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## **FCC PART 22 TEST REPORT**

|                         |                                                                        |
|-------------------------|------------------------------------------------------------------------|
| APPLICANT               | FUNK-ELECTRONIC PICIORGROS GMBH                                        |
|                         | Claudiastr. 5 * 51149                                                  |
|                         | Cologne, GERMANY                                                       |
| FCC ID                  | TO9TMO100                                                              |
| MODEL NUMBER            | TMO100                                                                 |
| PRODUCT DESCRIPTION     | TMO-100 SCADA and Telemetry Modem for<br>TETRA Infrastructures         |
| STANDARD APPLIED        | CFR 47 Part 22                                                         |
| DATE SAMPLE<br>RECEIVED | 4/16/2014                                                              |
| DATE TESTED             | 4/22/2014                                                              |
| REPORT ISSUE DATE       | 4/24/2014                                                              |
| TESTED BY               | NAM NGUYEN                                                             |
| APPROVED BY             | NAM NGUYEN                                                             |
| TIMCO REPORT NO.        | 619AUT14TestReport                                                     |
| TEST RESULTS            | <input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL |

|                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------|
| <b>THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL<br/>WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.</b> |
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## GENERAL REMARKS

The attached report shall not be reproduced except in full without the written permission of Timco Engineering Inc.

## Summary

The device under test does:

- ☒ fulfill the general approval requirements as identified in this test report  
☐ not fulfill the general approval requirements as identified in this test report

## Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that the necessary measurements were made, under my supervision, at:

Timco Engineering Inc.  
849 NW State Road 45  
Newberry, Fl 32669



## Authorized Signatory Name:

Nam Nguyen  
Engineering Project Manager

**Date: 4/24/2014**

## GENERAL INFORMATION

### EUT Specification

|                                    |                                                                           |
|------------------------------------|---------------------------------------------------------------------------|
| <b>EUT Description</b>             | TMO-100 SCADA and Telemetry Modem for TETRA Infrastructures               |
| <b>FCC ID</b>                      | TO9TMO100                                                                 |
| <b>Model Number</b>                | TMO100                                                                    |
| <b>Operating Frequency</b>         | 454 -460 MHz                                                              |
| <b>Serial Number</b>               | 2180                                                                      |
| <b>Type of Emission</b>            | 21K0D1W                                                                   |
| <b>Modulation</b>                  | $\pi/4$ DQPSK (TETRA)                                                     |
| <b>EUT Power Source</b>            | <input type="checkbox"/> 110–120Vac/50– 60Hz                              |
|                                    | <input checked="" type="checkbox"/> DC Power (12V to 24V)                 |
|                                    | <input type="checkbox"/> Battery Operated Exclusively                     |
| <b>Test Item</b>                   | <input type="checkbox"/> Prototype                                        |
|                                    | <input checked="" type="checkbox"/> Pre-Production                        |
|                                    | <input type="checkbox"/> Production                                       |
| <b>Type of Equipment</b>           | <input checked="" type="checkbox"/> Fixed                                 |
|                                    | <input type="checkbox"/> Mobile                                           |
|                                    | <input type="checkbox"/> Portable                                         |
| <b>Test Conditions</b>             | The temperature was 26°C<br>relative humidity of 50%.                     |
| <b>Revision History to the EUT</b> | None                                                                      |
| <b>Test Exercise</b>               | The EUT was placed in continuous transmit mode.                           |
| <b>Applicable Standards</b>        | ANSI/TIA 603-C:2004, FCC CFR 47 Part 22                                   |
| <b>Test Facility</b>               | Timco Engineering Inc.<br>849 NW State Road 45<br>Newberry, FL 32669 USA. |

## EQUIPMENT LIST

| Device                                 | Manufacturer    | Model      | Serial Number | Cal/Char Date | Due Date |
|----------------------------------------|-----------------|------------|---------------|---------------|----------|
| Antenna: Biconnical                    | Eaton           | 94455-1    | 1096          | 05/10/13      | 05/10/15 |
| Antenna: Log-Periodic                  | Electro-Metrics | LPA-25     | 1122          | 05/09/13      | 05/09/15 |
| Antenna: Double-Ridged Horn/ETS Horn 2 | ETS-Lindgren    | 3117       | 00041534      | 10/05/12      | 10/05/14 |
| Hygro-Thermometer                      | Extech          | 445703     | 0602          | 06/20/13      | 06/20/15 |
| Digital Multimeter                     | Fluke           | 77         | 35053830      | 08/22/13      | 08/22/15 |
| Notch Filter                           | Microlab        | HA-10N     | NA            | 5/17/13       | 5/17/15  |
| Notch Filter                           | Microlab        | HA-20N     | NA            | 5/17/13       | 5/17/15  |
| Tunable Notch Filter                   | Eagle           | 210BFBF    | NA            | 9/15/13       | 9/15/15  |
| Antenna: Double-Ridged Horn            | Electro-Metrics | RGA-180    | 2319          | 06/19/12      | 06/19/14 |
| Antenna: Dipole Kit                    | Electro-Metrics | TDA-30/1-4 | 152           | 11/01/13      | 11/01/15 |
| 3-Meter Semi-Anechoic Chamber          | Panashield      | N/A        | N/A           | 12/31/13      | 12/31/15 |
| EMI Test Receiver                      | Rohde & Schwarz | ESIB40     | 100274        | 2/15/13       | 2/15/15  |
| EMI Test Receiver                      | Rohde & Schwarz | ESU40      | 100320        | 3/21/13       | 3/21/15  |

### EMI TEST RECEIVER FIRMWARE VERSION USED

| Manufacturer    | Model  | Receiver Firmware | BIOS Ver  |
|-----------------|--------|-------------------|-----------|
| Rohde & Schwarz | ESU40  | 4.43 SP3          | V5.1-24-3 |
| Rohde & Schwarz | ESIB40 | 4.34.3            | 3.3       |

## TEST PROCEDURE

**Power Line Conducted Interference:** The procedure used was ANSI/TIA 603-C: 2004, using a 50uH LISN. Both lines were observed with the DUT transmitting. The bandwidth of the spectrum analyzer was 10 kHz with an appropriate sweep speed.

**Bandwidth 20 dB:** The measurements were made with the spectrum analyzer's resolution bandwidth (RBW) = 1 MHz and the video bandwidth (VBW) = 3 MHz and the span set as shown on plot.

**Power Output:** The RF power output was measured at the antenna feed point using a peak power meter.

**Antenna Conducted Emissions:** The RBW = 100 kHz, VBW = 300 kHz and the span set to 10.0 MHz and the spectrum was scanned from 30 MHz to the 10<sup>th</sup> harmonic of the fundamental. Above 1 GHz the resolution bandwidth was 1 MHz and the VBW = 3 MHz and the span to 50 MHz.

**Radiation Interference:** The test procedure used was ANSI/TIA 603-C:2004, using a Rohde & Schwarz – EMI test receiver. The bandwidth (RBW) of the spectrum ANSI/TIA 603-C:2004, receiver was 100 kHz up to 1 GHz and 1 MHz above 1 GHz with an appropriate sweep speed. The VBW above 1 GHz was 3 MHz. The analyzer was calibrated in dB above a microvolt at the output of the antenna.

## RF POWER OUTPUT

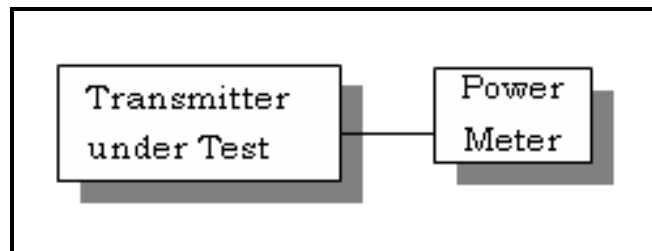
**Rule Part No.:** Part 2.1046(a), Part 22

**Test Requirements:** Manufacturer's Specification

**Method of Measurement:** RF power is measured by using a 50-ohm, resistive wattmeter to the RF output connector. With a nominal battery voltage (if battery operated), or a properly adjusted power supply (if not battery operated), and the transmitter properly adjusted the RF output measures:

For the device with a fixed or integral antenna, the RF power is measured as ERP. The substitution method was used. The RF output measures:

**Test Setup Diagram:**



**Test Data: RF power of the EUT can be set at 5.00W.**

OUTPUT POWER:

| Tuned Frequency (MHz) |      |
|-----------------------|------|
| 454.025               | 4.91 |
| 459.975               | 5.05 |

### Part 2.1033 (C)(8) DC Input into the final amplifier

Nominal dc voltage: 12.0-24.0 V, dc maximum current: 0.3 A

FOR HIGH POWER SETTING INPUT POWER:  $(18.0V)(0.3A) = 5.4Watts$

## **MODULATION CHARACTERISTICS**

**Rule Part No.:** Part 2.1047(a)(b)

### **Method of Measurement:**

*Audio frequency response*

The audio frequency response was measured in accordance with ANSI/TIA 603-D: 2010. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 – 5000Hz shall be submitted. The audio frequency response curve is shown below.

#### **AUDIO FREQUENCY RESPONSE PLOT**

NA (TETRA equipment - digital modulation)

## **VOICE MODULATED COMMUNICATION EQUIPMENT**

**Part 2.1047(a):** For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all the circuitry installed between the modulation limiter and the modulated stage shall be submitted.

#### **AUDIO LOW PASS FILTER.**

NA (TETRA equipment - digital modulation)

## **AUDIO INPUT VERSUS MODULATION**

**Rule Part No.:** Part 2.1047(b)

**Method of Measurement:** **Modulation cannot exceed 100%,** The audio input level needed for a particular percentage of modulation was measured in accordance with ANSI/TIA 603-D: 2010. The audio input curves versus modulation are shown below. Curves are provided for audio input frequencies of 300, 1000, and 3000 Hz.

NA (TETRA equipment - digital modulation)

## **OTHER MODULATION CHARACTERISTICS**

**Part 2.1033(c)**

**Part 2.1033(c) (4)** Type of Emission: 21K0D1W

**Part 22.357**

Type of Emission:  $\pi/4$ DQPSK TETRA as defined in EN 300 392-2.

TETRA is a digital, trunked radio technology that operates with Time Division Multiple Access (TDMA) in four-slot channels within a twenty-five kilohertz bandwidth.

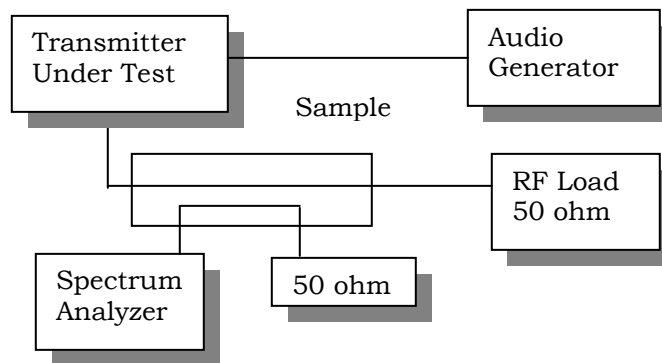
## EMISSION LIMITATIONS

### Part 22.731

Upon application for multichannel operation, the FCC may authorize emission bandwidths wider than those specified in §22.357, provided that spectrum utilization is equal to or better than that achieved by single channel operation.

**Method of Measurement: ANSI/TIA 603-D: 2010**

#### Test Setup Diagram:



**Test Data:** See the plots below

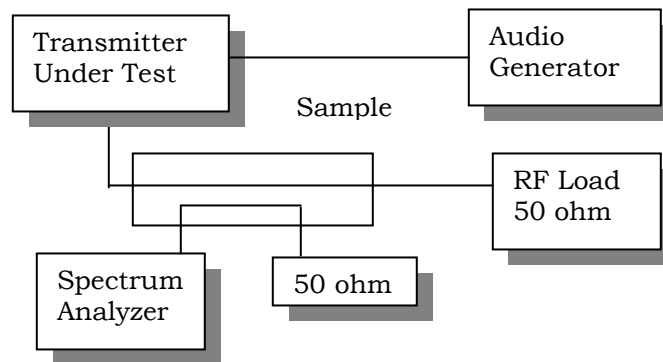
## OCCUPIED BANDWIDTH

### Part 2.1049(c) EMISSION BANDWIDTH: **25kHz Channel Spacing**

Data in the plots show that on any frequency removed from the assigned frequency by more than 50%, but not more than 100%: At least 25dB. On any frequency removed from the assigned frequency by more than 100%, but not more than 250%: At least 35 dB. On any frequency removed from the assigned frequency by more than 250%, of the authorized bandwidth: At least  $43 + 10\log(P)$ dB.

**Method of Measurement: ANSI/TIA 603-D: 2010**

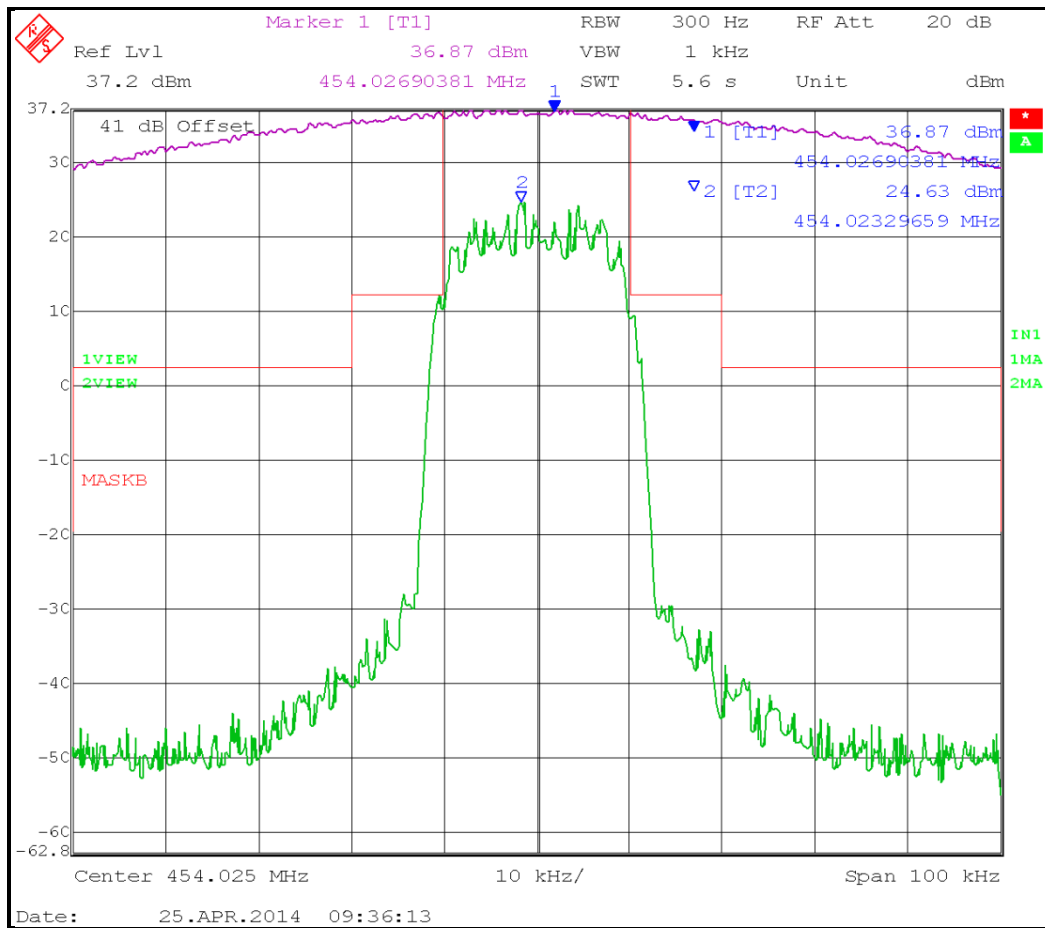
#### Test Setup Diagram:



**Test Data:** See the plots below

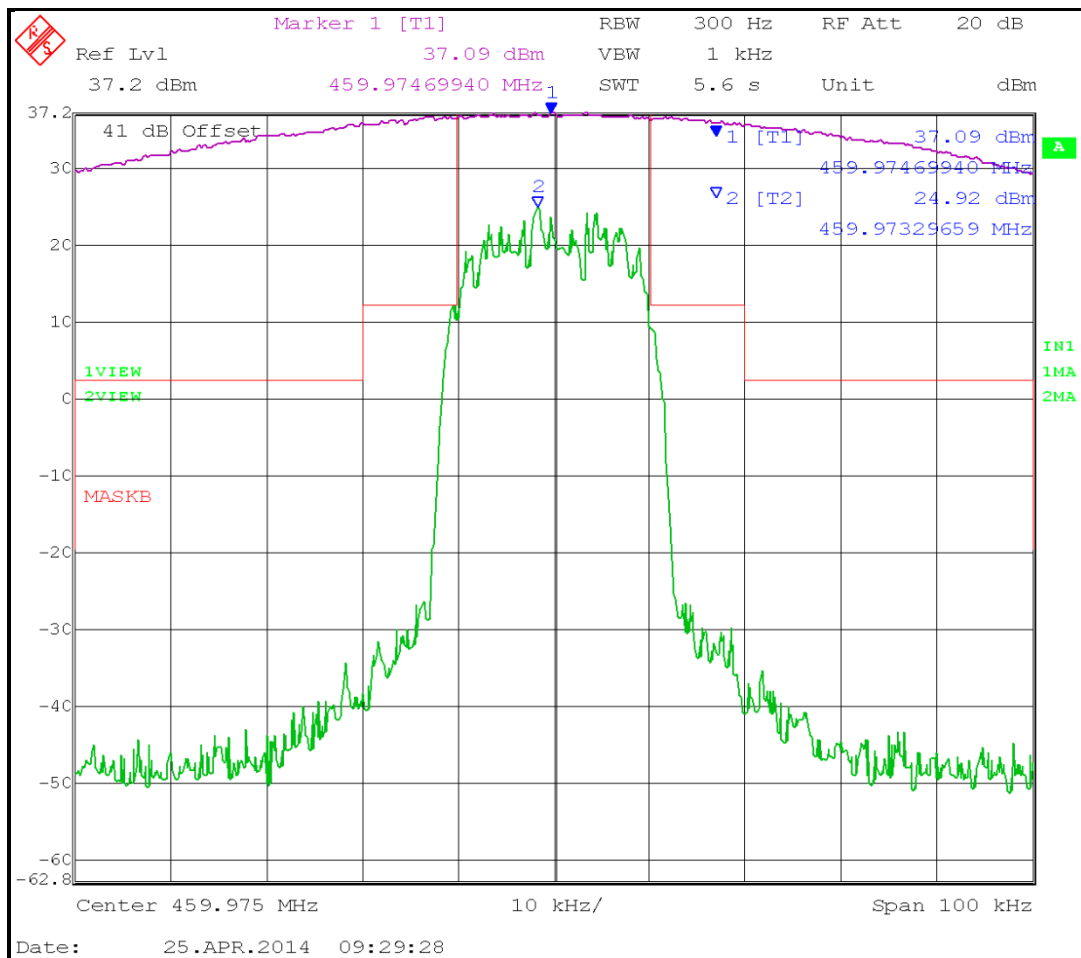
## OCCUPIED BANDWIDTH PLOT

25kHz Channel Spacing: Low End of Band



## OCCUPIED BANDWIDTH PLOT

25kHz Channel Spacing: High End of Band



## SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

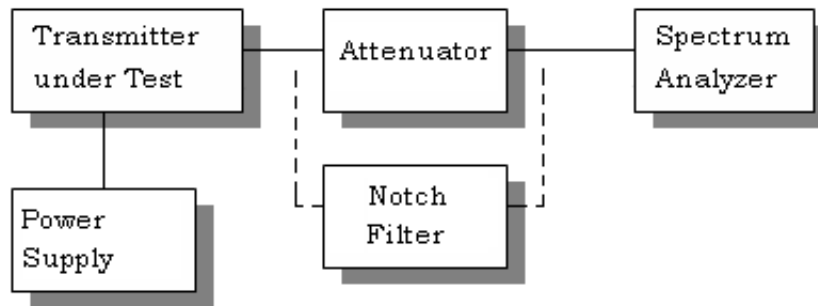
**Rule Part No.:** Part 2.1051(a)

**Requirements:**

25kHz Channel Spacing =  $43 + 10 \log(5.00) = 50.0$  dBc (High power)

**Method of Measurement:** The carrier was modulated 100% using a 2500 Hz tone. The spectrum was scanned from 0.4 to at least the 10th harmonic of the fundamental. The measurements were made in accordance with standard ANSI/TIA 603-C: 2004.

### Method of Measuring Conducted Spurious Emissions



**Test Data:**

**Low End of Band**

| TF<br>HIGH POWER | EF      | dB below<br>carrier |
|------------------|---------|---------------------|
| 454.03           | 908.05  | 95.9                |
|                  | 1362.08 | 89.9                |
|                  | 1816.10 | 88.6                |
|                  | 2270.13 | 90.3                |
|                  | 2724.15 | 90.8                |
|                  | 3178.18 | NE                  |
|                  | 3632.20 | NE                  |
|                  | 4086.23 | NE                  |
|                  | 4540.25 | NE                  |

- NE : No emission found.

**High End of Band**

| <b>TF<br/>HIGH POWER</b> | <b>EF</b> | <b>dB below<br/>carrier</b> |
|--------------------------|-----------|-----------------------------|
| 459.98                   | 919.95    | 89.7                        |
|                          | 1379.93   | 91.1                        |
|                          | 1839.90   | 90.1                        |
|                          | 2299.88   | 91.9                        |
|                          | 2759.85   | 91.2                        |
|                          | 3219.83   | NE                          |
|                          | 3679.80   | NE                          |
|                          | 4139.78   | NE                          |
|                          | 4599.75   | NE                          |

NE : No emission found.

**RESULTS: PASS/FAIL**

## FIELD STRENGTH OF SPURIOUS EMISSIONS

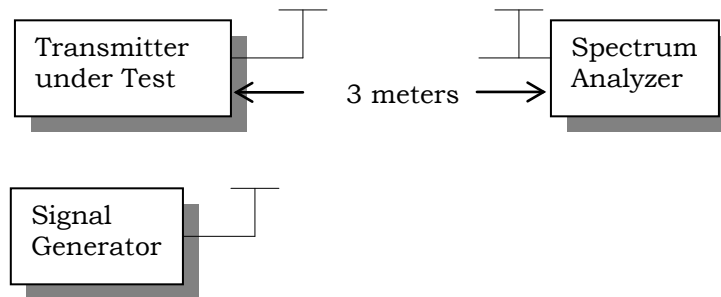
**Rule Parts. No.:** Part 2.1053

**Requirements:**

25kHz Channel Spacing =  $43 + 10 \log(5.00) = 50.0$  dBc (High power)

**METHOD OF MEASUREMENT:** The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from 30 MHz to at least the tenth harmonic of the fundamental. This test was conducted per ANSI/TIA 603-C: 2004 using the substitution method. Measurements were made at the test site of TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669.

**Test Setup Diagram:**



**Test Data:**

**Low End of the Band**

| Emission Frequency MHz | Ant. Polarity | dB Below Carrier (dBc) |
|------------------------|---------------|------------------------|
| 454.03                 | 0             | 0                      |
| 908.05                 | H             | 93.6                   |
| 1362.08                | H             | 91.1                   |
| 1816.10                | H             | 87.8                   |
| 2270.13                | H             | 84.4                   |
| 2724.15                | H             | 84.0                   |
| 3178.18                | H/V           | NE                     |
| 3632.20                | H/V           | NE                     |
| 4086.23                | H/V           | NE                     |
| 4540.25                | H/V           | NE                     |

NE : No emission found.

### High End of the Band

| Emission Frequency MHz | Ant. Polarity | dB Below Carrier (dBc) |
|------------------------|---------------|------------------------|
| 459.98                 | 0             | 0                      |
| 919.95                 | H             | 94.1                   |
| 1379.93                | H             | 92.0                   |
| 1839.90                | H             | 88.0                   |
| 2299.88                | H             | 85.5                   |
| 2759.85                | H             | 83.7                   |
| 3219.83                | H/V           | NE                     |
| 3679.80                | H/V           | NE                     |
| 4139.78                | H/V           | NE                     |
| 4599.75                | H/V           | NE                     |

NE : No emission found.