

# ENGINEERING TEST REPORT



**Product Marketing Name (PMN): Pulsar radar R86 26 GHz  
Hardware Version Identification Number (HVIN): R86  
FCC ID: LPN-R86**

*Applicant:*

**Magnetrol**  
705 Enterprise St.  
Aurora, IL 60504  
USA

*In Accordance With*

**Federal Communications Commission (FCC)  
Part 15, Subpart C, Section 15.256**

**UltraTech's File No.: 17MGNP006\_F15C256**

This Test report is Issued under the Authority of  
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Vice President of Engineering  
UltraTech Group of Labs

Date: March 28, 2017

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91038



1309



46390-2049



AT-1945



SL2-IN-E-1119R



Korea  
KCC-RRA  
CA2049

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## EXHIBIT 1. INTRODUCTION

### 1.1. SCOPE

|                                      |   |
|--------------------------------------|---|
| <b>Reference:</b>                    | FCC Part 15, Subpart C, Sec. 15.256 - Operation of level probing radars within the bands 5.925-7.250 GHz, 24.05-29.00 GHz, and 75-85 GHz. |
| <b>Title:</b>                        | Code of Federal Regulations (CFR), Title 47 Telecommunication, Part 15, Subpart C - Intentional Radiators                                 |
| <b>Purpose of Test:</b>              | To gain FCC Equipment Certification for FCC Part 15.256.  |
| <b>Test Procedures:</b>              | ANSI C63.4, ANSI C63.10 and KDB 890966 D01 Meas Level Probing Radars v01r01   |
| <b>Environmental Classification:</b> | Commercial, industrial or business environment  |

### 1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

### 1.3. NORMATIVE REFERENCES

| Publication   | Year                         | Title   |
|---|------------------------------|---|
| FCC 47 CFR 15                                       | 2017                         | Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 Radio Frequency Devices  |
| ANSI C63.4  | 2014                         | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz |
| ANSI C63.10   | 2013                         | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices  |
| FCC KDB 890966 D01 Meas level Probing Radars v01r01 | 2014                         | Measurement Procedure for Level Probing Radars  |
| CISPR 22 & EN 55022                                 | 2008-09, Edition 6.0<br>2006 | Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement  |

## EXHIBIT 2. PERFORMANCE ASSESSMENT

### 2.1. CLIENT INFORMATION

| Applicant              |   |
|------------------------|---|
| <b>Name:</b>           | Magnetrol   |
| <b>Address:</b>        | 705 Enterprise St<br>Aurora IL 60504<br>USA   |
| <b>Contact Person:</b> | David Wittenborn<br>Phone #: 630-969-4000 ext 6538<br>Fax #: 630-969-9489<br>Email Address: dwittenborn@magnetrol.com |

| Manufacturer           |   |
|------------------------|---|
| <b>Name:</b>           | Magnetrol   |
| <b>Address:</b>        | 705 Enterprise St<br>Aurora IL 60504<br>USA   |
| <b>Contact Person:</b> | David Wittenborn<br>Phone #: 630-969-4000 ext 6538<br>Fax #: 630-969-9489<br>Email Address: dwittenborn@magnetrol.com |

### 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

|                                       |  |
|---------------------------------------|--|
| <b>Brand Name:</b>                    | Magnetrol International Inc.   |
| <b>HVIN:</b>                          | R86  |
| <b>Model Name or Number:</b>          | R86-511A-110   |
| <b>Serial Number:</b>                 | Test sample  |
| <b>Type of Equipment:</b>             | Level Probing Radar  |
| <b>Input Power Supply Type:</b>       | 24V DC   |
| <b>Primary User Functions of EUT:</b> | Level probing radars operate in open-air and inside an enclosure containing the substance being measured |

## 2.3. EUT'S TECHNICAL SPECIFICATIONS

| Transmitter                            |   |
|--|---|
| <b>Equipment Type:</b>                 | Fixed                                       |
| <b>Intended Operating Environment:</b> | Commercial, light industry & heavy industry |
| <b>Power Supply Requirement:</b>       | 24 V DC                                     |
| <b>Field Strength:</b>                 | 108.09 dB $\mu$ V/m Peak at 3 m             |
| <b>Operating Frequency Range:</b>      | 25.8 GHz                                    |
| <b>RF Output Impedance:</b>            | 50 Ω  |
| <b>10 dB Bandwidth:</b>                | 1298.6 MHz                                  |
| <b>Modulation Type:</b>                | Pulsed radar                                |
| <b>Antenna Connector Type:</b>         | Integral                                    |

## 2.4. ASSOCIATED ANTENNA DESCRIPTIONS

The EUT is equipped with the 3 inch or 4 inch antenna, the unit with highest gain antenna will be used for compliance testing.

| Antenna Description |                        |                        |
|---------------------|------------------------|------------------------|
| Antenna:            | # 1                    | #2                     |
| Manufacturer:       | Magnetrol              | Magnetrol              |
| Type:               | Horn                   | Horn                   |
| Model:              | R86 3" Horn            | R86 4" Horn            |
| Frequency Range:    | 24050 MHz to 26500 MHz | 24050 MHz to 26500 MHz |
| Impedance:          | 50 Ohm                 | 50 Ohm                 |
| Gain:               | 24.1 dBi               | 25.5 dBi               |

## 2.5. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|-------------|------------------------|---------------------------|----------------|------------------------------------|
| 1           | 24 VDC                 | 1                         | Terminal block | Non-Shielded                       |

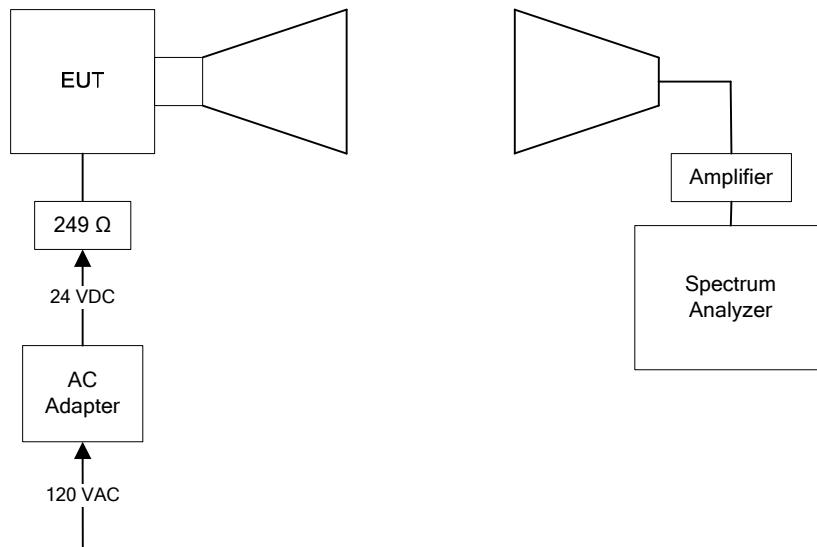
## 2.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

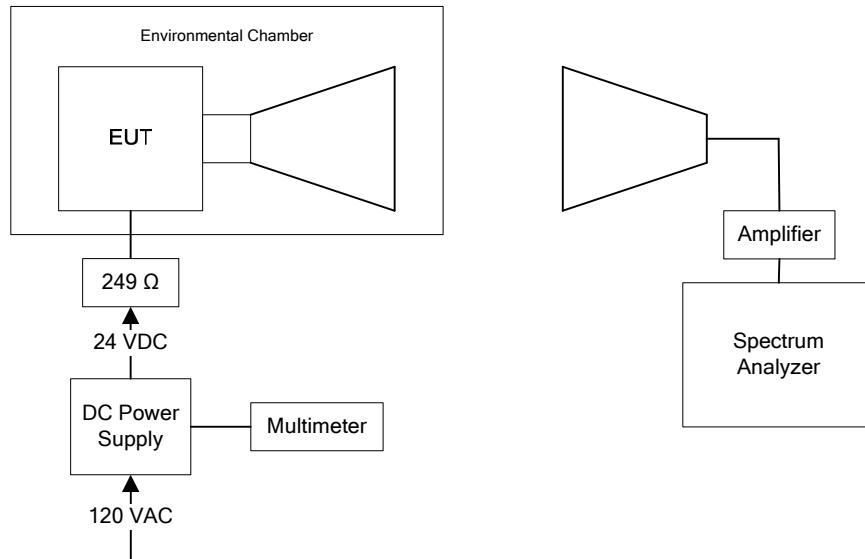
None.

## 2.7. GENERAL TEST SETUP

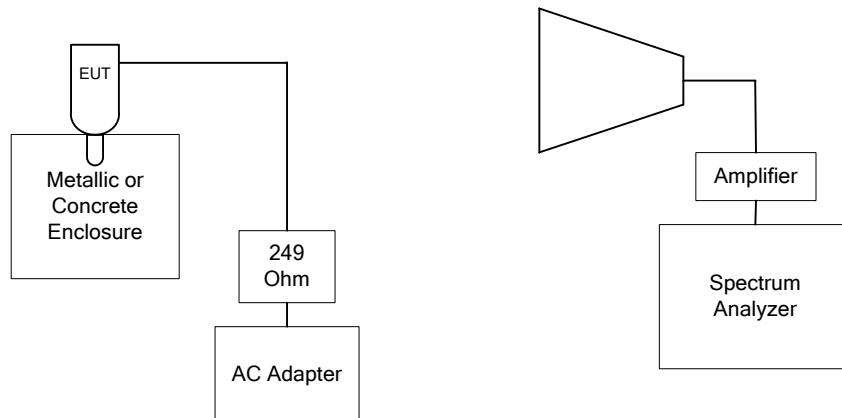
### 2.7.1. Fundamental Emissions, Unwanted Emissions and Emissions Bandwidth Test Setup



### 2.7.2. Frequency Stability Test Setup



### 2.7.3. TLPR Unwanted Emissions Test Setup



## EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

### 3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

|                     |             |
|---------------------|-------------|
| Temperature:        | 21 to 23 °C |
| Humidity:           | 45 to 58%   |
| Pressure:           | 102 kPa     |
| Power input source: | 24 VDC      |

### 3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

|                                  |  |
|----------------------------------|--|
| <b>Operating Modes:</b>          | The EUT was configured for continuous transmission for the duration of testing.                                      |
| <b>Special Test Software:</b>    | N/A  |
| <b>Special Hardware Used:</b>    | N/A  |
| <b>Transmitter Test Antenna:</b> | The EUT was tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment. |

|  |                                 |
|--|---------------------------------|
| <b>Transmitter Test Signals:</b>                   |                                 |
| <b>Frequency Band(s):</b>                          | 25.8 GHz                        |
| <b>Test Frequency(ies):</b>                        | 25.8 GHz                        |
| <b>Transmitter Wanted Output Test Signals:</b>     |                                 |
| ▪ RF Power Output (measured maximum output power): | 108.09 dB $\mu$ V/m Peak at 3 m |
| ▪ Normal Test Modulation:                          | Pulsed radar                    |
| ▪ Modulating signal source:                        | Internal                        |

## EXHIBIT 4. SUMMARY OF TEST RESULTS

### 4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2017-04-02.

### 4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

| FCC Regulations            | Test Requirements  | Compliance (Yes/No) |
|----------------------------|--|---------------------|
| 15.203, 15.204 & 15.256(b) | The transmitter shall utilize a dedicated or integrated transmit antenna and installation requirement of LPR | Yes*                |
| 15.209                     | Emissions from Digital Circuitry   | Yes                 |
| 15.256(f)                  | Fundamental Emission Bandwidth   | Yes                 |
| 15.215(c) & 15.256(f)(2)   | Frequency Stability  | Yes                 |
| 15.256(g)                  | Fundamental Emission   | Yes                 |
| 15.256(h)                  | Unwanted Emissions   | Yes                 |
| 1.1307                     | RF Exposure  | N/A**               |

\* The EUT complies with the requirements; it employs integral antenna and is in compliance with the installation requirement.

\*\* Device is categorically excluded from routine environmental evaluation for RF exposure.

### 4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

## EXHIBIT 5. TEST DATA

### 5.1. FUNDAMENTAL EMISSION BANDWIDTH [47 CFR §15.256(f)]

#### 5.1.1. Limit(s)

§15.256(f) The fundamental bandwidth of an LPR emission is defined as the width of the signal between two points, one below and one above the center frequency, outside of which all emissions are attenuated by at least 10 dB relative to the maximum transmitter output power when measured in an equivalent resolution bandwidth.

§15.256(f)(1) The minimum fundamental emission bandwidth shall be 50 MHz for LPR operation under the provisions of this section.

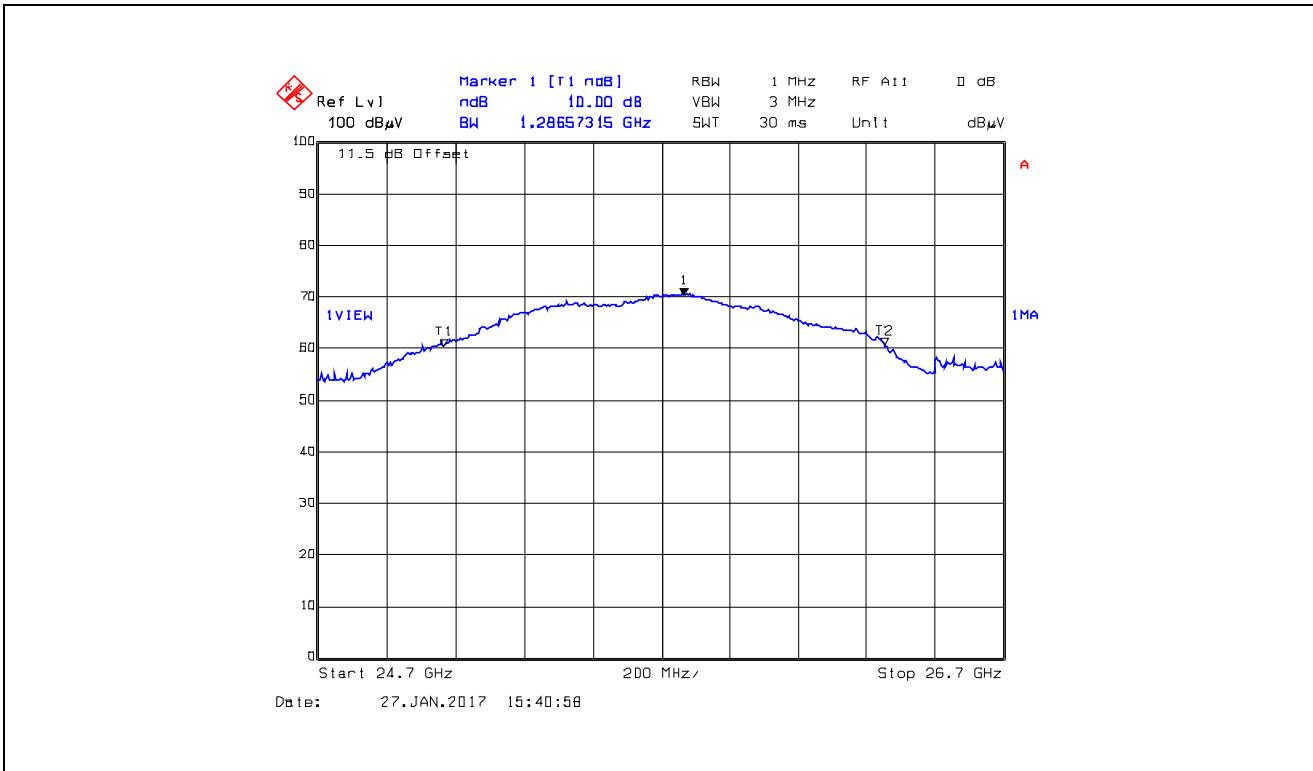
#### 5.1.2. Method of Measurements

KDB 890966 D01 Meas level Probing Radars v01r01, Section D.

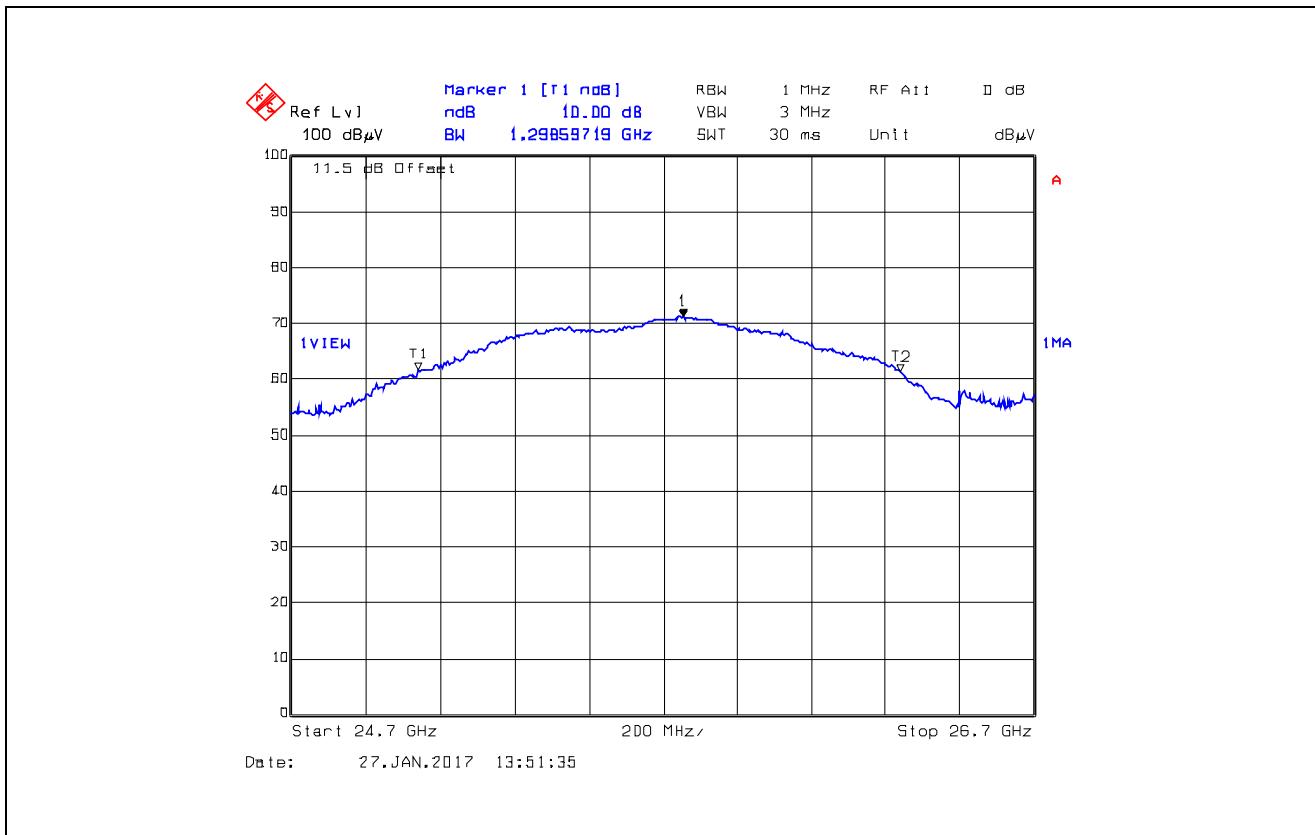
#### 5.1.3. Test Data

| Antenna Type    | Test Frequency (GHz) | 10 dB Bandwidth (MHz) | Minimum Limit (MHz) |
|-----------------|----------------------|-----------------------|---------------------|
| 3" Horn Antenna | 25.8                 | 1286.6                | 50                  |
| 4" Horn Antenna | 25.8                 | 1298.6                | 50                  |

Plot 5.1.3.1. 10 dB Bandwidth, Fc: 25.8 GHz, 3" Horn Antenna



Plot 5.1.3.2. 10 dB Bandwidth, Fc: 25.8 GHz, 4" Horn Antenna



## 5.2. FREQUENCY STABILITY [47 CFR §§ 15.215(c) & 15.256]

### 5.2.1. Limit(s)

15.256(f)(2) LPR devices operating under this section must confine their fundamental emission bandwidth within the 5.925-7.250 GHz, 24.05-29.00 GHz, and 75-85 GHz bands under all conditions of operation.

The bandwidth of the fundamental emission must be contained within the frequency band over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage.

### 5.2.2. Method of Measurements

KDB 890966 D01 Meas level Probing Radars v01r01, Section H

### 5.2.3. Test Data

|   |  |
|---|--|
| <b>Designated Frequency Band:</b>         | 24.05 to 29.00 GHz   |
| <b>Nominal Channel Center Frequency:</b>  | 25.8 GHz   |
| <b>Frequency Tolerance Limit:</b>         | Fundamental emission bandwidth shall be within 24.05-29.00 GHz |
| <b>Max. Frequency Tolerance Measured:</b> | +126.3 MHz   |
| <b>Input Voltage Rating:</b>              | 24 VDC   |

| Ambient Temperature (°C) | Frequency Drift (MHz)              |                                      |                                      |
|--------------------------|------------------------------------|--------------------------------------|--------------------------------------|
|                          | Supply Voltage (Nominal)<br>24 VDC | Supply Voltage (Minimal)<br>20.4 VDC | Supply Voltage (Maximal)<br>27.6 VDC |
| -20                      | +120.2                             | --                                   | --                                   |
| -10                      | +126.3                             | --                                   | --                                   |
| 0                        | +78.1                              | --                                   | --                                   |
| +10                      | +78.0                              | --                                   | --                                   |
| +20                      | 0.0                                | +6.0                                 | +78.0                                |
| +30                      | +108.2                             | --                                   | --                                   |
| +40                      | +24.0                              | --                                   | --                                   |
| +50                      | +18.0                              | --                                   | --                                   |

### 5.3. RADIATED FUNDAMENTAL EMISSIONS [47 CFR 15.256(g)]

#### 5.3.1. Limits

15.256(g)(3) The EIRP limits for LPR operations in the bands authorized by this rule section are provided in Table 1. The emission limits in Table 1 are based on boresight measurements (*i.e.*, measurements performed within the main beam of an LPR antenna).

15.256(g)(3) - Table 1 LPR EIRP Emission Limits

| Frequency band of operation (GHz) | Average emission limit (EIRP in dBm measured in 1 MHz) | Peak emission limit (EIRP in dBm measured in 50 MHz) |
|-----------------------------------|--|--|
| 5.925 - 7.250                     | -33  | 7  |
| 24.05 - 29.00                     | -14  | 26   |
| 75 - 85                           | -3   | 34   |

#### 5.3.2. Method of Measurements

FCC KDB Publication No. 890966 D01 Meas level Probing Radars v01r01, Section E.

#### 5.3.3. Test Data

##### 5.3.3.1. Radiated Fundamental Emissions, Average EIRP in 1 MHz

| Frequency (GHz)          | Antenna Plane (H/V) | Average Emissions Measured in 1 MHz (dB $\mu$ V/m) | <sup>1</sup> EIRP Average Emissions Measured in 1 MHz (dBm) | Limit (dBm) | Margin (dB) |
|--------------------------|---------------------|--|---|-------------|-------------|
| EUT with 3" horn antenna |                     |  |   |             |             |
| 25.8                     | V                   | 67.34  | -27.92  | -14         | -13.92      |
| 25.8                     | H                   | 67.12  | -28.14  | -14         | -14.14      |
| EUT with 4" horn antenna |                     |  |   |             |             |
| 25.8                     | V                   | 68.07  | -27.19  | -14         | -13.19      |
| 25.8                     | H                   | 68.60  | -26.66  | -14         | -12.66      |

<sup>1</sup>EIRP is calculated by applying the radiated emission measurements equation, EIRP (dBm) = E (dB $\mu$ V/m) – 104.8 + 20 Log D, where D = 3

### 5.3.3.2. Radiated Fundamental Emissions, Peak EIRP in 50 MHz

| Frequency (GHz)          | Antenna Plane (H/V) | Peak Emissions Measured in 10 MHz (dB $\mu$ V/m) | <sup>1</sup> Peak Emissions Calculated in 50 MHz (dB $\mu$ V/m) | <sup>2</sup> Peak EIRP Emissions Calculated in 50 MHz (dBm) | Limit (dBm) | Margin (dB) |
|--------------------------|---------------------|--|---|---|-------------|-------------|
| EUT with 3" horn antenna |                     |  |   |   |             |             |
| 25.8                     | V                   | 91.88  | 105.86  | 10.60   | 26          | -15.40      |
| 25.8                     | H                   | 92.26  | 106.24  | 10.98   | 26          | -15.02      |
| EUT with 4" horn antenna |                     |  |   |   |             |             |
| 25.8                     | V                   | 92.52  | 106.50  | 11.24   | 26          | -14.76      |
| 25.8                     | H                   | 94.11  | 108.09  | 12.83   | 26          | -13.17      |

<sup>1</sup>Convert measurement in 10 MHz to 50 MHz by adding the correction factor  $20 \times \log(50/10) = 13.98$  dB

<sup>2</sup>EIRP is calculated by applying the radiated emission measurements equation, EIRP (dBm) = E (dB $\mu$ V/m) – 104.8 + 20 Log D, where D = 3

## 5.4. RADIATED UNWANTED EMISSIONS [47 CFR 15.256(h)]

### 5.4.1. Limits

Unwanted emissions from LPR devices shall not exceed the general emission limit in §15.209.

#### §15.209(a) Radiated emission limits; general requirements

| Frequency (MHz) | Field strength (microvolts/meter) | Measurement distance (meters) |
|-----------------|-----------------------------------|-------------------------------|
| 0.009-0.490     | 2400/F(kHz)                       | 300                           |
| 0.490-1.705     | 24000/F(kHz)                      | 30                            |
| 1.705-30.0      | 30                                | 30                            |
| 30-88           | 100**                             | 3                             |
| 88-216          | 150**                             | 3                             |
| 216-960         | 200**                             | 3                             |
| Above 960       | 500                               | 3                             |

\*\*Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

### 5.4.2. Method of Measurements

ANSI C63.4.

### 5.4.3. Test Data

#### 5.4.3.1. Field Strength of Emissions Outside the Permitted Band at 3 m

| Remark(s):      |  |                             |                     |   |             |
|-----------------|--|-----------------------------|---------------------|---|-------------|
| Frequency (MHz) | Measured Field Strength @ 3 m (dB $\mu$ V/m) | Detector Used (Peak/QP/Avg) | Antenna Plane (H/V) | § 15.209 Field Strength Limits (dB $\mu$ V/m) | Margin (dB) |
| 30 - 100000     | *  | Peak                        | V/H                 | *   | *           |

\* No unwanted emission detected that are in excess of 20 dB below the specified limit. Verified at test distance of 30 cm.

## EXHIBIT 6. TEST EQUIPMENT LIST

| Test Instruments                                | Manufacturer    | Model No.  | Serial No.       | Frequency Range   | Cal. Due Date |
|---|-----------------|------------|------------------|-------------------|---------------|
| EMI Receiver                                    | Rohde & Schwarz | ESU40      | 100037           | 20 Hz to 40 GHz   | 8 May 2017    |
| Spectrum Analyzer                               | Rohde & Schwarz | FSEK30     | 100077           | 20Hz–40 GHz       | 5 Dec 2018    |
| Pre Amplifier                                   | Com-Power       | Pam-118A   | 551052           | 500 MHz to 18 GHz | 14 July 2017  |
| Amplifier                                       | Spacek Labs     | SLKKa-30-6 | 6D26             | 18–40 GHz         | Note 1        |
| Biconilog Antenna                               | EMCO            | 3142       | 9601-1005        | 26 – 3000 MHz     | 12 May 2017   |
| Horn Antenna                                    | EMCO            | 3115       | 9911-6570        | 1GHz – 18 GHz     | 10 Oct 2018   |
| Horn Antenna                                    | ETS-Lindgren    | 3160-09    | 00118385         | 18 – 26.5 GHz     | 11 Oct 2018   |
| Horn Antenna                                    | ETS-Lindgren    | 3160-10    | 00102686         | 26.5 – 40 GHz     | 11 Oct 2018   |
| AC Adapter                                      | Triad           | WDU24-500  | --               | --                | --            |
| DC Power Supply                                 | Tenma           | 72-7295    | 490300270        | 0-40 VDC          | Note 1        |
| Multi-meter                                     | Extech          | EX530      | 12070737         | 0.01mV - 1kV      | 14 May 2017   |
| Environmental Chamber                           | Envirotronics   | SSH32C     | 11994847-S-11059 | -60 to 177 °C     | 2 Jun 2017    |
| Horn Antenna & Mixer                            | OML             | WR-19      | U30625-1         | Band U 40-60 GHz  | Note 2        |
| Horn Antenna & Mixer                            | OML             | E Band     | E30625-1         | Band E 60-90 GHz  | Note 2        |
| Horn Antenna & Mixer                            | OML             | WR-08      | F30625-1         | Band F 90-140 GHz | Note 2        |
| Note 1: Internal Verification/Calibration check |                 |            |                  |                   |               |
| Note 2: Dimensions Verified on use              |                 |            |                  |                   |               |

## EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

### 7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

|       | Line Conducted Emission Measurement Uncertainty (9 kHz – 30 MHz):                | Measured   | Limit     |
|-------|--|------------|-----------|
| $u_c$ | <b>Combined standard uncertainty:</b><br>$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$ | $\pm 1.44$ | $\pm 1.8$ |
| $U$   | <b>Expanded uncertainty U:</b><br>$U = 2u_c(y)$                                  | $\pm 2.89$ | $\pm 3.6$ |

### 7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

|       | Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):        | Measured (dB) | Limit (dB) |
|-------|--|---------------|------------|
| $u_c$ | <b>Combined standard uncertainty:</b><br>$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$ | $\pm 2.39$    | $\pm 2.6$  |
| $U$   | <b>Expanded uncertainty U:</b><br>$U = 2u_c(y)$                                  | $\pm 4.79$    | $\pm 5.2$  |

|       | Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):          | Measured (dB) | Limit (dB) |
|-------|--|---------------|------------|
| $u_c$ | <b>Combined standard uncertainty:</b><br>$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$ | $\pm 2.39$    | $\pm 2.6$  |
| $U$   | <b>Expanded uncertainty U:</b><br>$U = 2u_c(y)$                                  | $\pm 4.78$    | $\pm 5.2$  |

|       | Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz): | Measured (dB) | Limit (dB)          |
|-------|--|---------------|---------------------|
| $u_c$ | <b>Combined standard uncertainty:</b><br>$u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$     | $\pm 1.87$    | Under consideration |
| $U$   | <b>Expanded uncertainty U:</b><br>$U = 2u_c(y)$                                      | $\pm 3.75$    | Under consideration |