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Federative Republic of Brazil

ELECTROMAGNETIC COMPATIBILITY TESTS OF WIRELESS CHARGER FOR MOBILE PHONE

PRELIMINARY REPORT - **Document in the final stage of preparation**

1 Introduction

The objective of this report is to present the results of the electromagnetic compatibility tests in the wireless charger for mobile phone equipment, based on Electromagnetic Compatibility Requirements for Evaluation of Product Conformity for Telecommunications and Requirements Techniques and Test Procedures Applicable to the Certification of Products for Telecommunication Category I.

This report is a useful material to Study Group 3 – Working Party 3L - Ionospheric Propagation and Radio Noise, on harmful interferences studies to receivers operating at lower frequency range.

2 Tested Product Identification

The device used for tests is a Mobile Phone Charger (Vehicular).

Equipment is identified, by three sides, in the Figure 1.

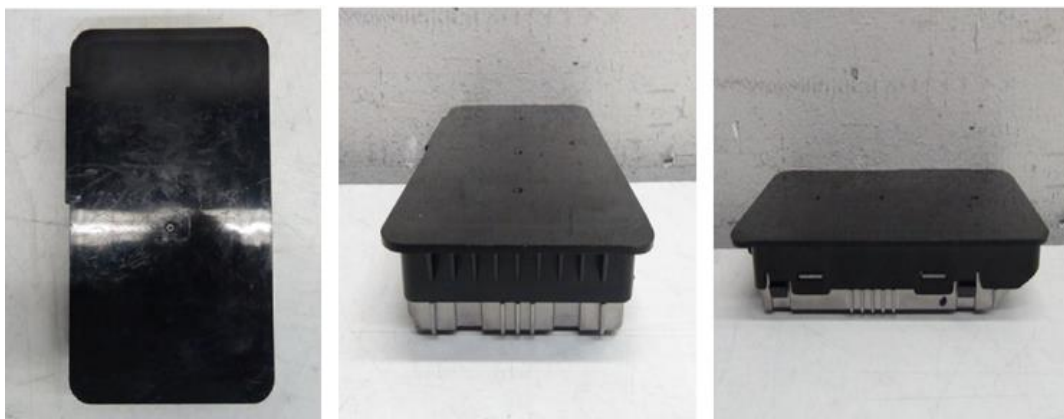


Figure 1: Equipment Views.

3 References and Testing Methods

Technical Requirements and Test Procedures Applicable to Certification of Category I Telecommunication Products.

- a) ETSI EN 301 489-1 V1.9.2 (2011) Electromagnetic Compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part1: Common technical requirements;
- b) ISO 7637 – 2: Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads;
- c) IEC 61000-4-2 (2008) - Electromagnetic Compatibility (EMC) - Part 4: Testing and Measurement Techniques. Section 2: Electrostatic discharge immunity test;
- d) FCC part 18 - Code of Federal Regulations – CFR FCC PART 18 — INDUSTRIAL, SCIENTIFIC, AND MEDICAL EQUIPMENT.

Remark: Other Regulation Documents from Brazilian National Telecommunication Agency – ANATEL have been applied.

4 Test Laboratory

Foundation - Centre for Research and Development in Telecommunications - CPqD

Park II of the High Technology Pole - Campinas - SP

Conformity Assessment in Products and Systems Management

Electromagnetic Compatibility Area

5 Summary of Tests

Table 1 - Summary of Tests.

Test	Reference document	Specification	Configuration	Sample
Radiated Field Intensity	FCC part 18 Act 1135	§18.305 - Field strength limits (Equipment Any type, Operating frequency: Any non-ISM frequency)	Standard	38192
Electrostatic Discharge Immunity	ANATEL Regulation	6 kV for contact discharge 8 kV for air discharge	Standard	38192
Driven Electric Transient Immunity	ETSI EN 301 489-1 V1.9.2 (2011) – Item 9.6 ISO 7637-2 (2011)	Pulses (1, 2a, 2b, 3a, 3b, 4)	Standard	38192
Fundamental Frequency	ANATEL Regulation	Table 2 - Forbidden frequencies for ISM equipment	Standard	38192

6 Terminology

The terms and definitions used in this document are as follows:

AE - Auxiliary Equipment

EUT - Equipment Under Test

LISN - Line Impedance Stabilization Network

EMC - Electromagnetic Compatibility

EMI - Electromagnetic Interference

ESD - Electrostatic Discharge

CC - Continuous Current

AC - Alternating Current

7 Operating conditions of the equipment under test

During the tests, the equipment was set up in “*Default setting*” according to manufacturer.

Default setting:

In order to perform the test, a load supplied by the customer was used and a Cell Phone as well.

The Field Intensity monitoring and Basic Frequency tests were carried out, using a led on the load to indicate a drain of current during the measurements.

During the tests of Electrostatic Discharge Immunity and Transient Immunity Electric Driven, the charging of the Mobile Phone was monitored.

The EUT operates at **111 kHz** central frequency.

8 Radiated Field Intensity

8.1 Instruments

Table 1 - List of equipment used in the Radiated Field Intensity Measurement.

Equipment	Manufacturer	Model	Identification	Validity of Calibration / Verification - Traceability
Semi Anechoic Chamber	ETS-LINDGREN	10 METER	CSA PR-L4	Site Attenuation: January/2019 – CPqD
EMI Test Receiver	Rohde & Schwarz	ESI26	sn 835336/007	February/2019 - CPqD
Rack	Rohde & Schwarz	TS9975	sn 100.710	No calibration required
OPEN SWITCH AND CONTROL UNIT	Rohde & Schwarz	OSP120	sn 100.161	No calibration required
MULTI-DEVICE CONTROLLER	ETS-LINDGREN	2090	sn 00102276	No calibration required
MAST	ETS-LINDGREN	2070B	sn 00106596	No calibration required
ROD ANTENNA	ETS	3301C	CPqD038585	June/2019 – CPqD
Thermal - Digital Hygrometer	Ebro	EBI20	CPqD036921	December/2019 – Novus

8.2 Test Procedure

The procedures adopted for the measurement are based on the FCC Part 18, using as reference the near-peak values of field intensity as defined by the reference procedure.

The limits and conditions are those of FCC Part 18. The exercise and assembly of the EUT are described in item 9.

8.3 Environmental Conditions

All the tests were carried out in a controlled environment, as specified by the reference documents listed in following items.

- Temperature Initial: 20,1 °C / Final: 19,8 °C
- Air relative humidity: Initial: 67,8% / Final: 68,1%

8.4 Results

Results are described on table 3.

Table 3 - Table 3 - Results of Radiation Field Strength Measurement from 9 kHz to 30 MHz.

Graph 1 – Radiated Field Intensity Measurements Results Standard Configuration – Power: Vehicle Battery – Sample 38192						
Near-Peak Values						
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin	Height (cm)	Azimuth (°)	Polarization
0,1108	76,10	103,50	27,40	100,00	180,00	V
0,1110	69,50	103,50	34,00	100,00	180,00	V

Comments:

Measuring distance between ESE and receiving antenna: 3 meters

Limits already fixed. Factor used for extrapolation of the limits from 300 m to 3 m is 80 dB and from 30 m to 3 m is 40 dB (According to ANATEL Regulation: factor is 40 dB per decade for $f < 30$ MHz).

Frequency: Frequency tuned.

Level: Measured level (already corrected by the respective factors) using the detector.

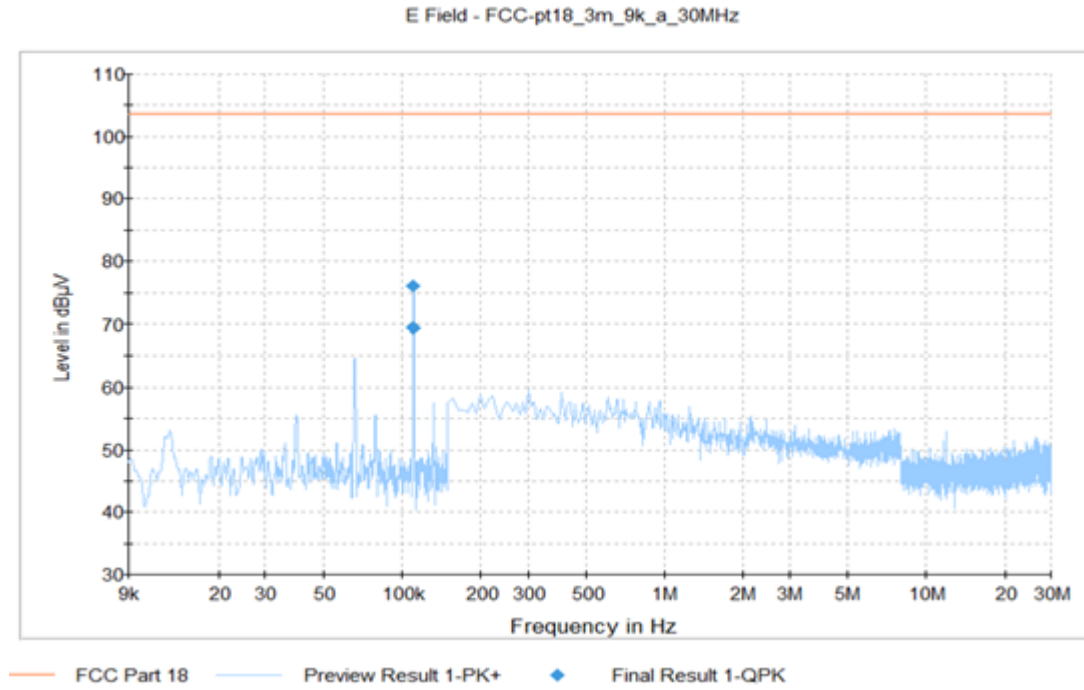
Limit: Limit of Resolution FCC part 18.

Margin: Difference between the respective limit and the measured level (positive: does not exceed limit / negative: exceeds limit)

Height: Receiving antenna height

Azimuth: Turntable angle

Polarization: Polarization of the receiving antenna



Graph 1 – Radiated Field Intensity Measurements Results.

8.4.1 Measurements Uncertainty

In the table below are the electromagnetic field strength measurement uncertainty values.

Table 4 - Uncertainty values.

Test (chamber CSA pr-L4)	Physical Quantity	Measurement distance	Frequency Range	Uncertainty	k	Trust Rating
Radiated Field Intensity	Electric Field Intensity	3 m	9 kHz – 30 MHz	±4,77 dB	2	95%

8.5 Test Assembly Photos

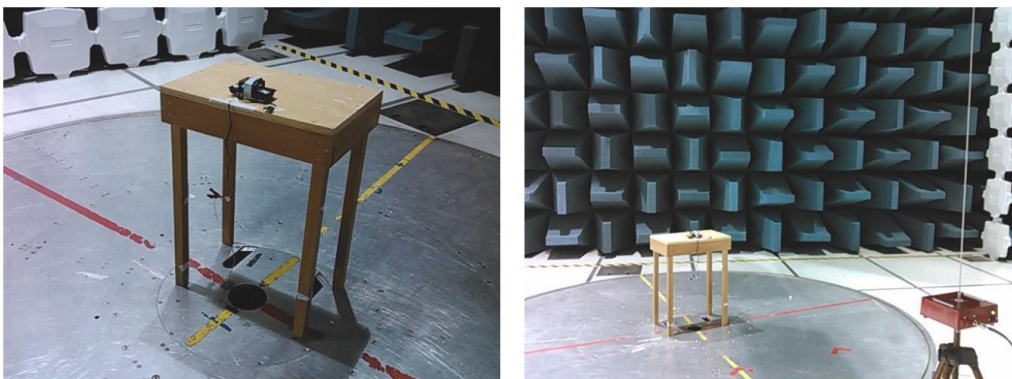


Figure 2 – Test setup in the Semi Anechoic Chamber.

9 Electrostatic Discharge Immunity

9.1 Instruments used in the tests

The table 5 shows the list of equipment used in the Electrostatic Discharge Immunity test.

Table 5: List of equipment.

Equipment	Manufacturer	Model	Identification	Validity of Calibration / Verification - Traceability
Armored Chamber	CPqD	-	CB pr-T3	No calibration required
ESD Simulator	EM TEST	ESD 30 C	CPqD035535	February/2019 – CPqD
Thermal - Digital Hygrometer	Ebro	EBI20	CPqD035630	August/2019 - Novus

9.2 Test Procedures

The procedures adopted are in accordance with the requirements of IEC 61000-4-2, adopting the limit of severity prescribed in Act n°. 1120, that is, 6 kV for discharge by contact and 8 kV for air discharge.

9.3 Environmental Conditions

All the tests were carried out in a controlled environment, as specified by the reference documents listed in item 3.

- Temperature Initial: 22,3 °C / Final: 22,9 °C
- Air relative humidity: Initial: 66,0% / Final: 64,4%

9.4 Results

All the tests were carried out in a controlled environment, as specified by the reference documents listed in item 3. The figure 3 shows two faces of the equipment. The table 6 indicates the results of the Electrostatic Discharge Immunity

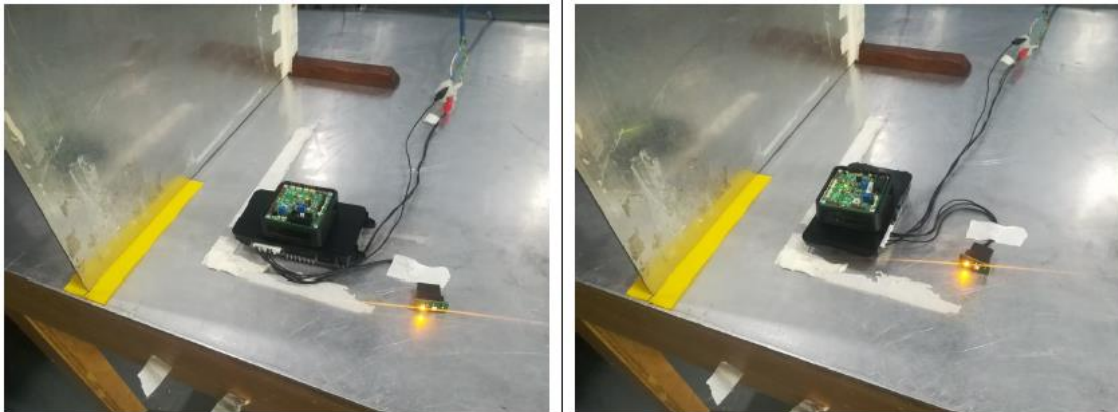


Figure 3 - References with the faces of the equipment.

Table 6: Results of the Electrostatic Discharge Immunity.

Sample 38192 – Configuration: Standard			
HCP – Horizontal Coupling Plane			
EUT Face	Reference: Figure	10 discharges of +6kV	10 discharges of -6 kV
		Observation	Observation
Frontal	Figure 3	Nothing	Nothing
Right	Figure 3	Nothing	Nothing
Back	Figure 3	Nothing	Nothing
Left	Figure 3	Nothing	Nothing
Sample 38192 – Configuration: Standard			
HCP – Vertical Coupling Plane			
EUT Face	Reference: Figure	10 discharges of +6kV	10 discharges of -6 kV
		Observation	Observation
Frontal	Figure 3	Nothing	Nothing
Right	Figure 3	Nothing	Nothing
Back	Figure 3	Nothing	Nothing
Left	Figure 3	Nothing	Nothing
Air Discharge (Applied only in non-conductive portions)			
There are no discharge points through the air.			
Direct Contact Discharge (Applied only in non-conductive portions)			
There are no discharge points for contact.			

Based on the performance criteria B prescribed in Act n°. 1120, the performance of the EUT during the application of the disturbance was monitored, not being verified a difference in performance in the ESE, compared to the operating mode without disturbance.

- Criteria B prescribed in Act n°. 1120 from ANATEL Regulation.

10 Immunity to Conducted Electric Transients

10.1 Used Instruments

Table 7: List of equipment used in the test.

Equipment	Manufacturer	Model	Identification	Validity of Calibration / Verification - Traceability
ARMORED CHAMBER	CPqD	-	CB pr-T3	No calibration required
MICROCOMPUTER	CPqD	OptiPlex 755	CPqD03570409	No calibration required
AUTOWAVE	EM TEST	-	CPqD03693405	No calibration required

VOLTAGE DROP SIMULATOR	EM TEST	VDS 200N	CPqD03693408	No calibration required
ULTRA COMPACT SIMULATOR	EM TEST	UCS 200N	CPqD3693410	No calibration required
Oscilloscope	Rohde & Schwarz	RTO-1022	CPqD036854	July/2019 - CPqD
DIGITAL THERMAL HYGROMETER	Ebro	EBI20	CPqD035630	August/2019 - Novus

10.2 Test Procedures

The procedures adopted for the measurement are based on ISO 7637-2, the and the assembly of the DUT followed the requirements of ISO 7637-2 and are described in item 7.

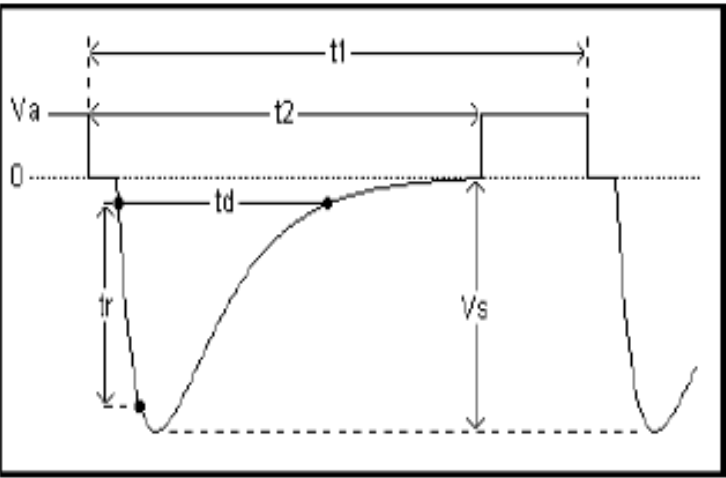
10.3 Environmental conditions

All the tests were carried out in a controlled environment, as specified by the reference documents listed in item 3.

- Temperature: Initial: 22,4 °C / Final: 23,1 °C
- Air relative humidity: Initial: 48,7% / Final: 50,2%

10.4 Results

Table 8 - Results of the Conduct Transient Immunity test.

Pulse 1_12V System		
	Vs::	-112 V
	T1:	0.5 S
	T2:	200 Ms
	Tr:	1 Us
	Td:	2000 Us
	Rl:	10 Ohm
	Coupling:	Battery
	Events:	10
	Test duration:	00:00:05 H
Configuration: Standard		

Sample 38192

Based on the performance criteria prescribed in ISO 7637-2, the ESE performance was monitoring during the application of the disturbance, the following differences in the performance of the ESE were detected, in relation to the operating mode without disturbance:

a) Temporary loss of function or degradation of performance, that ceases after application of the disturbance and in which the ESE recovers its normal performance without operator intervention. (ESE remains off during all pulses, from the first, losing its loading mode, returning to normal after the end of the application).

11 Fundamental Frequency

11.1 Used Instruments

Table 9 – List of equipment.

Equipment	Manufacturer	Model	Identification	Validity of Calibration / Verification - Traceability
SMIANECOIC CHAMBER	ETS-LINDGREN	10 METER	CSA pr-L4	Site Attenuation: January/2019 – CPqD
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESI26	s/n 835336/007	August/2019 – CPqD
RACK	ROHDE & SCHWARZ	TS9975	sn 100.710	No calibration required
OPEN SWITCH AND CONTROL UNIT	ROHDE & SCHWARZ	OSP120	sn 100.161	No calibration required
MULTI-DEVICE CONTROLLER	ETS-LINDGREN	2090	sn 00102276	No calibration required
MAST	ETS-LINDGREN	2070B	sn 00106596	No calibration required
ROD ANTENNA	ETS	3301C	CPqD038585	July/2019 – CPqD
PRE-AMPLIFIER	HP	8447F	CPqD026480	March/2019 - CPqD
DIGITAL THERMAL HYGROMETER	Ebro	EBI20	CPqD036921	December/2019 - Novus

11.2 Test Procedures

The procedures adopted are based on Ordinance No. 176 of June 10, 1992. The exercise and assembly of the EUT are described in item 5.

11.3 Environmental Conditions

All tests were carried out in a controlled environment, as specified by the reference documents listed in item 3.

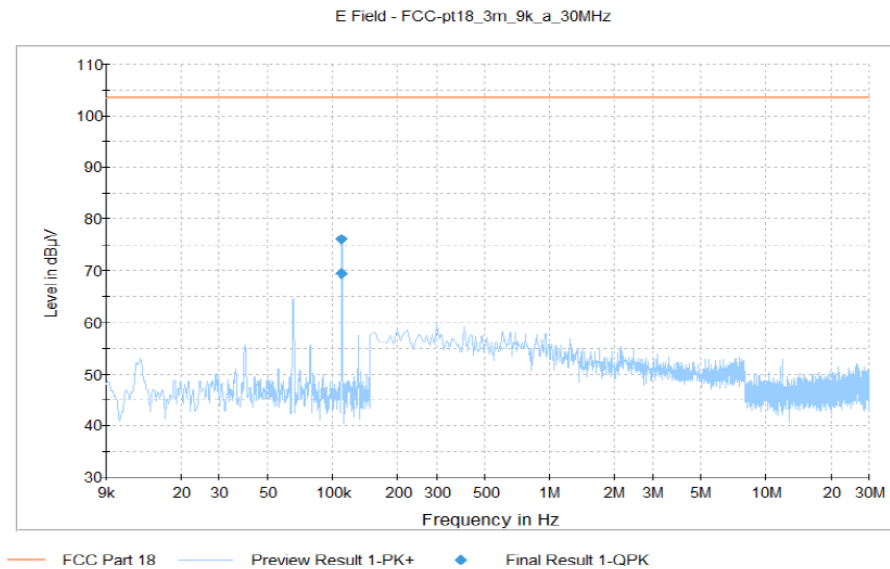
- Temperature: Initial: 20,9 °C / Final: 20,8 °C
- Air relative humidity: Initial: 53,3% / Final: 53,7%

11.4 Results

Results are show in the Graph 2.

Prohibited frequencies for Industrial, Scientific and Medical (ISM) equipment.

Central Frequency	Frequency Range
500,00 kHz	495,00 - 505,00 kHz
2182,00 kHz	2173,50 - 2190,50 kHz
3023,00 kHz	3014,50 - 3031,50 kHz
4125,00 kHz	4116,50 - 4133,50 kHz
5680,00 kHz	5671,50 - 5688,50 kHz
8364,00 kHz	8355,50 - 8372,50 kHz
10003,00 kHz	10000,00 - 10006,00 kHz
14993,00 kHz	14990,00 - 14996,00 kHz
19993,00 kHz	19990,00 - 19996,00 kHz
121,50 MHz	121,45 - 121,55 MHz
123,50 MHz	123,45 - 123,55 MHz
156,30 MHz	156,25 - 156,35 MHz
156,80 MHz	156,75 - 156,85 MHz
243,00 MHz	242,95 - 243,05 MHz
406,05 MHz	406,00 - 406,10 MHz
1544,50 MHz	1544,00 - 1545,00 MHz
1646,00 MHz	1645,50 - 1646,50 MHz



Graph 2 – ISM Spectrum analysis.

11.4.1 Measurements Uncertainty

In the table below are the electromagnetic field strength measurement uncertainty values.

Test (ambient chamber CSA pr-L4)	Quantity	Measurement Distance	Frequency Range	Uncertainty	k	Trust rating
Radiated Field Intensity	Electric Field Intensity	3 m	9 kHz – 30 MHz	±4,77 dB	2	95%

12 Immunity tests measurement uncertainty

In immunity tests, no measurement uncertainty is applied. The uncertainty in these cases is relative to the calibration of disturbance generators. CPqD maintains and updates the calibration uncertainty of test. If necessary, it may be made available, upon formal request of the client.

13 Conclusion

The results of the test refer only to the equipment tested; however, it can reference to other models, which operate in the frequency range from 100 to 148.5 kHz.

14 References

- [1] QUESTION ITU-R 214-5/3 – Radio Noise;
- [2] Recommendation ITU-R P.526-13 - (11/2013) - Propagation by diffraction;
- [3] Document 3L/80-E - REPORT ON THE MEETING OF WORKING PARTY 3L – IONOSPHERIC PROPAGATION AND RADIO NOISE - 1 August 2018;

Thanks to Eng André Luiz Nascimento Ramos, who developed this work.