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Date of handing in: 03.08.2009

Tested by:



Pekka Kälviäinen, Test Engineer



Reviewed by:



Timo Leismala, Test Manager

SORT OF EQUIPMENT:

Radio Modem (PCB unit)

MARKETING NAME:

SATELLINE-M3-TR1

TYPE:

SATEL-TA13

MANUFACTURER:

Satel Oy

SERIAL NUMBER:

0926 21, 0926 20

CLIENT:

Satel Oy

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TEST SPECIFICATION:

EN 301 489-1, v.1.8.1, EN 301 489-5, v.1.3.1**SUMMARY:**

In regard to the performed tests the EUT fulfils the requirements defined in the test specifications EN 301 489-1, v.1.8.1 and EN 301 489-5, v.1.3.1, see page 2 for details.

According to the standards the emission measurements results have been compared directly with the limit lines without considering measurement uncertainties.

The test results are valid for the tested unit only. Without a written permission of Nemko Oy it is allowed to copy this report as a whole, but not partially.

Summary of performed tests and test results

Emission tests according to the test specifications EN 301 489-1, v.1.8.1 and EN 301 489-5, v.1.3.1:

Emission test	Test method	Conclusion
Conducted disturbance at mains ports	EN 55022	Pass

Immunity tests according to the test specifications EN 301 489-1, v.1.8.1 and EN 301 489-5, v.1.3.1:

Immunity test	Test method	Conclusion
Radiated radio-frequency electromagnetic field	EN 61000-4-3	Pass
Electrostatic discharge (ESD)	EN 61000-4-2	Pass
Conducted radio-frequency common mode	EN 61000-4-6	Pass
Electrical fast transients (EFT/B)	EN 61000-4-4	Pass
Transients and surges in the vehicular environment	ISO 7637-2 (2004)	Pass

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1. General

The equipment under test (EUT) was a radio modem. The purpose of the performed tests was to see if in regard to these tests the EUT fulfils the EMC requirements defined in the EC Council Directive 89/336/EEC and 1999/5/EC. The tests were performed according to the test specifications EN 301 489-1, v.1.8.1, EN 301 489-5, v.1.3.1 by using accredited test methods.

2. System Configuration

2.1 Test set-up

Equipment under test (EUT):

unit	type	S/N
Radio modem (EUT1)	SATEL-TA13 (6.5-28V)	0926 21
Radio modem (EUT2)	SATEL-TA13 (3.2-8.5V)	0926 20
Adapters	2 x Satel, ARS-1F-4A	-

Peripheral devices:

unit	type	S/N
Computer 1	Compaq Admada, 1540D	0509Q114
Computer 2	Fujitsu LifeBook, 555T	R6Y00015
20 dB 50W attenuator	Narda, 765-20	9605
Variable attenuator	R&S, DPU-BN 18043/50	2519/1

Cables:

from	to	type	length [m]
Radio modem EUT	Computer 1	unshielded	10
Radio modem EUT RX/TX port	Attenuator, 20dB + Variable	coaxial	3
Attenuator, 20dB + Variable	Radio modem RX/TX port	coaxial	3
Radio modem	Computer 2	unshielded	10
Radio modem EUT	DC power source	unshielded	1.7
Radio modem	DC power source	unshielded	1.7

Operating voltage of the EUT:

- EUT1 6.0V
- EUT2 12 VDC was used in all tests and also 24 VDC in transients and surges in vehicular environment immunity test

2.2 Operating conditions and monitoring of the EUT

The radio modems were connected to the computers. The antenna ports of the radio modems were connected together via the attenuators. One computer was set to send a data pack. That data pack was received with the second computer. Quality of the data transfer was monitored. TX/RX frequency was 438 MHz.

2.3 Performance criteria for immunity tests

Criterion CT/CR

Four messages of five or 90 % of the transmitted symbols shall be received correctly.

At the conclusion of the test, the EUT shall operate as intended with no loss of user control functions or stored data, and the communication link shall have been maintained during the test.

Criterion TT/TR1

At the conclusion of each exposure the EUT shall operate with no user noticeable loss of the communication link.

At the conclusion of the total test comprising the series of individual exposures, the EUT shall operate as intended with no loss of user control functions or stored data, as declared by the manufacturer, and the communication link shall have been maintained during the test.

Criterion TT/TR2 (transients and surges, vehicular environment)

The communication link need not to be maintained during exposure and may have to be re-established. After the test the EUT shall operate as intended with no loss of user control functions and stored data.

3. Test procedures

3.1 Emission tests

3.1.1 Conducted disturbance at mains ports emission test

The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	EN 55022
Frequency range	0.150 – 30 MHz
Site name	Nemko Oy / Perkkää
Date of testing	28.08.2009
Test equipment	5, 168, 348
Test uncertainty U95	+2.4 dB / -3.0 dB
Test conditions	21 °C, 31 % RH
Tested operation states	EUT1: TX EUT2: TX

The test was performed inside a shielded room where the floor comprised the reference ground plane (RGP). For the duration of the test the EUT was placed on a non-conductive table 0.8 m high (see photograph 1). The excess lengths of the cables of the EUT were made into bundles 30-40 cm in length. The power input cable of the EUT was connected to an artificial mains network. The test was performed separately on the positive and the negative pole.

The disturbances were first examined by performing a spectrum scan by using a peak detector. The general procedure in the conducted disturbance emission test is that no further measurements are necessary if the disturbance levels measured by using the peak detector are below the limit value defined for the measurement performed by using an average detector. If not, then at the test frequencies concerned the measurement is performed also by using a quasi-peak detector. If the disturbance levels measured by using the quasi-peak detector are below the limit value defined for the measurement performed by using an average detector, then measurements by using the average detector are not necessary.

3.2 Immunity tests

3.2.1 Radiated radio-frequency electromagnetic field immunity test

The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	EN 61000-4-3
Frequency range	80 – 1000 and 1400 – 2700 MHz
Modulation	AM 80% 1 kHz
Sweep	Step: 1 %, Time/step: 3 s
Test level	3 V/m
Performance criterion	CT/CR
Site name	Nemko Oy / Perkkää
Date of testing	06.08.2009
Test equipment	176, 201, 354, 417, 525, 534
Test conditions	22 °C, 45 % RH
Tested operation states	EUT1: TX EUT2: RX

The test was carried out in an absorber lined anechoic shielded room. The EUT was placed on a non-conductive turntable 1 m above the floor absorbers (see photograph 2). The distance between the transmitting bilog antenna (80 – 1000 MHz) and the EUT was 2.2 m measured from the antenna tip. The distance between the transmitting horn antenna (1400 – 2700 MHz) and the EUT was 3.0 m. The test was performed with the field generating antenna facing four sides of the EUT. Both vertical and horizontal polarizations were tested. The field strength was checked with a calibrated field sensor. The uniformity of field has been calibrated. The cables were oriented in a position anticipated to be the worst-case.

3.2.2 Electrostatic discharge (ESD) immunity test

The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	EN 61000-4-2
Test level	Contact discharge: ± 2 and ± 4 kVp Air discharge: ± 2 , ± 4 and ± 8 kVp
Performance criterion	TT/TR1
Site name	Nemko Oy / Perkkaa
Date of testing	18.09.2009
Test equipment	409, 348, 405, 406
Test conditions	21 °C, 31 % RH, 99.1 kPa
Tested operation states	EUT1: TX EUT2: RX

The test was carried out inside a shielded room. The EUT was placed on a non-conductive support 0.1 m above the reference ground plane (RGP) (see photographs 3 - 4). Direct contact discharges were applied on the conductive parts of the EUT. Indirect contact discharges were applied on the EUT by discharging to a vertical coupling plane (VCP) and horizontal coupling plane (HCP). Air discharges were applied on the non-conductive parts of the EUT. At least 10 discharges of both polarities were applied on each test point at each test level.

3.2.3 Conducted radio-frequency common mode immunity test

The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	EN 61000-4-6
Frequency range	0.150 – 80 MHz
Modulation	AM 80% 1 kHz
Sweep	Step: 1 %, Time/step: 3 s
Test level	3 V _{emf}
Performance criterion	CT/CR
Site name	Nemko Oy / Perkkaa
Date of testing	07.08.2009
Test equipment	351, 348, 294, 299, 363, 339, 560
Test conditions	22 °C, 40 % RH
Tested operation states	EUT1: TX EUT2: RX

The test was carried out inside a shielded room. The EUT was placed on a non-conductive support 0.1 m above the reference ground plane (RGP). Coupling/decoupling networks (CDNs) were used to realize a defined impedance for the test signal and to prevent the test signal from reaching the assisting equipment (see photograph 5). The EUT cables were placed 30 - 50 mm above the RGP. The distance between the CDNs and the EUT was 0.3 m.

3.2.4 Electrical fast transients (EFT/B) immunity test

The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	EN 61000-4-4
Test pulse	5 (Tr) / 50 (Th) ns, repetition frequency 5 kHz, duration 1 minute
Test level	± 0.5 kVp
Performance criterion	TT/TR1
Site name	Nemko / Perkkaa
Date of testing	18.09.2009
Test equipment	224, 225, 348
Test conditions	22 °C, 31 % RH
Tested operation state	EUT1: TX EUT2: RX

The test was carried out inside a shielded room. The EUT was placed on a non-conductive support 0.1 m above the RGP (see photograph 6). A capacitive coupling clamp was used to test the signal and DC input ports of the EUT. The distance between the generator or the clamp and the EUT was 0.5 - 1.0 m. The cable between the generator and the clamp was 0.5 m in length.

3.2.5 Transients and surges in the vehicular environment immunity test

The test was performed as a compliance test. The test parameters concerned were as follows:

Parameter	Specification
Test method	ISO 7637-2 (2004)
Pulse 12V input	1: 1/2000 μ s, -75 V, 1000 pulses 2a: 1/50 μ s, +37 V, 1000 pulses 2b: 20V, 220 ms, 1 pulse 3a: 5/100 ns, -112 V, 60 minutes 3b: 5/100 ns, +75 V, 60 minutes 4: 25 ms -6.0 (8.0) V, 5 s -2.5 (12.0) V, 1 pulses
Pulse 24V input	1: 3/2000 μ s, -450 V, 5000 pulses 2a: 1/50 μ s, +37 V, 5000 pulses 2b: 20V, 220 ms, 10 pulses 3a: 5/100 ns, -150 V, 60 minutes 3b: 5/100 ns, +150 V, 60 minutes 4: 50 ms -12 V, 5 s -5 V, 1 pulses
Performance criterion	3a and 3b: TT/TR1, others: TT/TR2
Site name	Nemko / Perkkaa
Date of testing	27.-28.08.2009
Test equipment	347, 348
Test conditions	22°C, 40 % RH
Tested operation state	EUT1: TX

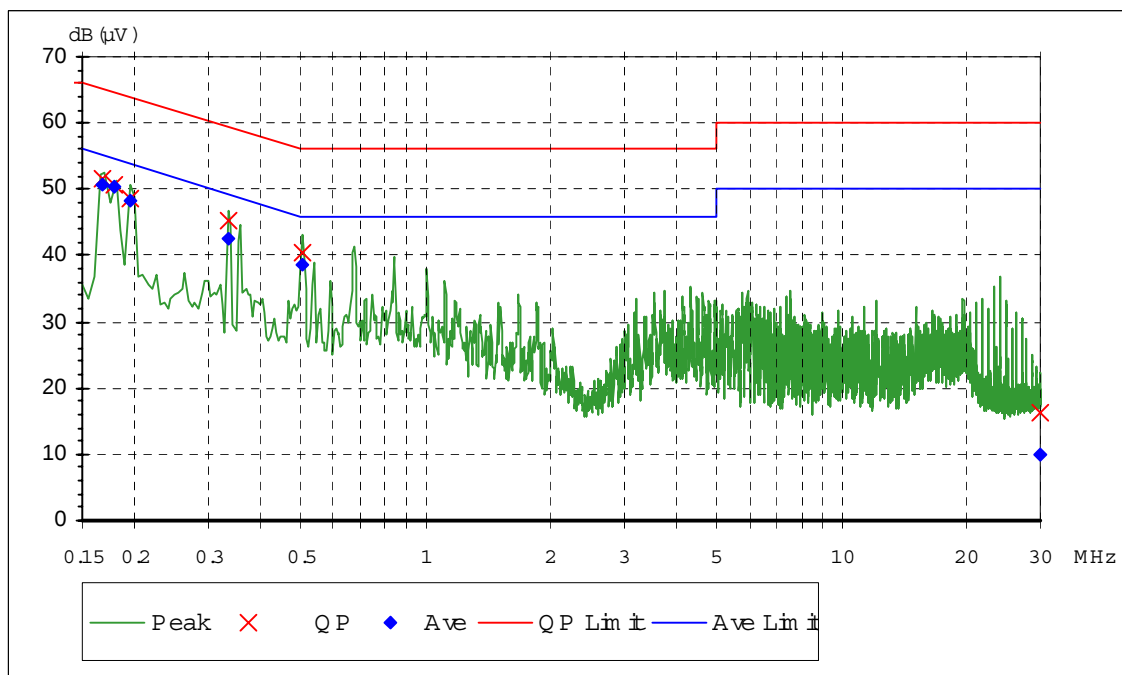
The test was carried out inside a shielded room. The EUT was placed on a non-conductive support 0.05 m above the RGP. The internal coupling network of the test generator was used to test the DC power port of the EUT (see photograph 7). The cable between the generator and the EUT was 0.5 m in length.

4. Test results

4.1 Emission tests

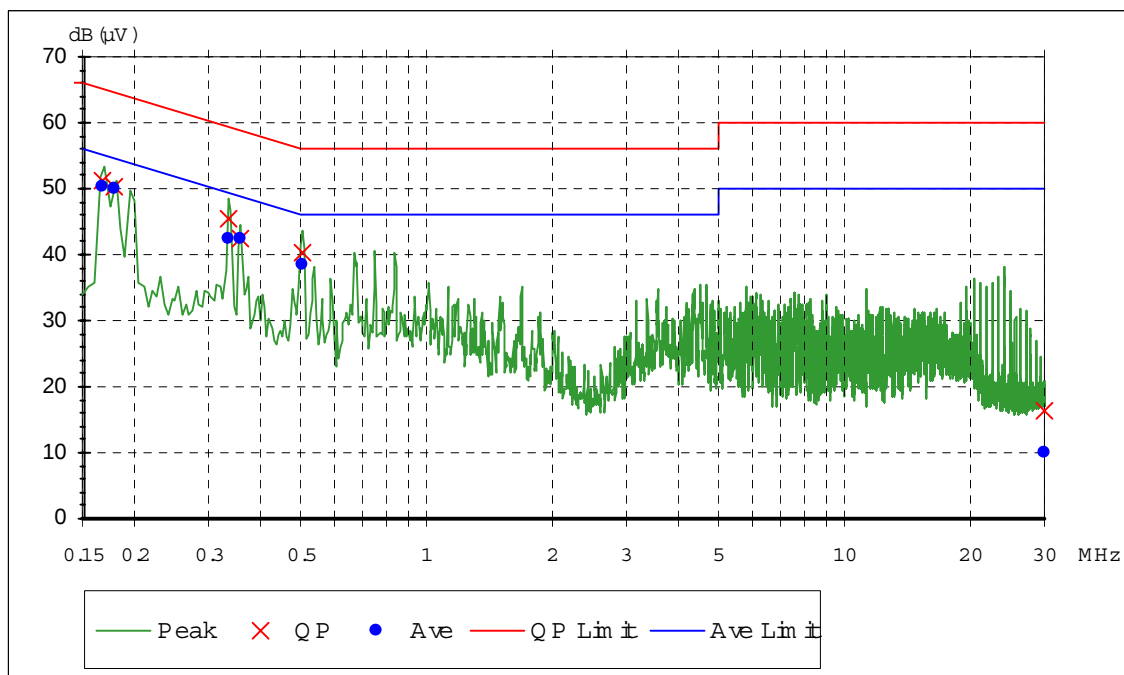
4.1.1 Conducted disturbance at mains ports emission test

EUT1, TX, 12 VDC plus pole



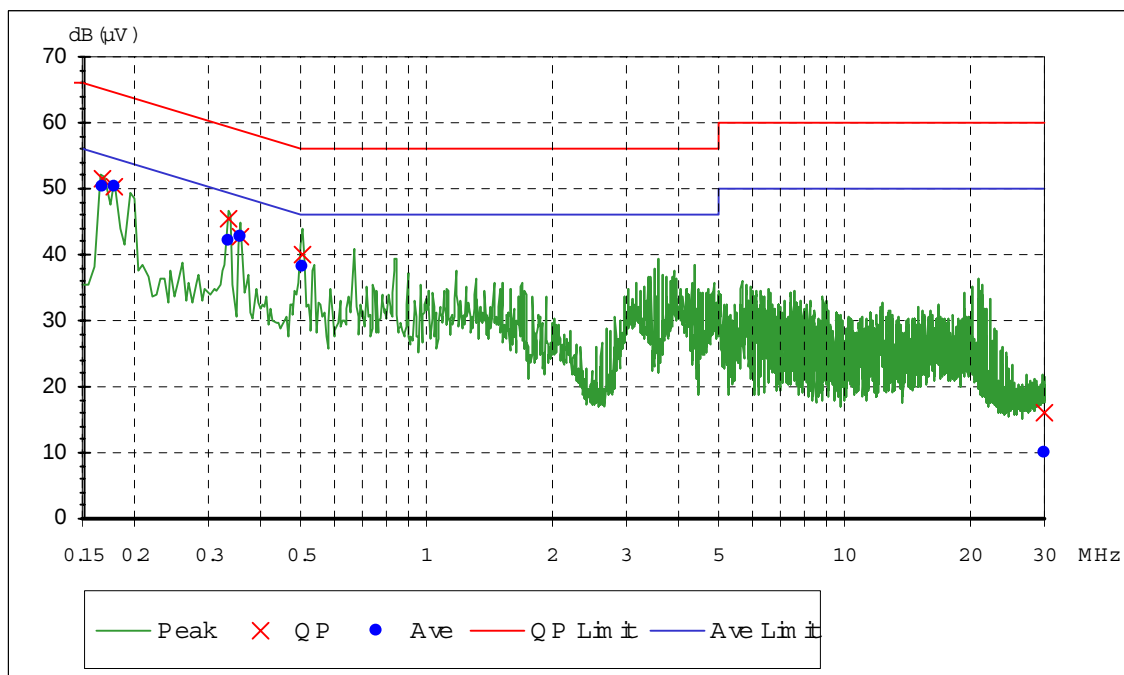
Frequency MHz	Result Quasi-peak dB(μV)	Limit value Quasi-peak dB(μV)	Result Average dB(μV)	Limit value Average dB(μV)	Conclusion Pass/Fail
0.168	51.6	65.1	50.8	55.1	Pass
0.179	50.6	64.5	50.3	54.5	Pass
0.196	48.5	63.8	48.2	53.8	Pass
0.336	45.3	59.3	42.4	49.3	Pass
0.505	40.5	56.0	38.6	46.0	Pass
29.992	16.4	60.0	10.0	50.0	Pass

EUT1, TX, 12 VDC minus pole



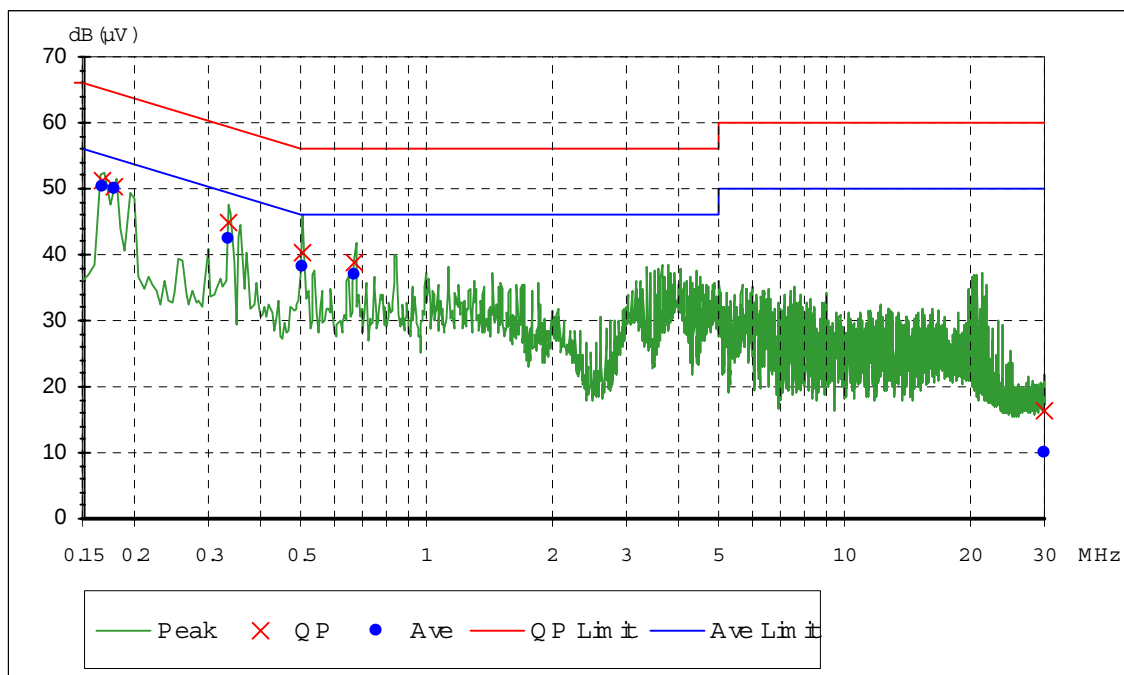
Frequency MHz	Result Quasi-peak dB(µV)	Limit value Quasi-peak dB(µV)	Result Average dB(µV)	Limit value Average dB(µV)	Conclusion Pass/Fail
0.168	51.3	65.1	50.4	55.1	Pass
0.179	50.3	64.5	50.1	54.5	Pass
0.337	45.4	59.3	42.4	49.3	Pass
0.359	42.3	58.8	42.3	48.8	Pass
0.505	40.3	56.0	38.5	46.0	Pass
29.993	16.4	60.0	10.0	50.0	Pass

EUT2, TX, 6 VDC plus pole



Frequency MHz	Result Quasi-peak dB(µV)	Limit value Quasi-peak dB(µV)	Result Average dB(µV)	Limit value Average dB(µV)	Conclusion Pass/Fail
0.168	51.4	65.1	50.4	55.1	Pass
0.179	50.4	64.5	50.2	54.5	Pass
0.336	45.4	59.3	42.2	49.3	Pass
0.359	42.6	58.8	42.6	48.8	Pass
0.505	40.1	56.0	38.3	46.0	Pass
29.995	16.2	60.0	10.0	50.0	Pass

EUT2, TX, 6 VDC minus pole



Frequency MHz	Result Quasi-peak dB(μV)	Limit value Quasi-peak dB(μV)	Result Average dB(μV)	Limit value Average dB(μV)	Conclusion Pass/Fail
0.168	51.3	65.1	50.4	55.1	Pass
0.179	50.3	64.5	50.1	54.5	Pass
0.336	45.0	59.3	42.4	49.3	Pass
0.505	40.3	56.0	38.2	46.0	Pass
0.673	38.7	56.0	36.9	46.0	Pass
29.992	16.4	60.0	10.0	50.0	Pass

4.2 Immunity tests

4.2.1 Radiated radio-frequency electromagnetic field immunity test

EUT1 TX and EUT2 RX

Polarisation	Frequency MHz	Test level V/m	Remarks	Conclusion Pass/Fail
Vertical	80 – 1000	3	–	Pass
Horizontal	80 – 1000	3	–	Pass

Polarisation	Frequency MHz	Test level V/m	Remarks	Conclusion Pass/Fail
Vertical	1400 – 2700	3	–	Pass
Horizontal	1400 – 2700	3	–	Pass

4.2.2 Electrostatic discharge (ESD) immunity test

EUT1 TX and EUT2 RX

Discharge mode	Test points	Test level kVp	Remarks	Conclusion Pass/Fail
Direct contact	Conductive parts of the EUT	$\pm 2, \pm 4$	–	Pass
Indirect contact	VCP, HCP	$\pm 2, \pm 4$	–	Pass
Air	Non-conductive parts of the EUT	$\pm 2, \pm 4, \pm 8$	–	Pass

4.2.3 Conducted radio-frequency common mode immunity test

EUT1 TX and EUT2 RX

Port	Frequency MHz	Test level V _{emf}	Remarks	Conclusion Pass/Fail
DC power input	0.150 – 80	3	–	Pass
Serial port	0.150 – 80	3	–	Pass
Antenna port(s)	0.150 – 80	3	–	Pass

4.2.4 Electrical fast transients (EFT/B) immunity test

EUT1 TX and EUT2 RX

Port	Test level kVp	Remarks	Conclusion Pass/Fail
DC power input	± 0.5	—	Pass
Serial port	± 0.5	—	Pass
Antenna port(s)	± 0.5	—	Pass

4.2.5 Transients and surges in the vehicular environment immunity test

EUT1 TX

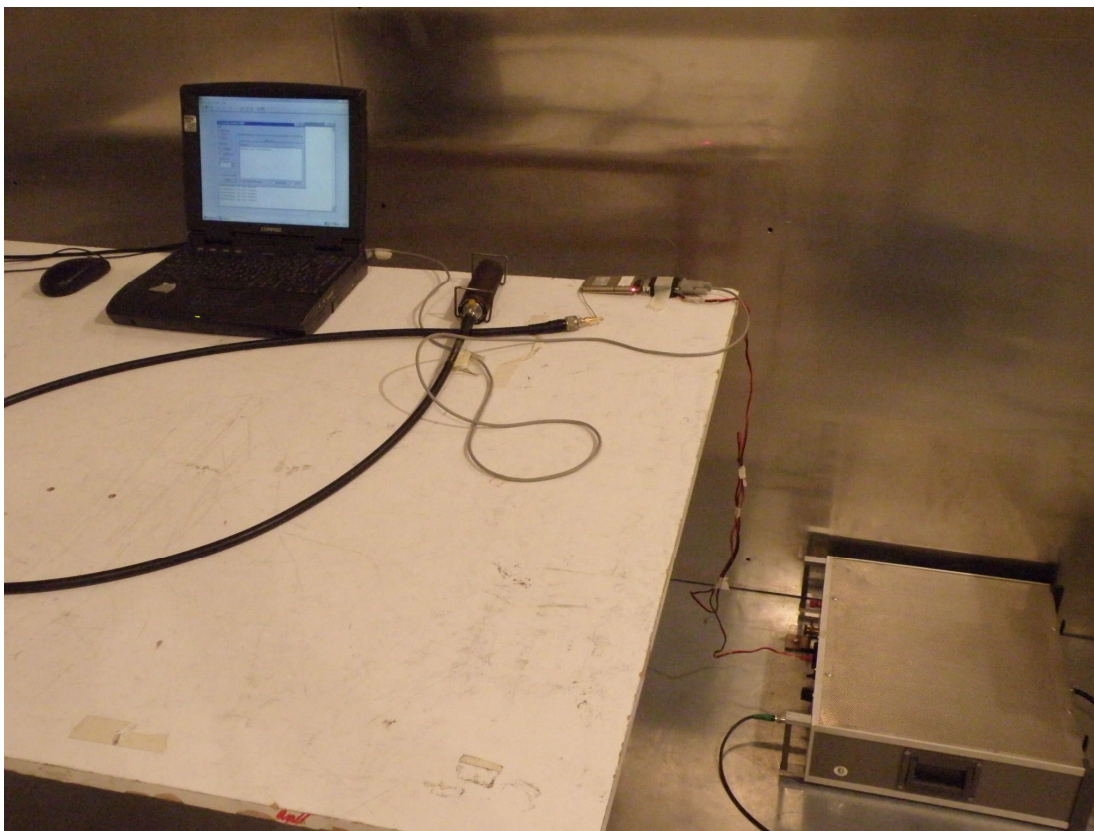
Port	Pulse	Remarks	Conclusion Pass/Fail
12 V DC input	1	—	Pass
	2a	—	Pass
	2b	—	Pass
	3a	—	Pass
	3b	—	Pass
	4	—	Pass
24 V DC input	1	—	Pass
	2a	—	Pass
	2b	—	Pass
	3a	—	Pass
	3b	—	Pass
	4	—	Pass

5. List of test equipment

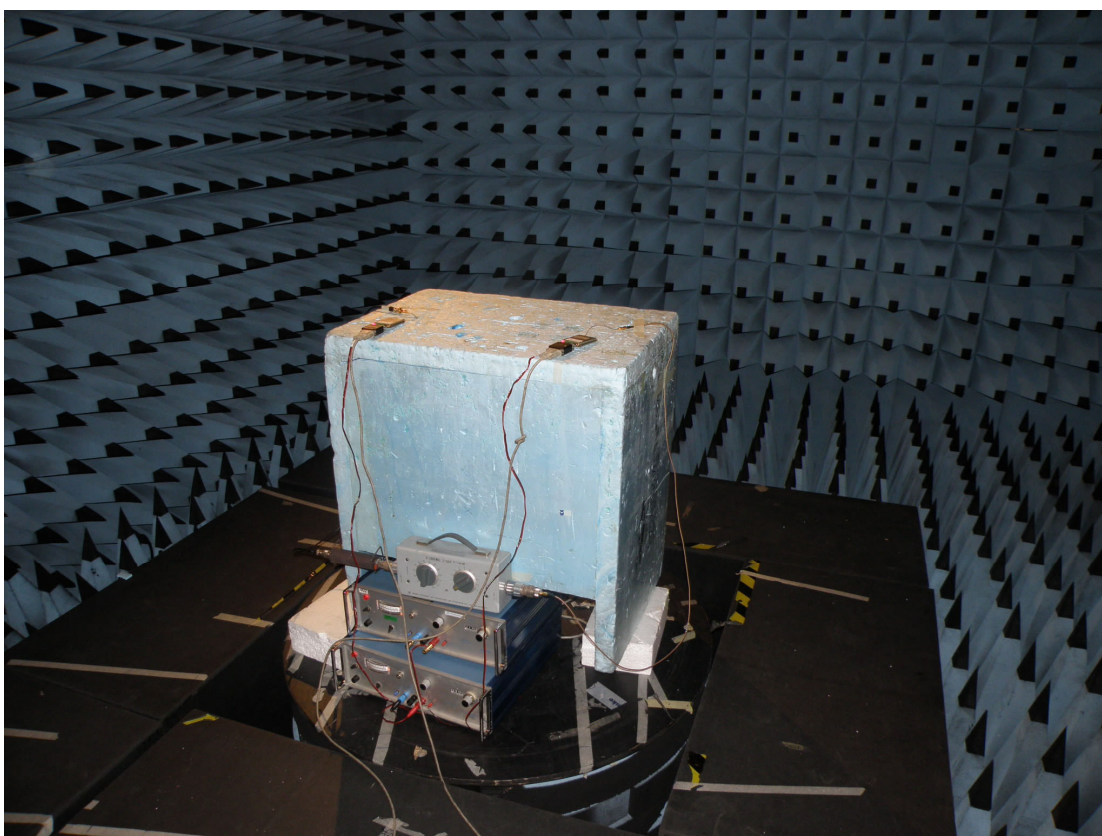
Nr.	Equipment	Type	Manufacturer	Serial number
234	Measuring amplifier	2636	Brüel & Kjær	1601424
235	Band pass filter	1617	Brüel & Kjær	1375358
574	Microphone	4192-B-001	Brüel & Kjær	1536771
9	Modulation analyzer	8901B	Hewlett Packard	2718A01220
233	Measuring amplifier	2636	Brüel & Kjær	1601422
315	RF generator	8656B	Hewlett Packard	2530A02373
42	Spectrum analyzer	8566B	Hewlett Packard	2637A04102
5	Test receiver	ESH-3	Rohde & Schwarz	894718/015
38	RF generator	SMG	Rohde & Schwarz	883590/035
55	Power meter	NAUS	Rohde & Schwarz	2177/064
362	Power supply	B32-20R	Oltronix	653
167	Artificial Mains	NSLK 8126	Schwartzbeck	8126101
168	Artificial Mains	NSLK 8127	Schwartzbeck	8127162
176	Anechoic chamber	RFD-60	Euroshield	509
184	Temp. & humidity meter	H MI 32	Vaisala	63837
188	Antenna	CBL6111	Chase	1028
190	Shielded room	L3000	Belling-Lee	S4566
193	ESD generator	NSG435	Schaffner	316
201	RF-Generator	2042	Marconi	119571/062
222	Impulse tester	PSURGE4	Haefely	083070-10
223	Coupling network	IP6.2	Haefely	083038-20
224	EFT/Burst generator	PEFT JUNIOR	Haefely	083180-46
225	HF coupling clamp	IP4A	Haefely	083078-008
289	Universal power analyzer	PM 3000A	Voltech	8448
290	Ref. impedance network	IEC555	Voltech	8448
291	Field sensor	BA05		
292	Optical repeater	ORO1		
293	Isotropic field meter	PMM 8051		
294	DCN-network	801-M2/M3	Lüthi GmbH	
299	RF injection clamp	EM 100	Lüthi GmbH	-
300	Coupling network	CDN 801-AF2	Self made	-
316	Power supply	HP 6032A	Hewlett Packard	2517A-00654
317	RF generator	2052	Marconi	119754/058
319	Antenna	CBL6112	Chase	2018
320	Voltage dip tester	PLINE 1610	Haefely Trench AG	083690-22
321	Coupling network	FP-EFT 32.1	Haefely Trench	083590-08
322	Coupling network	HV-SURGE 63.3	EMCEC OY	011996
323	T-network	EZ-10	Rohde & Schwarz	843074/005
324	T-network	ESH3-Z4	Rohde & Schwarz	842929/012
325	T-network	ESH3-Z4	Rohde & Schwarz	842929/010
336	Magnetic field tester	MAG 100.1	Haefely Trench AG	080015-9
338	Test receiver	ESS	Rohde & Schwarz	847151/009
339	RF-power amplifier	116FC-CE	Kalmus	7583A-1
340	RF-power amplifier	7100LC-CE	Kalmus	7583B1
341	Multimeter	Fluke 87	Fluke	593100386
342	Multimeter	Fluke 12	Fluke	58720270
343	Artificial Mains Network	NSLK8128	Schwartzbeck	8128177
344	mV-meter	URV4	Rohde & Schwarz	879747/013
347	Automotive test system	NSG5000	Shaffner	EK3396-021
348	Shielded room	RFSD-100	Euroshield Oy	1320
349	Shielded room	RFSD-100	Euroshield Oy	1319
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327
351	RF generator	SMT 06	Rohde & Schwarz	845715/001
352	Antenna	3142	EMCO	9701-1122
353	RF power amplifier	AR 10S1G4	Amplifier Research	20156
354	RF power amplifier	AR 500W1000M7	Amplifier Research	20487
355	RF power amplifier	LA100V - CE	Kalmus	7809-1
359	E-field probe	HI-4422	Holaday	95835
360	Antenna	3303	Emco	9702-2978
361	Current probe	CIP 9136	Chase	1043
363	Coupling/decoupling dev.	CDN 801-S1	Robert Lüthi GmbH	554
364	Coupling/decoupling dev.	CDN 801-M4/63A	MEB	12998

365	Coupling/decoupling dev.	CDN 801-M5/25A	MEB	11514
366	RF-amplifier	AR15A25	Amplifier Research	10783
367	LISN	NNB-4/200	Rolf Heine	4/200X-96009
369	Discont.Interf.analyzer	DIA 1512A	Chase	5115
370	AC Power source	15003i-400/3	California Instr.	
371	AC Power source	500i-400	California Instr.	HK 52064
372	AC Power source	500i-400	California Instr.	HK 52065
373	AC Power source	500i-400	California Instr.	HK 52063
374	Impedance network	OMNI 3-18i	California Instr.	X71344
403	Processmeter	787	Fluke	6975028
404	Processmeter	787	Fluke	7005196
405	Horizontal coupling plane	HCP1	Self made	-
406	Vertical coupling plate	VCP1	Self made	-
409	ESD generator	NSG435	Schaffner	2288
410	ELF Survey meter	HI-3604	Holaday	91604
411	E-field probe	HI-4433-GRE	Holaday	96730
412	Decoupling clamp	FGZ 40X15 C	Lüthi	4561
413	Decoupling clamp	FGZ 40X15 C	Lüthi	4562
414	Decoupling network	DEC1A	Haefely	080 641-04
416	RF High-Power Attenuator	765-6	Narda	9708
417	Antenna, bilog	CBL 6141	Chase	4028
418	Coupling network	CDN L801 M2/50	Luthi	1655
419	Audio power amplifier	S900	Dynacord	9815010364
421	Hand simulator	-	Oma valmiste	021996
427	Directional coupler	DC2500	Amplifier Research	24148
428	Directional coupler	RK 100	MEB	13703
429	Directional coupler	DC6280	Amplifier Research	24067
430	Directional coupler	DC7144	Amplifier Research	24230
431	Power meter	NRVD	Rohde & Schwarz	826224/047
432	Voltage probe	URV5-Z2	Rohde & Schwarz	826853/030
433	Voltage probe	UVR5-Z2	Rohde & Schwarz	826853/029
485	Horizontal coupling plane	HCP2	Self made	992
506	4 wire ISN	ENY41	Rohde & Schwarz	866824/029
507	2 x 2 wire ISN	ENY22	Rohde & Schwarz	833823/017
510	Audio isolation transformer	6220-1A	Solar Electronics Co.	
519	RF High-Power Attenuator	765-20	Narda	
520	Injection clamp	EM101	Robert Lüthi GmbH	903557
524	Active Rod Antenna	3301B	Emco	4432
525	Double-Ridged Horn	3115	Emco	6691
528	Matching device	CN-DC1	Emcec Oy	01
529	Matching device	CN-DC1	Emcec Oy	02
534	RF-amplifier	25S1G4A	Amplifier Research	303881
535	True RMS Multimeter	189	Fluke	80350519
542	Double-Ridged Horn	3115	Emco	00023905
544	RF-amplifier	ZFL-2000VH2	Mini-Circuits	D01080
560	Power attenuator 6 dB	BN 74 53 52	Spinner	-
561	Power attenuator 6 dB	BN 74 53 52	Spinner	-
564	RF-amplifier	CA018-4010	CIAO Wireless	101
X1	Automotive electronic switch	SWE-25A	AFJ International	499
X2	Static Generator	ZCP40-1000	AFJ International	502

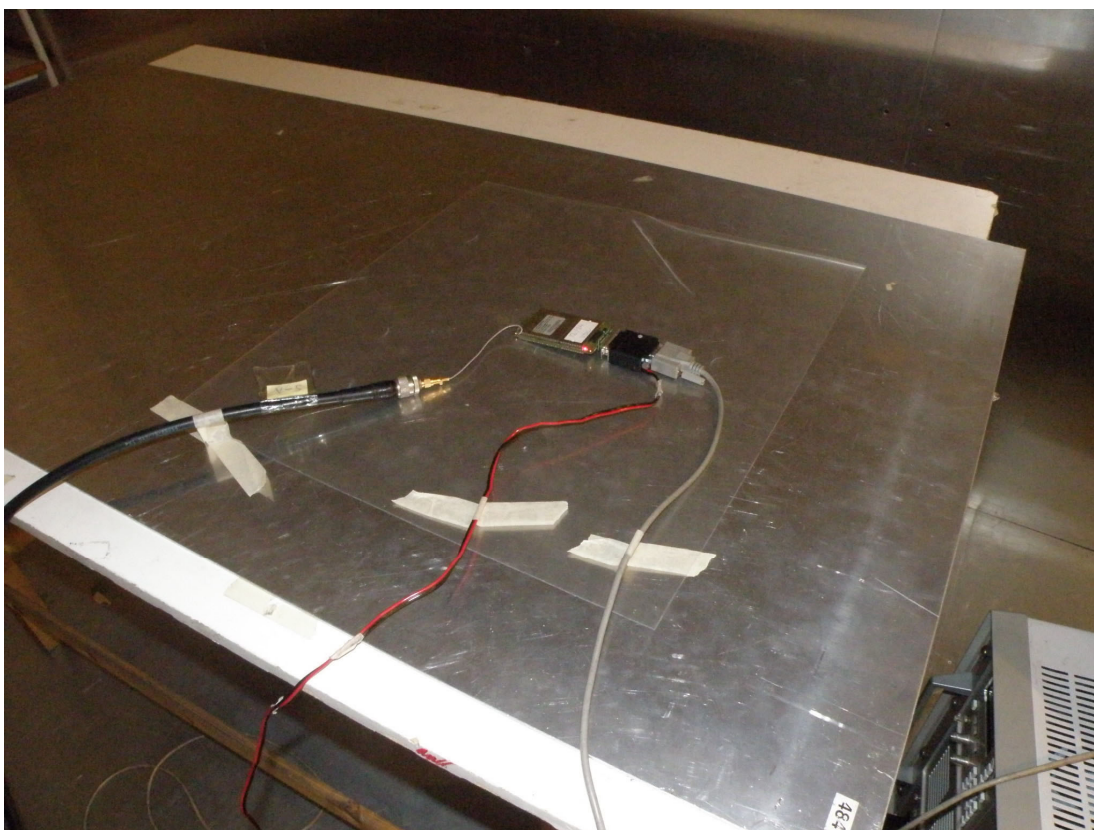
6. Photographs



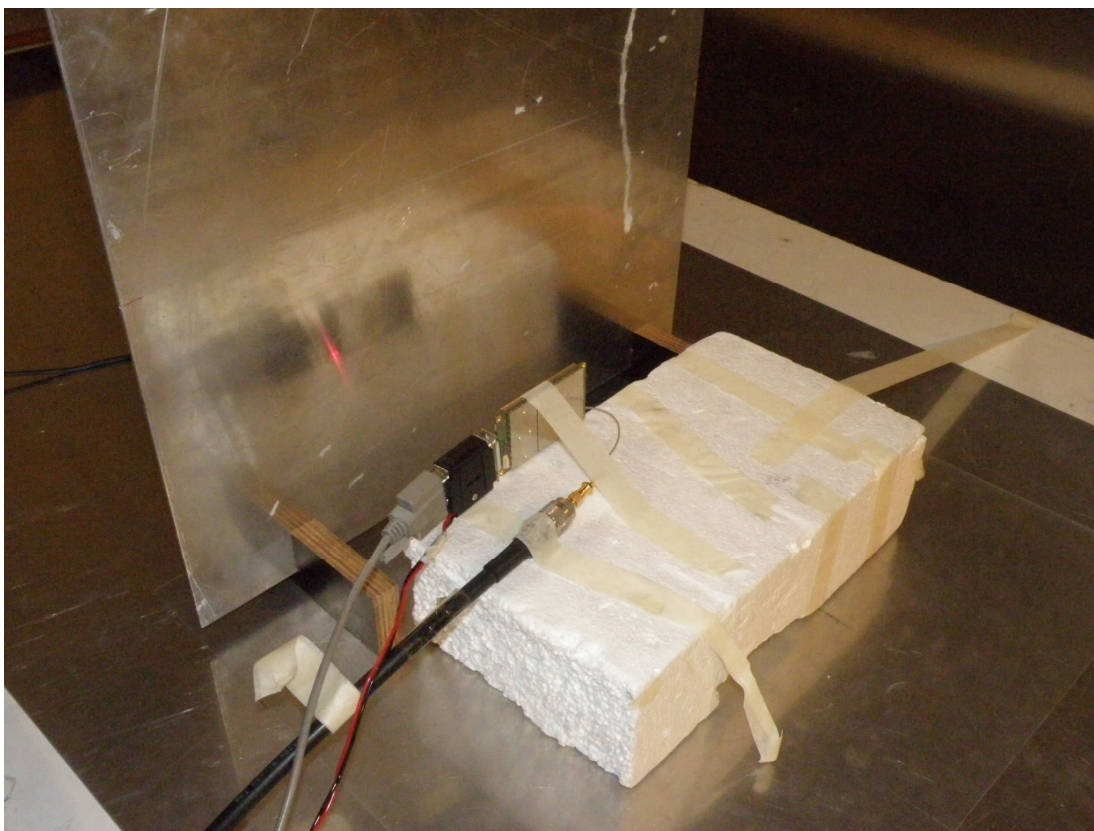
Photograph 1. Conducted disturbance at mains ports emission test.



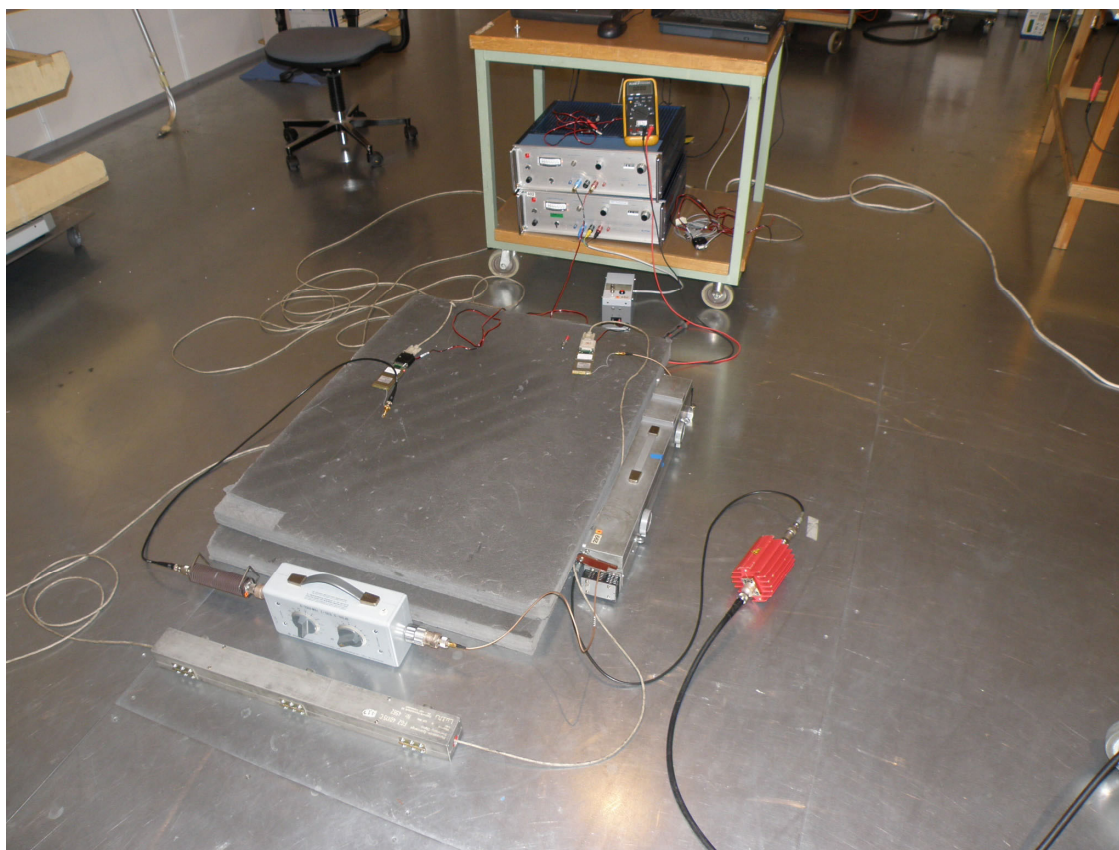
Photograph 2. Radiated radio-frequency electromagnetic field immunity test.



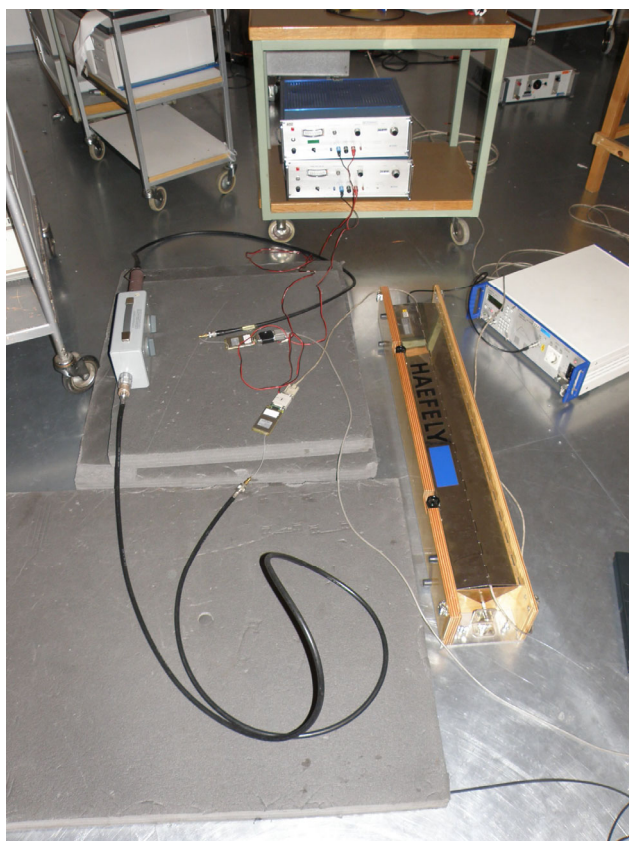
Photograph 3. Electrostatic discharge (ESD) immunity test.



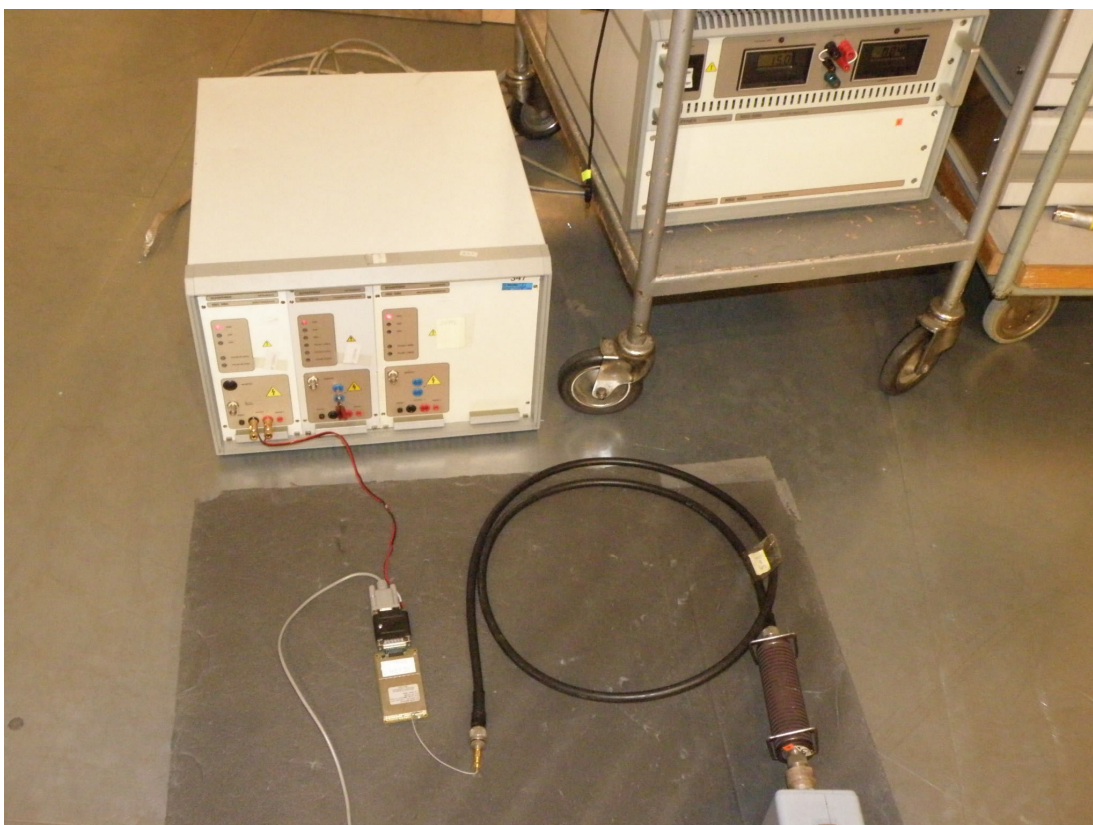
Photograph 4. Electrostatic discharge (ESD) immunity test.



Photograph 5. Conducted radio-frequency common mode immunity test.



Photograph 6. Electrical fast transient / burst (EFT/B) immunity test.



Photograph 7. Transients and surges in the vehicular environment immunity test.