Finatel
Fundação Instituto Nacional de Telecomunicações

TEST REPORT

MANUFACTURER:
WEG Equipamentos Elétricos S.A.

MODEL:
PCB Antenna sensor WEGscan 100 and 101

RE039/023i

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1 Customer

a) Name: WEG Equipamentos Elétricos S.A - Motores.
b) Address: Rua Venâncio da Silva Porto– Parque Fabril 1 – Prédio 23– ZIP CODE: 89.252-230 – City: Jaraguá do Sul – State: Santa Catarina – Country: Brasil
c) Phone.: 55-47- 3276-6651
d) Contacts: Sr. Hugo Gustavo Gomes Mello e-mail: hugom@weg.net

2 Laboratory

a) Test site:: **INATEL – Instituto Nacional de Telecomunicações**
Competence Center Laboratório de Ensaios e Calibração
Tel.: 0XX35 3471 9333 / 9298 FAX.: 0XX35 3471 9310
www.inatel.br ensaios@inatel.br
b) Responsible: Gilberto V. B. Magalhães
c) Date of receipt of sample: 20/11/2023
d) Period of the test: 21/11/2023 a 29/11/2023
e) OS Number da OS: 1171/2023
f) Report number: **RE039/023i**

3 Manufacturer

a) Name: WEG Equipamentos Elétricos S.A - Motores.
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4 Product

a) Description: PCB Antenna sensor WEGscan 100 and 101
b) Part number:
Antenna – NS 1069530525

c) Photograph record: (Figure 1)

The tests were performed in the following sequence:
- Return Loss
- Antenna Gain

Antenna – NS 1069530525

Figure 1- Equipment under test overview.

5 Laboratory Conditions

- Temperature: 22,0 ºC a 24,5ºC
- Humidity : 43,7% a 58,1%

6 Revision History

Revision number	Description	Date	Page number
0	First issue	19/12/2023	---

7 Gain Measurement - Three antenna Method description

Reference: https://ieeexplore.ieee.org/document/8963498

7.1 *Introduction*

Antenna is a part of a transmitting or receiving system that is designed to radiate or to receive electromagnetic waves. The gain of an antenna is defined as "the ratio of the radiation intensity, in a given direction, to the radiation intensity that would be produced if the power accepted by the antenna were isotropically radiated"[1]. The realized gain is the antenna gain that reduced by its impedance mismatch factor. The three-antenna extrapolation technique is well known as the most accurate way to determine the antenna gain.

7.2 *Three-antenna extrapolation method*

Gain measurements are based upon the Friis transmission formula, for a pair of antennas, the power received at the matched load connected to the receiving antenna is given by:

1 IEEE Standard for Definitions of Terms for Antennas.

$$P_r = P_0 G_A G_B \left(\frac{\lambda}{4\pi R}\right)^2$$

Where Pr is the power received, P0 is the power accepted by the transmitting antenna, GA and GB are the gains of the transmitting antenna and the receiving antenna, respectively, R is the separation between the two antennas, and λ is the wavelength.

For a three-antenna method, three sets of measurements are performed, and three gain products equations are obtained for nominally linearly polarised antennas, from which each antenna's gain can be solved. It is an absolute method, and no transfer standard is required.

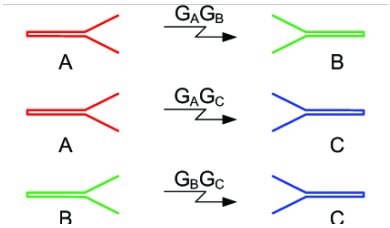

Figure 2- Three-antenna gain measurement.

8 Measurement Uncertainty

8.1 *What is Measurement Uncertainty*

When a measure is executed, the result will be different from the true value or the correct target value. The difference is the result of measurement system tolerances that cannot be completely eliminated. To some extent we can minimize this error. The following measurement uncertainty statement is used to reflect the accuracy of the measurement result to compare with the "true" value.

8.2 *Uncertainty Calculations*

The expanded measurement uncertainty reported ("U") is declared as the combined standard uncertainty (uc) multiplied by factor "K" (Coverage Factor), to a confidence level of 95%.

8.2.1 Return loss Uncertainty

U=±0,5dB for RL until 10 dB.
U=±0,7dB for RL from 10 dB until 20dB.
U=±1,0dB for RL from 20 dB until 30dB.
U=±1,5dB for RL from 20 dB until 30dB.

8.2.2 Gain Measurement Uncertainty

U=±2,0dB

9 Test Development

9.1 *Return Loss (50Ω)*

Test equipment:

- Network Analyzer Agilent (E5071C)
- Open, Short and Load

Setup/Test Procedure:

The Return Loss was done directly by the network analyzer (S11 port) after the calibration procedure using Open, Short and Load. To do the test it was mounted some components (match circuit) (C17 - 0,3pF; L3 - 4,7nH; C18 - 0,8pF; C13 - 5,6nH and C16- 0,8pF) and was solder the cable as we can see in Figure 3. It was used the the cable CAB.720 (TAOGLAS).

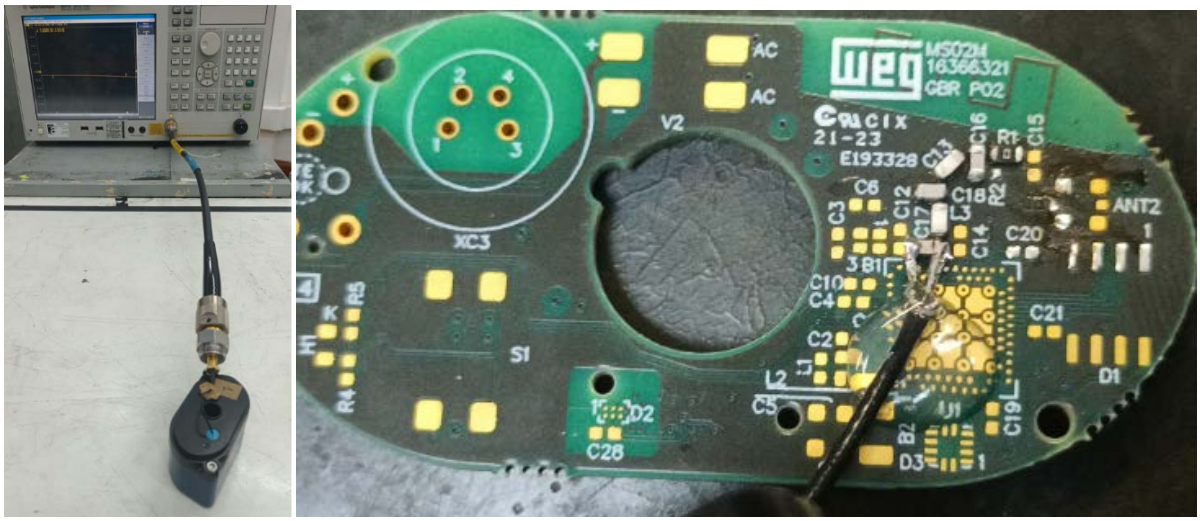

Figure 3- Product set up for Return Loss Measurement.

Test result:

The test result is show in and Figure 4 (Antenna)

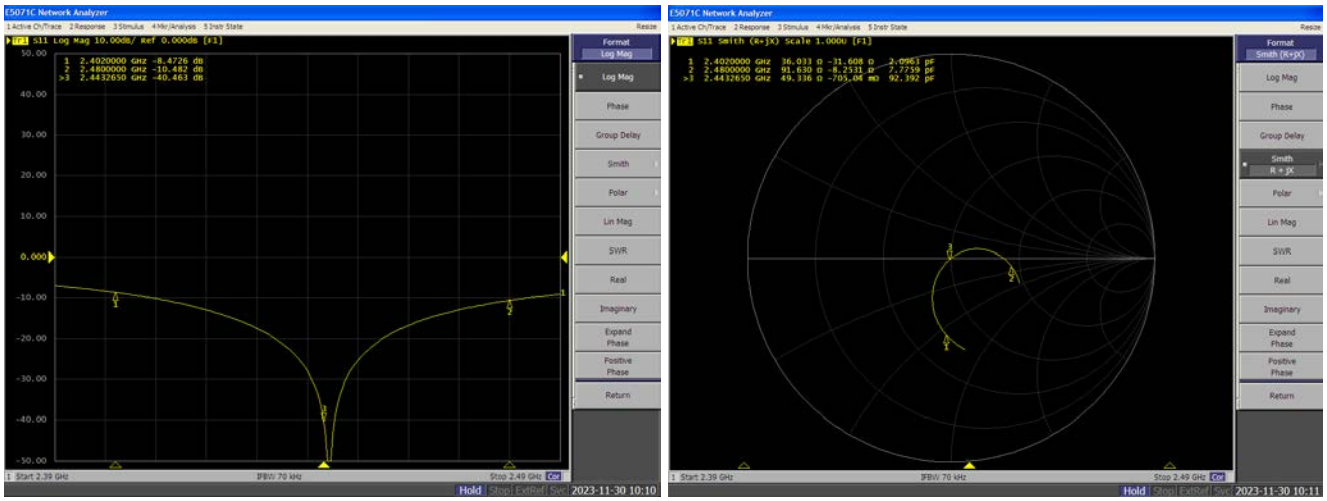

Figure 4- Antenna Measurement (Log Mag and Smith).

9.2 *Antenna Gain*

Test equipment:

- Network Analyzer Agilent (E5071C)
- Open, Short and Load
- Antenna test (1 and 2)

Setup/Test Procedure:

It was used three antenna method. The antennas was mounted inside a semi anechoic chamber (two antennas each time) with 3 meters distance from each other at 1,5 meters high. (Figure 5).

The Antenna Gain measurement was done using a network analyzer (Response) using two ports, one connected to a TX antenna and other to a RX antenna. All the system was calibrated together including RF cables (Huber SUHNER Sucoflex 104). First of all was calibrated Short and Open at the end of TX antenna. After that was calibrated the Response by connecting TX and RX cables using a F connector to adapt. So in this case, all the cables are compensated for the test. The test was made with -5dBm power.

To do the test it was mounted some components (match circuit) (C17 - 0,3pF; L3 - 4,7nH; C18 - 0,8pF; C13 - 5,6nH and C16- 0,8pF) and was solder the cable as we can see in Figure 3. It was used the cable CAB.720 (TAOGLAS). It was considered a cable loss of 0,85dB for calculation the gain.

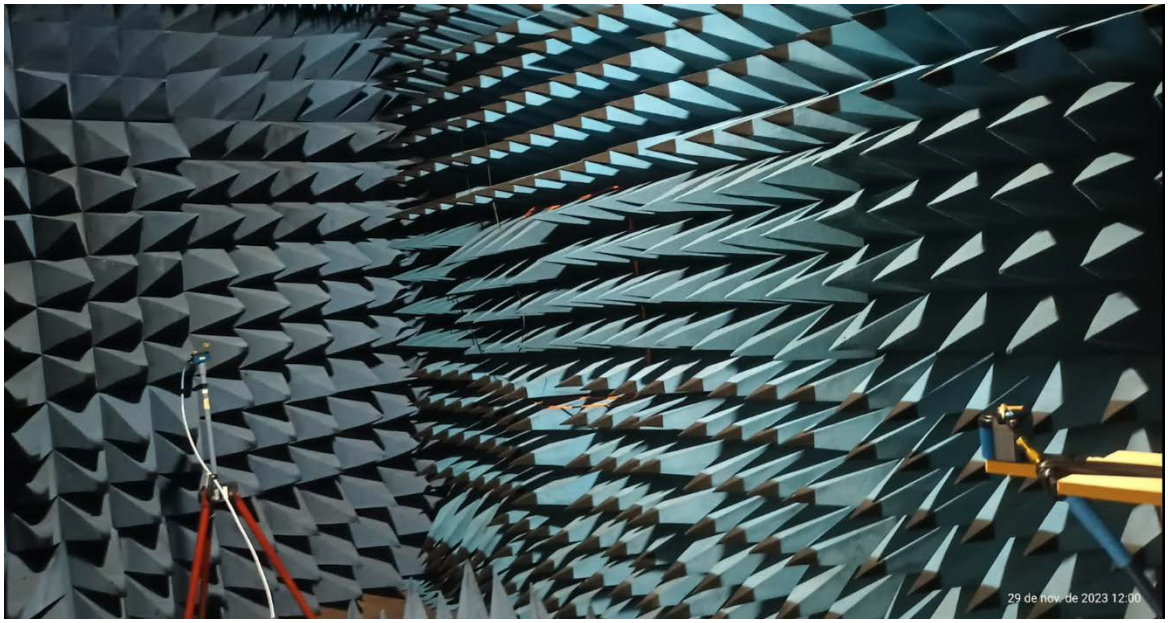

Figure 5- Setup for Antenna Gain measurement.

Test result:
The Gain versus frequency graph is shown in Figure 6.

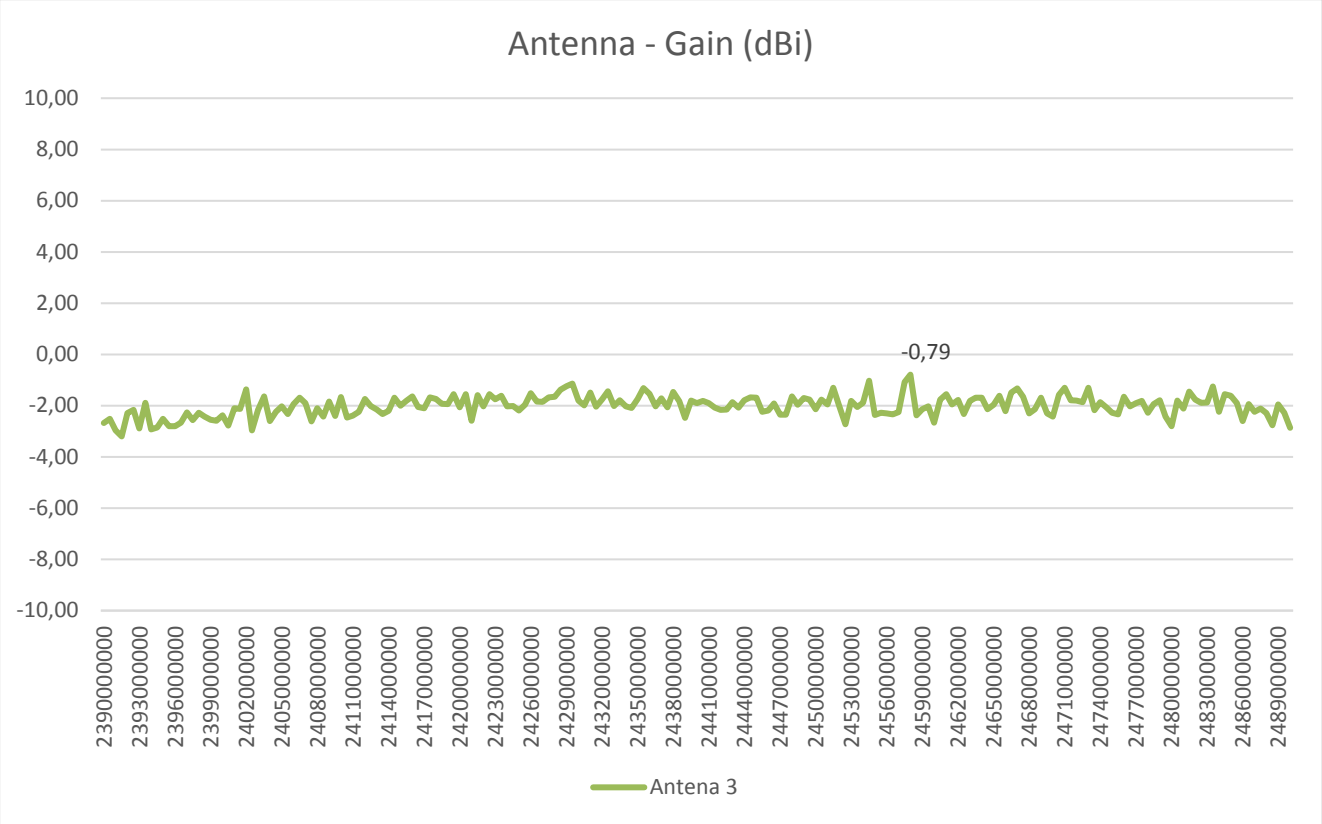

Figure 6- Antenna Gain Graph.

The medium and Maximum Gain are show in Table 1 and Table 2.

Table 1- Medium Gain.

Medium Gain	Range
-1,93dBi	2,402GHz to 2,480GHz

Table 2- Maximum Gain.

Maximum Gain	Frequency
-0,79dBi	2,458GHz

10 Statement

We declare that this report refers exclusively to the laboratory conditions registered herein and to the tests performed on the PCB Antenna sensor WEGscan 100 and 101 manufactured by WEG Equipamentos Elétricos S.A., and that the contents of this report cannot be extended to any other equipment, even if similar.

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This report contains 9 sheets numbered, digitally by the signatory.

As it is the exact expression of the truth, I sign this declaration.

Santa Rita do Sapucaí, December 19th, 2023.

Test Execution and Report Approval:

Gilberto Vilas Boas Magalhães
TECHNICAL MANAGER
Authorized signatory

GILBERTO VILAS BOAS MAGALHAES:72526661668

Assinado de forma digital por GILBERTO VILAS BOAS MAGALHAES:72526661668
Dados: 2023.12.19 09:41:10 -03'00'