Slovenski institut za kakovost in meroslovje
Slovenian Institute of Quality and Metrology

Poročilo o preskusu / Test Report

Št. / *No.:*
T251-0673/12

Datum / *Date:*
2012-08-27

Proizvod / *Product*	**Listov / *Pages***
RING BUS SYSTEM Types: RBCPU+RBFU	56
	Vrsta preskusa / *Test procedure*
	EMC
Naročnik / *Applicant*	**Št. merjencev / *No. of items tested***
BELIMO Automation AG Brunnenbachstrasse 1, CH-8340 Hinwil, Swiss	1
Proizvajalec / *Manufacturer*	**Mapa predmeta št. / *Subject file No.***
EUROICC d.o.o. Trščanska 21, 11080 Zemun, Serbia	C20120752
Blagovna znamka / *Trade Mark*	**Kraj preskusa / *Place of test***
BELIMO	SIQ, EMC lab., Trpinčeva ul.39, 1000 Ljubljana, SLOVENIA
Standardi – predpisi / *Standards - regulations*	**Opomba / *Remark***
IEC 61131-2:2007	/

Zaključek / *Conclusion*

Preskušani proizvod ustreza zahtevam navedenega standarda. / *Tested product complies with the requirements of stated standard.*

Rezultati preskusov se nanašajo samo na preskušan vzorec. / *The test results relate only to the item tested.*

Datum prispetja vzorca / *Date of receipt of test item: 2012-05-31*

Datum izvedbe preskusov / *Date of performance of tests: 2012-05-31 - 2012-06-19*

Odgovoren za preskušanje / *Responsible for the test*
Andrej Škof

Vodja področja / *Department Manager*
Marjan Mak

CONTENTS page

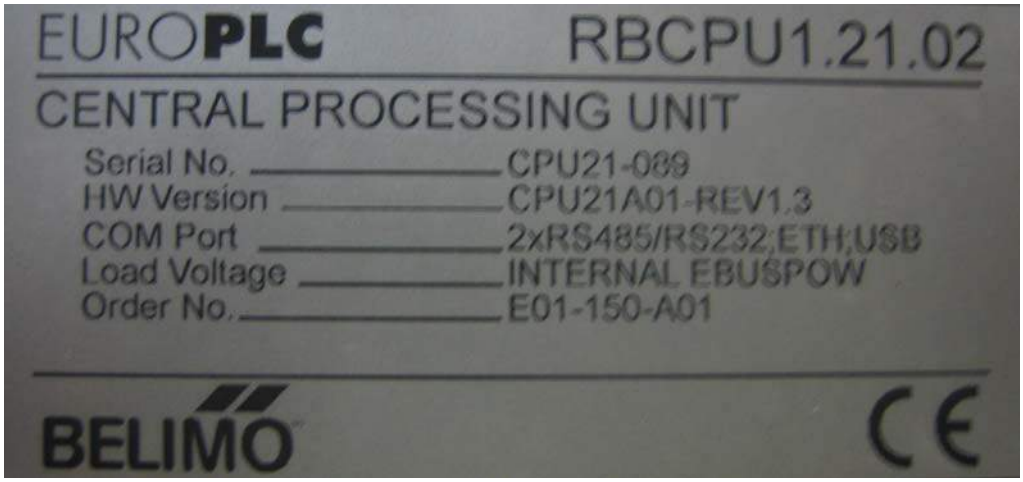
1. GENERAL

Equipment under test was tested according to EMC standards.
Test results are valid only for the tested device.

1.1 Equipment under test

RING BUS SYSTEM
Types: RBCPU+RBFU

EUT power supply: 100-265V AC, 50/60Hz
Protective class: II.



Picture label

2. TEST SUMMARY

STANDARDS	Tested		Samples	
	yes	no	pass	not pass
EN 61131-2 Programmable controllers - Part 2: Equipment requirements and tests	☑	☐	☑	☐

2.1 Purpose of the test

To determine whether the equipment under test fulfils the EMC requirements of the standards stated above.

2.2 Performance criteria

The performance criteria are based on the general criteria of the standard and specified by the manufacturer.

Criterion A: No degradation of performance or loss of function is allowed bellow a performance level specified by the manufacturer when the equipment is used as intended.

Criterion B: The EUT shall continue to operate as intended after the test. During the test, degradation of performance is allowed however.

Criterion C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by power on/off.

3. EMISSION TESTS

3.1 Conducted emission measurement

3.1.1 Limits AC ports

Frequency (MHz)	Limit CLASS A (dBuV)	
	Quasi-peak	Average
0.15 – 0.5	79	66
0.5 – 5.0	73	60
5.0 – 30.0	73	60

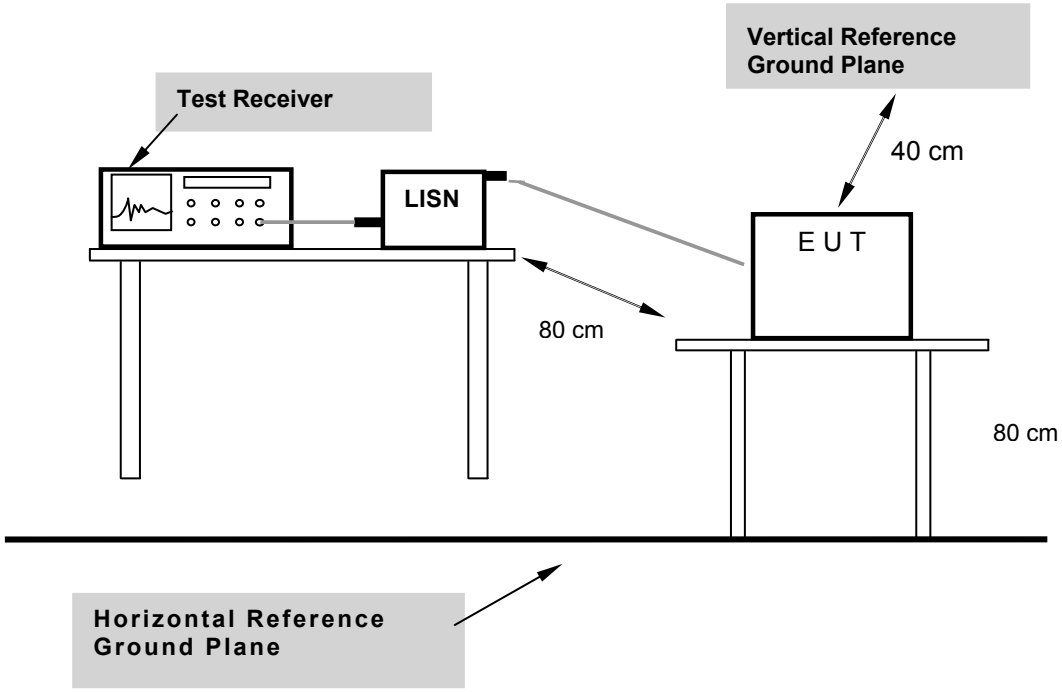
3.1.2 Test instruments

Description	Model No.	SIQ No.	Used	Calibrated until
Rohde & Schwarz, RFI test receiver	ESU8	105187	X	2013-04
Rohde & Schwarz, LISN	ESH2-Z5	06/048H	X	2012-12
Rohde & Schwarz, Current Probe	ESH2-Z1	EMC 002		2013-12

3.1.3 Test procedure

- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). LISN provide 50 Ohm/ 50 μH of coupling impedance for the measuring instrument.
- AC power lines of EUT were checked for maximum conducted interference.
- The frequency range from 150 kHz to 30 MHz was searched.

3.1.4 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

3.1.5 Test results

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal	**Bandwidth:**	9 kHz
Input voltage:	230V, 50Hz	**Date:**	07.06.2012
Environmental conditions:	22±5°C, 55±30% RH	**Tested by: Andrej Škof**	

NOTE: PASS

MEASUREMENT UNCERTAINTY:

- The measurement uncertainty is calculated in document EN122E

ROHDE&SCHWARZ

C20120752

07.Jun 12 08:00

Meas Type	CONDUCTED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU + RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	Uin 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

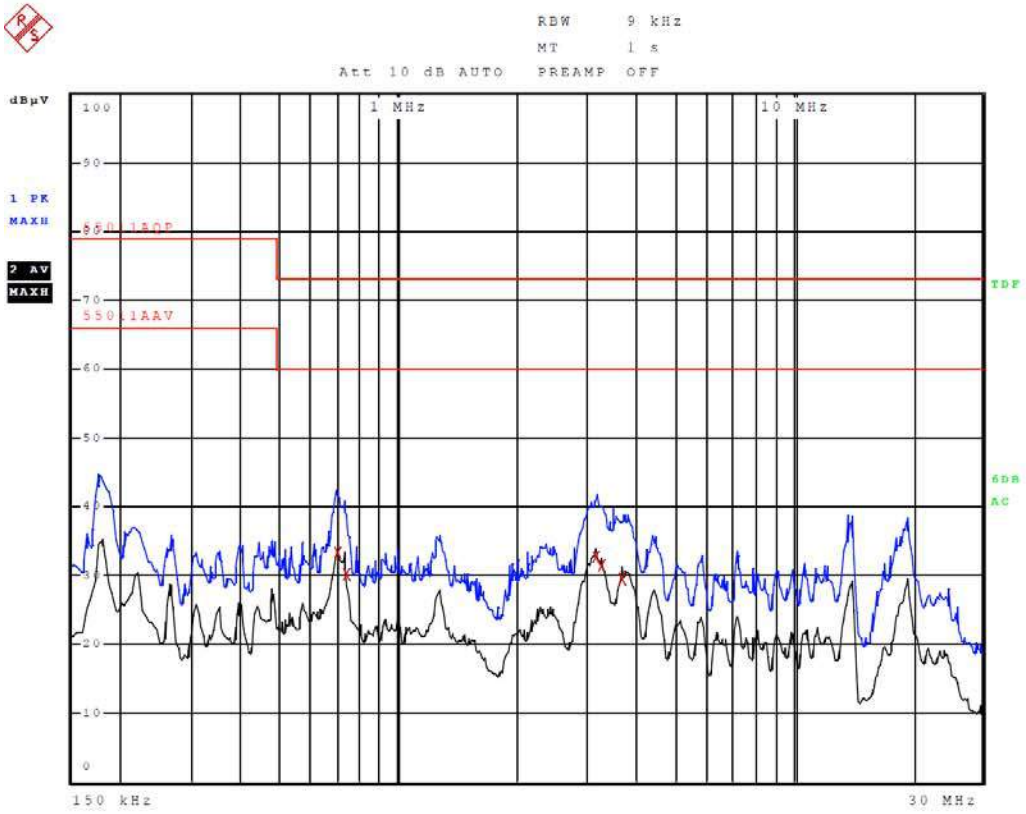
Test Spec

LINE L

Stepped Scan (1 Range)

Scan Start: 150 kHz
Scan Stop: 30 MHz
Detector: Trace 1: MAX PEAK Trace 2: Average
Transducer: ESH2-Z5

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Preamp	Input
150.000000 kHz	30.000000 MHz	4.00 kHz	9.00 kHz	5 ms	Auto	0 dB	INPUT2



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C20120752

07.Jun 12 08:00

Meas Type	CONDUCTED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU + RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	Uin 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

Test Spec
LINE L

Final Measurement

Meas Time:	1 s
Margin:	30 dB
Subranges:	5

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
2	698.000000000 kHz	33.26	Average	-26.74
2	3.154000000 MHz	32.59	Average	-27.41
2	3.258000000 MHz	31.50	Average	-28.50
2	738.000000000 kHz	30.22	Average	-29.78
2	3.686000000 MHz	29.48	Average	-30.52

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C20120752

07.Jun 12 07:57

Meas Type	CONDUCTED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU + RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	Uin 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

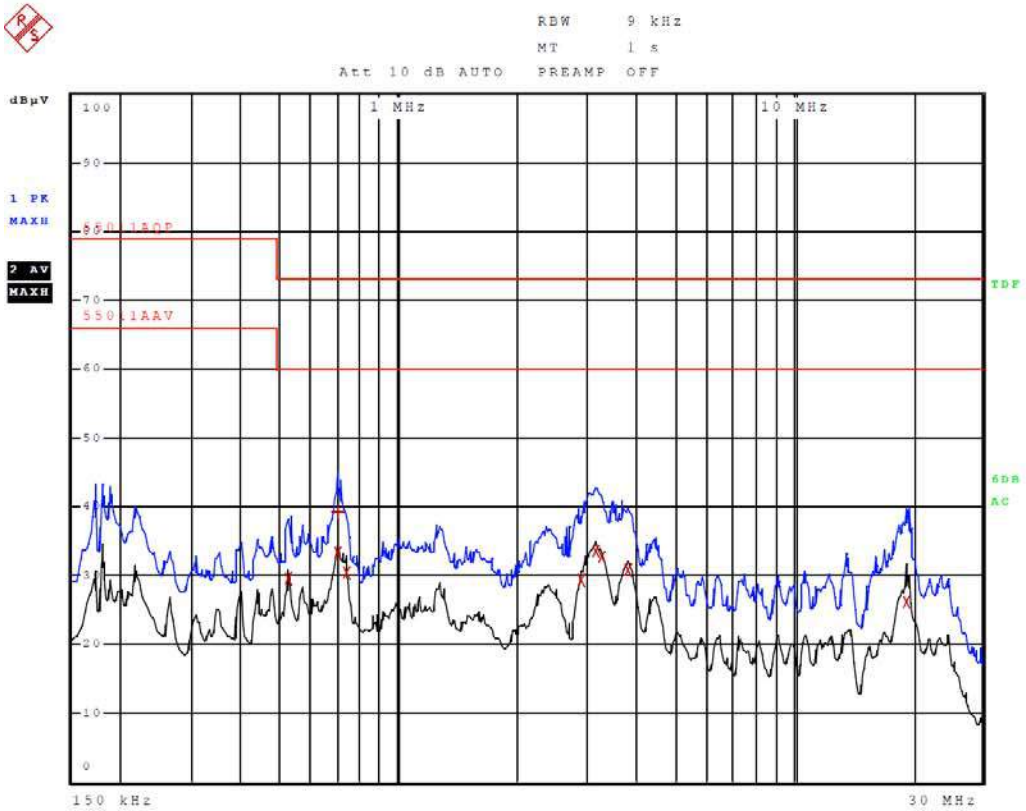
Test Spec

LINE N

Stepped Scan (1 Range)

Scan Start: 150 kHz
Scan Stop: 30 MHz
Detector: Trace 1: MAX PEAK Trace 2: Average
Transducer: ESH2-Z5

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Preamp	Input
150.000000 kHz	30.000000 MHz	4.00 kHz	9.00 kHz	5 ms	Auto	0 dB	INPUT2



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07.Jun 12 07:57

C20120752

Meas Type	CONDUCTED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU + RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	Uin 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

Test Spec
LINE N

Final Measurement

Meas Time:	1 s
Margin:	30 dB
Subranges:	9

Trace	Frequency	Level (dBµV)	Detector	Delta Limit/dB
2	3.162000000 MHz	33.41	Average	-26.59
2	698.000000000 kHz	33.20	Average	-26.80
2	3.274000000 MHz	32.63	Average	-27.37
2	3.814000000 MHz	30.85	Average	-29.15
2	738.000000000 kHz	30.38	Average	-29.62
2	522.000000000 kHz	29.59	Average	-30.41
2	2.906000000 MHz	29.40	Average	-30.60
1	698.000000000 kHz	39.27	Quasi Peak	-33.73
2	19.342000000 MHz	26.19	Average	-33.81

Figure 1: Conducted emission test – AC lines

3.2 Radiated emission measurement

3.2.1 Limits of radiated emission measurement

FREQUENCY (MHz)	Limits (at 3 m) (dBuV/m)
30 - 230	50
230 - 1000	57

NOTE: • The lower limit shall apply at the transition frequencies.
• Emission level (dBuV/m) = 20 log Emission level (uV/m).

3.2.2 Test instruments

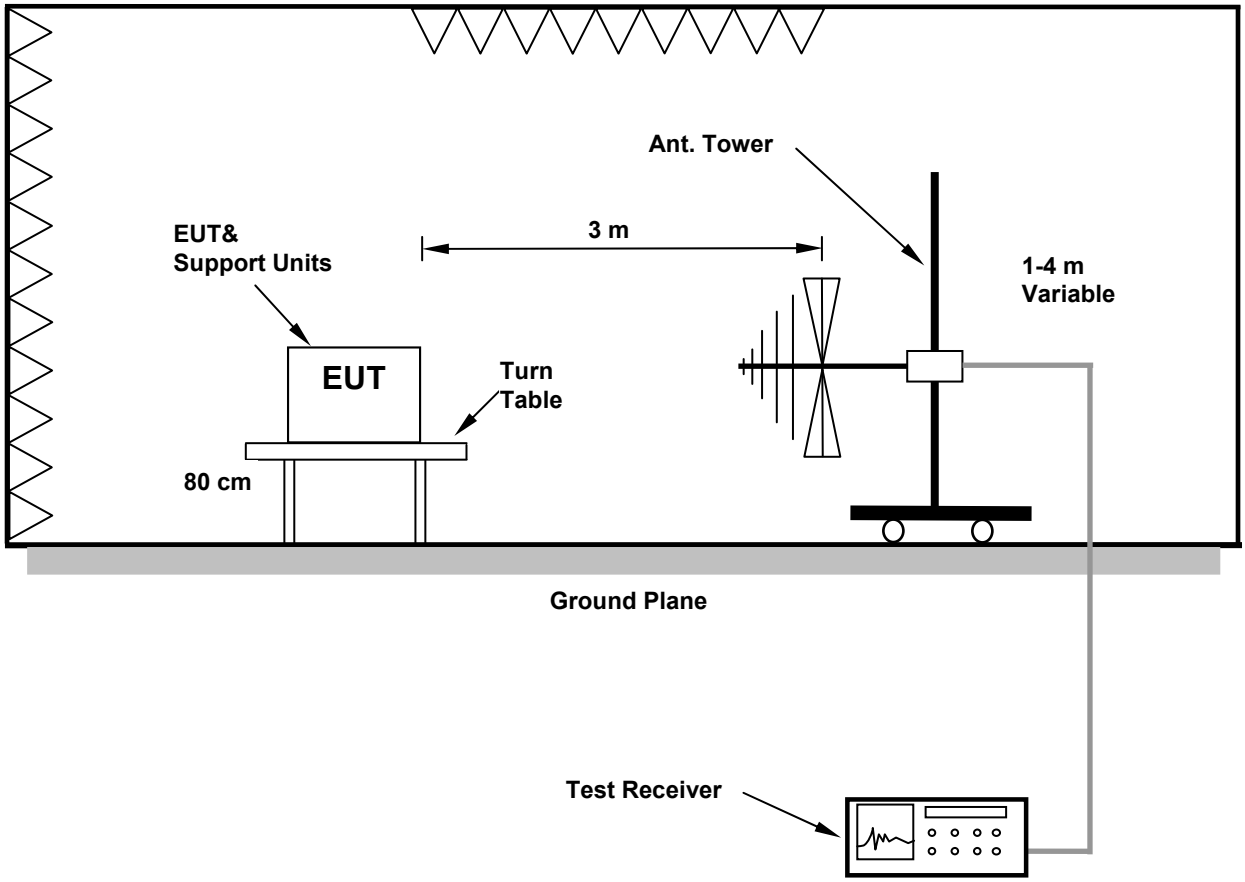
Description & Manufacturer	Model No.	SIQ No.	Used	Calibrated until
ETS, Anechoic chamber	3m	103949	X	2012-09
Rohde & Schwarz, RFI test receiver	ESU8	105187	X	2013-04
EMCO, Antenna	model 3142	06/068	X	2013-09
Heinrich Deisel, Turn table	DS 420.00	103337	X	NA
ETS, Antenna tower			X	NA

3.2.3 Test procedure

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at an Anechoic Chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 m away from the interference-receiving antenna, which was mounted on the top of variable-height antenna tower.
3. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the turn table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. The highest points would be re-tested one by one using the quasi-peak method.

3.2.4 Test set up

For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.



3.2.5 Test result

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal	**Bandwidth:**	120 kHz
Input voltage:	230V, 50Hz	**Date:**	06.06.2012
Environmental conditions:	22±5°C, 55±30% RH	**Tested by: Andrej Škof**	

NOTE: PASS

MEASUREMENT UNCERTAINTY:

- The measurement uncertainty is calculated in document EN122E

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C20120752

06.Jun 12 09:21

Meas Type	RADIATED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	INPUT: 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

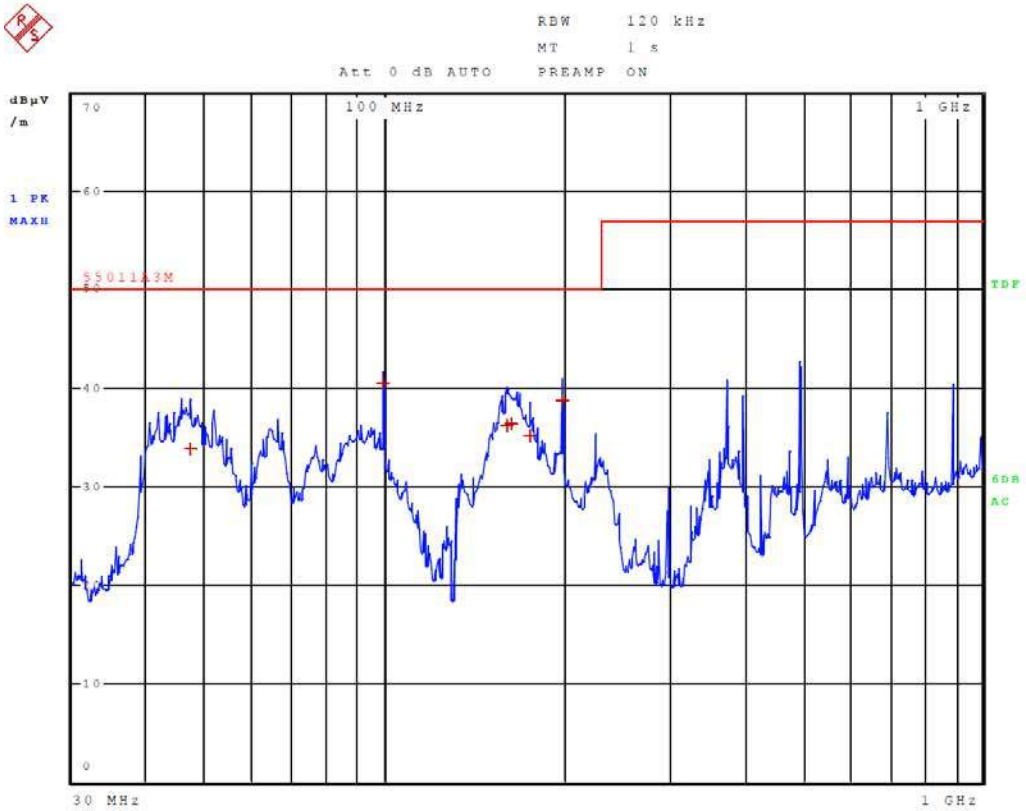
Test Spec

VERTICAL, 0 DEG

Stepped Scan (1 Range)

Scan Start: 30 MHz
Scan Stop: 1 GHz
Detector: Trace 1: MAX PEAK
Transducer: 3142B

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Preamp	Input
30.000000 MHz	1.000000 GHz	40.00 kHz	120.00 kHz	1 ms	Auto	20 dB	INPUT2



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06.Jun 12 09:21

Meas Type RADIATED EMISSION
Equipment under Test RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer EUROICC D.O.O.
OP Condition INPUT: 230V/50Hz, NORMAL
Operator ANDREJ SKOF
Test Spec
VERTICAL, 0 DEG

Final Measurement

Meas Time: 1 s
Margin: 12 dB
Subranges: 6

Trace	Frequency	Level (dBµV/m)	Detector	Delta Limit/dB
1	99.520000000 MHz	40.56	Quasi Peak	-9.44
1	198.680000000 MHz	38.70	Quasi Peak	-11.30
1	163.000000000 MHz	36.36	Quasi Peak	-13.64
1	159.880000000 MHz	36.24	Quasi Peak	-13.76
1	175.000000000 MHz	35.18	Quasi Peak	-14.82
1	47.200000000 MHz	33.83	Quasi Peak	-16.17

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06.Jun 12 09:22

Meas Type	RADIATED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	INPUT: 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

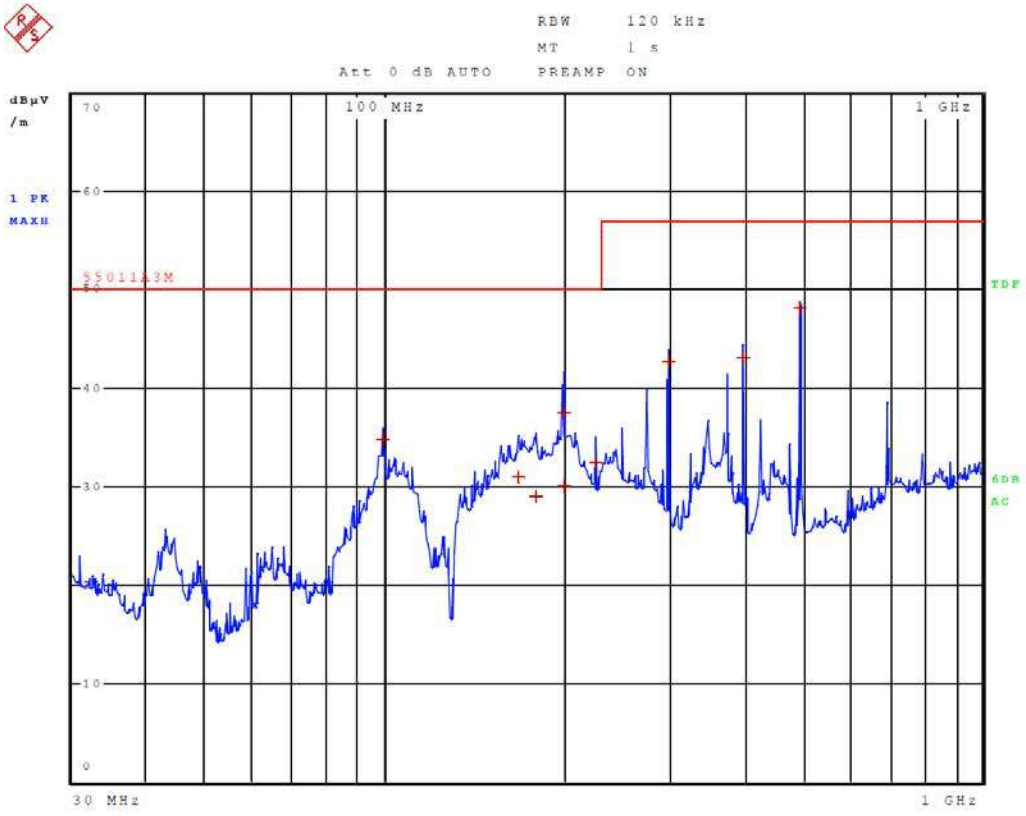
Test Spec

HORIZONTAL, 0 DEG

Stepped Scan (1 Range)

Scan Start:	30 MHz
Scan Stop:	1 GHz
Detector:	Trace 1: MAX PEAK
Transducer:	3142B

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Preamp	Input
30.000000 MHz	1.000000 GHz	40.00 kHz	120.00 kHz	1 ms	Auto	20 dB	INPUT2



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06.Jun 12 09:22

Meas Type RADIATED EMISSION
Equipment under Test RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer EUROICC D.O.O.
OP Condition INPUT: 230V/50Hz, NORMAL
Operator ANDREJ SKOF
Test Spec
HORIZONTAL, 0 DEG

Final Measurement

Meas Time: 1 s
Margin: 15 dB
Subranges: 9

Trace	Frequency	Level (dBµV/m)	Detector	Delta Limit/dB
1	496.680000000 MHz	48.10	Quasi Peak	-8.90
1	198.800000000 MHz	37.53	Quasi Peak	-12.47
1	398.120000000 MHz	43.22	Quasi Peak	-13.78
1	298.560000000 MHz	42.69	Quasi Peak	-14.31
1	99.520000000 MHz	34.71	Quasi Peak	-15.29
1	225.000000000 MHz	32.38	Quasi Peak	-17.62
1	167.840000000 MHz	30.98	Quasi Peak	-19.02
1	199.320000000 MHz	30.12	Quasi Peak	-19.88
1	179.440000000 MHz	29.09	Quasi Peak	-20.91

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06.Jun 12 09:25

Meas Type	RADIATED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	INPUT: 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

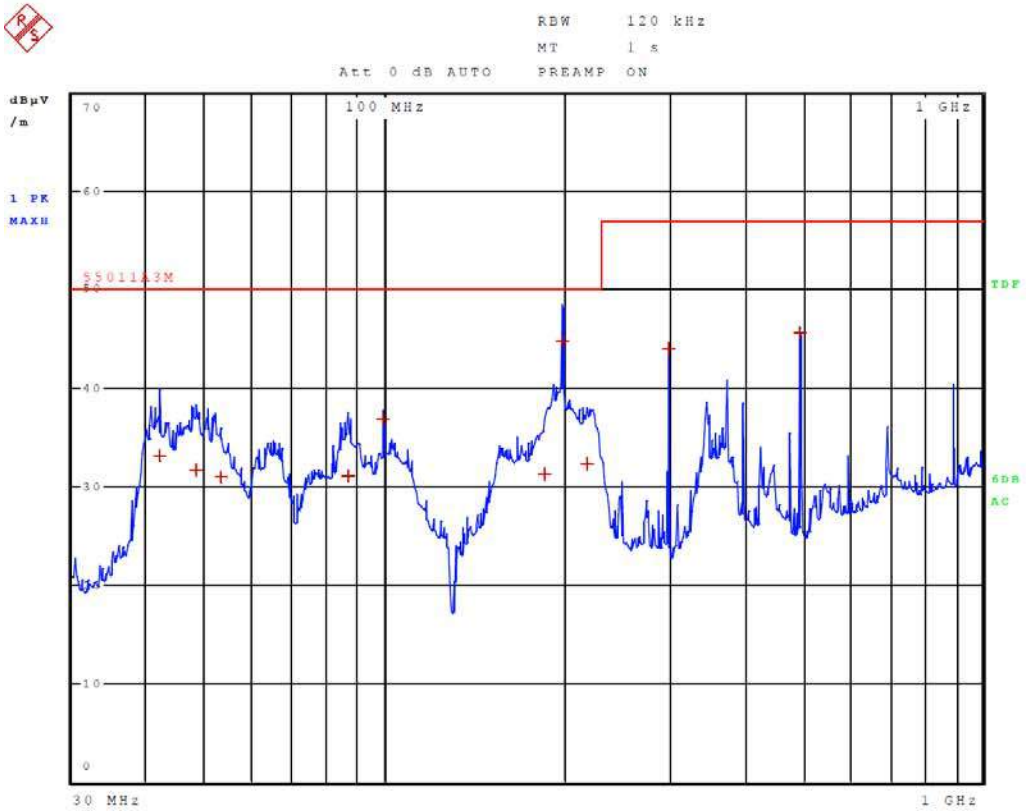
Test Spec

VERTICAL, 90 DEG

Stepped Scan (1 Range)

Scan Start: 30 MHz
Scan Stop: 1 GHz
Detector: Trace 1: MAX PEAK
Transducer: 3142B

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Preamp	Input
30.000000 MHz	1.000000 GHz	40.00 kHz	120.00 kHz	1 ms	Auto	20 dB	INPUT2



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06.Jun 12 09:25

Meas Type RADIATED EMISSION
Equipment under Test RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer EUROICC D.O.O.
OP Condition INPUT: 230V/50Hz, NORMAL
Operator ANDREJ SKOF
Test Spec
VERTICAL, 90 DEG

Final Measurement

Meas Time: 1 s
Margin: 15 dB
Subranges: 10

Trace	Frequency	Level (dBµV/m)	Detector	Delta Limit/dB
1	198.560000000 MHz	44.83	Quasi Peak	-5.17
1	496.640000000 MHz	45.64	Quasi Peak	-11.36
1	298.560000000 MHz	44.03	Quasi Peak	-12.97
1	99.520000000 MHz	36.85	Quasi Peak	-13.15
1	41.960000000 MHz	33.14	Quasi Peak	-16.86
1	218.200000000 MHz	32.24	Quasi Peak	-17.76
1	48.240000000 MHz	31.63	Quasi Peak	-18.37
1	184.880000000 MHz	31.31	Quasi Peak	-18.69
1	86.960000000 MHz	31.16	Quasi Peak	-18.84
1	53.280000000 MHz	30.98	Quasi Peak	-19.02

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C20120752

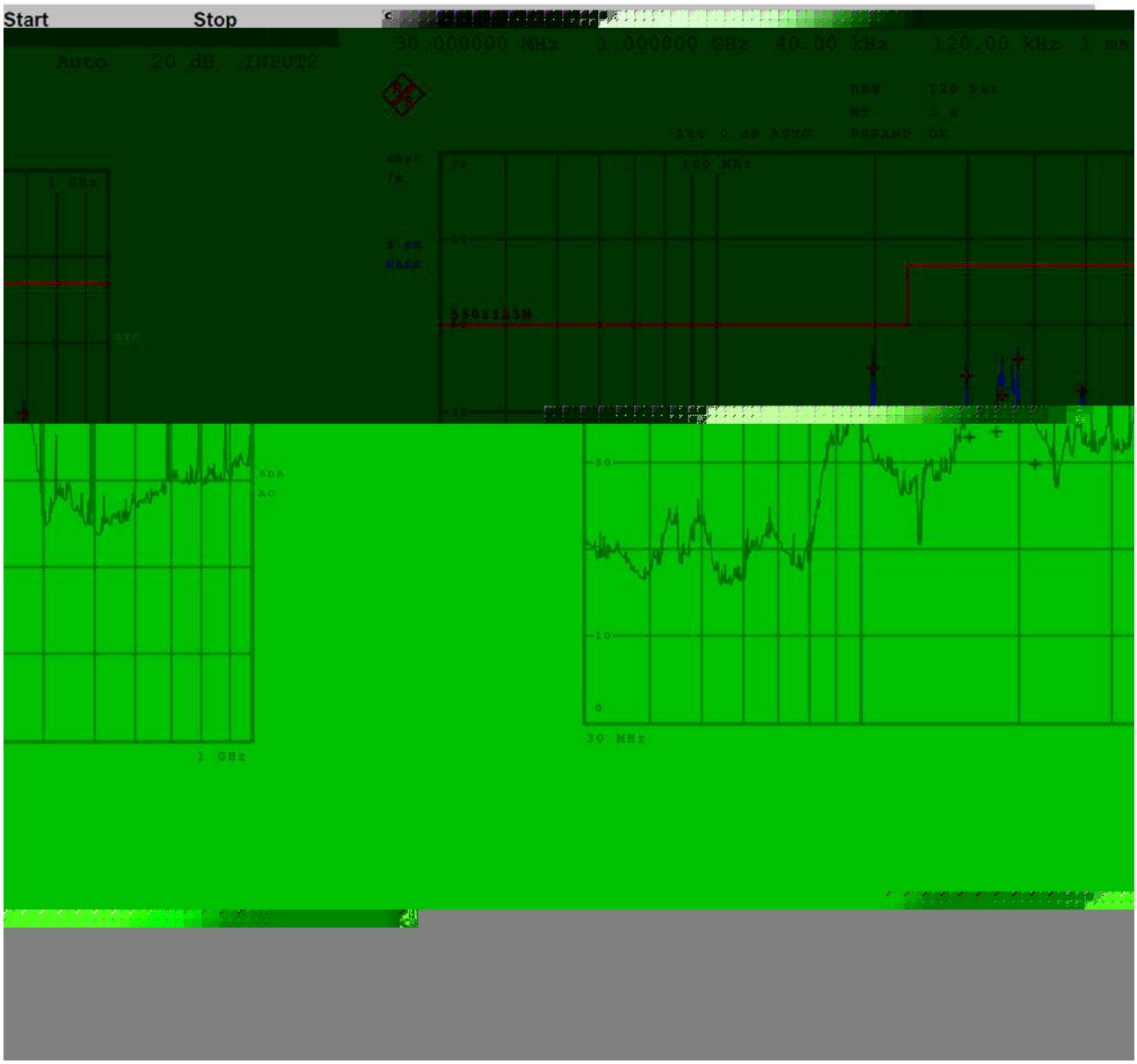
06.Jun 12 09:24

Meas Type	RADIATED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	INPUT: 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

Test Spec
HORIZONTAL, 90 DEG

Stepped Scan (1 Range)

Scan Start:	30 MHz
Scan Stop:	1 GHz
Detector:	Trace 1: MAX PEAK
Transducer:	3142B



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06.Jun 12 09:27

Meas Type	RADIATED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer	EUROICC D.O.O.
OP	[illegible]

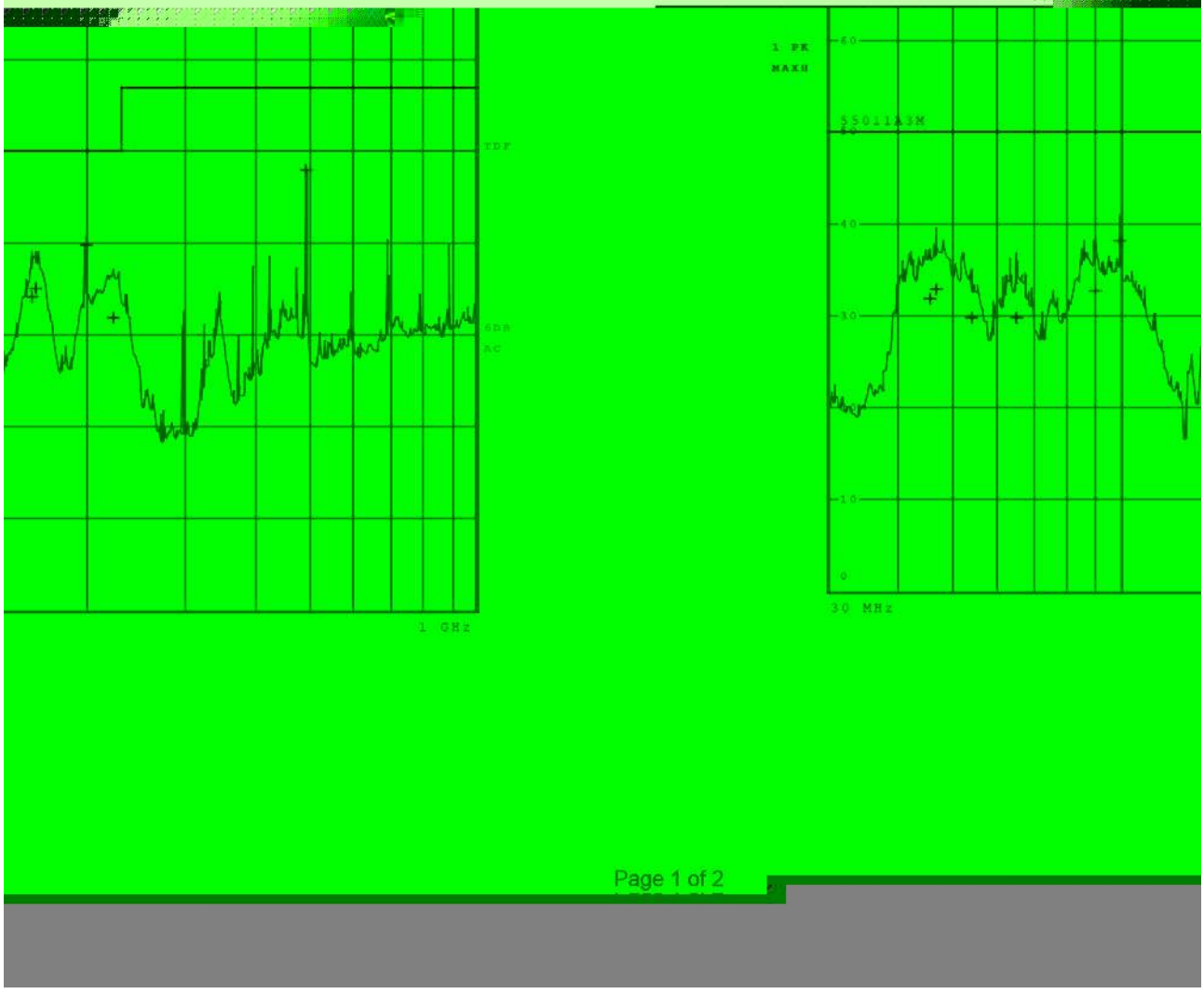
Test Spec
VERTICAL, 180 DEG

Stepped Scan (1 Range)

Scan Start:	30 MHz
Scan Stop:	1 GHz
Detector:	Trace 1: MAX PEAK
Transducer:	3142B

Start Frequency	Stop Frequency	Step Size	Re
30.000000 MHz	1.000000 GHz	40.00 kHz	12

s BW	Meas Time	RF Atten	Preamp	Input
0.00 kHz	1 ms	Auto	20 dB	INPUT2



Page 1 of 2

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C20120752

06.Jun 12 09:27

Meas Type RADIATED EMISSION
Equipment under Test RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer EUROICC D.O.O.
OP Condition INPUT: 230V/50Hz, NORMAL
Operator ANDREJ SKOF
Test Spec
VERTICAL, 180 DEG

Final Measurement

Meas Time: 1 s
Margin: 15 dB
Subranges: 11

Trace	Frequency	Level (dBµV/m)	Detector	Delta Limit/dB
1	496.640000000 MHz	47.99	Quasi Peak	-9.01
1	199.040000000 MHz	39.72	Quasi Peak	-10.28
1	99.520000000 MHz	38.14	Quasi Peak	-11.86
1	161.800000000 MHz	35.07	Quasi Peak	-14.93
1	159.200000000 MHz	34.21	Quasi Peak	-15.79
1	46.360000000 MHz	32.85	Quasi Peak	-17.15
1	89.600000000 MHz	32.74	Quasi Peak	-17.26
1	223.080000000 MHz	31.86	Quasi Peak	-18.14
1	45.200000000 MHz	31.84	Quasi Peak	-18.16
1	64.680000000 MHz	29.81	Quasi Peak	-20.19
1	53.640000000 MHz	29.80	Quasi Peak	-20.20

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C20120752

06.Jun 12 09:29

Meas Type	RADIATED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	INPUT: 230V/50Hz, NORMAL
Operator	ANDRE

Final Measurement

Meas Time: 1 s
Margin: 15 dB
Subranges: 9

46.40	Quasi Peak	-3.60
47.58	Quasi Peak	-9.42
38.02	Quasi Peak	-11.98
37.38	Quasi Peak	-12.62
36.93	Quasi Peak	-13.07
42.70	Quasi Peak	-14.30
41.52	[illegible]	[illegible]

1	198.800000000	MHz
1	298.560000000	MHz
1	163.960000000	MHz
1	99.520000000	MHz
1	160.800000000	MHz
1	398.080000000	MHz
1	275.000000000	MHz

[redacted]

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C20120752

06.Jun 12 09:32

Meas Type RADIATED EMISSION

Equipment under Test RING BUS SYS

UT: 230V/50Hz, NORMAL

DREJ SKOF

OP Condition IN

Operator AN

Test Spec

VERTICAL, 270 DEG

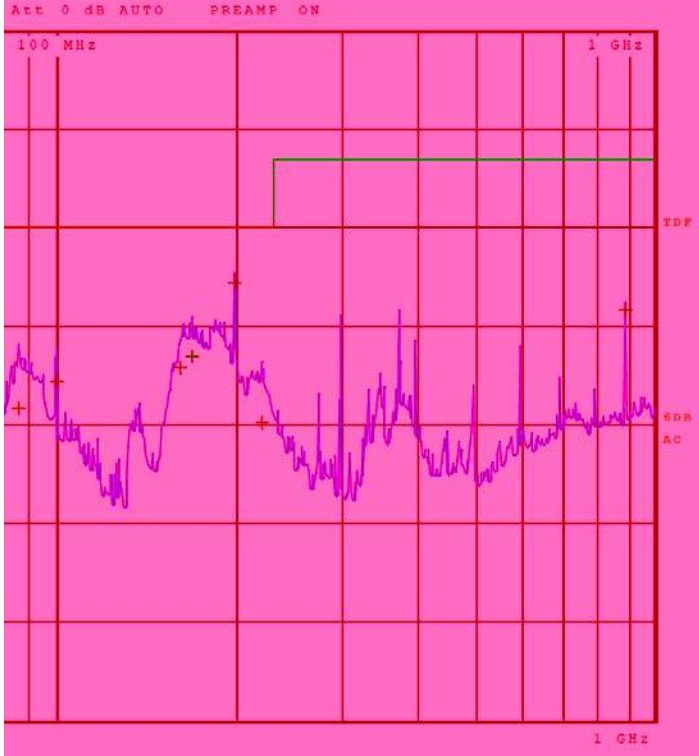
Stepped Scan (1 Range)

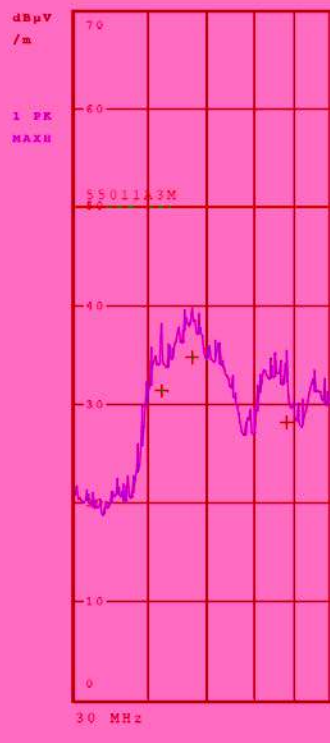
Scan Start:	30 MHz
Scan Stop:	1 GHz
Detector:	Trace 1: MAX
Transducer:	3142B

PEAK

Step Size	Res BW	Meas Time	RF Atten	Preamp	Input
00 GHz 40.00 kHz	120.00 kHz	1 ms	Auto	20 dB	INPUT2

Start Frequency	Stop Frequency
30.000000 MHz	1.000





Page 1 of 2

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C20120752

06.Jun 12 09:32

Meas Type RADIATED EMISSION
Equipment under Test RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer EUROICC D.O.O.
OP Condition INPUT: 230V/50Hz, NORMAL
Operator ANDREJ SKOF
Test Spec
VERTICAL, 270 DEG

Final Measurement

Meas Time: 1 s
Margin: 15 dB
Subranges: 10

Trace	Frequency	Level (dBµV/m)	Detector	Delta Limit/dB
1	198.720000000 MHz	44.42	Quasi Peak	-5.58
1	168.240000000 MHz	36.95	Quasi Peak	-13.05
1	161.440000000 MHz	35.76	Quasi Peak	-14.24
1	47.120000000 MHz	34.71	Quasi Peak	-15.29
1	893.960000000 MHz	41.62	Quasi Peak	-15.38
1	99.560000000 MHz	34.42	Quasi Peak	-15.58
1	86.360000000 MHz	31.68	Quasi Peak	-18.32
1	41.680000000 MHz	31.44	Quasi Peak	-18.56
1	220.400000000 MHz	30.29	Quasi Peak	-19.71
1	67.680000000 MHz	28.10	Quasi Peak	-21.90

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C20120752

06.Jun 12 09:31

Meas Type	RADIATED EMISSION
Equipment under Test	RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer	EUROICC D.O.O.
OP Condition	INPUT: 230V/50Hz, NORMAL
Operator	ANDREJ SKOF

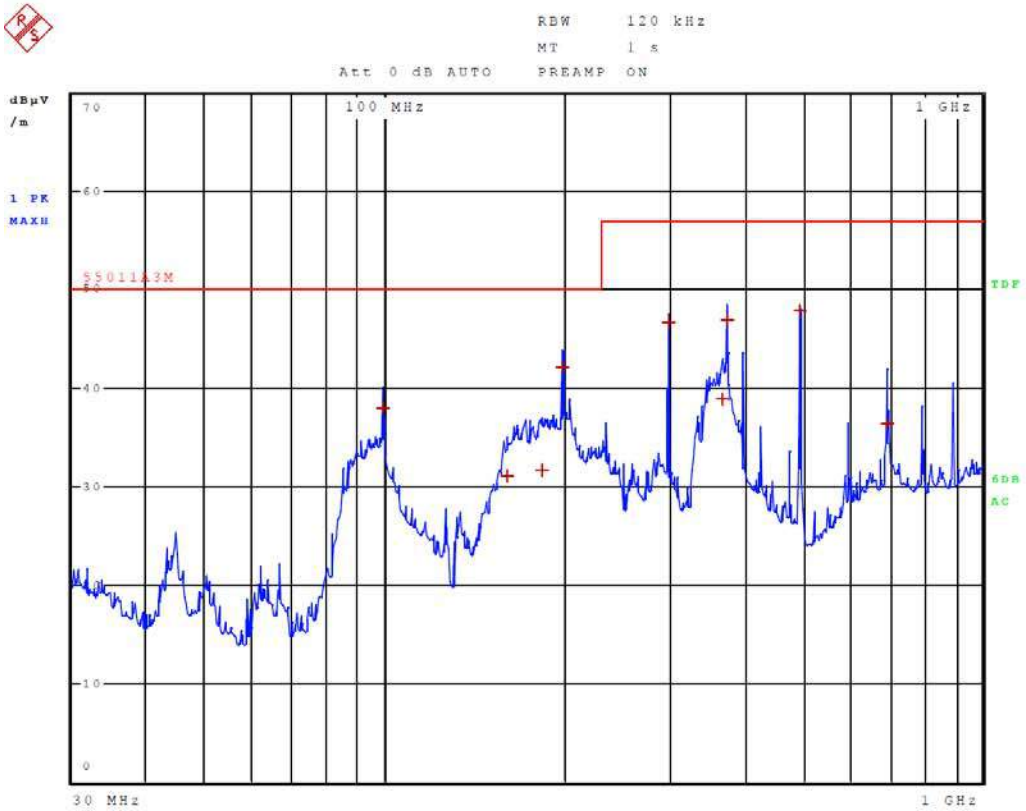
Test Spec

HORIZONTAL, 270 DEG

Stepped Scan (1 Range)

Scan Start:	30 MHz
Scan Stop:	1 GHz
Detector:	Trace 1: MAX PEAK
Transducer:	3142B

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Preamp	Input
30.000000 MHz	1.000000 GHz	40.00 kHz	120.00 kHz	1 ms	Auto	20 dB	INPUT2



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06.Jun 12 09:31

Meas Type RADIATED EMISSION
Equipment under Test RING BUS SYSTEM, Type RBCPU+RBFU
Manufacturer EUROICC D.O.O.
OP Condition INPUT: 230V/50Hz, NORMAL
Operator ANDREJ SKOF
Test Spec
HORIZONTAL, 270 DEG

Final Measurement

Meas Time: 1 s
Margin: 15 dB
Subranges: 9

Trace	Frequency	Level (dBµV/m)	Detector	Delta Limit/dB
1	198.720000000 MHz	42.14	Quasi Peak	-7.86
1	496.680000000 MHz	47.82	Quasi Peak	-9.18
1	375.000000000 MHz	47.02	Quasi Peak	-9.98
1	298.560000000 MHz	46.70	Quasi Peak	-10.30
1	99.520000000 MHz	37.96	Quasi Peak	-12.04
1	367.840000000 MHz	38.97	Quasi Peak	-18.03
1	182.840000000 MHz	31.67	Quasi Peak	-18.33
1	160.360000000 MHz	31.15	Quasi Peak	-18.85
1	695.640000000 MHz	36.42	Quasi Peak	-20.58

Figure 2: Radiated emission test

4. Immunity

4.1 General description

Basic Standard, Specification, and Performance Criteria:	EN 61000-4-2	Electrostatic Discharge – ESD: 8 kV air discharge, 4 kV Contact discharge, Performance criterion B
	EN 61000-4-3	Radio-Frequency Electromagnetic Field Susceptibility Test – RS: 80-1000MHz - 10V/m 1400-2000MHz - 3V/m 2000-2700MHz - 1V/m 80% AM (1 kHz), Performance criterion A
	EN 61000-4-4	Electrical Fast Transient/Burst – EFT, AC Power line: 2 kV Performance criterion B
	EN 61000-4-5	Surge Immunity Test: 1.2/50 us Open Circuit Voltage, 8 /20 us Short Circuit Current, Power line 1 kV L-N, Performance criterion B
	EN 61000-4-6	Conducted Radio Frequency Disturbances 0,15-80 MHz, 3 V, 80% AM (1kHz), Performance criterion A
	EN 61000-4-8	Magnetic field immunity, 30 A/m, Performance criterion A
	EN 61000-4-11	Electromagnetic compatibility-Voltage dips, short interruptions and voltage variations immunity test Performance criterion B,C

4.2 Immunity to electrostatic discharge

4.2.1 Test specification

Basic Standard:	IEC 61000-4-2
Discharge Impedance:	330 Ω / 150 pF
Discharge Voltage:	Air Discharge- 8 kV Contact Discharge- 4 kV
Polarity:	Positive / Negative
Number of Discharge:	Minimum 10 times at each test point
Discharge Mode:	Single Discharge
Discharge Period:	1-second minimum

4.2.2 Test instruments

Description& Manufacturer	Model No.	SIQ No.	Used	Calibrated until
EM TEST, Simulator ESD	P30N	105296	X	2013-06

4.2.3 Test procedure

The discharges shall be applied in two ways:

1. Contact discharges to the conductive surfaces and coupling planes:

   The EUT shall be exposed to at least 10 discharges, 5 each at negative and positive polarity, at a minimum of four test points. One of the test points shall be subjected to at least 10 indirect discharges to the center of the front edge of the horizontal coupling plane. If no direct contact test points are available, than at least 20 indirect discharges shall be applied in the indirect mode. Test shall be performed at a maximum repetition rate of one discharge per second.

   On each discharge point the test shall start with 2 kV and continue with value increased for 2 kV.

2. Air discharges at slots and apertures and insulating surfaces:

   On those parts of the EUT where it is not possible to perform contact discharge testing, the equipment should be investigated to identify user accessible points where breakdown may occur. Such points are tested using the air discharge method. This investigation should be restricted to those area normally handled by the user. A minimum of 10 single air discharges shall be applied to the selected test point for each such area.

The basic test procedure was in according with IEC 61000-4-2:

1. Electrostatic discharges were applied only to those points and surfaces of the EUT that are accessible to users during normal operation.

2. The test was performed with at least ten single discharges on the pre-selected points in the most sensitive polarity.

3. The time interval between two successive single discharges was at least 1 second.

4. The ESD generator was held perpendicularly to the surface to which the discharge was applied and the return cable was at least 0.2 meters from the EUT.

5. Contact discharges were applied to the non-insulating coating, with the pointed tip of the generator penetrating the coating and contacting the conducting substrate.

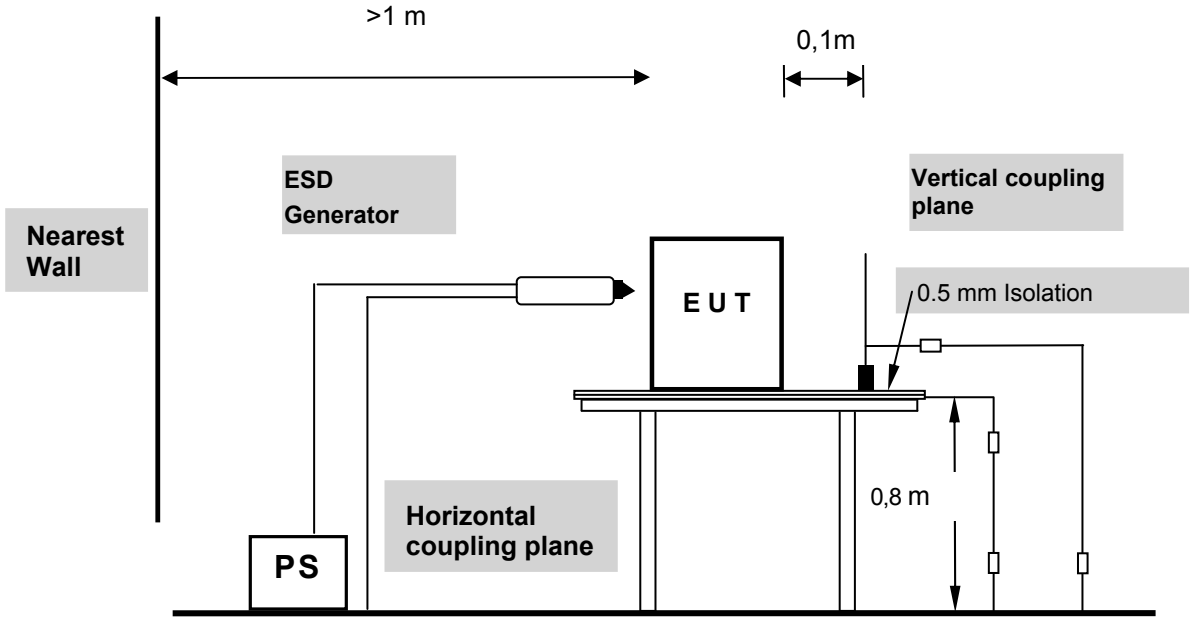
6. Air discharges were applied with the round discharge tip of the discharge electrode approaching the EUT as fast as possible (without causing mechanical damage) to touch the EUT. After each discharge, the ESD generator was removed from the EUT and re-triggered for a new single discharge. The test was repeated until all discharges were complete.

7. At least ten single discharges (in the most sensitive polarity) were applied to the Horizontal Coupling Plane at points on each side of the EUT. The ESD generator was positioned vertically at a distance of 0.1 meters from the EUT with the discharge electrode touching the Horizontal Coupling Plane.

8. At least ten single discharges (in the most sensitive polarity) were applied to the center of one vertical edge of the Vertical Coupling Plane in sufficiently different positions that the four faces of the EUT were completely illuminated. The Vertical Coupling Plane (dimensions 0.5m x 0.5m) was placed vertically to and 0.1 meters from the EUT.

4.2.4 Test setup

For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.



The configuration consisted of a wooden table 0.8 meters high standing on the **G**round **R**eference **P**lane. The **GPR** consisted of a sheet of aluminum at least 0.25 mm thick, and 2.5 meters square connected to the protective grounding system. A **H**orizontal **C**oupling **P**lane (1.6m x 0.8m) was placed on the table and attached to the **GPR** by means of a cable with 940 kΩ total impedance. The equipment under test, was installed in a representative system as described in section 7 of EN 61000-4-2, and its cables were placed on the **HCP** and isolated by an insulating support of 0.5 mm thickness. A distance of 1-meter minimum was provided between the EUT and the walls of the laboratory and any other metallic structure.

4.2.5 Test results

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal		
Input voltage:	230V, 50Hz	**Date:**	19.06.2012
Environmental conditions:	25±10°C, 45±15% RH	**Tested by: Andrej Škof**	

Test results of direct application					
Discharge Level (kV)	Polarity	Test Point	Contact Discharge	Air Discharge	Performance Criterion
4	+/-	1 / HCP	X		B
4	+/-	2 / VCP	X		B
4	+/-	3	X		B
8	+/-	1A - 9A		X	B

NOTE: PASS

Figure 3: Electrostatic discharge test – HCP

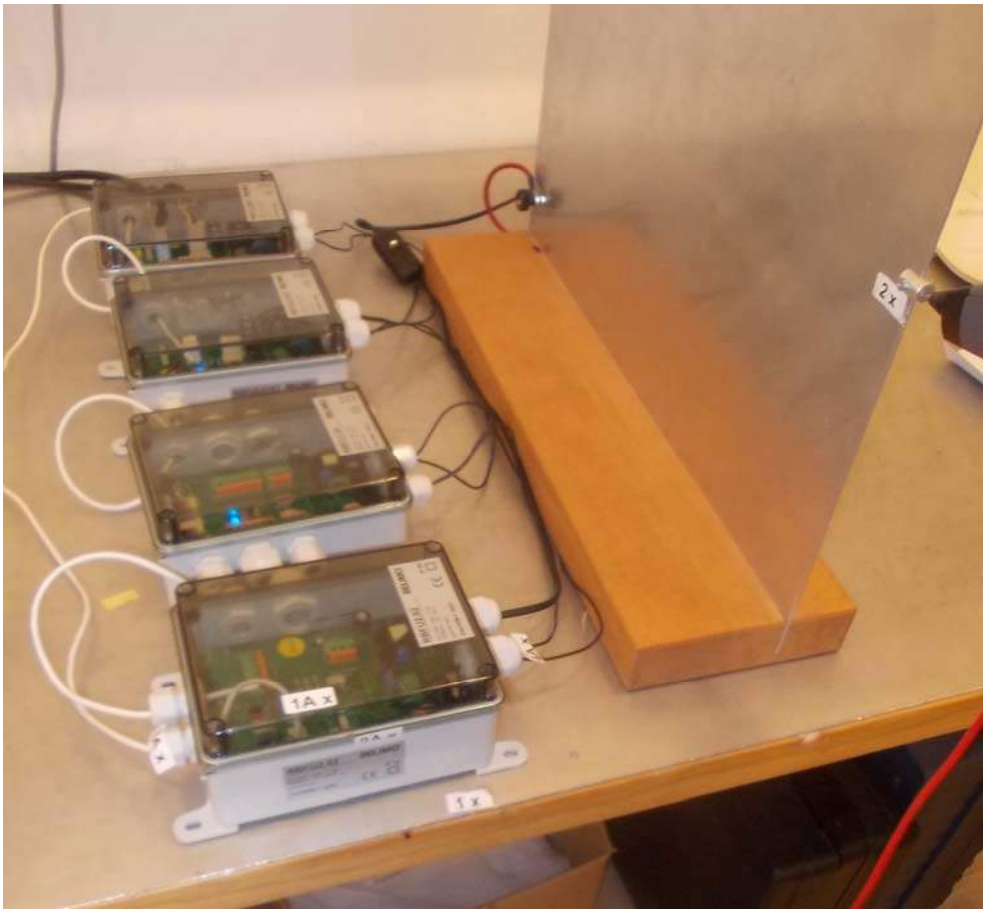


Figure 4: Electrostatic discharge test – VCP

Figure 5: Electrostatic discharge test

Figure 6: Electrostatic discharge test

Figure 7: Electrostatic discharge test

Figure 8: Electrostatic discharge test

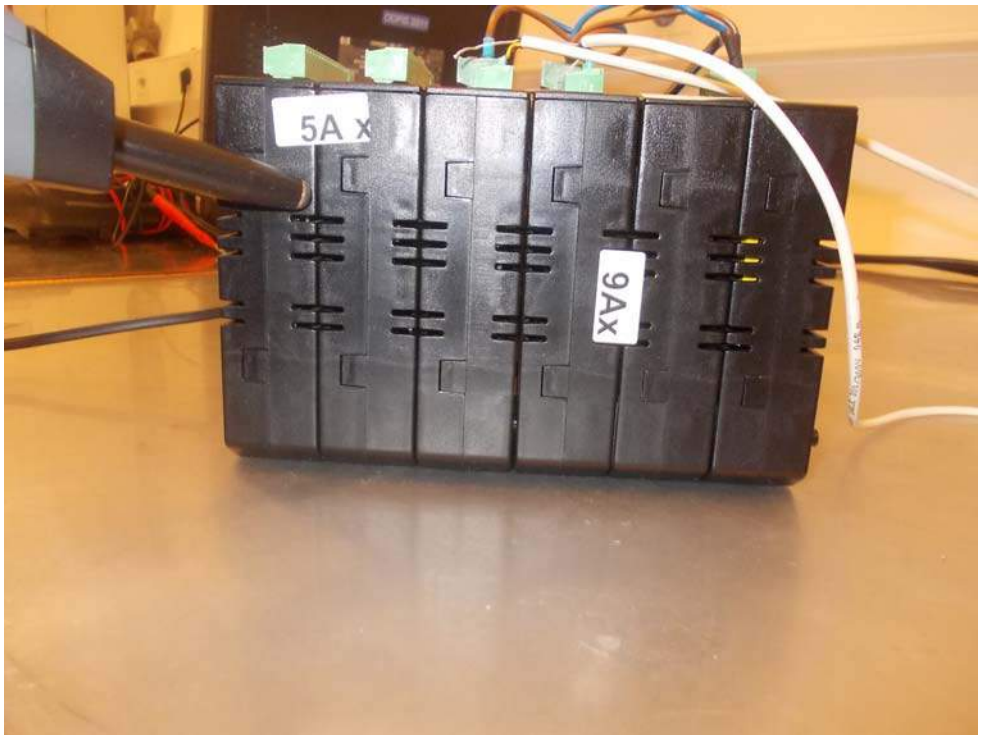


Figure 9: Electrostatic discharge test

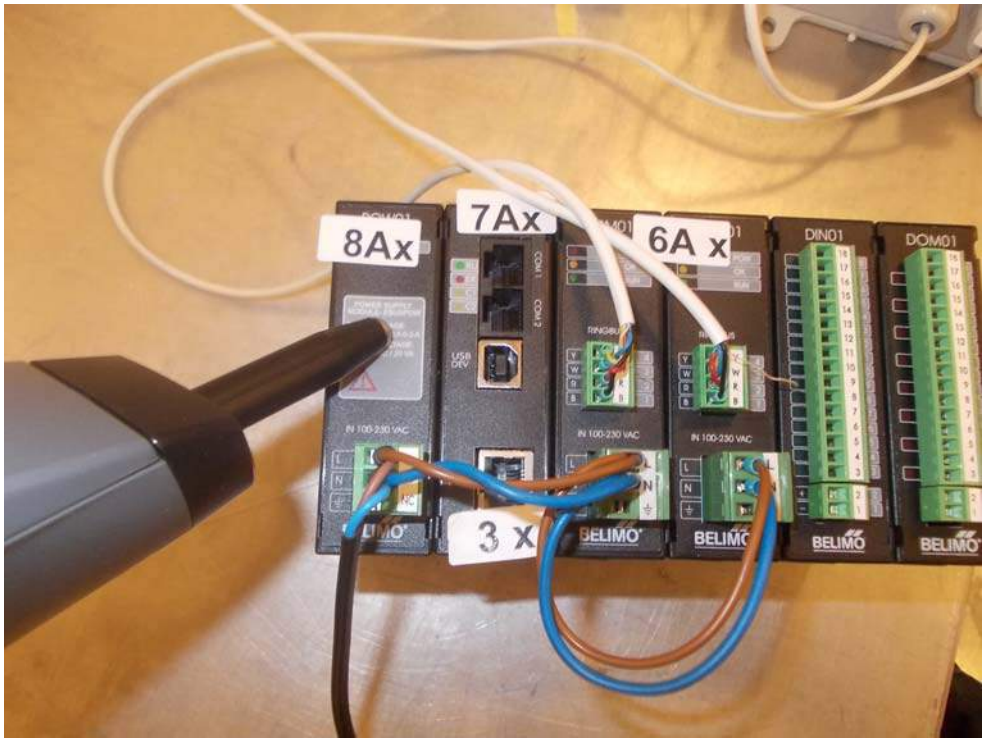


Figure 10: Electrostatic discharge test

4.3 Radiated electromagnetic field immunity test (RS)

4.3.1 Test specification

Basic Standard:	IEC 61000-4-3
Frequency Range:	80 – 1000 MHz; 1400 – 2000MHz, 2000 – 2700MHz
Field Strength:	10 V/m, 3 V/m, 1 V/m
Modulation:	1 kHz Sine Wave, 80 %, AM Modulation
Frequency Step:	1 % of fundamental
Polarity of Antenna:	Horizontal and Vertical
Test Distance:	3 m
Antenna Height:	1.5 m

4.3.2 Test instruments

Description& Manufacturer	Model No.	SIQ No.	Used	Calibrated until
EMCO, Antenna	model 3142	104351	X	2013-09
ETS, Anechoic chamber	3m	103949	X	2012-09
HP, signal generator	8648C	105045	X	2013-11
WARLATONE, Directional coupler	C5100	104257	X	2013-11
WARLATONE, Directional coupler	C3910	104258		2013-11
KALMUS, RFAMPLIFIER	827FC	104256	X	2012-12
HORN, Antenna	BBHA 9120 E	105063	X	2013-09
OPHIR RF, Amplifier	5172	105059	X	2013-10

4.3.3 Test procedure

The test procedure was in accordance with IEC 61000-4-3

1. The transmit antenna was located at a distance of 3 meters from the EUT.

2. The frequency range is swept from 80 MHz to 1000 MHz, 1400 MHz to 2700 MHz with the signal 80 % amplitude modulated with 1 kHz sine-wave. The rate of sweep did not exceed 1.5 x 10^{-3} decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.

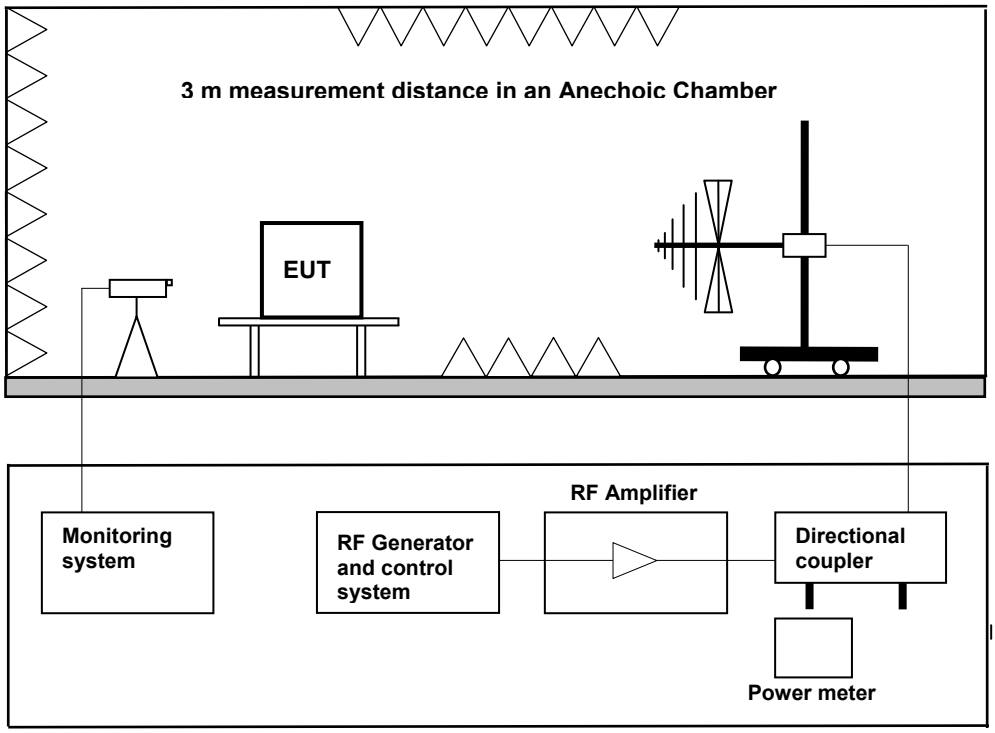
3. The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.

4. The field strength level was 10 V/m, 3 V/m and 1 V/m.

5. Test was performed with the EUT exposed to both vertically and horizontally polarized fields on each of the four sides.

4.3.4 Test setup

For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.



The EUT installed in a representative system as described in section 7 EN 61000-4-3 was placed on the floor. The system under test was connected to the power and signal wire according to relevant installation instructions.

4.3.5 Test results

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal		
Input voltage:	230V, 50Hz	**Date:**	19.06.2012
Environmental conditions:	22±5°C, 55±30% RH	**Tested by: Andrej Škof**	

Frequency (MHz)	Polarity	Azimuth	Field Strength (V/m)	Observation	Performance Criterion
80 – 1000	V / H	0, 90, 180, 270	10	Operating	A
1400 – 2000	V / H	0, 90, 180, 270	3	Operating	A
2000 – 2700	V / H	0, 90, 180, 270	1	Operating	A

NOTE: PASS

Figure 11: Radiated immunity test – under 1GHz

Figure 12: Radiated immunity test – over 1GHz

4.4 Electrical fast transient/burst immunity test

4.4.1 Test specification

Basic Standard:	IEC 61000-4-4
Test Voltage:	AC power Line – 2 kV I/O Line – 1 kV Data communication Line – 0,5 kV
Polarity:	Positive/Negative
Impulse Frequency:	5 kHz
Impulse Waveshape:	5/50 ns
Burst Duration:	15 ms
Burst Period:	300 ms
Test Duration:	not less than 1 min.

4.4.2 Test instruments

Description& Manufacturer	Model No.	SIQ No.	Used	Calibrated until
EM TEST, Universal immunity simulator	UCS 500 N5	105294	X	2013-04
EM TEST, Capacitance coupling clamp	HFK	06/060A	X	NA

4.4.3 Test procedure

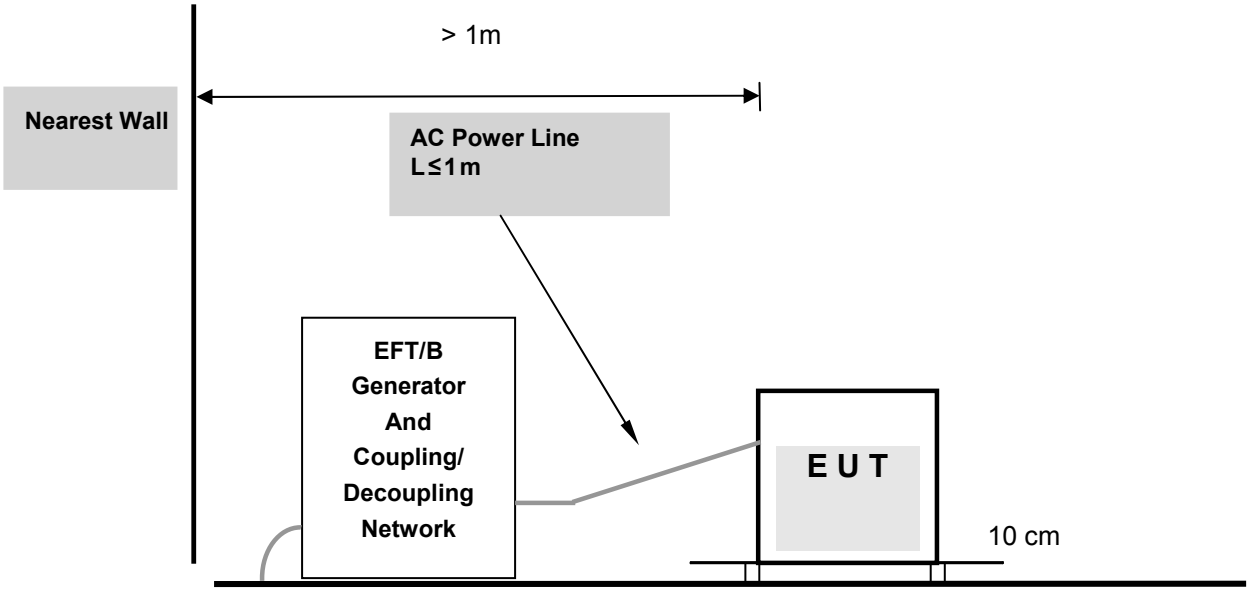
1. Both positive and negative polarity discharges were applied.

2. The length of the "hot wire" from the coaxial output of the EFT generator to the terminals on the EUT should not exceed 1 meter.

3. The duration time of each test sequential was 1 minute.

4. The transient/burst waveform was in accordance with IEC 61000-4-4, 5/50 ns.

4.4.4 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

The EUT installed in a representative system as described in section 7 of EN 61000-4-4 and its cables were isolated from the Ground Reference Plane. The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5 m square) connected to the protective grounding system.

4.4.2 EUT operating conditions

Normal operating.

4.4.5 Test results

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal		
Input voltage:	230V, 50Hz	**Date:**	19.06.2012
Environmental conditions:	25±10°C, 50±25% RH	**Tested by: Andrej Škof**	

Test Point	Polarity	Test Level (kV)	Observation	Performance Criterion
AC port L	+/-	2	Operating	B
AC port N	+/-	2	Operating	B
I/O	+/-	1	Operating	B
Data communication	+/-	0,5	Operating	B

NOTE: PASS

Figure 13: Fast transient and burst immunity test – AC lines

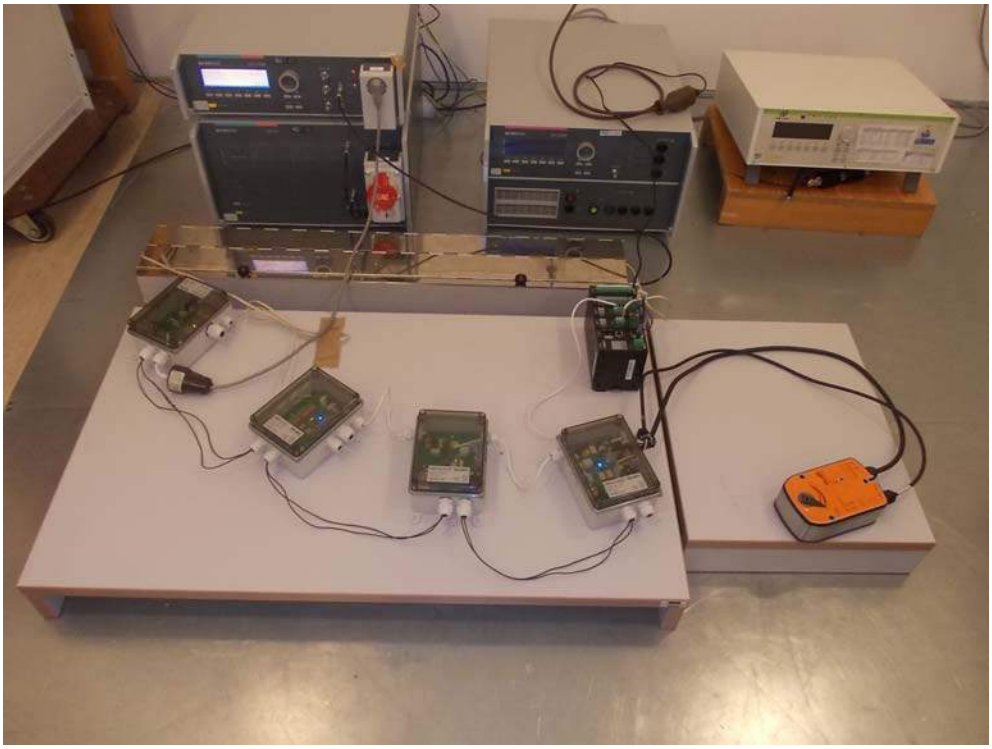


Figure 14: Fast transient and burst immunity test – signal lines

4.5 Surge immunity test

4.5.1 Test specification

Basic Standard:	IEC 61000-4-5
Wave-Shape:	Combination Wave
Test Voltage:	±1 kV symmetrical, ±1 kV I/O, ±1 kV AUX, 1.2/50 us Open Circuit Voltage
Generator Source:	2 ohm between networks (symmetrical)
Polarity:	Positive/Negative
Phase Angle:	0 ° / 90 ° / 180 ° / 270 °
Pulse Repetition rate:	1 time / min. (maximum)
Number of Tests:	5 positive and 5 negative at selected points

4.5.2 Test instruments

Description& Manufacturer	Model No.	SIQ No.	Used	Calibrated until
EM TEST, Universal immunity simulator	UCS 500 N5	105294	X	2013-04
EM TEST, 3-phase network matrix	CNI 503 A	105295		2013-04

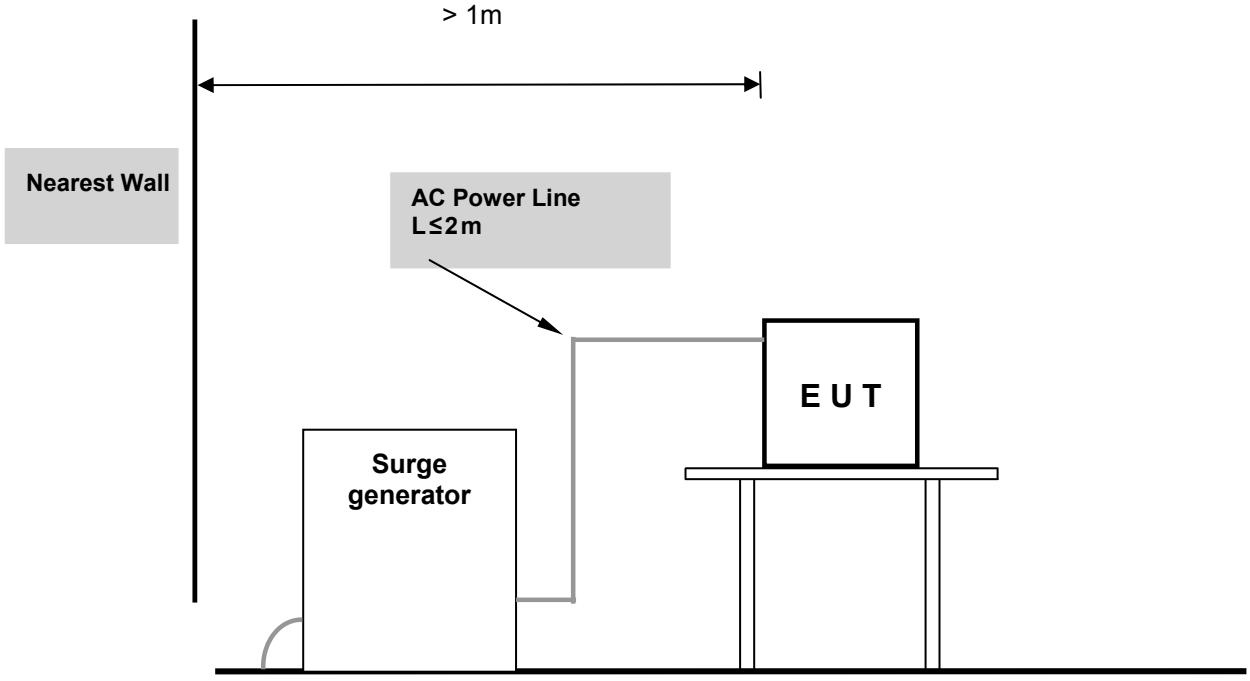
4.5.3 Test procedure

1. For EUT power supply:

   The surge is to be applied to the EUT power supply terminals via the capacitive coupling network. Decoupling networks are required in order to avoid possible adverse effects on equipment not under test that may be powered by the same lines, and to provide sufficient decoupling impedance to the surge wave. The power cord between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

   The test shall be started with low voltage 0,5 kV and continued with level, which is higher for 0,5 kV.

4.5.4 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

4.5.5 EUT operating conditions

Normal operating.

4.5.6 Test results

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal		
Input voltage:	230V, 50Hz	**Date:**	19.06.2012
Environmental conditions:	25±10°C, 10-75% RH	**Tested by: Andrej Škof**	

Test Point	Polarity	Angle (^{0})	Test Level (kV)	Observation	Performance Criterion
L–N	+/-	0, 90, 180, 270	1	Operating	B
AUX	+/-	/	1	Operating	B
I/O	+/-	/	1	Operating	B

NOTE: PASS

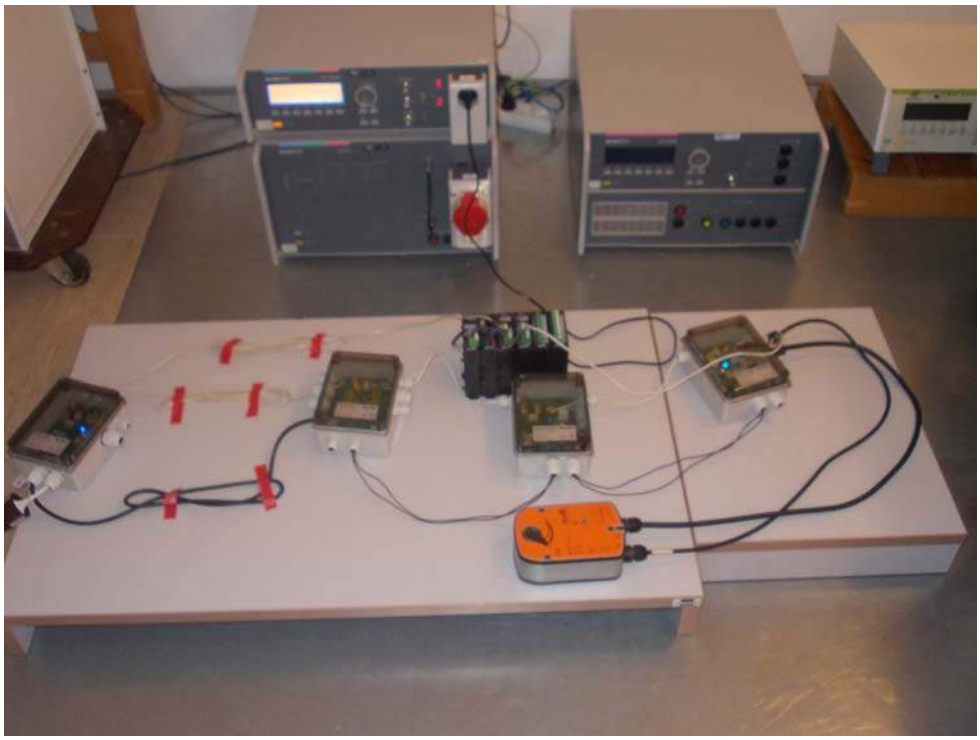


Figure 15: Surge immunity test – AC lines

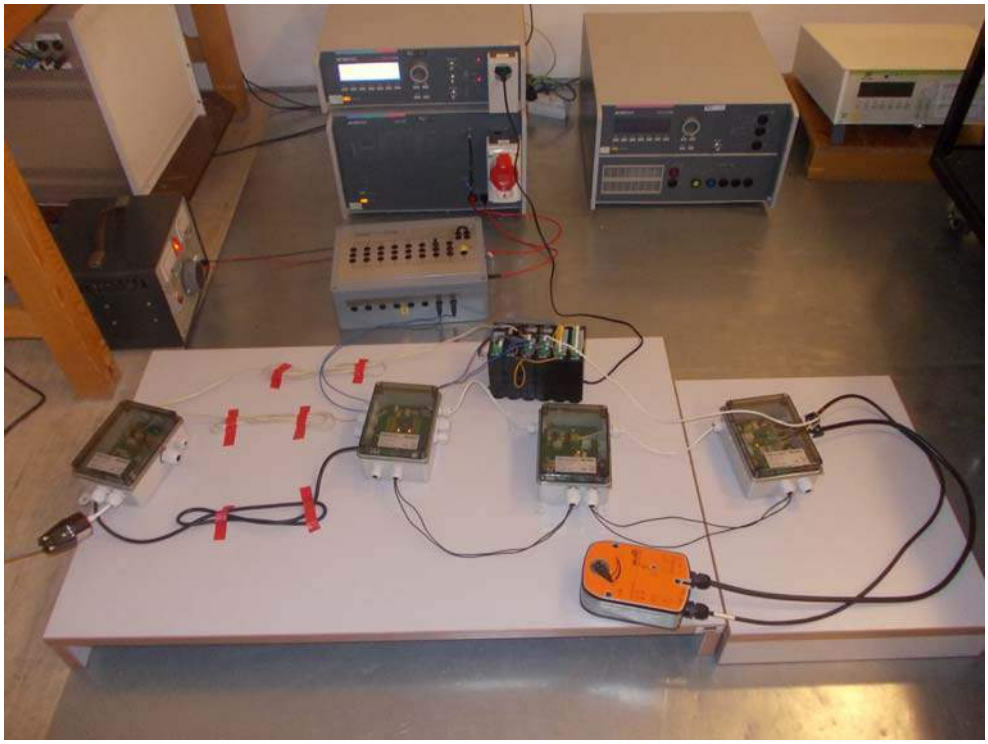


Figure 16: Surge immunity test – I/O lines

Figure 17: Surge immunity test – AUX port

4.6 Immunity to conducted disturbances induced by RF fields (CS)

4.6.1 Test specification

Basic Standard:	IEC 61000-4-6
Frequency Range:	0.15 MHz – 80 MHz
Field Strength:	AC power, AUX power: 10 V Data communication, I/O lines: 3 V
Modulation:	1 kHz Sine Wave, 80 %, AM Modulation
Frequency Step:	1 % of fundamental
Coupled Cable:	Power Mains, Unshielded Signal lines

4.6.2 Test instruments

Description& Manufacturer	Model No.	SIQ No.	Used	Calibrated until
Robert Luthi, EM clamp	EM 101	06/059A	X	2013-06
EM TEST, Conductive CW immunity system	CWS 500	06/059	X	2013-05
EM TEST, Coupling/decoupling device	CDN-M2	06/059C	X	2013-05
EM TEST, Coupling/decoupling device	CDN-M3	06/59E		2013-05
EM TEST, Coupling/decoupling device	CDN-AF2	06/059F		2013-05
EM TEST, Coupling/decoupling device	CDN-AF4	06/059D		2013-05
NARDA, Attenuator	768-3	768/3	X	With instrument

4.6.3 Test procedure

1. The EUT shall be tested within its intended operating and climatic conditions.

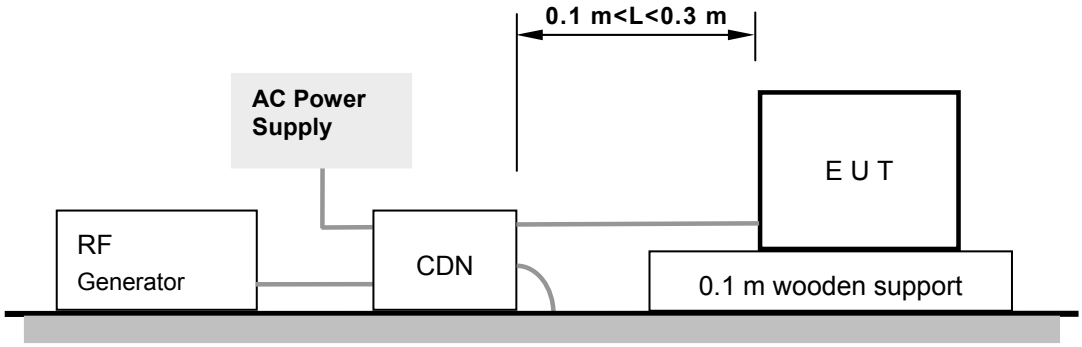
2. The test shall be performed with the test generator connected to each of the coupling and decoupling devices in turn, while the other non-excited RF input ports of the coupling devices are terminated by a 50 Ω load resistor.

3. The frequency range is swept from 150 kHz to 80 MHz, using the signal level established during the setting process and with a disturbance signal of 80 % amplitude. The signal is modulated with a 1 kHz sine wave, pausing to adjust the RF signal level or the switch coupling devices as necessary. The sweep rate shall not exceed 1.5×10^{-3} decades/s. The step size shall not exceed 1 % of the start and thereafter 1 % of the preceding frequency value where the frequency is swept incrementally.

4. The dwell time at each frequency shall not be less than the time necessary for the EUT to be exercised, and able to respond. Sensitive frequencies such as clock frequency(ies) and harmonics or frequencies of dominant interest, shall be analyzed separately.

5. Attempts should be made to fully exercise the EUT during testing, and to fully interrogate all exercise modes selected for susceptibility.

4.6.4 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

The equipment to be tested is placed on an insulating support on a ground reference plane. All relevant cables shall be provided with the appropriate coupling and decoupling devices at a distance between 0.1 meters and 0.3 meters from the projected geometry of the EUT on the ground reference plane.

4.6.5 EUT operating conditions

Normal operating,

4.6.6 Test results

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal		
Input voltage:	230V, 50Hz	**Date:**	19.06.2012
Environmental conditions:	22±5°C, 55±30% RH	**Tested by: Andrej Škof**	

Lines	Frequency	Level	Modulation	Observed function	Performance criterion
AC power, AUX power	150kHz - 80MHz	10 V	AM, 1kHz, 80%	Operating	A
Data communication, I/O lines	150kHz - 80MHz	3 V	AM, 1kHz, 80%	Operating	A

NOTE: PASS

Figure 18: Immunity to conducted disturbances induced by RF fields – AC lines

Figure 19: Immunity to conducted disturbances induced by RF fields – signal lines

4.7 Voltage dips and short interruptions immunity test (DIP)

4.7.1 Test specification

Basic Standard:	IEC 61000-4-11
Test Duration Time:	Minimum three test events in sequence
Interval between Event:	Minimum ten seconds
Phase Angle:	0 °, 180°
Test Cycle:	3 times

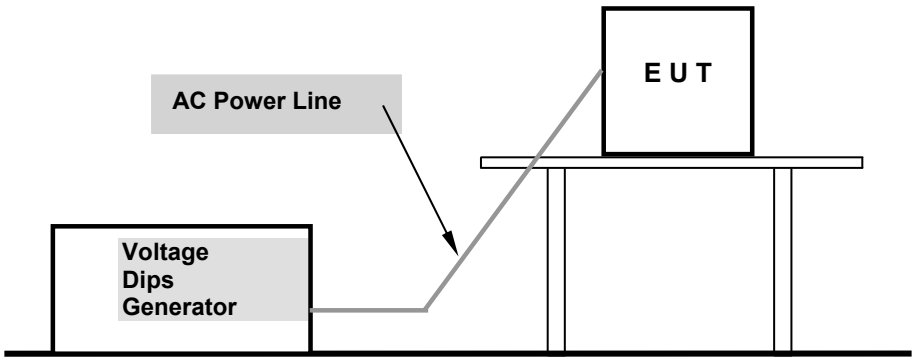
4.7.2 Test instruments

Description& Manufacturer	Model No.	SIQ No.	Used	Calibrated until
EM TEST, Universal immunity simulator	UCS 500 N5	105294	X	2013-04
EM TEST, AC source	EAC/MT 2716	06/059C	X	NA

4.7.3 Test procedure

The EUT shall be tested for each selected combination of test levels and duration with a sequence of tree dips/interruptions with intervals of 10s minimum (between each test event). Each representative mode of operation shall be tested. Abrupt changes in supply voltage shall occur at zero crossings of the voltage waveform.

4.7.4 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

4.7.5 Test result

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal		
Input voltage:	230V, 50Hz	**Date:**	19.06.2012
Environmental conditions:	22±5°C, 55±30% RH	**Tested by: Andrej Škof**	

Phenomena	Test level (dip)	Duration (in periods)	Performance criterion	Pass / Fail
Voltage dips	>95%	0,5	A	Pass
Voltage dips	60%	10	C	Pass
Voltage dips	30%	25	C	Pass
Voltage dips	>95%	250	C	Pass

NOTE: PASS

Figure 20: Immunity to voltage dips and short interruptions

4.8 Magnetic field immunity test

4.8.1 Test specification

Basic Standard:	IEC 61000-4-8
Frequency Range:	50 Hz
Field Strength:	30 A/m;

4.8.2 Test instruments

Description& Manufacturer	Model No.	SIQ No.	Used
Transformer	MA 4802	100928	X
Loop antenna	300	/	X

4.8.3 Test procedure

The test procedure was in accordance with IEC 61000-4-8

The testing was performed in an anechoic chamber. The EUT was placed in loop antenna

The frequency was set to 50 Hz

The field strength level was 30 A/m.

The test was performed with the EUT exposed to both vertically and horizontally polarized fields

4.8.4 Test setup

The EUT installed in a representative system as described in section 7 EN 61000-4-8 was placed on non-conductive table 0.8 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

EUT	RING BUS SYSTEM	**Model / Type:**	RBCPU+RBFU
Mode:	Normal		
Input voltage:	230V, 50Hz	**Date:**	19.06.2012
Environmental conditions:	22±5°C, 55±30% RH	**Tested by: Andrej Škof**	

Frequency (Hz)	Result	Polarity	Field Strength (A/m)	Observation	Performance Criterion
50	PASS	X, Y, Z	30	Operating	A

NOTE: PASS

Figure 21: Magnetic field immunity