

LABORATORY OF INTEGRATION AND TEST – LIT

Test Report

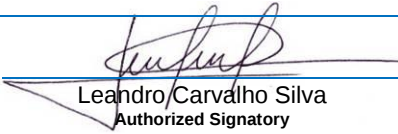
EMI / EMC and Telecommunications Laboratory

Report Number: RTLS01-R01 (Version 01)

Equipment: Anticorrosive Electronic Module

Model: RAC-00-V1

Customer: RUSTLESS Tecnologia, Comércio, Serviços,
Importação e Exportação Ltda.


Leandro Carvalho Silva
Authorized Signatory

12/21/22
Date


Marco Antonio Strobino
Area Manager

12/21/22
Date

The results presented refer exclusively to the object tested, as received and under the specified conditions.

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For legal purposes, only the version sent by the laboratory via data transfer from the eLIT system is valid.

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1. GENERAL INFORMATION

CUSTOMER: RUSTLESS Tecnologia, Comércio, Serviços, Importação e Exportação Ltda.
ADDRESS: Rua Desembargador Martins Pereira, 221 - Graças, Recife, PE, Brasil, 52050-205
E-MAIL: andre@rustless.com
CONTRACT NUMBER: INPE.LIT.PX 111/22
PROCESS: 3819.22.PRO

EQUIPMENT: Anticorrosive Electronic Module
MODEL: RAC-00-V1
S/N: ALF22080 048
CLASS: -

PERIOD OF TEST: November 28th and December 15th and 19th of 2022.

LABORATORY NAME: National Institute for Space Research - INPE
Laboratory of Integration and Test - LIT
ADDRESS: Av. dos Astronautas, 1758 - Jd. da Granja
São José dos Campos – SP
12227-010
TESTS PERFORMED BY: Rodolfo Gonçalves, Felipe de Oliveira and Alexandre Andrade
AUTHORIZED SIGNATORY: Leandro Carvalho Silva
RESPONSIBLE ENGINEER: Marco Antônio Strobino
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APPLICABLE DOCUMENTS:

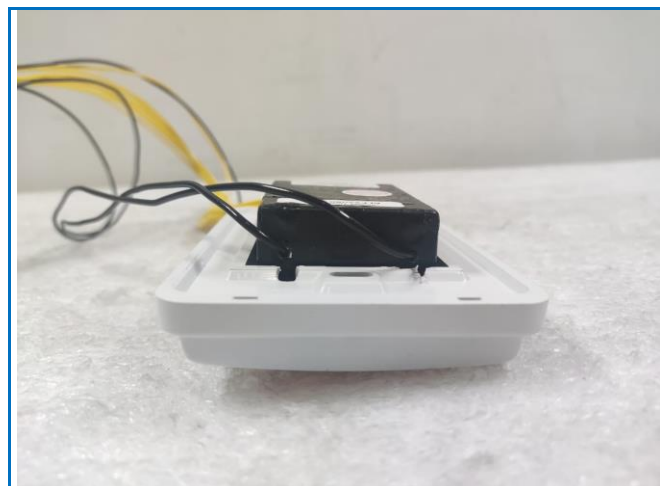
- IEC 61000-6-4 Ed.2.0:2006+A1: 2020;
- IEC 61000-6-2 Ed.2.0: 2005;
- IEC 61000-4-2 (2008);
- IEC 61000-4-3 (2020);
- IEC 61000-4-4 (2012);
- IEC 61000-4-5 (2014) + A1:2017;
- IEC 61000-4-6 (2013);
- IEC 61000-4-8 (2009);
- IEC 61000-4-11 (2020).

TEST PLAN: -

2. PICTURES OF THE DEVICE UNDER TEST



Pictures 1 and 2 – Equipment Under Test



Pictures 3 and 4 – Equipment Under Test



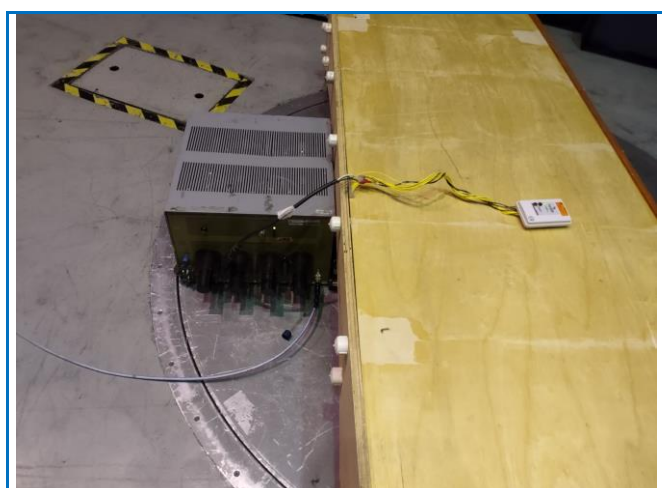
Pictures 5 and 6 – Equipment Under Test



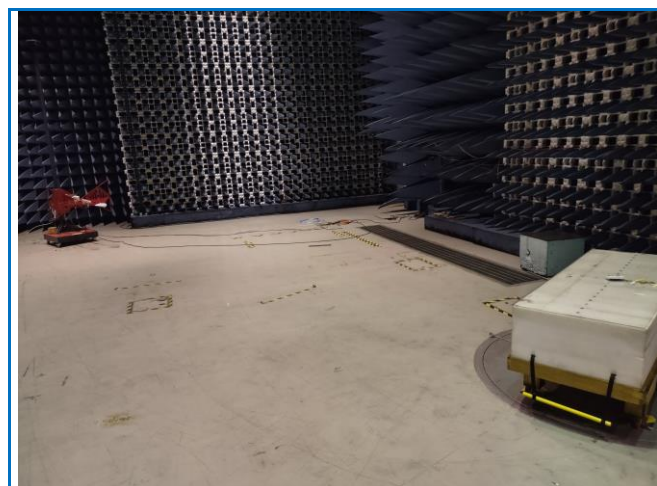
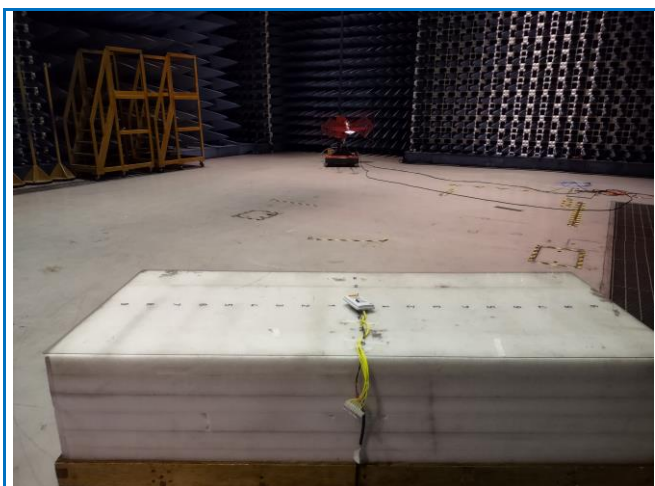
Pictures 7 and 8 – Equipment Under Test



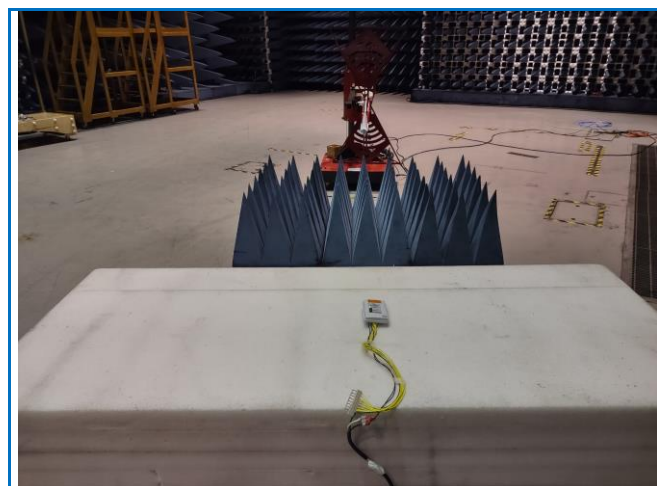
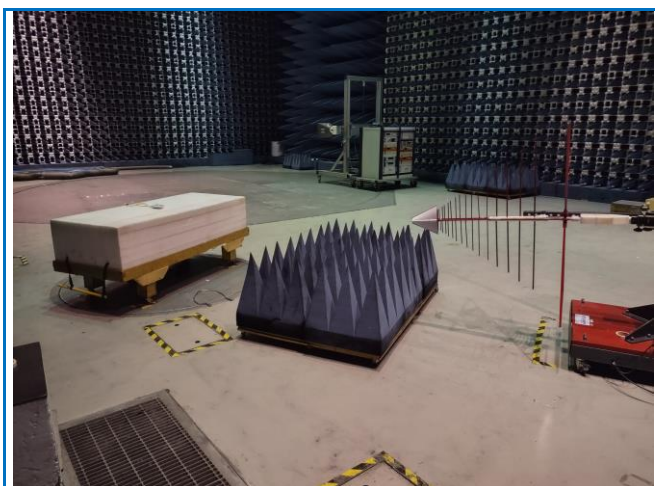
Pictures 9 and 10 – Equipment Under Test



Pictures 11 and 12 – Test Setup (Conducted Emission)



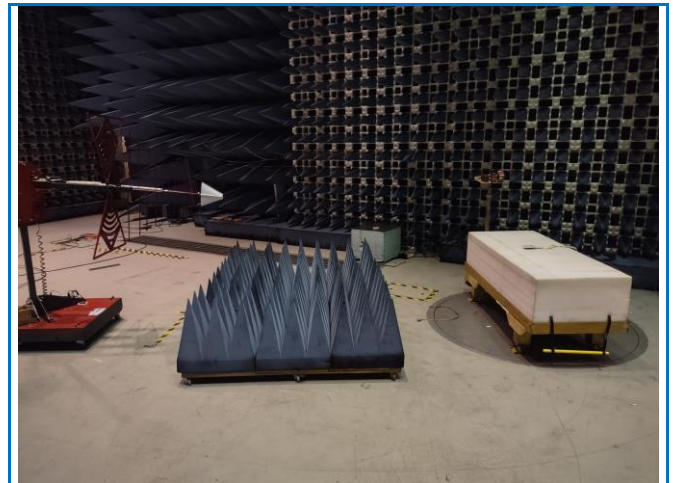
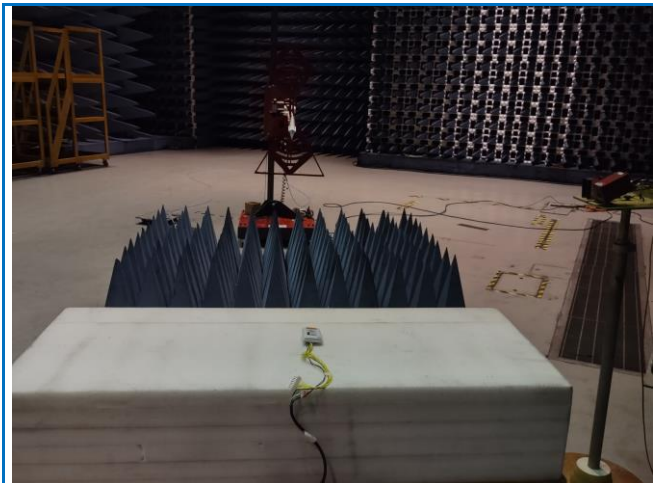
Pictures 13 and 14 – Test Setup (Radiated Emission)



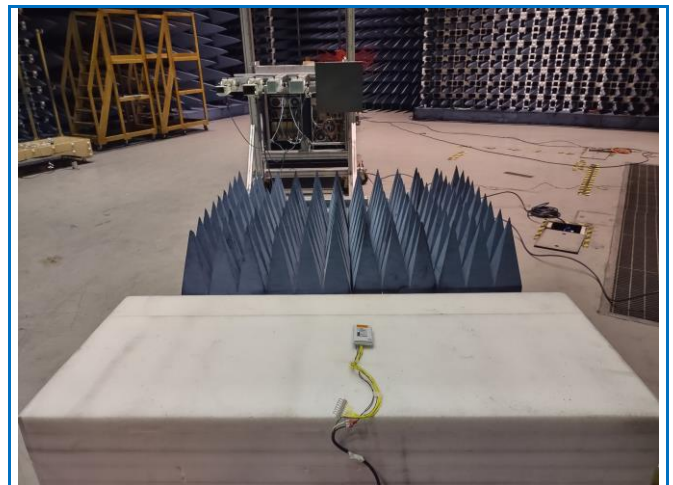
Pictures 15 and 16 – Test Setup (Radiated Emission)



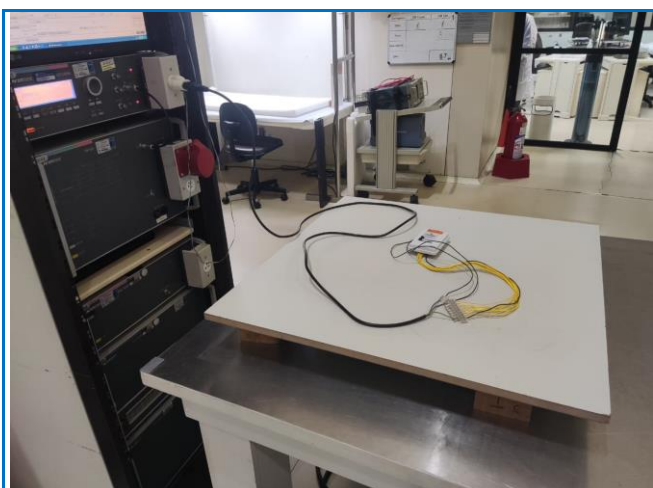
Pictures 17 and 18 – Test Setup (ESD – Electrostatic Discharge)



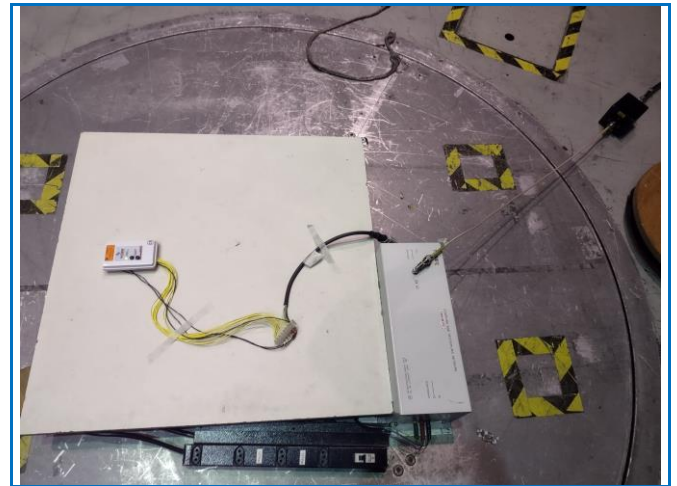
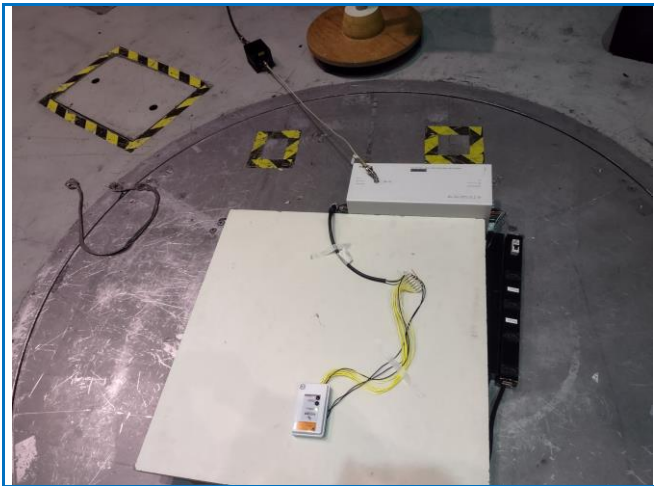
Pictures 19 and 20 – Test Setup (Radiated Electromagnetic)



Pictures 21 and 22 – Test Setup (Radiated Electromagnetic)



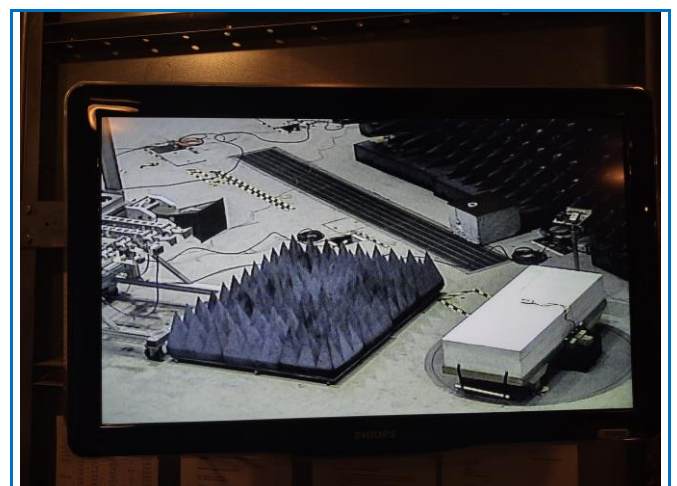
Pictures 23 and 24 – Test Setup (Burst, Surge and DIP)



Pictures 25 and 26 – Test Setup (Immunity to Conducted)



Pictures 27 and 28 – Test Setup (Magnetic field)



Pictures 29 and 30 – Monitoring

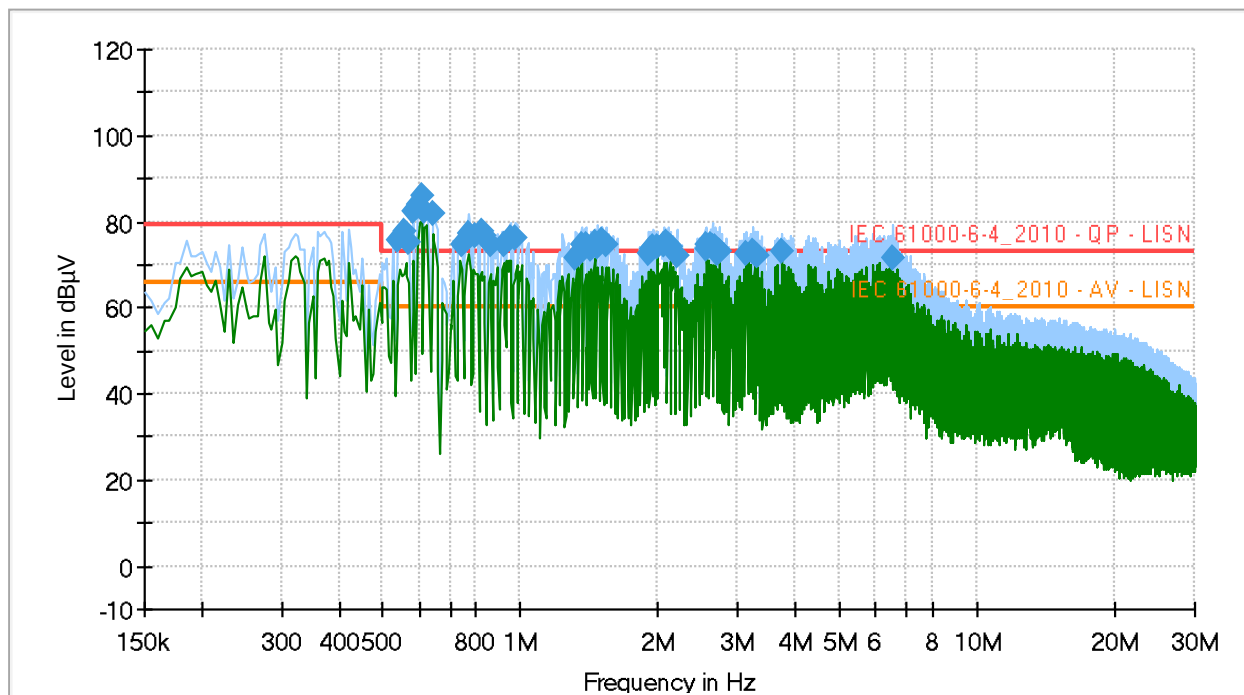
3. PERFORMED TESTS

3.1. CONDUCTED EMISSION TEST

Standard	Voltage	Notes
IEC 61000-6-4	127 Vac / 60 Hz 220 Vac / 60 Hz	Preview Measurement Detector 1 Peak detector
		Preview Measurement Detector 2 Average detector
		Final Measurement Detector 1 Quasi-Peak detector (if necessary)

Class	Line	Voltage	Operator
-	Neutral and Phase	127 Vac / 60 Hz	Alexandre
Note: Normal Operating Mode.			

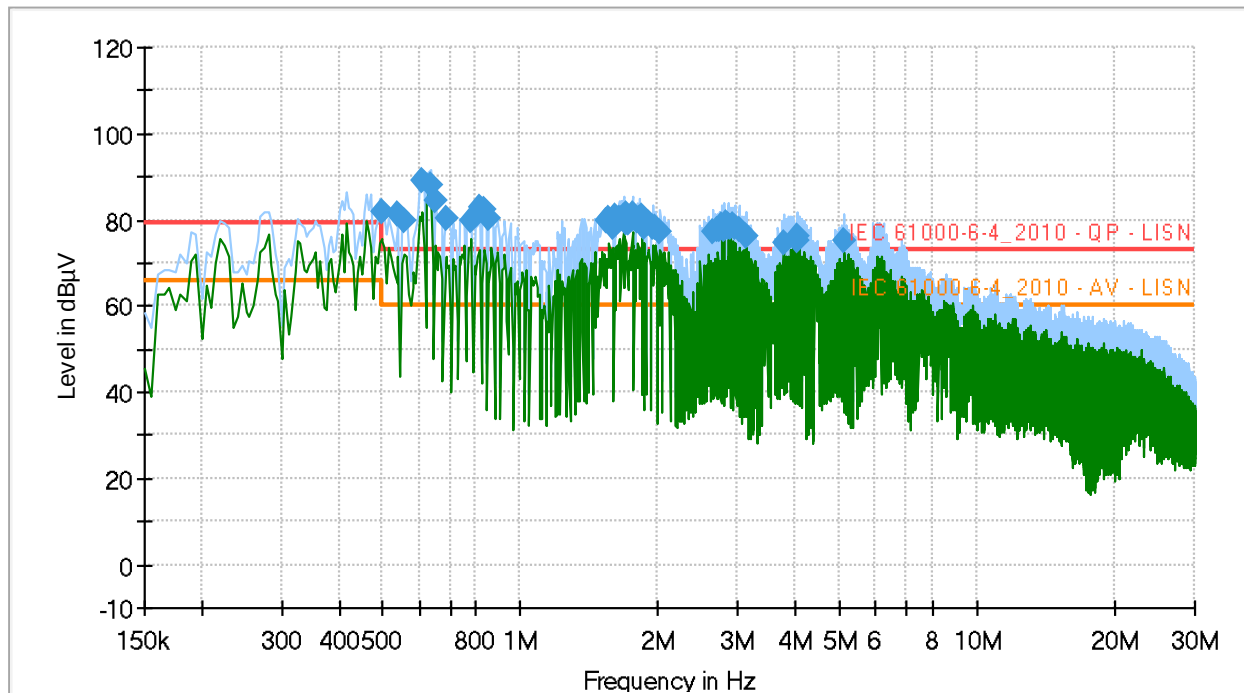
IEC61000-6-4_2010 CE- LISN



Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.540000	75.6	1000.0	9.000	GND	L1	10.3	-2.6	73.0
0.555000	77.8	1000.0	9.000	GND	L2	10.3	-4.8	73.0
0.570000	75.2	1000.0	9.000	GND	L1	10.2	-2.2	73.0
0.585000	82.2	1000.0	9.000	GND	L2	10.2	-9.2	73.0
0.595000	83.8	1000.0	9.000	GND	L1	10.2	-10.8	73.0
0.605000	85.7	1000.0	9.000	GND	L2	10.2	-12.7	73.0
0.615000	82.4	1000.0	9.000	GND	L1	10.2	-9.4	73.0
0.640000	82.1	1000.0	9.000	GND	L2	10.2	-9.1	73.0
0.745000	74.7	1000.0	9.000	GND	L1	10.2	-1.7	73.0
0.770000	77.0	1000.0	9.000	GND	L1	10.3	-4.0	73.0
0.800000	76.4	1000.0	9.000	GND	L2	10.3	-3.4	73.0
0.820000	77.7	1000.0	9.000	GND	L2	10.2	-4.7	73.0
0.830000	76.9	1000.0	9.000	GND	L1	10.2	-3.9	73.0
0.860000	74.5	1000.0	9.000	GND	L1	10.2	-1.5	73.0
0.920000	74.5	1000.0	9.000	GND	L1	10.3	-1.5	73.0
0.950000	76.3	1000.0	9.000	GND	L1	10.3	-3.3	73.0
0.975000	76.2	1000.0	9.000	GND	L2	10.2	-3.2	73.0
1.325000	71.5	1000.0	9.000	GND	L2	10.3	1.5	73.0
1.360000	74.8	1000.0	9.000	GND	L1	10.3	-1.8	73.0
1.390000	74.7	1000.0	9.000	GND	L1	10.3	-1.7	73.0
1.425000	73.6	1000.0	9.000	GND	L1	10.3	-0.6	73.0
1.455000	75.0	1000.0	9.000	GND	L1	10.3	-2.0	73.0
1.480000	74.2	1000.0	9.000	GND	L1	10.3	-1.2	73.0
1.510000	75.4	1000.0	9.000	GND	L1	10.3	-2.4	73.0
1.540000	74.7	1000.0	9.000	GND	L1	10.3	-1.7	73.0
1.905000	72.7	1000.0	9.000	GND	L1	10.3	0.3	73.0
1.935000	73.8	1000.0	9.000	GND	L1	10.3	-0.8	73.0
1.960000	74.0	1000.0	9.000	GND	L2	10.3	-1.0	73.0
1.990000	74.2	1000.0	9.000	GND	L2	10.3	-1.2	73.0
2.055000	74.5	1000.0	9.000	GND	L2	10.3	-1.5	73.0
2.065000	74.8	1000.0	9.000	GND	L2	10.3	-1.8	73.0
2.085000	74.9	1000.0	9.000	GND	L2	10.3	-1.9	73.0
2.100000	74.4	1000.0	9.000	GND	L1	10.3	-1.4	73.0
2.125000	74.2	1000.0	9.000	GND	L1	10.4	-1.2	73.0
2.195000	72.1	1000.0	9.000	GND	L1	10.4	0.9	73.0
2.540000	73.7	1000.0	9.000	GND	L2	10.5	-0.7	73.0
2.565000	74.5	1000.0	9.000	GND	L2	10.5	-1.5	73.0
2.605000	74.4	1000.0	9.000	GND	L1	10.5	-1.4	73.0
2.625000	74.3	1000.0	9.000	GND	L1	10.5	-1.3	73.0
2.650000	74.1	1000.0	9.000	GND	L1	10.5	-1.1	73.0
2.680000	73.9	1000.0	9.000	GND	L2	10.4	-0.9	73.0
2.695000	72.6	1000.0	9.000	GND	L1	10.5	0.4	73.0
2.725000	73.2	1000.0	9.000	GND	L2	10.4	-0.2	73.0
2.740000	72.8	1000.0	9.000	GND	L1	10.5	0.2	73.0
3.135000	72.8	1000.0	9.000	GND	L2	10.5	0.2	73.0
3.225000	73.3	1000.0	9.000	GND	L2	10.5	-0.3	73.0
3.270000	72.7	1000.0	9.000	GND	L1	10.5	0.3	73.0
3.315000	72.1	1000.0	9.000	GND	L2	10.5	0.9	73.0
3.735000	72.8	1000.0	9.000	GND	L1	10.5	0.2	73.0
6.570000	71.6	1000.0	9.000	GND	L1	10.6	1.4	73.0

Class	Line	Voltage	Operator
-	Phase 1 and Phase 2	220 Vac / 60 Hz	Alexandre
Note: Normal Operating Mode.			

IEC 61000-6-4_2010 CE- LISN





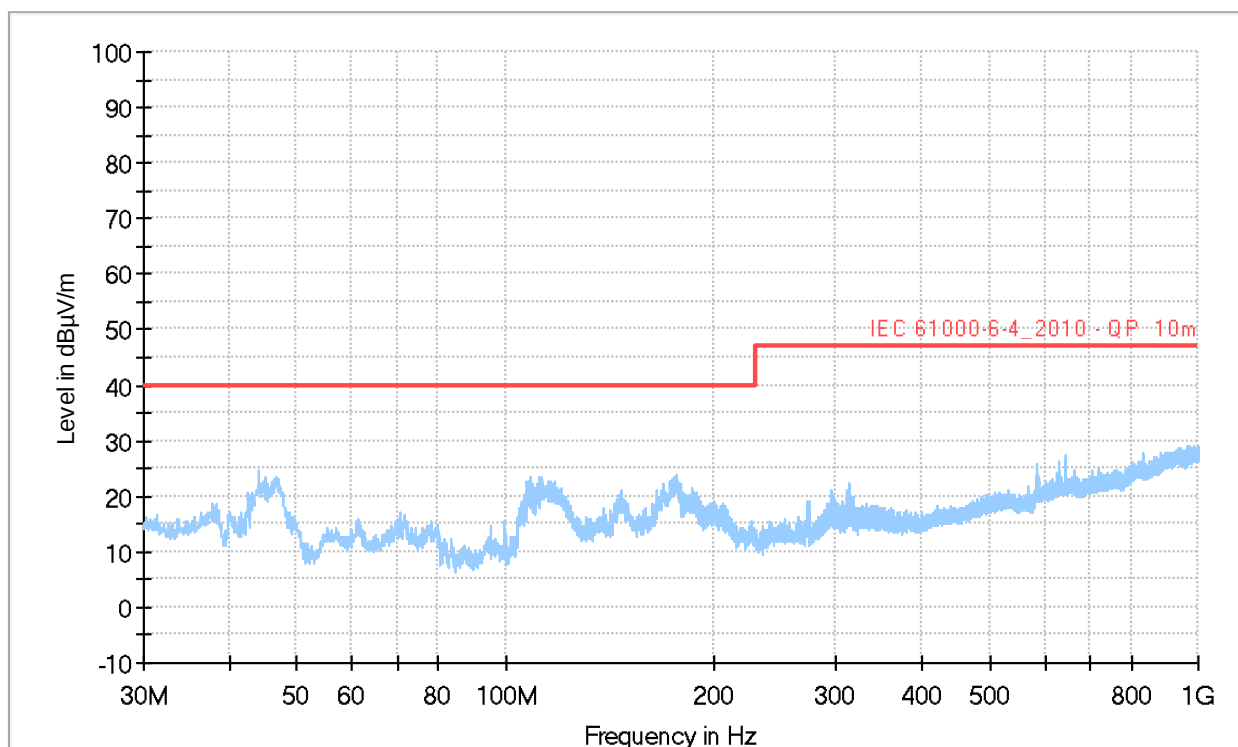
Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.500000	81.6	1000.0	9.000	GND	L1	10.3	-2.6	79.0
0.540000	81.6	1000.0	9.000	GND	L2	10.3	-8.6	73.0
0.555000	79.8	1000.0	9.000	GND	L2	10.3	-6.8	73.0
0.610000	88.9	1000.0	9.000	GND	L1	10.2	-15.9	73.0
0.635000	88.2	1000.0	9.000	GND	L2	10.2	-15.2	73.0
0.650000	84.3	1000.0	9.000	GND	L2	10.2	-11.3	73.0
0.685000	80.3	1000.0	9.000	GND	L1	10.2	-7.3	73.0
0.780000	80.0	1000.0	9.000	GND	L1	10.3	-7.0	73.0
0.810000	82.9	1000.0	9.000	GND	L2	10.3	-9.9	73.0
0.835000	82.3	1000.0	9.000	GND	L2	10.2	-9.3	73.0
0.850000	80.1	1000.0	9.000	GND	L1	10.2	-7.1	73.0
1.540000	79.6	1000.0	9.000	GND	L2	10.3	-6.6	73.0
1.555000	80.2	1000.0	9.000	GND	L1	10.3	-7.2	73.0
1.595000	78.4	1000.0	9.000	GND	L2	10.3	-5.4	73.0
1.620000	80.6	1000.0	9.000	GND	L2	10.3	-7.6	73.0
1.640000	80.5	1000.0	9.000	GND	L1	10.3	-7.5	73.0
1.670000	80.4	1000.0	9.000	GND	L1	10.3	-7.4	73.0
1.680000	80.6	1000.0	9.000	GND	L2	10.3	-7.6	73.0
1.700000	81.4	1000.0	9.000	GND	L1	10.3	-8.4	73.0
1.710000	79.4	1000.0	9.000	GND	L2	10.3	-6.4	73.0
1.725000	79.2	1000.0	9.000	GND	L1	10.3	-6.2	73.0
1.755000	81.1	1000.0	9.000	GND	L1	10.3	-8.1	73.0
1.765000	80.7	1000.0	9.000	GND	L2	10.3	-7.7	73.0
1.790000	80.2	1000.0	9.000	GND	L2	10.3	-7.2	73.0
1.810000	80.0	1000.0	9.000	GND	L1	10.3	-7.0	73.0
1.820000	80.2	1000.0	9.000	GND	L2	10.3	-7.2	73.0
1.835000	81.0	1000.0	9.000	GND	L1	10.3	-8.0	73.0
1.865000	78.1	1000.0	9.000	GND	L2	10.3	-5.1	73.0
1.905000	79.3	1000.0	9.000	GND	L1	10.3	-6.3	73.0
1.950000	78.1	1000.0	9.000	GND	L1	10.3	-5.1	73.0
1.975000	78.4	1000.0	9.000	GND	L2	10.3	-5.4	73.0
2.025000	77.1	1000.0	9.000	GND	L2	10.3	-4.1	73.0
2.640000	77.4	1000.0	9.000	GND	L1	10.5	-4.3	73.0
2.710000	77.8	1000.0	9.000	GND	L2	10.4	-4.8	73.0
2.730000	77.9	1000.0	9.000	GND	L2	10.4	-4.9	73.0
2.755000	78.6	1000.0	9.000	GND	L1	10.5	-5.6	73.0
2.800000	77.9	1000.0	9.000	GND	L2	10.4	-4.9	73.0
2.825000	79.4	1000.0	9.000	GND	L1	10.5	-6.4	73.0
2.845000	78.3	1000.0	9.000	GND	L1	10.5	-5.3	73.0
2.870000	78.6	1000.0	9.000	GND	L2	10.5	-5.6	73.0
2.890000	78.4	1000.0	9.000	GND	L2	10.5	-5.4	73.0
2.915000	78.7	1000.0	9.000	GND	L1	10.5	-5.7	73.0
2.935000	78.6	1000.0	9.000	GND	L2	10.5	-5.6	73.0
2.960000	78.1	1000.0	9.000	GND	L1	10.5	-5.1	73.0
3.005000	77.5	1000.0	9.000	GND	L1	10.4	-4.5	73.0
3.120000	76.4	1000.0	9.000	GND	L2	10.5	-3.4	73.0
3.760000	74.4	1000.0	9.000	GND	L1	10.5	-1.4	73.0
4.035000	76.3	1000.0	9.000	GND	L1	10.5	-3.3	73.0
4.060000	75.0	1000.0	9.000	GND	L2	10.5	-2.0	73.0
5.105000	74.9	1000.0	9.000	GND	L1	10.6	-1.9	73.0

3.2. RADIATED EMISSION TEST

Standard	Voltage	Notes
IEC 61000-6-4	127 Vac / 60 Hz 220 Vac / 60 Hz	Preview Measurement Detector 1 Peak detector
		Final Measurement Detector 1 Quasi-Peak detector (if necessary)

Class	Distance	Polarization	Voltage	Operator
-	10 m	PV / PH	127 Vac / 60 Hz	Alexandre
Note: Normal Operating Mode.				

IEC61000-6-4_2010 RE BICONILOG 10m - PV e PH

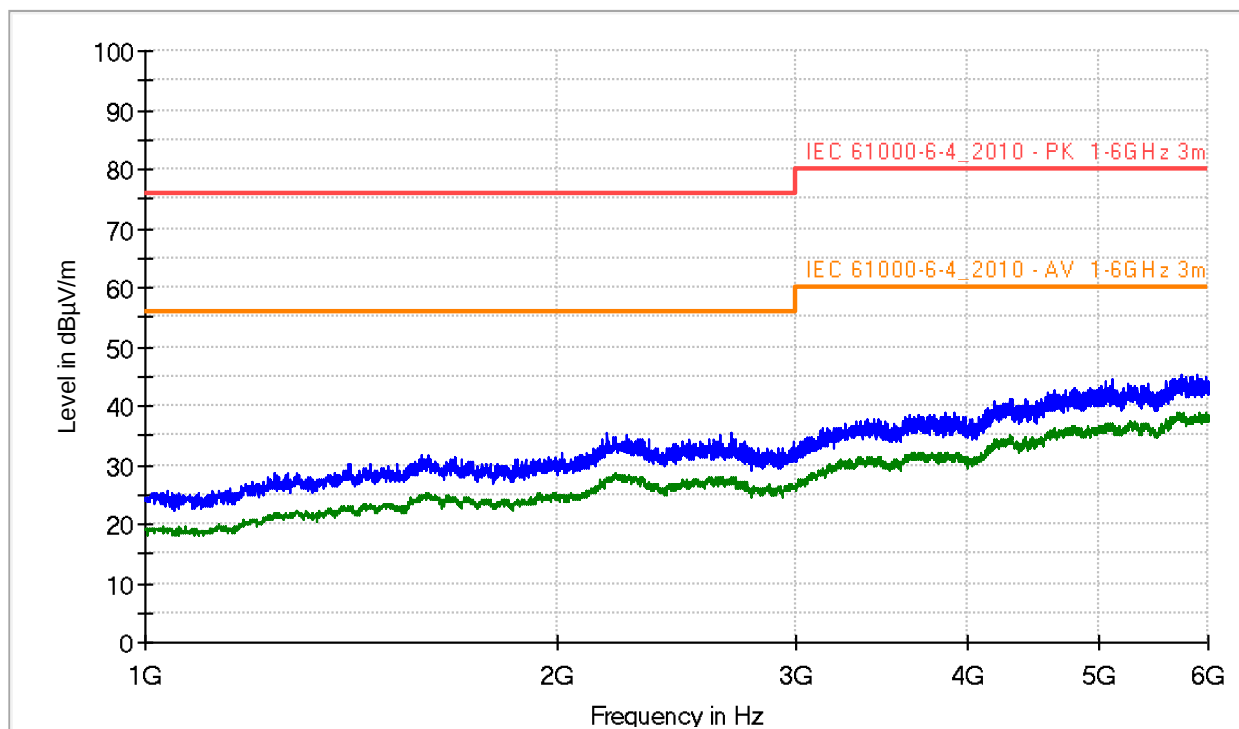


— IEC61000-6-4_2010 - QP 10m — Preview Result 1-PK+



Class	Distance	Polarization	Voltage	Operator
-	3 m	PV / PH	127 Vac / 60 Hz	Alexandre
Note: Normal Operating Mode.				

IEC 61000-6-4_2010 RE BICONILOG PK & AV 3m

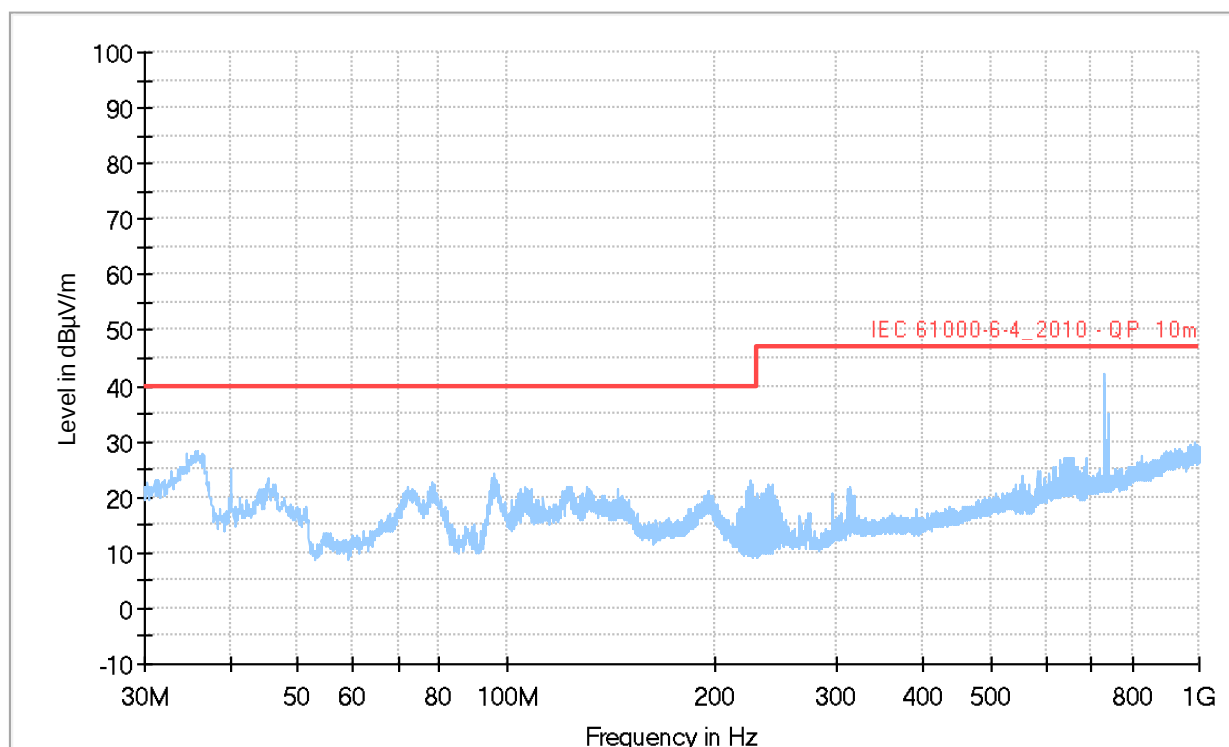


MaxPeak-MaxHold-PK+ Average-MaxHold-AVG
IEC 61000-6-4_2010 - PK 1-6GHz 3m IEC 61000-6-4_2010 - AV 1-6GHz 3m



Class	Distance	Polarization	Voltage	Operator
-	10 m	PV / PH	220 Vac / 60 Hz	Alexandre
Note: Normal Operating Mode.				

IEC 61000-6-4_2010 RE BICONILOG 10m - PV e PH

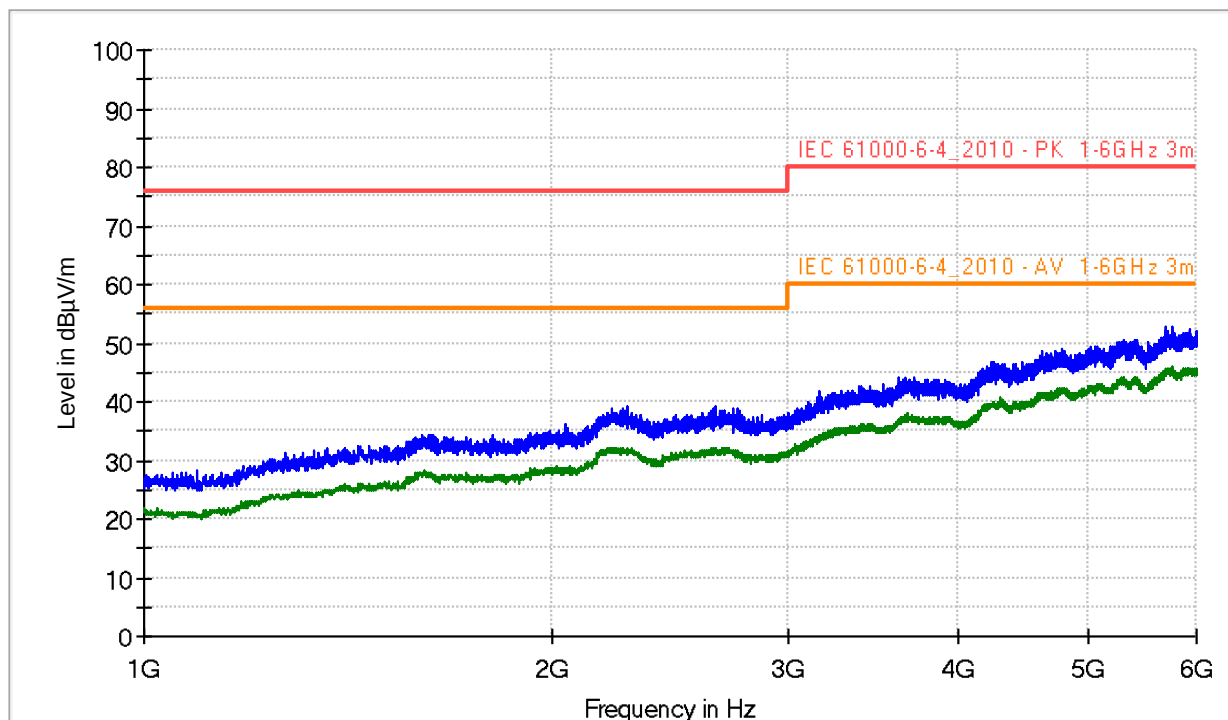


— IEC 61000-6-4_2010 - QP 10m — Preview Result 1-PK+



Class	Distance	Polarization	Voltage	Operator
-	3 m	PV / PH	220 Vac / 60 Hz	Alexandre
Note: Normal Operating Mode.				

IEC 61000-6-4_2010 RE BICONILOG PK & AV 3m



MaxPeak-MaxHold-PK+ Average-MaxHold-AVG
IEC 61000-6-4_2010 - PK 1-6GHz 3m IEC 61000-6-4_2010 - AV 1-6GHz 3m

3.3. ELECTROSTATIC DISCHARGE IMMUNITY TEST

Standard	Voltage	Discharge Level (kV)		Performance Criteria
IEC 61000-4-2	220 Vac / 60 Hz	Direct:	(1)	-
		VCP / HCP:	±4	A
		Air:	±8	A
Note: (1)The equipment tested has no accessible metal parts.				

3.4. RADIATED ELECTROMAGNETIC FIELD IMMUNITY TEST

Standard	Voltage	Pol.	Level	Frequency range	Modulation	Performance Criteria
IEC 61000-4-3	127 Vac / 60 Hz	H / V	10 V/m	80 MHz – 1.0 GHz	AM, 80%, 1 kHz	A
			3 V/m	1.4 GHz – 6.0 GHz		A

3.5. ELECTRICAL FAST TRANSIENT/BURST IMMUNITY TEST

Standard	Voltage	Test Level (kV)	Repetition frequency kHz	Performance Criteria
IEC 61000-4-4	220 Vac / 60 Hz	±2	5	A

3.6. SURGE IMMUNITY TEST

Standard	Voltage	Test Level (kV)		Performance Criteria
IEC 61000-4-5	220 Vac / 60 Hz	Between Lines:	±1	A
		Between Line / Ground:	±2	A
Note: Sync: 0° / 90° / 180° / 270°.				

3.7. IMMUNITY TO CONDUCTED DISTURBANCES INDUCED BY RADIO-FREQUENCY FIELDS

Standard	Voltage	Level	Frequency range	Modulation	Performance Criteria
IEC 61000-4-6	127 Vac / 60 Hz 220 Vac / 60 Hz	3 Vrms	150 kHz - 80 MHz	AM, 80%, 1 kHz	A

3.8. POWER FREQUENCY MAGNETIC FIELD IMMUNITY TEST

Standard	Frequency (Hz)	Voltage	Test Level (A/m)	Performance Criteria
IEC 61000-4-8	60	220 Vac / 60 Hz	30	A

3.9. VOLTAGE DIPS, SHORT INTERRUPTIONS AND VOLTAGE VARIATIONS IMMUNITY TESTS

Standard	Voltage reduction (%)	Period duration (cycles)	Performance Criteria	
			127 Vac / 60 Hz	220 Vac / 60 Hz
IEC 61000-4-11	100	1	A	A
	60	12	A	A
	30	30	A	A
	100	300	B ⁽¹⁾	B ⁽¹⁾
Note: ⁽¹⁾ The tested equipment restarted during the test, but returned to its normal operation automatically.				

4. MONITORING

Monitored by the video camera viewing the Leds and the operation of the tested equipment.

5. PERFORMANCE CRITERIA

Criterion A: Normal functioning inside of the specification limits;

Criterion B: Temporary loss of function or degradation of performance which ceases after cessation of the disturbance, and from which the equipment under test recovers its normal performance, without operator intervention;

Criterion C: Temporary loss of function or degradation of performance, return to normal performance requires operator intervention;

Criterion D: Loss of function or degradation of performance which is not recoverable due to damage to hardware or software or data loss.

6. MEANS AND DEVICES USED FOR TESTING

Equipments	Model	Manufactured	Serial Number
Anechoic chamber	-	-	-
Computer	-	-	-
Software	EMC32	Rohde & Schwarz	-
Antenna Biconilog	3142 E	ETS - Lindgren	157711
Test Receiver	ESPI	Rohde & Schwarz	101038
LISN – “Line Impedance Stabilization Network”	ENV4200	Rohde & Schwarz	825358/007
Sensor de Campo Elétrico	HI-6105	ETS - Lindgren	117934
Signal Generator	SMB 100A	Rohde & Schwarz	107259
Amplifier	10.000L	AR	310813
Amplifier	2000W	AR	311388
Power Meter	NRP2	Rohde & Schwarz	102770
Power Sensor	NRP-Z91	Rohde & Schwarz	102048
Power Sensor	NRP-Z91	Rohde & Schwarz	102049
Signal Generator	SMF 100A	Rohde & Schwarz	101928
Amplifier	AS0102-400	MILMEGA	1036942
Amplifier	300T2G8M7	AR	310601
Antenna Horn 1	ATH800M5GA	AR	345939
Power Meter	NRP2	Rohde & Schwarz	102771
Power Sensor	NRP-Z85	Rohde & Schwarz	101195
Power Sensor	NRP-Z85	Rohde & Schwarz	102606
Coupling / decoupling network	FCC-801-m5-50A	FCC	5002
Signal Generator	SMC 100A	Rohde & Schwarz	102937
Amplifier	BBA-100	Rohde & Schwarz	101023
Power Meter	NRVD	Rohde & Schwarz	101125
Power Sensor	URV5-Z2	Rohde & Schwarz	100519
Power Sensor	URV5-Z2	Rohde & Schwarz	100520
Electrostatic discharge simulator	ESD30N	EM TEST	V1016106291
Hand held discharge unit	P30N	EM TEST	V1016106292
Ultra-compact simulator	UCS500N5	EM TEST	V1016106293
Coupling / decoupling network	CNI503A2	EM TEST	V1016106294
Variac Motor	MV1626	EM TEST	V0932105052
Coil	MS100	EM TEST	0209-236
Transformer	MC2630	EM TEST	0309-62
Transformer	MC26100	EM TEST	0209-136
Toroidal transformer	V4780S20	EM TEST	0109-43

7. MEASUREMENT UNCERTAINTY

The following table shows the values of uncertainty for each type of measurement performed.

Item	Test	Uncertainty U
3.1	Conducted Emission	- In the Frequency Range from 9 kHz to 30 MHz 3,9 dB
3.2	Radiated Emission	- In the Frequency Range from 30 MHz to 1000 MHz 6,6 dB
3.3	Electrostatic discharge immunity test	12 %
3.4	Radiated electromagnetic field immunity	1,9 dB
3.5	Electrical fast transient/burst immunity	13 %
3.6	Surge immunity	13 %
3.7	Immunity to conducted disturbances induced by radio-frequency fields	2,4 dB
3.8	Power Frequency Magnetic Field Immunity	9,2 %
3.9	Voltage dips, short interruptions and voltage variations immunity	5,9 dB
Note: The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor of $k=2.00$, which for normal distribution corresponds to a coverage probability of 95.45%.		

8. VERSION CONTROL

Pagination	Version	Date	Change reference
1 to 21	01	December 21 th , 2022	- Original version.

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