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ELECTROMAGNETIC COMPATIBILITY (EMC / EMI)

TEST REPORT REF. EMCKP4948A
ISSUE DATE 2021-10-18
PROJECT NO. EMCK4948

REF. DOCUMENTS RTCA DO-160G: December 8, 2010
ENVIRONMENTAL CONDITIONS AND TEST
PROCEDURES FOR AIRBORNE EQUIPMENT
SECTION 21, Cat. H

EQUIPMENT UNDER TEST (EUT) Data loggers:
MSR63, MSR64, MSR83, MSR84
MSR145, MSR165, MSR165B52
MSR175, MSR175B54, MSR175plus

TEST RESULT Complied, see page 7

CLIENT MSR Electronics GmbH
Mettlenstrasse 6
8472 Seuzach
SWITZERLAND

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1. TEST REPORT APPROVAL

Test performed by: Armin FREI, EMC Engineer 2021-10-07
Name/Function Signature Date

Test report reviewed by: Christoph HAUSER, Head of EMC Lab 2021-10-18
Name/Function Signature Date

Test report approved by: Christoph HAUSER, Head of EMC Lab 2021-10-18
Name / Function Signature Date

REVISION INDEX

Table with 4 columns: Document Number, Issue date, Replaces, No. of revised pages / * deleted pages. Row 1: EMCKP4948A, 2021-10-18, ---, ---.



2. REFERENCED REQUIREMENTS

The tests allowed to prove whether the data loggers do transmit electromagnetic radiation, which exceed the limit of the above mentioned standards and could disturb co-located equipment.

3. CONFIGURATION OF TESTED EQUIPMENT

All tests were carried out with all EUTs installed together in SAC3 on a table with ground plane.

Equipment Under Test (EUT):

EUTs: Data loggers

AUXILIARY EQUIPMENT: None

PART NUMBERS (P/N):	MSR63	SERIAL NUMBER (S/N):	4632000114
	MSR64	SERIAL NUMBER (S/N):	4642000001
	MSR83	SERIAL NUMBER (S/N):	7832000195
	MSR84	SERIAL NUMBER (S/N):	7842000017
	MSR145	SERIAL NUMBER (S/N):	SN328840
	MSR165	SERIAL NUMBER (S/N):	SN456944
	MSR165B52	SERIAL NUMBER (S/N):	SN456166
	MSR175	SERIAL NUMBER (S/N):	SN603435
	MSR175B54	SERIAL NUMBER (S/N):	SN603720
	MSR175plus	SERIAL NUMBER (S/N):	SN650081

MANUFACTURER: MSR Electronics GmbH, SWITZERLAND

OPERATION MODE: Normal operation, data logging with fastest rates

POWER SUPPLY: MSR63, MSR64, MSR83, MSR84: 3.0V Lithium battery CR2032
MSR145, MSR165, MSR175, MSR175plus: Lithium polymer battery
MSR165B52, MSR175B54: Li-SOCI2 batteries

3.1 MODIFICATION INCORPORATED IN EUTs

None

3.2 TEST CONDITIONS

Test conditions have been in accordance with "Referenced documents".

Temperature:	+22.5 °C	Requirement: +23 °C ± 5 °C
Relative Humidity:	51.1 %	Requirement: < 85 %
Atmospheric pressure:	976 hPa	Requirement: 840 hPa (840 mbar) to 1070 hPa (1070 mbar)

3.3 FUNCTIONAL TESTS

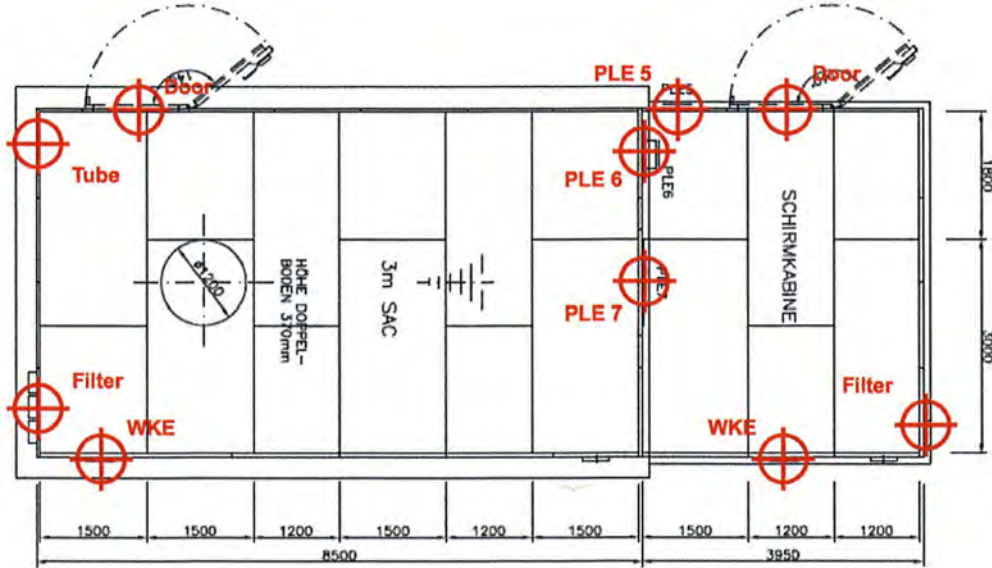
Functional tests checked by reading logged data.



4. CONFIGURATION OF TEST FACILITY

TEST SITE

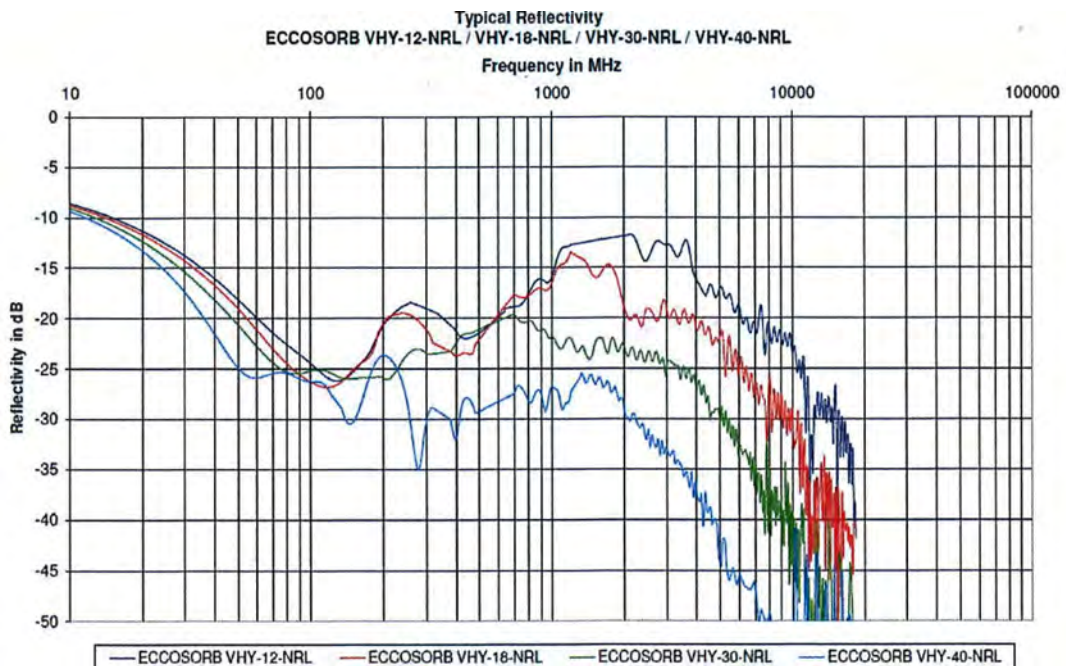
SEMI ANECHOIC CHAMBER SAC3 / CONTROL ROOM SAC3



SEMI ANECHOIC CHAMBER SAC3:

Dimension (inside): 7.4 m x 3.7 m x 4.7 m (L x W x H)

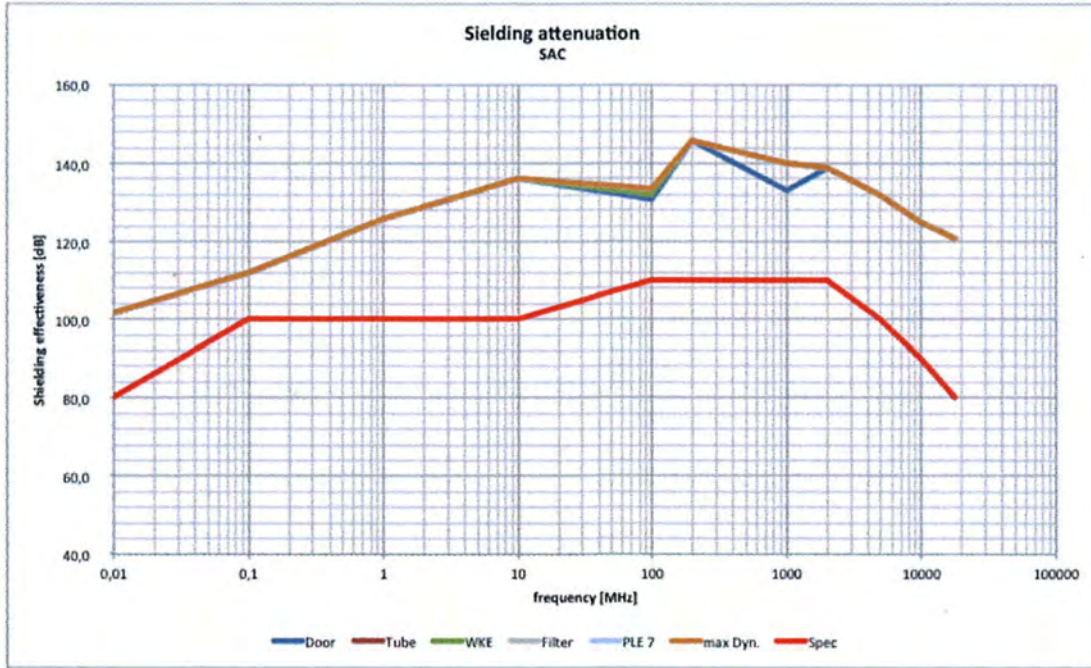
Fitted with absorbers: EMERSON & CUMMING, ECCOSORB Type VHY-12 and VHY-18





SEMI ANECHOIC CHAMBER SAC3:

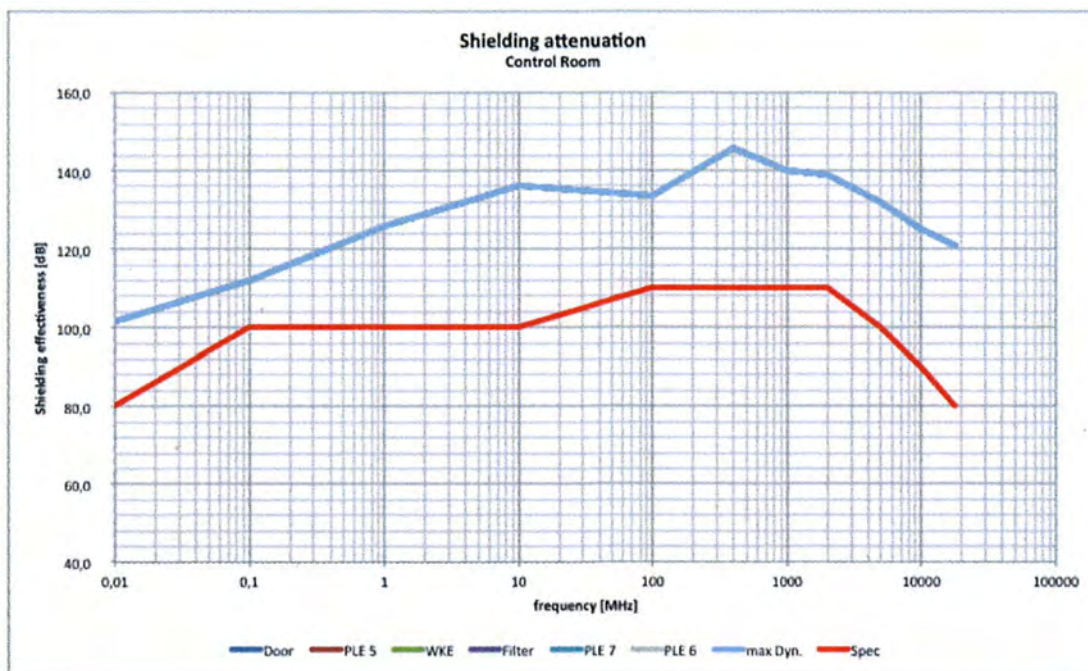
Shielding Effectiveness according to EN 50147-1:



CONTROL ROOM SAC3:

Dimension (inside): 4.90 m x 3.95 m x 3.00 m (L x W x H)

Shielding Effectiveness according to EN 50147-1:





5. SUMMARY OF TEST RESULTS / TEST LIST / WITNESSING

RTCA DO-160G

TEST NO.	TEST	CATEGORY	TEST DATE	PASSED	FAILED	COMMENTS
6.1	RADIATED RF EMISSIONS RTCA DO-160G, SECTION 21, 100 MHz - 6 GHz	CAT. H Figure 21-9	2021-10-07	PASSED	---	---

Witnessing: Mr. Wendelin K. EGLI



6. TEST RESULTS

6.1 RADIATED RF EMISSIONS according to RTCA DO-160G, Section 21, Category H

Para a) b) c)

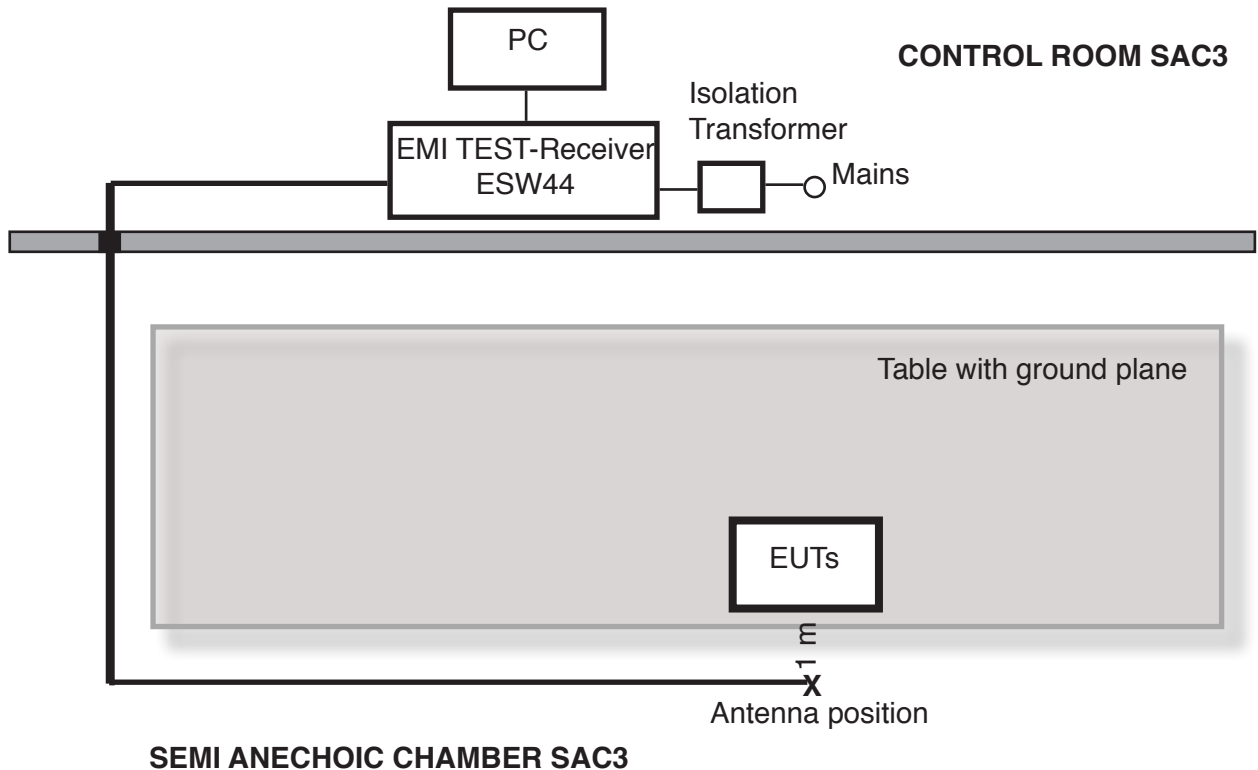
Inv. ID	Description	Manufacturer	Type	Calibration date	Calibration due date
1193	Biological Antenna, 25 MHz - 1 GHz	A.H. Systems Inc.	SAS-521-7	2020-12-04	2021-12-03
0311	Double Ridged Guide Antenna, 700 MHz - 18 GHz	ETS-Lindgren	3115	2021-05-28	2022-05-27
1396	Preamplifier, 20 MHz - 18 GHz	A.H. Systems Inc.	PAM-0118P	2021-03-29	2022-03-28
1367	RF Cable	Huber&Suhner	SF118 / 3 m	2020-10-26	2021-10-25
1563	RF Cable	Huber&Suhner	SF118A / 7 m	2021-09-17	2022-09-16
0529	Emission Software (SAC3-E)	ROHDE&SCHWARZ	EMC32 v10.20	Cal not reqd.	Cal not reqd.
1310	EMI Test Receiver	ROHDE&SCHWARZ	ESW44	2021-08-19	2022-08-18

Calibration procedures:

The calibration routine is performed according to the requirements of ISO/IEC 17025, ANSI C63.5 and is traceable to internationally supported realisations of the SI units.

d) **Test setup:**

In accordance with standard RTCA DO-160G, Section 21, Fig. 21-11





d) Test setup:

Test setup





d) Test setup:

100 MHz - 6 GHz, vertical polarization



100 MHz - 6 GHz, horizontal polarization





f) **Impedance of Line Impedance Stabilization Network (LISN)**
N/A

g) **Measured levels of emission**
See appendix 1

h) **Recording and graphs**
See appendix 1

i) **Used suppression devices**
None

j) **Susceptibility compliance**
Not applicable

k) **Sample calculation**
The Diagrams of paragraph h) show the measured EMI - values of the EMI-Receiver corrected with:
Narrowband: $\text{dB}\mu\text{V}_{\text{Receiver}} + \text{dB}_{\text{Antenna factor}} + \text{dB}_{\text{Cable attenuation}} = \text{dB}\mu\text{V} / \text{m}$
Broadband: $\text{dB}\mu\text{V}_{\text{Receiver}} + \text{dB}_{\text{Antenna factor}} + \text{dB}_{\text{Cable attenuation}} + \text{dB}_{\text{Broadband correction}} = \text{dB}\mu\text{V} / \text{m} / \text{MHz}$

l) **Success criteria**
The measured Radiated RF Emissions shall not exceed the limit according to RTCA DO-160G, Section 21, Figure 21-9, Cat. H (100 MHz - 6 GHz).

m) **Test result**
EUTs do meet the following limit:
Radiated RF Emissions: RTCA DO-160G, Section 21, Figure 21-9, Cat. H (100 MHz - 6 GHz)



e) Antenna factors

BiLogical Antenna, A.H. Systems Inc., SAS-521-7, Inv. ID 1193

Certificate of calibration No. 218-02318

Measurement results

Antenna factor

Frequency (GHz)	Antenna Factor (dB(1/m))	Frequency (GHz)	Antenna Factor (dB(1/m))	Frequency (GHz)	Antenna Factor (dB(1/m))	Frequency (GHz)	Antenna Factor (dB(1/m))
0.025	19.28	0.165	16.19	1.500	27.31	4.300	39.40
0.030	17.12	0.170	14.99	1.600	27.99	4.400	37.98
0.035	14.92	0.175	13.85	1.700	28.96	4.500	37.84
0.040	12.50	0.180	12.89	1.800	29.43	4.600	38.47
0.045	10.00	0.185	12.18	1.900	29.70	4.700	37.93
0.050	7.62	0.190	11.54	2.000	30.30	4.800	38.52
0.055	5.95	0.195	10.91	2.100	31.06	4.900	39.46
0.060	5.34	0.200	10.39	2.200	31.06	5.000	39.22
0.065	5.63	0.250	12.59	2.300	31.27	5.100	39.58
0.070	6.26	0.300	12.90	2.400	31.80	5.200	40.14
0.075	7.15	0.350	13.20	2.500	32.07	5.300	39.82
0.080	8.25	0.400	15.59	2.600	32.99	5.400	40.98
0.085	9.48	0.450	16.39	2.700	33.06	5.500	41.19
0.090	10.60	0.500	17.24	2.800	33.31	5.600	41.67
0.095	11.55	0.550	17.78	2.900	34.20	5.700	41.22
0.100	12.34	0.600	18.55	3.000	34.74	5.800	41.57
0.105	13.13	0.650	19.98	3.100	34.83	5.900	43.07
0.110	13.86	0.700	20.00	3.200	34.85	6.000	42.66
0.115	14.57	0.750	21.10	3.300	35.27	6.100	43.56
0.120	15.26	0.800	21.36	3.400	35.97	6.200	44.89
0.125	15.90	0.850	22.09	3.500	36.30	6.300	45.24
0.130	16.62	0.900	22.51	3.600	36.71	6.400	44.67
0.135	17.26	0.950	23.26	3.700	37.16	6.500	46.21
0.140	17.71	1.000	23.50	3.800	36.73	6.600	46.45
0.145	17.98	1.100	24.69	3.900	36.80	6.700	48.37
0.150	18.00	1.200	25.28	4.000	37.13	6.800	51.28
0.155	17.74	1.300	26.03	4.100	37.60	6.900	52.09
0.160	17.18	1.400	26.91	4.200	38.74	7.000	53.28



e) Antenna factors

Doubled Ridged Guide Antenna, ETS-Lindgren, 3115, Inv. ID 311

Certificate of calibration No. 218-02717

Measurement results

Antenna factor (free field)

Frequency (GHz)	Antenna Factor (dB(1/m))	Frequency (GHz)	Antenna Factor (dB(1/m))	Frequency (GHz)	Antenna Factor (dB(1/m))	Frequency (GHz)	Antenna Factor (dB(1/m))
0.750	24.74	3.900	31.25	7.300	36.93	11.400	38.60
0.800	23.72	4.000	31.22	7.400	36.97	11.600	38.53
0.850	23.21	4.100	31.74	7.500	36.82	11.800	38.48
0.900	23.15	4.200	31.74	7.600	36.85	12.000	38.34
0.950	23.28	4.300	31.63	7.700	36.78	12.200	38.24
1.000	23.33	4.400	31.57	7.800	36.91	12.400	38.33
1.100	23.85	4.500	31.69	7.900	36.72	12.600	38.35
1.200	24.49	4.600	31.90	8.000	36.80	12.800	39.04
1.300	24.82	4.700	32.18	8.100	36.80	13.000	39.43
1.400	25.22	4.800	32.39	8.200	36.86	13.200	39.51
1.500	25.22	4.900	32.50	8.300	36.85	13.400	40.16
1.600	25.12	5.000	32.63	8.400	37.20	13.600	40.52
1.700	25.23	5.100	32.57	8.500	37.04	13.800	40.73
1.800	25.41	5.200	32.58	8.600	36.95	14.000	41.65
1.900	26.22	5.300	32.86	8.700	38.25	14.200	41.94
2.000	28.37	5.400	33.19	8.800	37.80	14.400	41.21
2.100	28.80	5.500	33.53	8.900	37.13	14.600	40.81
2.200	27.84	5.600	33.61	9.000	37.39	14.800	39.94
2.300	27.32	5.700	33.76	9.100	37.54	15.000	39.08
2.400	27.42	5.800	34.03	9.200	37.64	15.200	38.55
2.500	27.65	5.900	34.65	9.300	38.08	15.400	38.14
2.600	28.30	6.000	35.11	9.400	37.86	15.600	37.88
2.700	28.69	6.100	35.02	9.500	37.82	15.800	37.83
2.800	28.70	6.200	35.06	9.600	37.68	16.000	38.10
2.900	28.68	6.300	34.98	9.700	37.64	16.200	38.58
3.000	28.95	6.400	35.00	9.800	37.90	16.400	39.63
3.100	29.34	6.500	35.11	9.900	37.78	16.600	40.21
3.200	29.55	6.600	35.81	10.000	38.06	16.800	41.88
3.300	29.80	6.700	36.24	10.200	38.32	17.000	43.01
3.400	30.02	6.800	35.98	10.400	38.12	17.200	43.47
3.500	30.28	6.900	35.79	10.600	38.29	17.400	43.73
3.600	30.25	7.000	35.80	10.800	38.65	17.600	42.93
3.700	30.59	7.100	36.35	11.000	38.28	17.800	42.29
3.800	30.88	7.200	36.94	11.200	38.37	18.000	42.68

Remark: The complete dataset is available in electronic format.



7. Appendices

Appendix 1

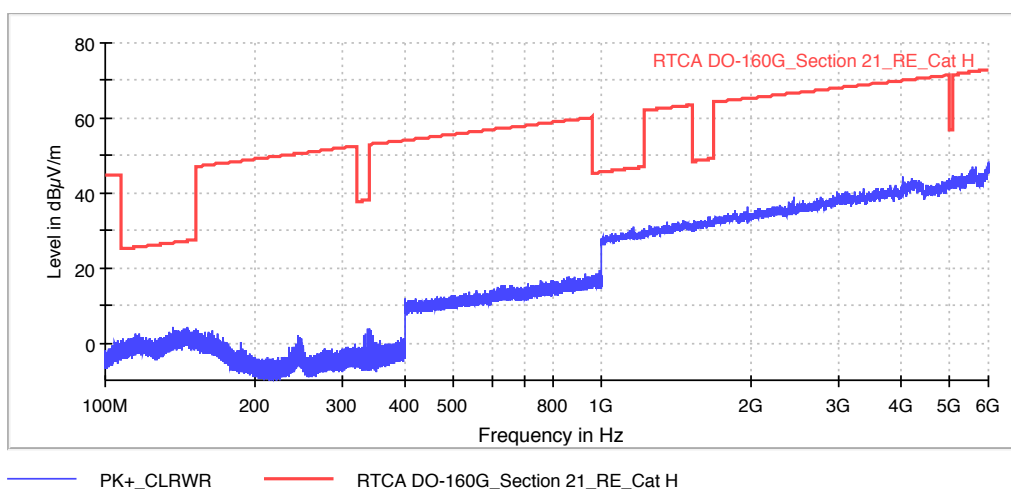
Radiated RF Emissions

- 4 Diagrams



Common Information

Customer: MSR Electronics GmbH
 E.U.T.: Various Data Loggers
 Operating Conditions: Ambient
 Standard: RTCA DO-160G, Section 21, Radiated RF Interference, Cat. H
 Antenna location: Distance 1 m
 Antenna polarization: Horizontal
 Test facility: SAC3
 Engineer: Armin FREI
 Project ID: EMCK4948



Scan Setup: RE_RTCA DO-160G_Sec21_CatM_100M-6GHz_PK-TXbelow1GHz-ReceiverInChamberAbove1GHz [EMI radiated]

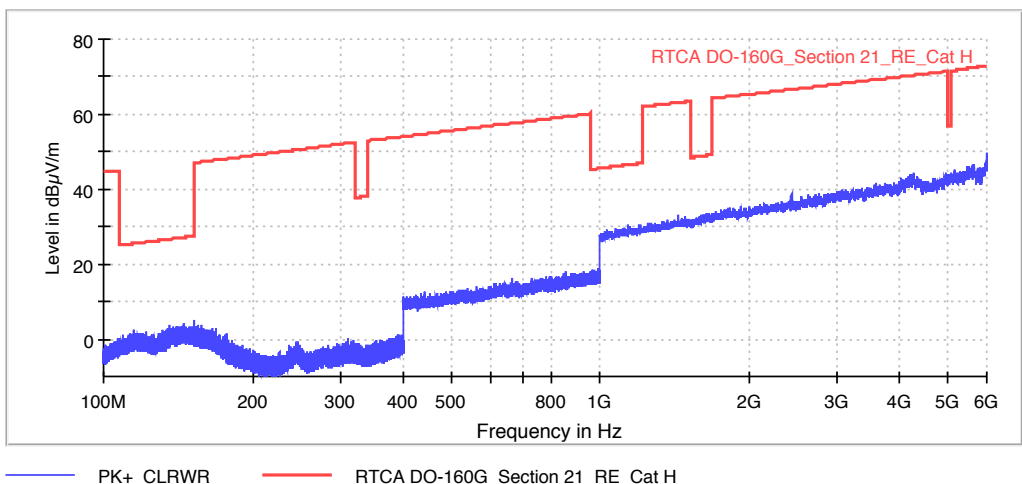
Hardware Setup: RE_RTCA DO-160G_Sec21_CatM_100M-6GHz-ReceiverInChamber
 Receiver: [ESW 44]
 Level Unit: dBµV/m

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
100 MHz - 400 MHz	2.5 kHz	PK+	10 kHz	0.015 s	20 dB
400 MHz - 960 MHz	25 kHz	PK+	100 kHz	0.015 s	20 dB
960 MHz - 1 GHz	25 kHz	PK+	100 kHz	0.015 s	20 dB
1 GHz - 1.5 GHz	250 kHz	PK+	1 MHz	0.015 s	20 dB
1.5 GHz - 6 GHz	250 kHz	PK+	1 MHz	0.015 s	20 dB



Common Information

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 E.U.T.: Various Data Loggers
 Operating Conditions: Ambient
 Standard: RTCA DO-160G, Section 21, Radiated RF Interference, Cat. H
 Antenna location: Distance 1 m
 Antenna polarization: Vertical
 Test facility: SAC3
 Engineer: Armin FREI
 Project ID: EMCK4948



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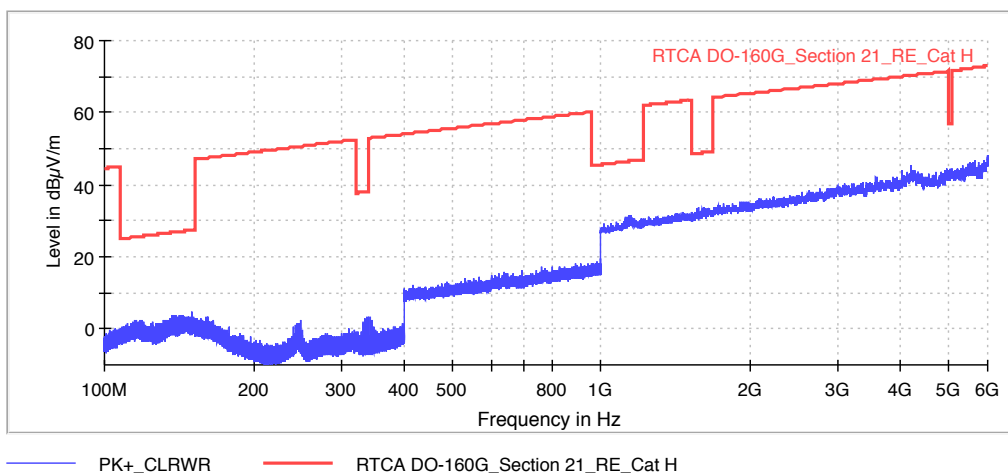
Hardware Setup: RE_RTCA DO-160G_Sec21_CatM_100M-6GHz-ReceiverInChamber
 Receiver: [ESW 44]
 Level Unit: dBµV/m

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
100 MHz - 400 MHz	2.5 kHz	PK+	10 kHz	0.015 s	20 dB
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1 GHz - 1.5 GHz	250 kHz	PK+	1 MHz	0.015 s	20 dB
1.5 GHz - 6 GHz	250 kHz	PK+	1 MHz	0.015 s	20 dB



Common Information

Customer: MSR Electronics GmbH
 E.U.T.: MSR63, MSR64, MSR83, MSR84, MSR145, MSR165
 E.U.T.: MSR165B52, MSR175, MSR175B54, MSR175Plus
 Operating Conditions: Normal operation, measuring
 Standard: RTCA DO-160G, Section 21, Radiated RF Interference, Cat. H
 Antenna location: Distance 1 m
 Antenna polarization: Horizontal
 Test facility: SAC3
 Engineer: Armin FREI
 Project ID: EMCK4948



Scan Setup: RE_RTCA DO-160G_Sec21_CatM_100M-6GHz_PK-TXbelow1GHz-ReceiverInChamberAbove1GHz [EMI radiated]

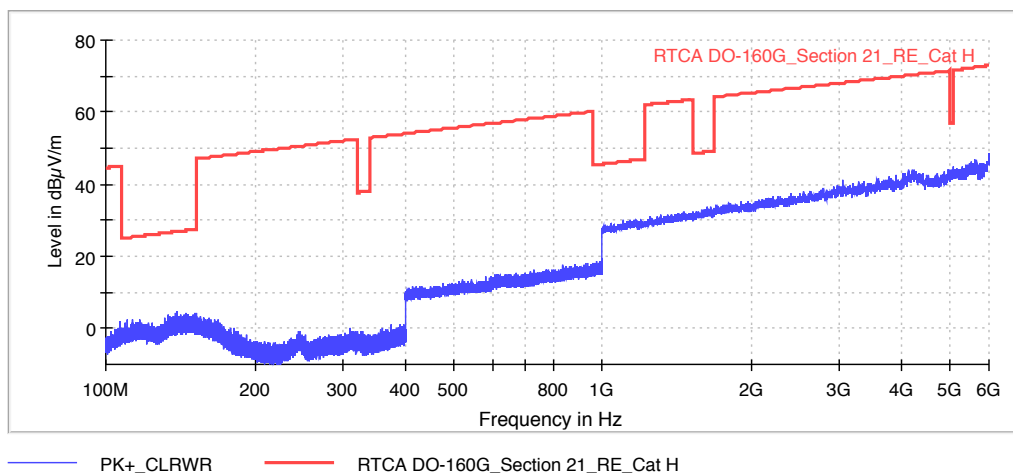
Hardware Setup: RE_RTCA DO-160G_Sec21_CatM_100M-6GHz-ReceiverInChamber
 Receiver: [ESW 44]
 Level Unit: dBµV/m

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
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1 GHz - 1.5 GHz	250 kHz	PK+	1 MHz	0.015 s	20 dB
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 Antenna polarization: Vertical
 Test facility: SAC3
 Engineer: Armin FREI
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 Receiver: [ESW 44]
 Level Unit: dBµV/m

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
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400 MHz - 960 MHz	25 kHz	PK+	100 kHz	0.015 s	20 dB
960 MHz - 1 GHz	25 kHz	PK+	100 kHz	0.015 s	20 dB
1 GHz - 1.5 GHz	250 kHz	PK+	1 MHz	0.015 s	20 dB
1.5 GHz - 6 GHz	250 kHz	PK+	1 MHz	0.015 s	20 dB