | h | | |

| Test result: | | |
|-------------------|---|--|
| Number of pulses: | 10 | |
| Requirement: | Criteria C | |
| Test result: | No degradation noticed, EUT conforms to the compliance criteria A & C | |