Electrical Metrology Laboratory / CTMetro

MEASUREMENT REPORT N° 18464-204

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Customer:	**Toshiba América do Sul Ltda.** **Rodovia BR 381, 3045** **32240-090 – Amazonas – Contagem – MG**
Item:	**Control of step voltage regulator**
Service description:	**Verification of accuracy on Control of step voltage regulator**
Reference:	**Purchase order n° 457112 and 457857 on 05.13.2015**

ITEM DESCRIPTION

Control of step voltage regulator, manufacturer Toshiba América do Sul, model TVC MP and serial n° 00003.

Note: Registered at LME under number 1504/15.

USED METHOD

The verification was carried out as described in item 9.4.1.1 "Accuracy" of Standard IEEE C57.15-2009.

The procedure, as well as other information relating to the measurement are described in the following items.

All current and voltage signals applied on unit under test has sinusoidal waveform.

1. Procedure

1.1. Tests for error in voltage level due to temperature

1.1.1. The standard calibrator and unit under test were energized with their nominal power and conditioned at an ambient temperature of (23 ± 3) °C for a period longer than 2 hour.

1.1.2. The unit under test was placed in a climate chamber to the pre-conditioned (20 ± 1) °C and was applied voltage of 120 V with a frequency of (50.000 ± 0.005) Hz with the standard calibrator at the voltage terminals.

1.1.3. The temperature of chamber was reduced to (-30 ± 1) °C at a rate of 0.6 °C/min.

1.1.4. The temperature of chamber was kept at (-30 ± 1) °C for a period longer than one hour, then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

1.1.5. The temperature of chamber was elevated to (-10 ± 1) °C at a rate of 0.6 °C/min.

1.1.6. The temperature of chamber was kept at (-10 ± 1) °C for a period longer than one hour, then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

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1.1.7. The temperature of chamber was elevated to (10 ± 1) °C at a rate of 0.6 °C/min.

1.1.8. The temperature of chamber was kept at (10 ± 1) °C for a period longer than one hour, then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

1.1.9. The temperature of chamber was elevated to (30 ± 1) °C at a rate of 0.6 °C/min.

1.1.10. The temperature of chamber was kept at (30 ± 1) °C for a period longer than one hour, then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

1.1.11. The temperature of chamber was elevated to (50 ± 1) °C at a rate of 0.6 °C/min.

1.1.12. The temperature of chamber was kept at (50 ± 1) °C for a period longer than one hour, readings were performed when the voltage value indicated by regular supervision. The results are presented in section RESULTS.

1.1.13. The temperature of chamber was elevated to (65 ± 1) °C at a rate of 0.6 °C/min.

1.1.14. The temperature of chamber was kept at (65 ± 1) °C for a period longer than one hour, then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

1.2. Tests for error in voltage level due to frequency

1.2.1 The standard calibrator and unit under test were energized with their nominal power and conditioned at an ambient temperature of (23 ± 3) °C for a period longer than 1 hour.

1.2.2 The standard calibrator applied a voltage of 120 V with a frequency of (49.875 ± 0.005) Hz on unit under test at the voltage terminals, with zero current applied in the line-drop compensation circuit. Then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

1.2.3 The standard calibrator applied a voltage of 120 V with a frequency of (50.000 ± 0.005) Hz on unit under test at the voltage terminals, with zero current applied in the line-drop compensation circuit. Then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

1.2.4 The standard calibrator applied a voltage of 120 V with a frequency of (50.125 ± 0.005) Hz on unit under test at the voltage terminals, with zero current applied in the line-drop compensation circuit. Then readings of voltage value indicated were performed by unit sob test. The results are presented in section RESULTS.

1.3. Tests for error in voltage level due to line-drop compensation

1.3.1 The standard calibrator and unit under test were kept energized with their nominal power at an ambient temperature of (23 ± 3) °C.

1.3.2 With the standard calibrator was applied a voltage of 120 V with a frequency of (50.000 ± 0.005) Hz at the voltage terminals on unit under test and a current of (0,2000 ± 0,0004) A in the line-drop compensation circuit on unit under test in phase with the voltage. Also, were set values 12 V on resistive compensation and 0 V on reactive compensation. Then we adjusted the voltage value generated by standard calibrator until the voltage value indicated by the indication unit under test reach the value 120 V. The results are presented in section RESULTS (**Test 1**).

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1.3.3 With the standard calibrator was applied a voltage of 120 V with a frequency of (50.000 ± 0.005) Hz at the voltage terminals on unit under test and a current of (0,2000 ± 0,0004) A in the line-drop compensation circuit on unit under test in phase with the voltage. Also, were set values 0 V on resistive compensation and 12 V on reactive compensation. Then we adjusted the voltage value generated by standard calibrator until the voltage value indicated by the indication unit under test reach the value 120 V. The results are presented in section RESULTS (**Test 2**).

1.3.4 With the standard calibrator was applied a voltage of 120 V with a frequency of (50.000 ± 0.005) Hz at the voltage terminals on unit under test and a current of (0,2000 ± 0,0004) A in the line-drop compensation circuit on unit under test with 90° lagging phase with the voltage. Also, were set values 12 V on resistive compensation and 0 V on reactive compensation. Then we adjusted the voltage value generated by standard calibrator until the voltage value indicated by the indication unit under test reach the value 120 V. The results are presented in section RESULTS (**Test 3**).

1.3.5 With the standard calibrator was applied a voltage of 120 V with a frequency of (50.000 ± 0.005) Hz at the voltage terminals on unit under test and a current of (0,2000 ± 0,0004) A in the line-drop compensation circuit on unit under test with 90° lagging phase with the voltage. Also, were set values 0 V on resistive compensation and 12 V on reactive compensation. Then we adjusted the voltage value generated by standard calibrator until the voltage value indicated by the indication unit under test reach the value 120 V. The results are presented in section RESULTS (**Test 4**).

2. Uncertainty

The reported expanded uncertainty of measurement in the RESULTS item is stated as the standard uncertainty of measurement multiplied by the coverage factor k, which for normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA-4/02 publication.

3. Standards and equipaments used

Description	Model	Serial No.	Certificate No.	Origin	Valid till
Multifunction Calibrator	5500A	6575020	140739-101 and 141358-101	IPT-LME	Oct/2015
Modular three-phase portable test system	400.3	43977	0638/2015 and 147103-101	Inmetro and IPT-LME	Apr/2016
Climate Chamber	WK3-340/40	58226098650010	LMM-TE 025	IPT-LMM	Apr/2016

4. Traceability

The measurement standards used are traceable to Inmetro (Electricity) and/or to Observatório Nacional (Time/Frequency) and/or to NIST-USA and/or to PTB-Germany (Radio-Frequency and Telecommunication).

5. Environment conditions

The measurements have been made under ambient air temperature of (23 ± 3) °C and relative humidity of (60 ± 20) %.

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Measurement Report No. 18464-204

6. Legend for abbreviation used on reported results

IV = Indicated Value (indication of the item)

RV = Reference Value (indication of the measurement standards)

EVS = Expected Value by Standard IEEE C57.15-2009

Error = IV – RV or EVS – CTV (error indication of the item)

U = Expanded uncertainty of measurement

k = Coverage factor (multiplier factor)

ν_{eff} = Effective degrees of freedom

7. Measurement execution period: 10.13.2015 and 10.14.2015.

8. Notes

The reported results on this document apply only to the tested or calibrated item.

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São Paulo, 19 October 2015.

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RESULTS

Tests for error in voltage level due to temperature

Temperature (°C)	Frequency (Hz)	IV (V)	CTV (V)	Error (V)	U (V)	k	ν_{eff}
-30	50	120.04	120.000	0.040	0.077	2.00	∞
-10	50	120.02	120.000	0.020	0.077	2.00	∞
10	50	120.00	120.000	0.000	0.077	2.00	∞
30	50	119.98	120.000	-0.020	0.077	2.00	∞
50	50	119.94	120.000	-0.060	0.077	2.00	∞
65	50	119.90	120.000	-0.100	0.077	2.00	∞

Tests for error in voltage level due to frequency

Frequency (Hz)	IV (V)	CTV (V)	Error (V)	U (V)	k	ν_{eff}
49.875	120.16	120.173	-0.013	0.028	2.00	∞
50.000	120.16	120.173	-0.013	0.028	2.00	∞
50.125	120.16	120.174	-0.014	0.028	2.00	∞

Tests for error in voltage level due to line-drop compensation

Test	Freq. (Hz)	Current Applied (A)	IV (V)	Phase	EVS (V)	CTV (V)	Error (V)	U ± (V)	k	ν_{eff}
1	50	0.2000	120.0	0°	132.0	131.960	0.040	0.084	2.00	∞
2	50	0.2000	120.0	0°	119.4	119.395	0.005	0.077	2.00	∞
3	50	0.2000	120.0	90°	119.4	119.470	-0.070	0.077	2.00	∞
4	50	0.2000	120.0	90°	132.0	131.970	0.030	0.084	2.00	∞

ANALYSIS OF RESULTS

From the measurements performed on the item and the guidelines described in subparagraphs 9.3.1.2.1 and 9.3.1.2.2 of IEEE C57.15-2009 Standard, the following results were obtained:

- maximum error of 0.083 % for the temperature of 65 °C;
- maximum error of 0.012 % at the frequency of 50.125 Hz, and no load current;
- maximum error of 0.059 % due to line-drop compensation and
- total error = 0.15 %.

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TSEA energia	REPORTE TECNICO CONTROL TVC-MP	NÚMERO: SC 59/2021
TÍTULO: **Errores debidos a la desviación de la marca del punto de ajuste en el panel del dispositivo de control.**	OF REGULADOR: OF21039	HOJA: Pág. 1 de 4

Revisión: 00			
HECHO: Pedro Colem	COMPROBADO: José R. Medeiros	APROBADO José R. Medeiros	COPIA ENVIADA A: Vendas

0000025

Cliente: **Flopower Chile SpA**
Dr. Manuel Barros Borgoño 71, Ofi. 1605
Providencia, Santiago, 7500593
Chile

Referencia: **OC 2021-006**

Item: **Control Eletrónico TVC-MP**

Descripción del servicio: Verificación de la precisión en el control electrónico

1. Objetivo

Determinar las desviaciones de marcado de los puntos de ajuste del nivel de voltaje, el ancho de banda de voltaje, la compensación de caída de voltaje de línea y los ajustes de tiempo de control electrónico para reguladores de voltaje monofásicos modelo TVC-MP de acuerdo con el estándar IEC 60076-21 Edition 2.0 2018-12; Power transformers – Part 21: Standard requirements, terminology, and test code for step-voltage regulators.

2. Ítem ensayado

Control Electrónico para Reguladores Monofásicos de Tensión;
Modelo TVC-MP;
N.º de serie: M21319;
Fabricante: TSEA-ENERGIA.

3. Imagen del ítem ensayado, estándar y equipos usados

Condiciones Ambientales:
Temperatura 23 ± 3 °C
Umidade: 43 ± 20 %UR

4. Ensayos realizados

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4.1. Desviación de visualización del nivel de tensión:

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Criterio de aprobación

La diferencia entre el valor del nivel de tensión real y el valor exhibido en cualquier configuración en el rango de 120 (1 ± 10%) V no debe exceder ± 1%.

Procedimiento del ensayo:

Con el calibrador estándar se aplicaron las tensiones indicada en la columna 1 de la Tabla 1, con frecuencia de 50,00Hz en los terminales de tensión del ítem ensayado y corriente de 200mA en el circuito de entrada de corriente, en fase con la tensión.

Luego se realizaron lecturas en el valor de tensión indicado en la pantalla LCD del ítem ensayado. Las lecturas son presentadas en la columna 2 de la Tabla 1:

Conclusión:

De manera que los errores obtenidos están de acuerdo con el criterio de aprobación, se aprobó el ítem ensayado. Los errores están presentados en la columna 3 de la Tabla 1.

Tabla 1: Desviación de visualización del nivel de tensión

Valor de referencia (V)	Valor medido	Erro
108,00 V	107,96 V	-0,04%
111,00 V	110,96 V	-0,04%
114,00 V	113,96 V	-0,04%
117,00 V	116,96 V	-0,03%
120,00 V	119,96 V	-0,03%
123,00 V	122,96 V	-0,03%
126,00 V	125,96 V	-0,03%
129,00 V	128,97 V	-0,02%
132,00 V	131,96 V	-0,03%

Tabla 2: Estándar y equipo(s) usado(s).

Equipo	Marca	Modelo	Catastro	Certificado N.º	Validad
Calibrador Estándar	Fluke	5080A	652/002	7614/2020	30/09/2021

4.2. Desviación de marcación del compensador de caída de línea

Criterio de aprobación:

La diferencia aritmética entre la caída de tensión a ser compensada expresa como un porcentual de 120 V, y los valores exhibidos para cualquier ajuste de los elementos resistivo y reactivo del compensador de caída de la línea (expreso como un porcentual de 120 V, con 0,2 A en el circuito de compensación) no debe exceder ± 1%.

Procedimiento del ensayo.

Con el calibrador estándar, se aplicó una tensión de 120V, con frecuencia de 50,00Hz en los terminales de tensión del ítem ensayado y corriente de 200mA en el circuito de entrada de la corriente, la fase se ajustó según lo indicado en la Tabla 3. Para cada valor de tensión, corriente y fase, los compensadores resistivo y reactivo se ajustaron según las columnas 4 y 5 de la Tabla 3.

Conclusión:

De manera que los errores obtenidos están de acuerdo con el criterio de aprobación, se aprobó el ítem ensayado. Los errores están presentados en la columna 8 de la Tabla 3.

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Tabla 3: Desviación de marcación del compensador de caída de línea

Valor de Referencia	Corriente (mA)	Fase (Graus)	LDC-R (V)	LDC-X (V)	Valor nominal	Valor medido	Error
120,00 V	200,00	30	6	12	121,54	121,63	0,07%
120,00 V	200,00	30	6	24	129,02	129,16	0,11%
120,00 V	200,00	30	24	12	107,57	107,70	0,12%
120,00 V	200,00	30	24	6	103,65	103,64	-0,01%
120,00 V	200,00	60	6	12	127,88	127,96	0,06%
120,00 V	200,00	60	6	24	138,85	138,97	0,08%
120,00 V	200,00	60	24	12	121,38	121,53	0,12%
120,00 V	200,00	60	24	6	115,67	115,67	0,00%

Tabla 4: Estándar y equipos(s) usado(s)

Equipo	Marca	Modelo	Catastro	Certificado N.°	Validad
Calibrador estándar	Fluke	5080A	652/002	7614/2020	30/09/2021

4.3. Desviación de visualización del ancho de banda

Criterio de aprobación:

La diferencia entre las tensiones límites del ancho de banda real y los valores marcados correspondientes no deben exceder ± 10% de los valores marcados.

Procedimiento del ensayo:

Con el calibrador estándar se aplicó una tensión de 120V, con frecuencia de 50,00Hz en los terminales de tensión del ítem ensayado y corriente de 200mA en el circuito de entrada de la corriente, en fase con la tensión. De ser así, el valor de insensibilidad en el ítem ensayado se ajustó según la columna 2 de la tabla 5. Para cada ajuste de insensibilidad la tensión del calibrador se varió gradualmente para determinar los limites máximo y mínimo en el ítem ensayado señalaba en su painel frontal, *Tensión fuera de banda.* Para cada configuración de insensibilidad, el procedimiento se repitió tres veces, y el valor medio de las lecturas de las tensiones indicadas en la pantalla LCD del ítem ensayado está presentado en las columnas 5 y 6 de la Tabla 5.

Conclusión:

De manera que los errores obtenidos están de acuerdo con el criterio de aprobación, se aprobó el ítem ensayado. Los errores están presentados en la columna 7 de la Tabla 5.

Tabla 5: Desviación de visualización del ancho de banda

Valor de referência(V)	Insensibilidade	Valor nominal máximo	Valor nominal mínimo	Valor medido máximo	Valor medido mínimo	Erro
120,00 V	2,0 V	122,00 V		122,01 V		-0,25%
			118,00 V		118,02 V	
120,00 V	3,0 V	123,00 V		123,01 V		0,33%
			117,00 V		116,99 V	
120,00 V	6,0 V	126,00 V		126,01 V		0,17%
			114,00 V		113,99 V	

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Tabla 6: Estándar y equipos(s) usado(s).

Equipo	Marca	Modelo	Catastro	Certificado N.°	Validad
Calibrador estándar	Fluke	5080A	652/002	7614/2020	30/09/2021

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4.4. Desviación del tiempo de retardo de la conmutación

Criterio de aprobación:

La diferencia entre la demora de tiempo real y el valor marcado de cualquier ajuste no debe exceder ± 2 s o ± 10%, lo que sea mayor. Un circuito de tipo integración debe ser empezado sin cualquier tiempo acumulado.

Procedimiento del ensayo:

Con el calibrador estándar se aplicó una tensión de 120V, con frecuencia de 50,00Hz en los terminales de tensión del ítem ensayado y corriente de 200mA en el circuito de entrada de la corriente, en fase con la tensión. De ser así, el valor de tiempo de retardo, en el ítem ensayado, se ajustó según la columna 1 de la Tabla 7. Para cada ajuste de tiempo la tensión del calibrador se varió gradualmente para determinar el tiempo trascurrido entre la señalización, en el panel frontal del ítem ensayado, desequilibrio y accionamiento del motor del cambiador de taps. Para cada ajuste del tiempo el procedimiento se repitió tres veces, el valor medio de las lecturas de tiempo cronometrado está presentado en la columna 2 de la Tabla 7.

Conclusión:

De manera que los errores obtenidos están de acuerdo con el criterio de aprobación, se aprobó el ítem ensayado. Los errores están presentados en la columna 3 de la Tabla 7.

Tabla 7: Desviación del tiempo de retardo de la conmutación

Tempo de retardo (s)	Tempo medido (s)	Erro (s)
10,0	9,5	0,47
30,0	29,7	0,35
60,0	59,9	0,12

Tabla 8: Estándar y equipos(s) usado(s).

Equipo	Marca	Modelo	Catastro	Certificado N.°	Validad
Calibrador estándar	Fluke	5080A	652/002	7614/2020	30/09/2021
Cronómetro digital	Technos	YP2151	608/028	0372/2020	30/11/2021

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Ensaios NBR ISO/IEC 17025
CRL 0290

EMI/EMC TEST REPORT

CUSTOMER:	**Toshiba América do Sul Ltda.**
EQUIPMENT:	**Electronic Control for Single-Phase Voltage Regulators**
MODEL:	**TVC-MP**
REPORT NUMBER:	**THBTD01-R01** **VERSION: 04**

INPE.LIT.PX 034/15

This document entirely replaces the version 3 of the document THBTD01-R01

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SUMMARY

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1. TESTS SUMMARY

CUSTOMER:	Toshiba América do Sul Ltda.
ADDRESS:	Rodovia BR 381, 3045 - Bairro Amazonas, Contagem, MG, Brasil, 32240-090

EQUIPMENT:	Electronic Control for Single-Phase Voltage Regulators
MODEL:	TVC-MP
S/N:	-
CLASS:	A

PERIOD OF TEST:	October, 13th, 14th and 15th of 2015.

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
RESPONSIBLE ENGINEER:	Marco Antônio Strobino strobino@lit.inpe.br
TESTS PERFORMED BY:	▪ Alexandre Andrade; ▪ Moisés Lobato; ▪ Rafael Massunaga; ▪ Anderson Gonçalves; ▪ Wagner Mello.
NORMATIVE REFERENCES :	▪ CISPR 11 (2009); ▪ CISPR 22 (2008); ▪ IEC 61000-4-2 (2008); ▪ IEC 61000-4-3 (2008); ▪ IEC 61000-4-4 (2004); ▪ IEC 61000-4-5 (2005); ▪ IEC 61000-4-6 (2008); ▪ IEC 61000-4-8 (2009); ▪ IEC 61000-4-11 (2004); ▪ IEC 60255-26 (2013); ▪ IEC 60255-27 (2013).

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2. PICTURES OF THE DEVICE UNDER TEST

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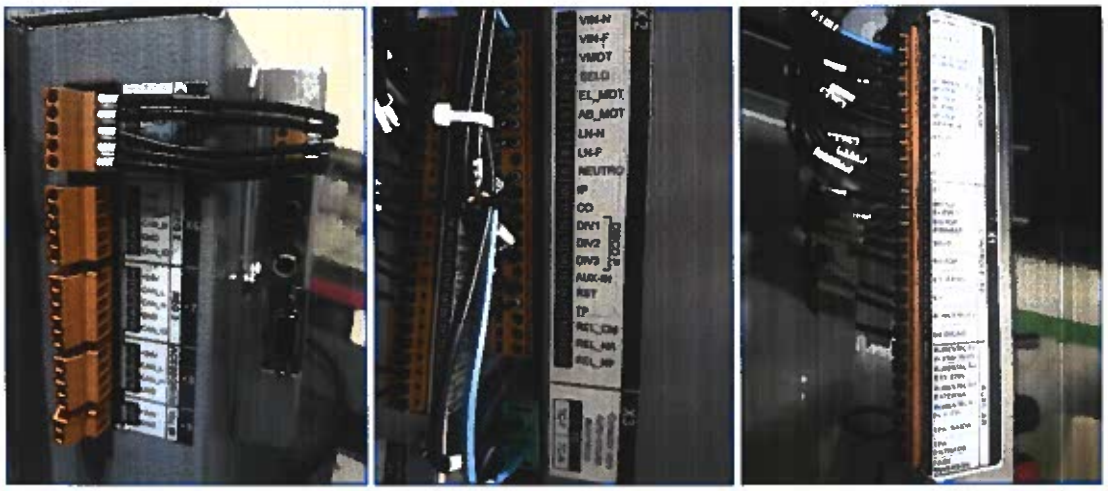
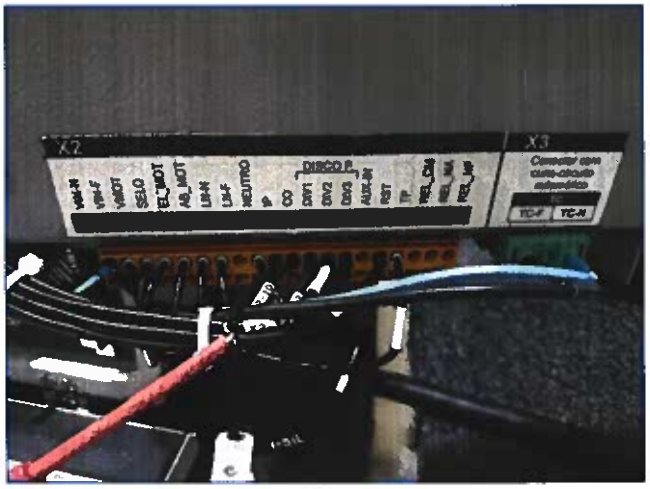
Pictures 1, 2 e 3 – Equipment under test



Pictures 4, 5 e 6 – Equipment under test



Picture 7 – Equipment under test.

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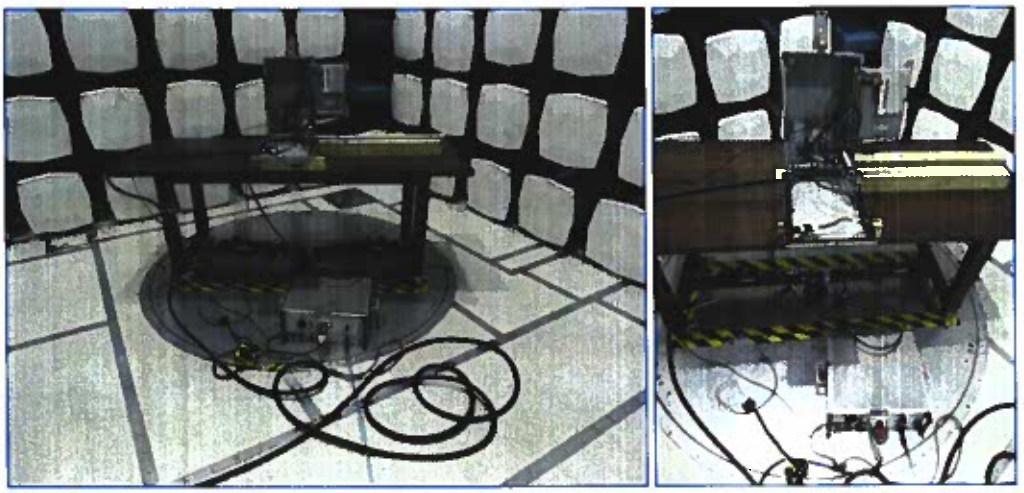
Pictures 8 e 9 – test jig

Pictures 10 e 11 – Setup Conducted Emission



Pictures 12 e 13 – Setup Conducted Emission

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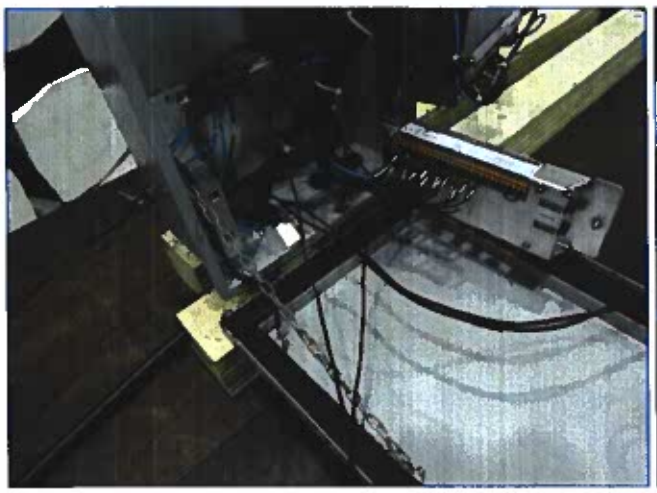
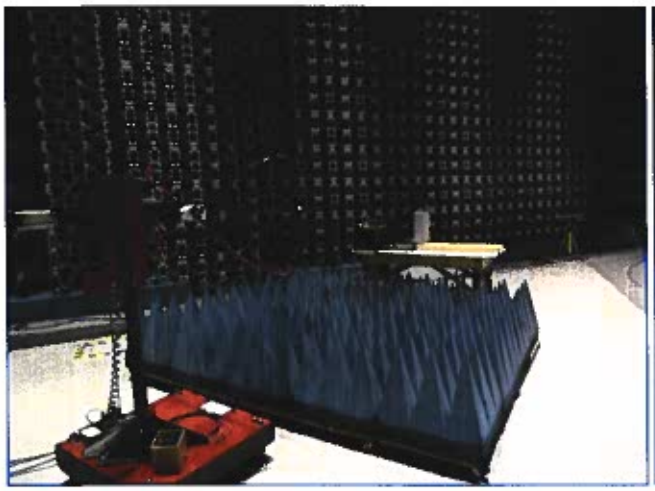
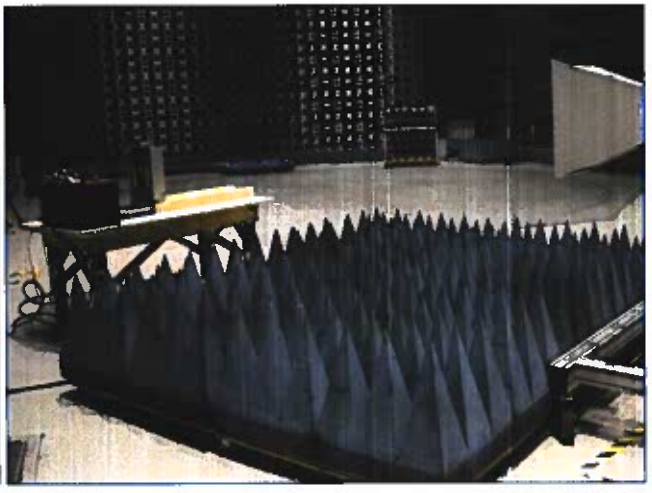


Pictures 14 e 15 – Setup Conducted Emission



Pictures 16 e 17 – Setup Radiated Immunity



Pictures 18 e 19 – Setup Radiated Immunity

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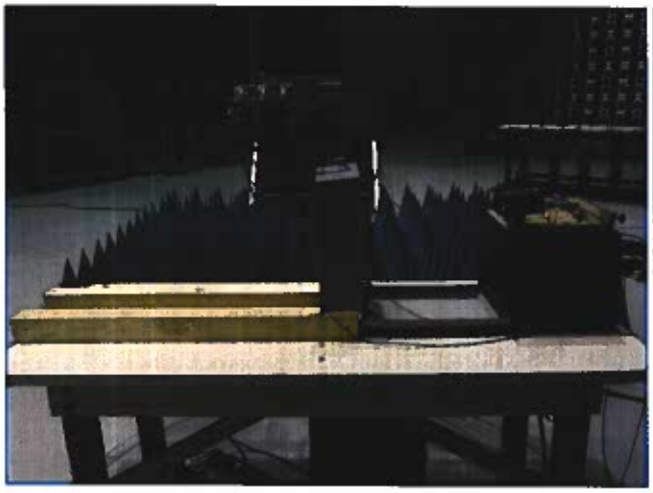
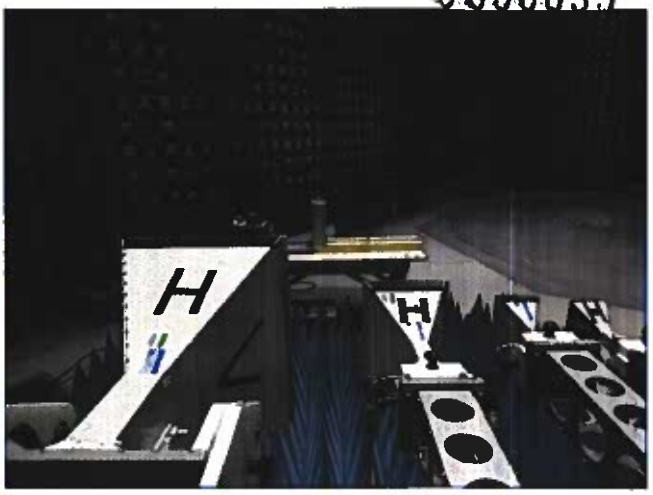
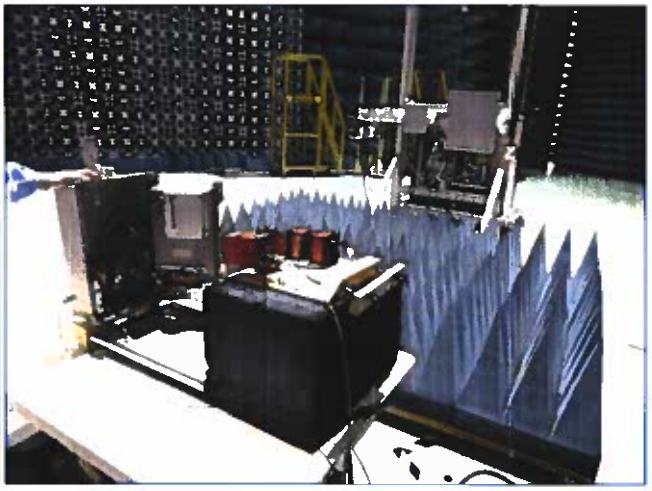
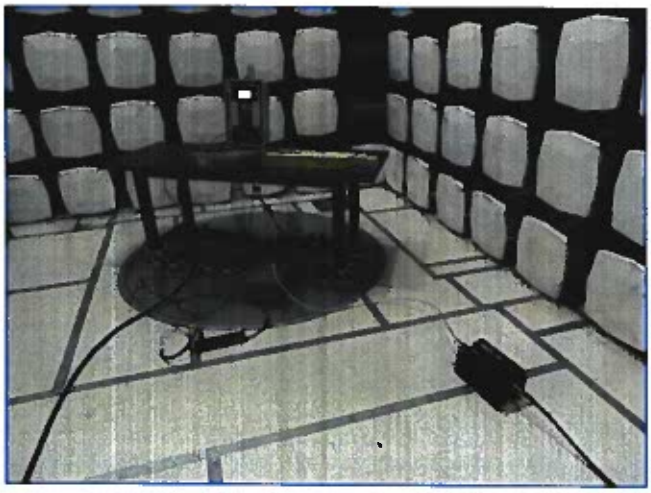


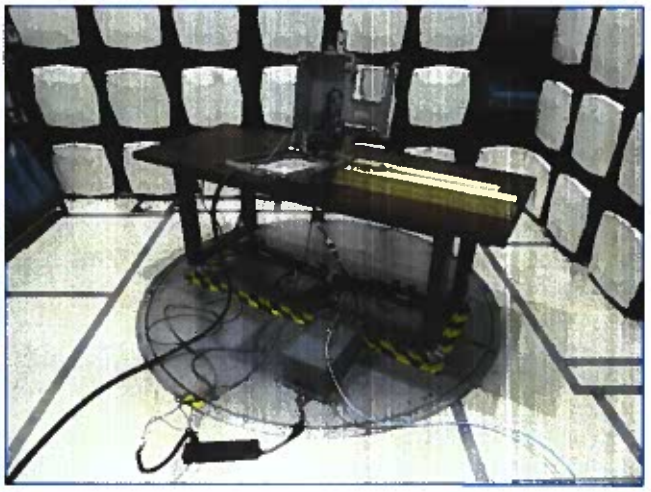


Pictures 20 e 21 – Setup Radiated Immunity



Pictures 22 e 23 – Setup Radiated Immunity





Pictures 24 e 25 – Setup Immunity Conducted (Phase / Neutral)

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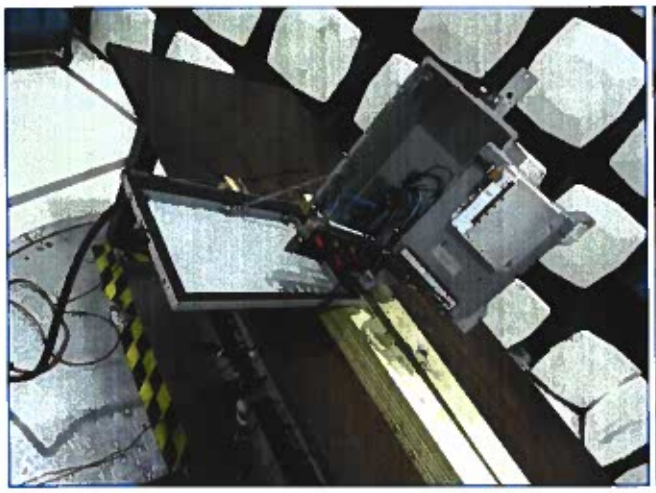
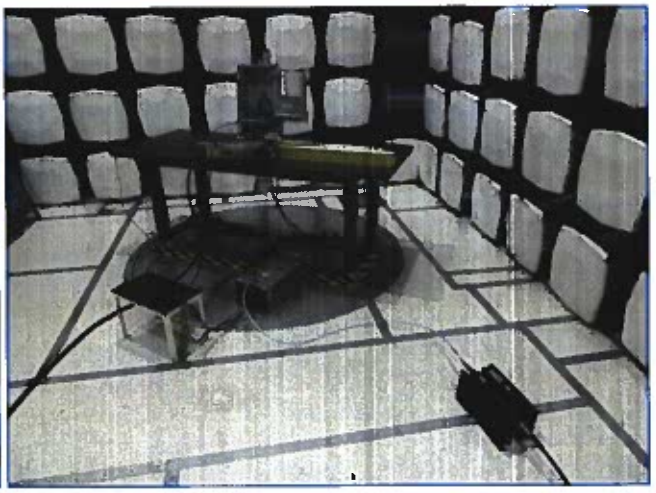
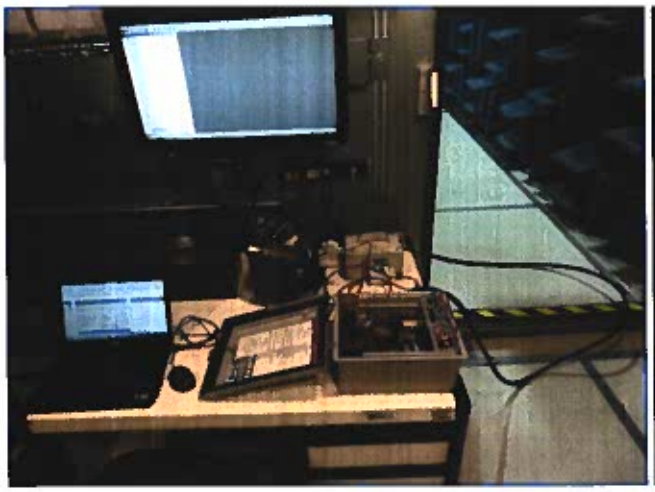




Pictures 26 e 27 – Setup Immunity Conducted (Phase / Neutral)

Pictures 28 e 29 – Setup Immunity Conducted (Phase / Neutral)



Pictures 30 e 31 – Setup Immunity Conducted (Phase / Neutral)

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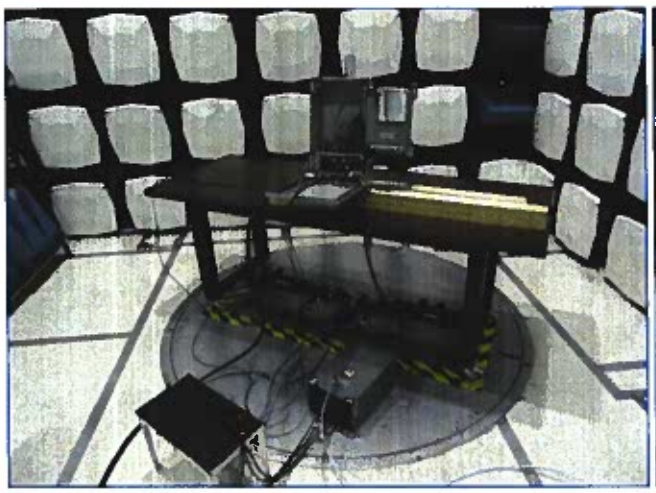
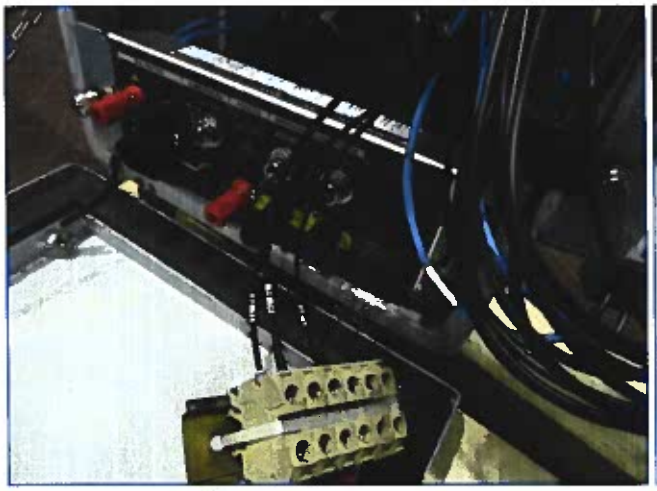
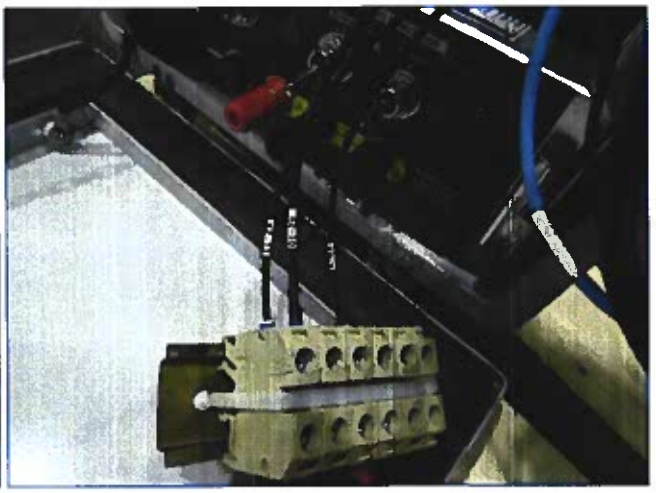
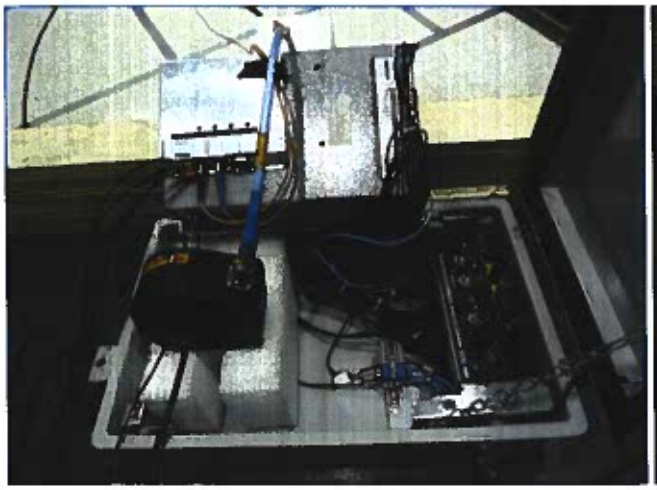


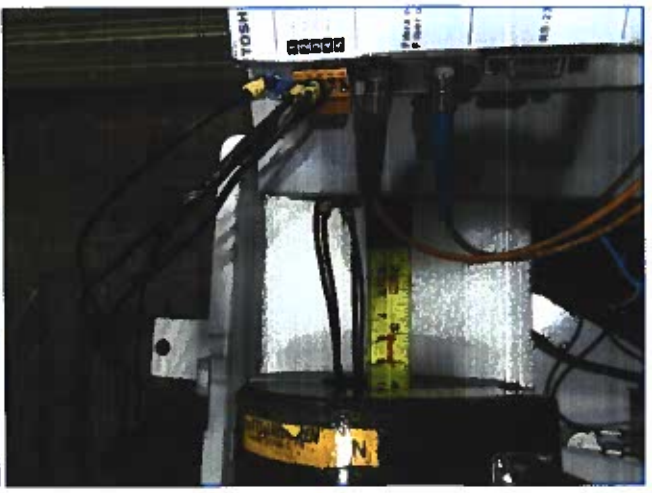
Pictures 32 e 33 – Setup Immunity Conducted (LN-Neutral - LN-Phase - IP - CO)





Pictures 34 e 35 – Setup Immunity Conducted (LN-Neutral - LN-Phase - IP - CO)





Pictures 36 e 37 – Setup Immunity Conducted (Jack X10 - +24 - CAN_L - CAN_H - GND)

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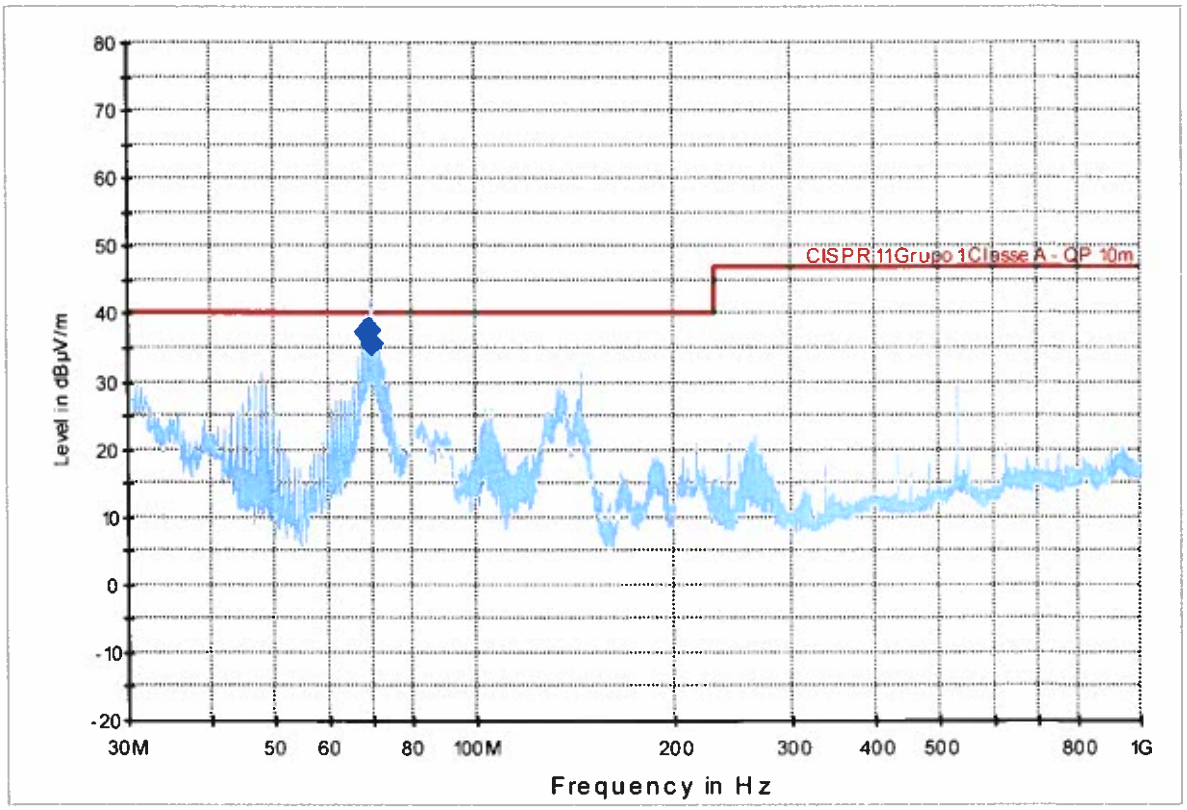
3. PERFORMED TESTS

3.1. RADIATED EMISSION TEST

Standard	Voltage	Notes	
CISPR 11 CISPR 22	120 Vac / 60 Hz	*Preview Measurement Detector 1*	*Peak detector*
		Final Measurement Detector 1	*Quasi-Peak detector (if necessary)*

Class	Distance	Polarization	Voltage	Operator
A	10 m	H / V	120 Vac / 60 Hz	Anderson Gonçalves

RE_CISPR 11_GR.1_CL.A_10 m



CISPR 11Grupo 1Classe A - QP 10m Preview Result 1-PK+ Final Result 1-QPK

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
68.400000	37.3	1000.0	120.000	200.0	V	270.0	-34.2	2.8	40.0
69.360000	37.6	1000.0	120.000	200.0	V	270.0	-34.3	2.4	40.0
69.840000	35.8	1000.0	120.000	200.0	V	270.0	-34.3	4.2	40.0

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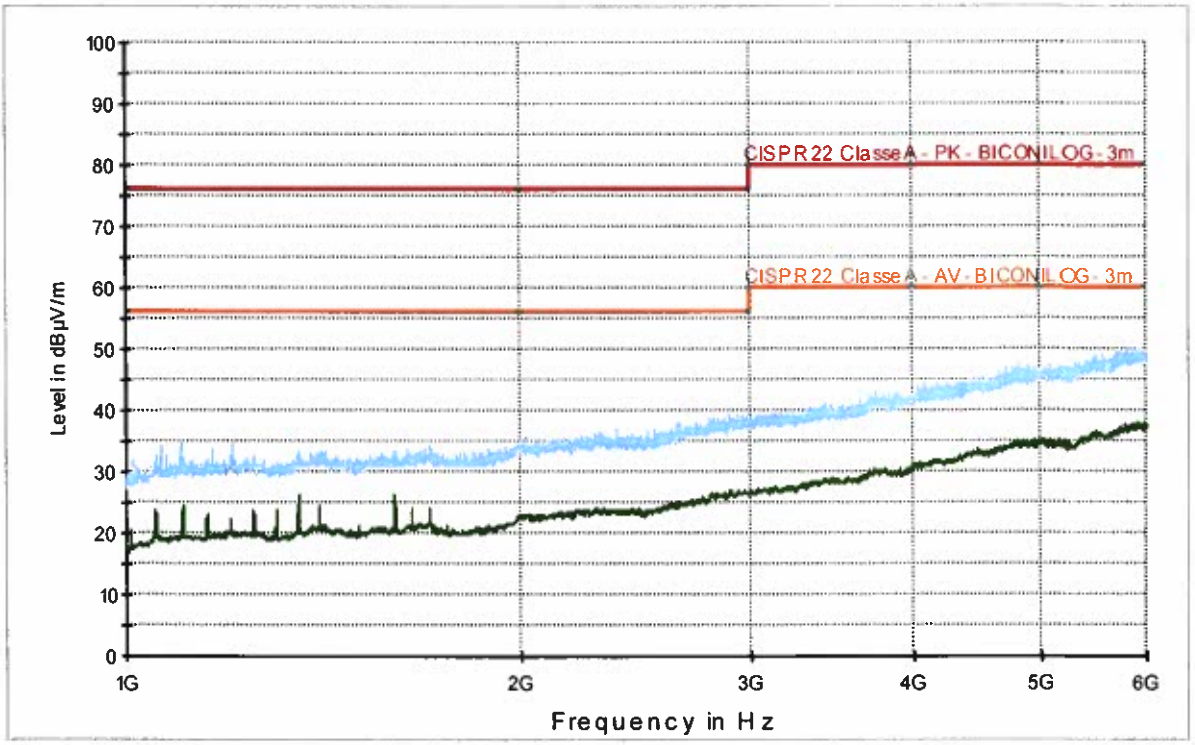
Class	Distance	Polarization	Voltage	Operator
A	3 m	H / V	120 Vac / 60 Hz	Anderson Gonçalves

RE_CISPR 22_CL.A_6 GHz_3 m



CISPR 22 Classe A - PK - BICONILOG - 3m
Preview Result 1-PK+
Data Reduction Result 1[3] - PK+
Final Measurement Result 1-QPK

CISPR 22 Classe A - AV - BICONILOG - 3m
Preview Result 2-AVG
Data Reduction Result 2[3] - AVG

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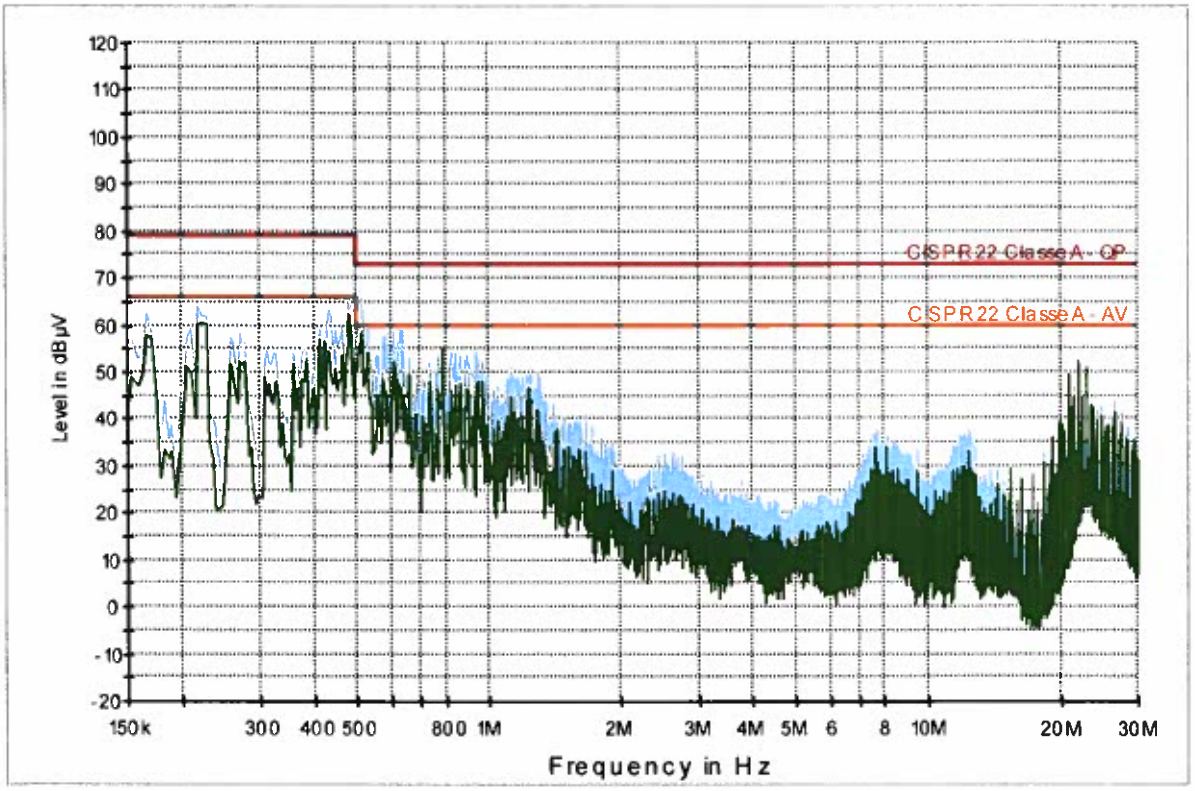
3.2. CONDUCTED EMISSION TEST

Standard	Voltage	Notes	
CISPR 22	120 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
A	Phase and Neutral	120 Vac / 60 Hz	Anderson Gonçalves

CE_CISPR 22_CL.A_LISN



CISPR 22 Classe A - QP
Preview Result 1-PK+
CISPR 22 Classe A - AV
Preview Result 2-AVG

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3.3. ELECTROSTATIC DISCHARGE IMMUNITY TEST

Standard base	Supply Voltage	Test Level Specification (kV)		Acceptance Criteria
IEC 61000-4-2	120 Vac / 60 Hz	Direct:	±2, ±4, ±6, ±8	B
		VCP / HCP:	±2, ±4, ±6, ±8	B
		Air:	±2, ±4, ±8, ±15	B
Note 1:	Test performed, and acceptance criteria according to IEC 60255-26: 2013.			
Note 2:	Functional assays before and after the test were conducted. The following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum. • Current Reading, voltage and frequency • Memories • alarms and faults Records • Data Display and operation of the HMI • Communication Ports. There were not observed operational changes while performing the functional tests. Analysis of the results indicates that the equipment is in accordance with the acceptance criteria.			

3.4. RADIATED ELECTROMAGNETIC FIELD IMMUNITY TEST

			Test Specification			
Standard base	Supply Voltage	Pol.	Level	Frequency range	Modulation	Acceptance Criteria
IEC 61000-4-3	120 Vac / 60 Hz	H / V	30 V/m	80 MHz a 1 GHz	AM, 80%, 1 kHz	A
			30 V/m	1,4 GHz a 2,7 GHz		A
Note 1:	Test performed, and acceptance criteria according to IEC 60255-26: 2013.					
Note 2:	Test SPOT FREQUENCY held in the 80 MHz frequency, 160 MHz, 380 MHz, 450 MHz, 900 MHz, 1850 MHz and 2150 MHz lasting 10 seconds each. For each frequency of interest a variation of the supply voltage is generated by a voltage inverter transformer causing the motor drive of the jig test, verifying the correct operation of the electronic control.					
Note 3:	Functional assays before and after the test were conducted. The following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum • Read current and voltage • Memories • Data Display and operation of the HMI • Communication Ports There were not observed operational changes while performing the functional tests. Analysis of the results indicates that the equipment is in accordance with the acceptance criteria.					
Note 4:	Performed with 7 seconds.					
Note 5:	A functional test was performed before and after the test and the machine does not show any change in its operation. The observation results indicate that the test was performed within the specified conditions.					

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3.5. ELECTRICAL FAST TRANSIENT/BURST IMMUNITY TEST

Standard base	Test Specification Level (kV)		Supply Voltage	Performance Criteria
IEC 61000-4-4	Supply terminals:	±4	120 Vac / 60 Hz	B
	Input and output terminals:	±4		B
Note 1:	Test performed, and acceptance criteria according to IEC 60255-26: 2013.			
Note 2:	Tested input and output terminals: EL_MOT, AB_MOT, LN-N, SELO, CO.			
Note 3:	During the test applied to power input there was temporary degradation of the displayed information on the LCD with equipment's re-initialization and self-recovery at the end of the test.			
Note 4:	Functional assays before and after the test were conducted. The following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum • Read current and voltage • Memories • Data Display and operation of the HMI • Communication Ports There were not observed operational changes while performing the functional tests. Analysis of the results indicates that the equipment is in accordance with the acceptance criteria			

3.6. SURGE IMMUNITY TEST

		Test Specification		
Standard base	**Supply Voltage**	**Type**	**Level (kV)**	**Performance Criteria**
IEC 61000-4-5	120 Vac / 60 Hz	Power supply terminal (differential mode)	±0,5; ±1; ±2	B
		Power terminal (common mode)	±0,5; ±1; ±2; ±4; ±5	B
		Input and output terminals (common mode)	±0,5; ±1; ±2; ±4	B
Note 1:	Test performed, and acceptance criteria according to IEC 60255-26: 2013.			
Note 2:	Tested input and output terminals: EL_MOT, AB_MOT, LN-N, SELO, CO. Pulse applied between line and ground.			
Note 3:	Functional assays before and after the test were conducted. The following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum. • Read current and voltage • Memories • Data Display and operation of the HMI • Communication Ports There were not observed operational changes while performing the functional tests. Analysis of the results indicates that the equipment is in accordance with the acceptance criteria.			

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

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		Test Specification			
Standard base	**Supply Voltage**	**Level**	**Frequency range**	**Modulation**	**Performance Criteria**
IEC 61000-4-6	120 Vac / 60 Hz	10 Vrms	150 kHz - 80 MHz	AM, 80%, 1 kHz	A

Note 1:	Test performed, and acceptance criteria according to IEC 60255-26: 2013.
Note 2:	The Test was applied to the power terminals, input and output terminals (EL_MOT, AB_MOT, LN-N, LN-F, IP, and SELO CO) and the socket terminals X5 (+ 24V, CAN_L, CAN_H and GND). During the test the equipment remained in automatic mode. The equipment was monitored by video camera focusing on display through jig testing and ASE software via DNP3 communication protocol.
Note 3:	SPOT FREQUENCY test performed at frequencies of 27 MHz and 68 MHz lasting 10 seconds each. For each frequency of interest a variation of the supply voltage is generated by a voltage inverter transformer causing the motor drive of the jig tests, verifying the correct operation of the electronic control. Functional assays before and after the test were conducted. The following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum. • Read current and voltage • Memories • Data Display and operation of the HMI • Communication Ports There were not observed operational changes while performing the functional tests. Analysis of the results indicates that the equipment is in accordance with the acceptance criteria.
Note 4:	Performed with 7 seconds.
Note 5:	A functional test was performed before and after the test and the machine does not show any change in its operation. The observation results indicates that the test was performed within the specified conditions.

3.8. POWER FREQUENCY MAGNETIC FIELD IMMUNITY TEST

Standard base	**Frequency (Hz)**	**Voltage**	**Test Level (A/m)**	**Performance Criteria**
IEC 61000-4-8	60	120 Vac / 60 Hz	30	A
			300	B

Note 1:	Test performed, and acceptance criteria according to IEC 60255-26: 2013.
Note 2:	The test duration for the level of 30 A / m was greater than 60 seconds; The duration of the test to the level of 300 A / m was greater than 3 seconds.
Note 3:	Functional assays before and after the test were conducted. The following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum • Read current and voltage • Memories • Data Display and operation of the HMI • Communication Ports There were not observed operational changes while performing the functional tests. Analysis of the results indicates that the equipment is in accordance with the acceptance criteria.

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

Standard base	Test Specification		Performance Criteria
	Voltage reduction (%)	Period duration (cycles)	120 Vac
IEC 61000-4-11	100	1	A
	60	12	C
	30	30	C
	100	300	C

Note 1:	Test performed, and acceptance criteria according to IEC 60255-26: 2013.
Note 2:	(Item 8.2 - Table 13 of the IEC 60255-26)
Note 3:	During the reduction test 60% for 12 cycles, 30% for 30 cycles, and reduction of 100% for 300 cycles was shutdown of the equipment. After completion of the test equipment without operator intervention, returned to normal operation. Functional assays before and after the test were conducted. The following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum. • Read current and voltage • Memories • Data Display and operation of the HMI • Communication Ports There were not observed operational changes while performing the functional tests. Analysis of the results indicates that the equipment is in accordance with the acceptance criteria.

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3.10. AC OR DC VOLTAGE TEST DIELECTRIC

Acceptance Criteria:

During testing should not occur dischargers or dielectric breakdown.

Independent Circuits		Run tests between independent circuits of each group	Test voltage
Group 1:	Circuit 1X1 (all pins)	Circuit 1 against the panel B chassis	2 kV
Group 2:	Circuit 2: X2 pin 1 to pin 17 and X3 (All pins); Circuit 3: X2 pin 18-20; Circuit 4: Rulers X5, X6, X7, X8 and X9 (all pins).	Circuit 2 against other circuits in the group E Control chassis; Circuit 3 against other circuits in the group E Control chassis; Circuit 4 against other circuits in the group E Control chassis.	2 kV 2 kV 2 kV
Group 3:	Circuit 5: Ruler X10 (all pins); Circuit 6: D89 connector (all pins).	Circuit 5 against other circuits in the group E Control chassis; Circuit 6 against other circuits in the group E Control chassis;	2 kV 0,5 kV
Note:	Test performed according to IEC 60255-27: 2013. During testing should not occur dischargers or dielectric breakdown. Functional tests were performed before and after the test, the following points have been checked. • Command raise and lower position • Counting operations • Reading actual position, maximum and minimum. • Read current and voltage • Memories • Data Display and operation of the HMI • Communication Ports Analysis of the results indicates that the equipment is in accordance with the criteria for acceptance.		

3.11. INSULATION RESISTANCE

Acceptance Criteria:

The measured insulation resistance must not have value less than 100MΩ.

Independent Circuits		Run tests between independent circuits of each group	Test voltage	Measured value
Group 1:	Circuit 1: X1 (all pins)	Circuit 1 against the panel B chassis	500 V	31,1 GΩ
Group 2:	Circuit 2: X2 pin 1 to pin 17 and X3 (All pins); Circuit 3: X2 pin 18 to 20; Circuit 4: Rulers X5, X6, X7, X8 and X9 (all pins).	Circuit 2 against other circuits of the group E control chassis; Circuit 3 against other circuits of the group E control chassis; Circuit 4 against other circuits of the group E control chassis;	500 V 500 V 500 V	2,58 GΩ 512 GΩ 3,13 GΩ
Group 3:	Circuit 5: Ruler X10 (all pins); Circuit 6: Connector D89 (all pins).	Circuit 5 against other circuits of the group E control chassis; Circuit 6 against other circuits of the group E control chassis;	500 V 500 V	2,45 GΩ 444 GΩ
Note 1:	Test performed according to IEC 60255-27: 2013.			
Note 2:	The measured value was given at a time interval after application of the test voltage is not less than 5 seconds. Analysis of the results indicates that the equipment is in accordance with the criteria for acceptance.			

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4. MONITORING

Through video camera viewing the display and via the test jig.

5. ADDITIONAL INFORMATION

All assays were performed with 15 m multicable control and communication card.

6. PERFORMANCE CRITERIA

Criteria	Function	Conditions for acceptance
A	Protection	Normal performance within the specification limits, during and after the test.
	Command and control	Normal performance within the specification limits, during and after the test.
	Measurement	No degradation during test.
	Integral human-machine interface and visual alarms	No degradation or no loss of function during test. No loss of stored data.
	Data communication b	Possible bit error rate increase but no loss of transmitted data.
	Binary input, binary output and output contacts	No unwanted change of status is allowed during the test a.
B	Protection	Normal performance within the specification limits, during and after the test.
	Command and control	Normal performance within the specification limits, during and after the test.
	Measurement	Temporary degradation during test, with self-recovery at the end of the test. No loss of stored data.
	Integral human-machine interface and visual alarms	Temporary degradation or loss of function during test, with selfrecovery at the end of the test. No loss of stored data.
	Data communication b	Possible bit error rate increase but no loss of transmitted data.
	Binary input, binary output and output contacts	No unwanted change of status is allowed during the test a.
C	Protection	Temporary loss of function provided the function is selfrecoverable. No unwanted operation shall be observed.
	Command and control	Temporary loss of function provided the function is selfrecoverable. No unwanted operation shall be observed.
	Measurement	Temporary loss of function provided the function is selfrecoverable.
	Integral human-machine interface and visual alarms	Temporary loss of function provided the function is selfrecoverable.
	Data communication b	Temporary loss of function provided the function is selfrecoverable Possible loss of transmitted data.
	Binary input, binary output and output contacts	No unwanted change of status is allowed during the test a.

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7. MEANS AND DEVICES USED FOR TESTING

Devices	Model	Manufacturer	Serial #
Anechoic chamber	-	-	-
Computer	-	-	-
Software	EMC32	Rohde & Schwarz	-
Antena Biconilog	3142 E	ETS - Lindgren	00157711
Receiver	ESPI 3	R&S	101344
LISN - Line Impedance Stabilization Network	NSLK 8126	Schwarzbeck Mess-Elektronik	8126-407
Electric Field Sensor	HI-6105	ETS - Lindgren	81315
Signal Generator	SMB 100A	Rohde & Schwarz	107258
Amplificador	BBA-100	R&S	101024
Power Meter	NRP2	Rohde & Schwarz	102769
Power Sensor	NRP-Z91	Rohde & Schwarz	102046
Power Sensor	NRP-Z91	Rohde & Schwarz	102047
Signal Generator	SMB 100A	Rohde & Schwarz	175847
Amplifier	AS0104-200/100	MILMEGA	1049223
Power Meter	NRP2	Rohde & Schwarz	102075-RH
Power Sensor	NRP-Z81	Rohde & Schwarz	101595
Coupling / decoupling network	FCC-801-m5-50A	05002	FCC
Electrostatic discharge simulator	ESD30N	EM TEST	V0116106291
Hand held discharge unit	P30N	EM TEST	V0116106292
Ultra-compact simulator	UCS500N5	EM TEST	V1016106293
Coupling / decoupling network	CNI503A2	EM TEST	V1016106294
Telecom surge generator	TSS500M4	EM TEST	V1016106295
Coupling / decoupling network	CNV508S1	EM TEST	V1016106296
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
Meter High Strength - Megômetro	4339B	Agilent	MY43102716
Hipot Tester	RD-736	Supplier	00287

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8. MEASUREMENT UNCERTAINTY

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

Item	Test	Uncertainty
3.1	Radiated Emission	- In the Frequency Range from 30 MHz to 1000 MHz $\mu = \pm 6,4$ dB / k = 2
3.2	Conducted Emission	- In the Frequency Range from 9 kHz to 30 MHz $\mu = \pm 3,75$ dB / k = 2
3.3	Electrostatic discharge immunity test	$\varepsilon = \pm 10$ % / k = 2
3.4	Radiated electromagnetic field immunity	$\mu = \pm 1,78$ dB / k = 2
3.5	Electrical fast transient/burst immunity	$\varepsilon = \pm 10$ % / k = 2
3.6	Surge immunity	$\varepsilon = \pm 10$ % / k = 2
3.7	Immunity to conducted disturbances induced by radio-frequency fields	$\mu = \pm 2,4$ dB / k = 2
3.8	Power Frequency Magnetic Field Immunity	$\varepsilon = \pm 9,24$ % / k = 2
3.9	Voltage dips, short interruptions and voltage variations immunity	$\mu = \pm 0,3$ dB / k = 2
3.10	AC or DC dielectric voltage test	-
3.11	Insulation Resistance	$\mu = \pm 9,24$ dB / k = 2

9. VERSION CONTROL

Pagination	Version	Date	Change reference
1 to 20	01	December 14th, 2015	- Original version.
1 to 20	02	January 07th, 2016	- Page 13: The item 3.3 was corrected. - Page 14: The item 3.5 was corrected. - Page 17: The item 3.10 was corrected.
1 to 20	03	January 08th, 2016	- The items 3.3 to 3.10 was corrected the notes.
1 to 20	04	February 15th, 2016	- Page 18: The performance criteria were corrected.

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INSTITUTO DE PESQUISAS TECNOLOGICAS

Electrical and Optical Equipment Laboratory / CTMNE / IPT

MEASUREMENT REPORT Nº 21 597-204

CUSTOMER: TRANSFORMADORES E SERVICOS DE ENERGIA DAS AMERICAS LTDA - TSEA
CNPJ: 08.870.769/0001-72
Rodovia BR-381, 3045
32240-090 – Contagem – MG

MATERIAL: Control for Voltage Multiphasic Regulator, TVC-MP model.

SUBJECT OF WORK: Tests performed according to IEC 60255-26:2013, IEC 60255-27:2013, IEC 60255-5:2000 and IEC 61000-4-18:2006 standards.

REFERENCE: Proposal CTMNE/LEO 2626/18 in 03/02/2018.
Acceptance by Purchase Order 514242 in 05/10/2018.

1 MATERIAL

Material declared by customer: Control for Voltage Multiphasic Regulator, TVC-MP model. The same is shown in Figure 1, below:

(a) **(b)**

Figure 1 – (a) e (b) Control for Voltage Multiphasic Regulator, TVC-MP model (no serial number presented).

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