# ENGINEERING TEST REPORT

## RFID Rd/Ex XR30
## Model No.: XR30

## FCC ID: PQG-XR30

*Applicant:*

**Lyngsoe Systems Ltd.**
*5570 Kennedy Road, Unit B*
*Mississauga, Ontario*
*Canada L4Z 2A9*

***In Accordance With***
**Federal Communications Commission (FCC)**
**Part 15, Subpart C, Sections 15.209 & 15.231(e)**
**Low Power Transmitter & Momentarily Operation (125 kHz & 433.92 MHz)**

**UltraTech's File No.: LYI-068F15C231**

| | |
|---|---|
| This Test report is Issued under the Authority of<br>Tri M. Luu, Professional Engineer,<br>Vice President of Engineering<br>UltraTech Group of Labs<br><br>Date: August 26, 2009 |  |
| Report Prepared by: Dan Huynh<br><br>Issued Date: August 26, 2009 | Tested by: Hung Trinh<br><br>Test Dates: July 13 - 31, 2009 |

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government*


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| ANSI | FC | VCCI | Industry Canada / Industrie Canada Approved Test Facility | NVLAP | BSMI | Korea KCC-RRL |
|---|---|---|---|---|---|---|
| 0685 | 91038 | 1309 | 46390-2049 | 200093-0 | SL2-IN-E-1119R | CA2049 |

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# EXHIBIT 1. INTRODUCTION

## 1.1. SCOPE

| | |
|---|---|
| **Reference:** | FCC Part 15, Subpart C, Sections 15.209 and 15.231 |
| **Title:** | Code of Federal Regulations (CFR), Title 47, Telecommunication - Part 15 |
| **Purpose of Test:** | To gain FCC Equipment Authorization for a Low Power Transmitter operating at 125 kHz and Section 15.231 - Momentarily Operation at 433.92 MHz. |
| **Test Procedures:** | Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - 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. |
| **Environmental Classification:** | Commercial, industrial or business environment |

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

None.

## 1.3. NORMATIVE REFERENCES

| Publication | Year | Title |
|---|---|---|
| FCC 47 CFR 15 | 2008 | Code of Federal Regulations – Telecommunication |
| ANSI C63.4 | 2003 | 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 |
| CISPR 22<br>EN 55022 | 2008-09, Edition 6.0<br>2006 | Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement |
| CISPR 16-1-1<br>+A1<br>+A2 | 2006<br>2006<br>2007 | Specification for radio disturbance and immunity measuring apparatus and methods.<br>Part 1-1: Measuring Apparatus |
| CISPR 16-1-2<br>+A1<br>+A2 | 2003<br>2004<br>2006 | Specification for radio disturbance and immunity measuring apparatus and methods.<br>Part 1-2: Conducted disturbances |

# EXHIBIT 2. PERFORMANCE ASSESSMENT

## 2.1. CLIENT INFORMATION

| APPLICANT | |
|---|---|
| **Name:** | Lyngsoe Systems Ltd. |
| **Address:** | 5570 Kennedy Road, Unit B<br>Mississauga, Ontario<br>Canada L4Z 2A9 |
| **Contact Person:** | Donald Ferguson<br>Phone #: 905-501-1533 ext 221<br>Fax #: 905-501-1538<br>Email Address: dfe@lyngsoesystems.com |

| MANUFACTURER | |
|---|---|
| **Name:** | Lyngsoe Systems Ltd. |
| **Address:** | 5570 Kennedy Road, Unit B<br>Mississauga, Ontario<br>Canada L4Z 2A9 |
| **Contact Person:** | Donald Ferguson<br>Phone #: 905-501-1533 ext 221<br>Fax #: 905-501-1538<br>Email Address: dfe@lyngsoesystems.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.

| | |
|---|---|
| **Brand Name:** | Lyngsoe Systems Ltd. |
| **Product Name:** | RFID Rd/Ex XR30 |
| **Model Name or Number:** | XR30 |
| **Serial Number:** | Test sample |
| **Type of Equipment:** | Low power transmitter & momentarily operated device |
| **Input Power Supply Type:** | 24 VDC |
| **Primary User Functions of EUT:** | In an RFID Automatic Mail Quality Measurement System XR30 provides 125KHz excitation signal for RFID postal tags; 433 MHz signal, transmitted at pre-set intervals, is used to check system's integrity. Its enclosed receiver RDS23 processes the signals from postal tags. |

## 2.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|---|---|
| **Equipment Type:** | Base station |
| **Intended Operating Environment:** | Commercial, light industry & heavy industry |
| **Power Supply Requirement:** | 24 VDC |
| **RF Output Power Rating:** | ▪ 112.56 dBµV/m peak (109.52 dBµV/m average) at 10m distance for 125 kHz Tx<br>▪ 84.81 dBµV/m peak (60.10 dBµV/m average) at 3m distance for 433.92 MHz Tx |
| **Operating Frequency Range:** | 125 kHz & 433.92 MHz |
| **Duty Cycle:** | 5.81 % (for 433.92 MHz transmitter) |
| **20 dB Bandwidth:** | 42.7 kHz |
| **Modulation Type:** | OOK (LF) & FSK (UHF) |
| **Oscillator Frequencies:** | 20.000 MHz, 13.560 MHz |
| **Antenna Connector Type:** | Integral |
| **Antenna Description:** | Manufacturer: Lyngsoe Systems<br>Type: Two loops 40 x 40cm, 16 turns each for 125 kHz;<br>PCB loop Antenna for 433.92 MHz<br>Model: N/A<br>Frequency Range: 125 kHz; 433.92 MHz<br>Gain: Not applicable for near field operation @ 125 kHz;<br>-17.2 dBi @ 433.92 MHz |

## 2.4. LIST OF EUT'S PORTS

| Port | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| **J9** (on EXB30) | 24Vdc | 1 | 3 pin header MOLEX 39-30-3035 | 2 wire 16AWG,non-shielded, 3 meter |
| **J10** (on EXB30) | 24Vdc (connected to J13 on RDB) | 1 | 3 pin header MOLEX 39-30-3035 | 2 wire 16AWG,non-shielded, 32 cm |
| **J4, J17** (on EXB30) | RS 485 | 4 | Dual RJ45 jack | 4 Patch Cat5e cables, shielded, 3 meter |
| **J22** (on EXB30) | External devices | 1 | 3 pin header MOLEX 43650-0304 | 3 wire 22AWG,non-shielded, 3 meter |
| **J1** (on RDB23) | Ethernet | 1 | RJ45 single port | 4 Patch Cat5e cables, shielded |
| **J13** (on RDB23) | 24Vdc –connected to Power supply | 1 | 3 pin header MOLEX 39-30-3035 | 2 wire 16AWG,non-shielded, 3 meter |
| **J16** (on RDB23) | 24Vdc | 1 | 3 pin header MOLEX 39-30-3035 | 2 wire 16AWG,non-shielded, 3 meter |
| **J14** (on RDB23) | 24Vdc (connected to J10 on EXB) | 1 | 3 pin header MOLEX 39-30-3035 | 2 wire 16AWG,non-shielded, 32 cm |
| **CON3** (on RBD23) | RS 485 (connected to J4A) | 2 | RJ45 single port | 4 Patch Cat5e cables, shielded, 1 meter |
| **CON4** (on RBD23) | RS 485 | 2 | RJ45 single port | 4 Patch Cat5e cables, shielded |

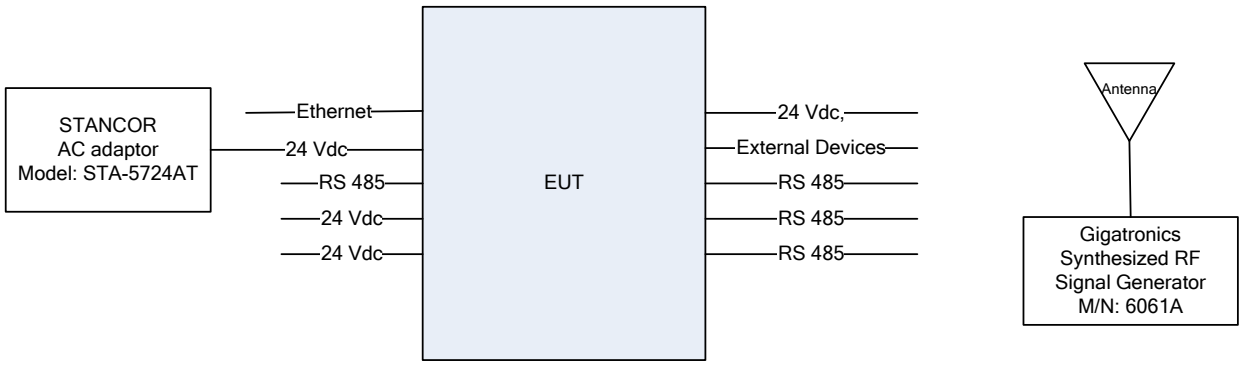
## 2.5. ANCILLARY EQUIPMENT

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

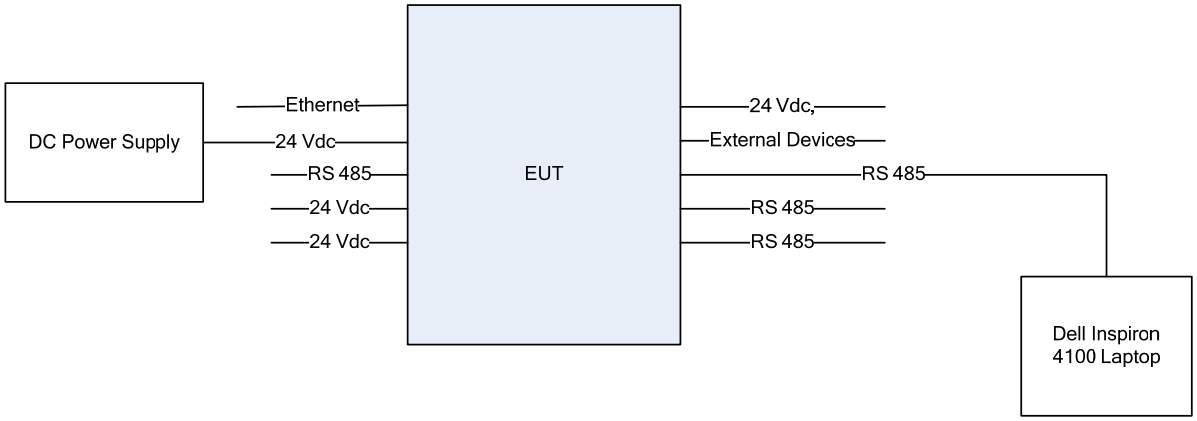
No ancillary equipment.

## 2.6. TEST SETUP BLOCK DIAGRAM

### 2.6.1. Powerline Conducted Emissions




### 2.6.2. Transmitter Radiated Emissions



# 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°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 24 VDC |

## 3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

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

| **Transmitter Test Signals** | |
|---|---|
| **Frequency Band(s):** | 125 kHz and 433.92 MHz |
| **Test Frequency(ies):** | 125 kHz and 433.92 MHz |
| **RF Power Output:** (measured maximum output power at antenna terminals) | ▪ 112.56 dBµV/m peak (109.52 dBµV/m average) at 10m distance for 125 kHz Tx<br>▪ 84.81 dBµV/m peak (60.10 dBµV/m average) at 3m distance for 433.92 MHz Tx |
| **Normal Test Modulation:** | OOK and FSK |
| **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 Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(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: 2011-05-01.

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

| FCC Section(s) | Test Requirements | Compliance (Yes/No) |
|---|---|---|
| 15.203 | Antenna Requirement | Yes |
| 15.207(a) | AC Power Line Conducted Emissions | Yes |
| 15.209 | General Radiated Emission requirements | Yes |
| 15.231(c) | 20 dB Bandwidth | Yes |
| 15.231(d) | Frequency Tolerance for Devices Operating within the Frequency Band 40.66-40.70 MHz | Not applicable |
| 15.231(e) | Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious Emissions | Yes |

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

The following modification was made on the EXB30 assembly (Exciter Board) to pass the conducted emissions test:

- Capacitors C72-C73 changed from 100nF, 10%, 50V, X7R to 3.3uF, 10%, 50V, X7R

# EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

## 5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in ANSI C63.4 and Ultratech's test procedures ULTR-P001-2004.

## 5.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document LAB 34 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

## 5.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1-1.

## 5.4. ANTENNA REQUIREMENTS [47 CFR § 15.203]

### 5.4.1. Requirements

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

N**otes**: This requirement does not apply to carrier current devices operated under the provisions of @ 15.211, 15.213, 15.217, 17.219 or 15.221.

### 5.4.2. Engineering Analysis

The antennas are an integral part of the EUT and located inside the enclosure.

## 5.5. POWER LINE CONDUCTED EMISSION [47 CFR 15.207(a)]

### 5.5.1. Limit

The equipment shall meet the limits of the following table:

| Frequency of emission (MHz) | Conducted Limits (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15–0.5 .....…….. | 66 to 56* ..... | 56 to 46* |
| 0.5–5 .....…….. | 56 ..... | 46 |
| 5-30 …….. | 60 ..…….. | 50 |

*Decreases linearly with the logarithm of the frequency

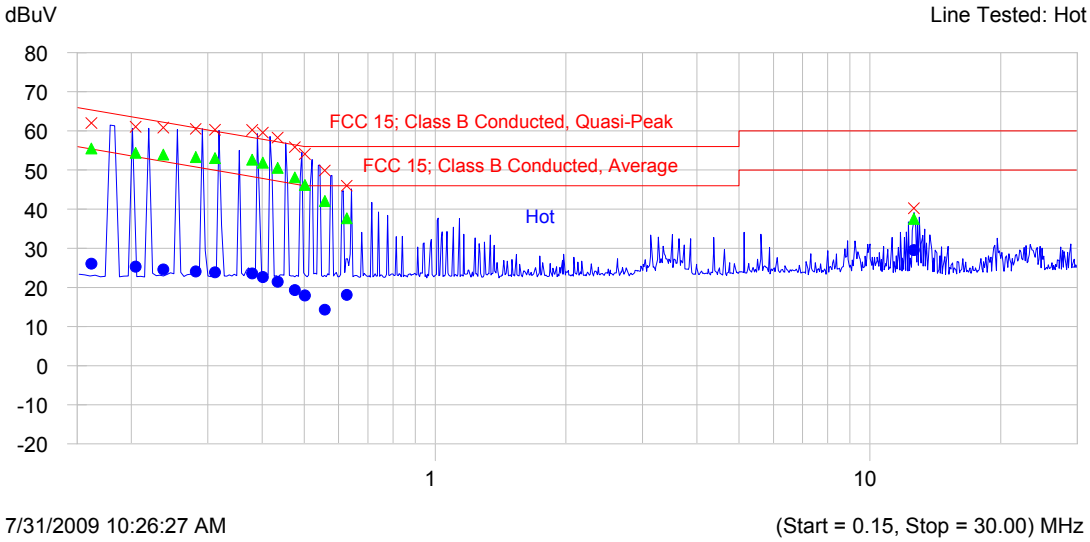
### 5.5.2. Method of Measurements

Refer to ANSI C63.4.

## 5.5.3. Test Data

**Plot 5.5.3.1.** Powerline Conducted Emission (Tx and Rx)
Line Voltage: 24VDC via STANCOR AC adaptor, Model: STA-5724AT
Line Tested: Hot

### Current Graph

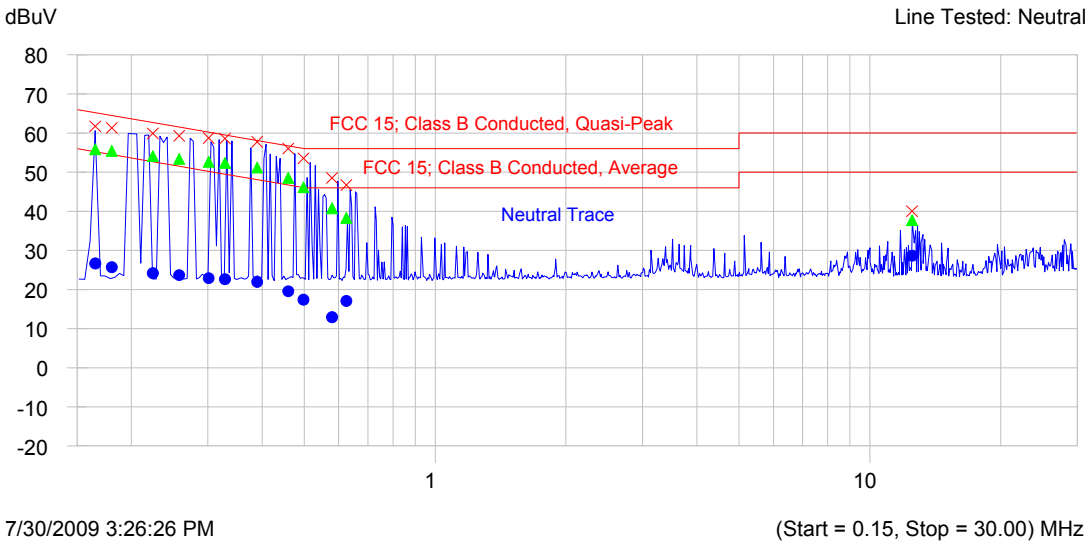



### Current List

| Frequency MHz | Peak dBuV | QP dBuV | Delta QP-QP Limit dB | Avg dBuV | Delta Avg-Avg Limit dB | Trace Name |
|---|---|---|---|---|---|---|
| 0.162 | 62.0 | 55.5 | -10.2 | 26.0 | -29.6 | Hot Trace |
| 0.205 | 61.0 | 54.4 | -10.0 | 25.3 | -29.1 | Hot Trace |
| 0.237 | 60.8 | 54.0 | -9.5 | 24.6 | -28.9 | Hot Trace |
| 0.281 | 60.5 | 53.3 | -8.9 | 24.1 | -28.1 | Hot Trace |
| 0.312 | 60.3 | 53.0 | -8.3 | 23.8 | -27.5 | Hot Trace |
| 0.379 | 60.2 | 52.6 | -6.8 | 23.5 | -25.8 | Hot Trace |
| 0.402 | 59.5 | 51.9 | -6.9 | 22.6 | -26.1 | Hot Trace |
| 0.434 | 58.3 | 50.5 | -7.3 | 21.4 | -26.4 | Hot Trace |
| 0.475 | 55.8 | 48.1 | -8.6 | 19.3 | -27.4 | Hot Trace |
| 0.501 | 54.1 | 46.2 | -9.8 | 17.9 | -28.1 | Hot Trace |
| 0.626 | 46.0 | 37.7 | -18.3 | 18.1 | -27.9 | Hot Trace |
| 0.557 | 49.9 | 42.0 | -14.0 | 14.3 | -31.7 | Hot Trace |
| 12.624 | 40.2 | 37.5 | -22.5 | 29.5 | -20.5 | Hot Trace |

**Plot 5.5.3.2.** Powerline Conducted Emission (Tx and Rx)
Line Voltage: 24VDC via STANCOR AC adaptor, Model: STA-5724AT
Line Tested: Neutral

## Current Graph




## Current List

| Frequency MHz | Peak dBuV | QP dBuV | Delta QP-QP Limit dB | Avg dBuV | Delta Avg-Avg Limit dB | Trace Name |
|---|---|---|---|---|---|---|
| 0.165 | 61.7 | 55.8 | -9.7 | 26.7 | -28.9 | Neutral Trace |
| 0.180 | 61.3 | 55.4 | -9.7 | 25.7 | -29.4 | Neutral Trace |
| 0.224 | 59.9 | 54.1 | -9.7 | 24.2 | -29.7 | Neutral Trace |
| 0.258 | 59.3 | 53.4 | -9.5 | 23.7 | -29.2 | Neutral Trace |
| 0.301 | 58.7 | 52.7 | -8.9 | 22.9 | -28.7 | Neutral Trace |
| 0.329 | 58.6 | 52.3 | -8.5 | 22.6 | -28.2 | Neutral Trace |
| 0.389 | 57.7 | 51.2 | -7.9 | 21.9 | -27.1 | Neutral Trace |
| 0.459 | 56.0 | 48.5 | -8.6 | 19.5 | -27.6 | Neutral Trace |
| 0.498 | 53.5 | 46.1 | -9.9 | 17.4 | -28.7 | Neutral Trace |
| 0.579 | 48.5 | 40.8 | -15.2 | 12.9 | -33.1 | Neutral Trace |
| 0.625 | 46.7 | 38.3 | -17.7 | 17.1 | -28.9 | Neutral Trace |
| 12.499 | 40.0 | 37.7 | -22.3 | 28.6 | -21.4 | Neutral Trace |

## 5.6. AUTOMATIC TRANSMISSION REQUIREMENT [§15.231(e)]

### 5.6.1. FCC Provision

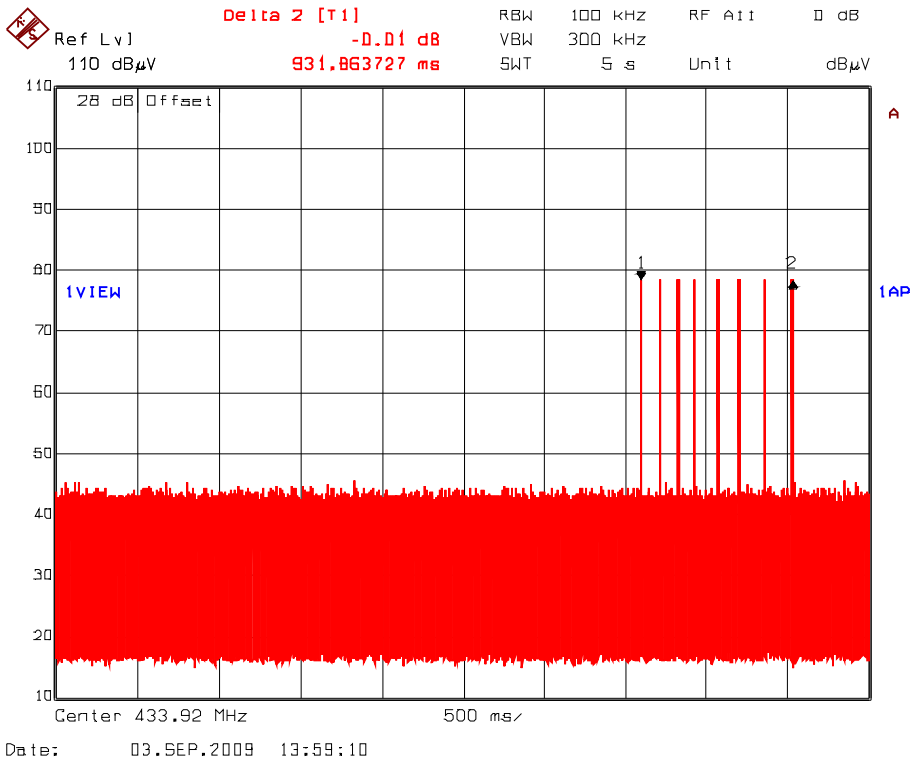
The devices operated under the provision of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be grater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

### 5.6.2. Test Data

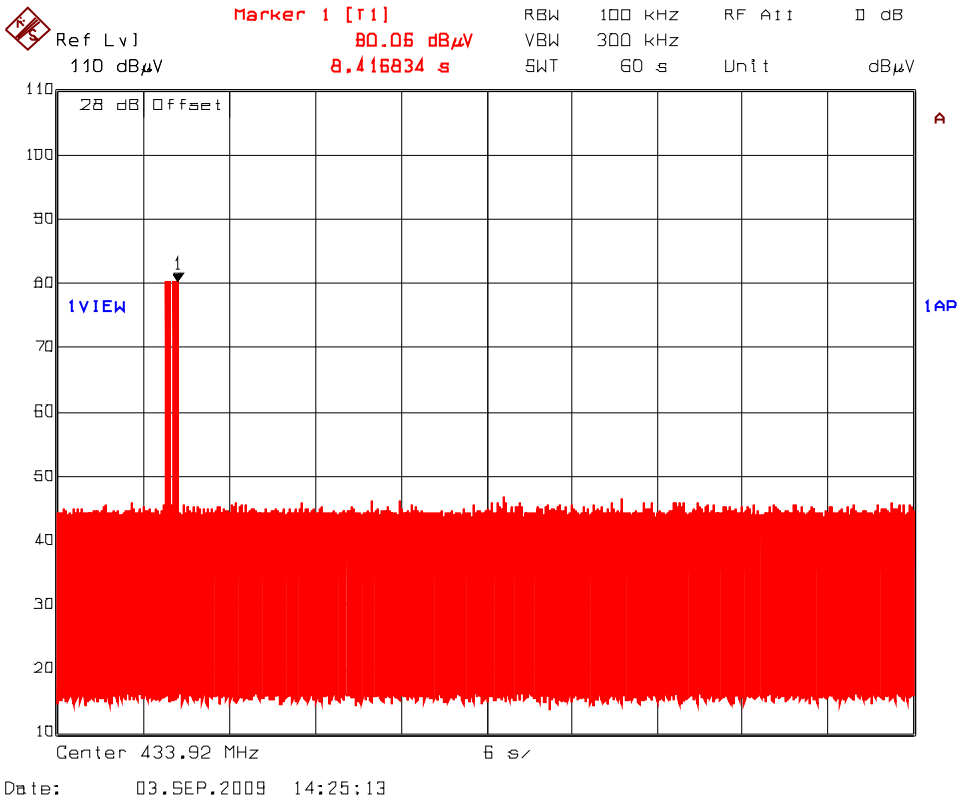
Kindly refer to the following plots for measurement details of transmission and silent period of this device.

(1) Total Transmission Time (Ton) = 931.86 mS, which is less than 1 Sec., OK
(2) 30*Ton = 30*931.86 = 27.96 Seconds; Which is less than T silent time of more than 50 Sec., OK
(3) T silent time of more than 50 Sec.; Which is greater than 10 Sec., OK

EUT complies with the above FCC provision.




**(Transmission Time of a Pulse)**




**(Pulse Repetition in 60 Seconds)**

## 5.7. TRANSMITTER RADIATED EMISSIONS [47 CFR §§ 15.231(e), 15.209 & 15.205]

### 5.7.1. Limits

**47 CFR 15.231(e) Field Strength Limits**

| Fundamental frequency (MHz) | Field strength of fundamental (microvolts/meter) | Field strength of spurious emissions (microvolts/meter) |
|---|---|---|
| 40.66-40.70. | 1,000 | 1,00 |
| 70–130 | 500 | 50 |
| 130–174 | 500 to 1,500[1] | 50 to 1,50[1] |
| 174–260 | 1,500 | 1,50 |
| 260–470 | 1,500 to 5,000[1] | 1,50 to 5,00[1] |
| Above 470 | 5,000 | 5,00 |

[1] Linear interpolations with frequency F in MHz:
For 130-174 MHz: FS (microvolts/m) = (22.73 x F) - 2454.55
For 260-470 MHz: FS (microvolts/m) = (16.67 x F) - 2833.33.

The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the

**47 CFR 15.209(a) General Field Strength Limits**

| 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. | | |

### 5.7.2. Method of Measurements

Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4 for measurement methods.

## 5.7.3. Test Data

**Remark:**

The 125 kHz transmitter and 433.92 MHz transmitter were configured to simultaneous transmission for the duration of the tests.

### 5.7.3.1. For Fundamental Frequency at 125 kHz

**Remarks:**

- The measuring receiver shall be tuned over the frequency range 9 kHz to 1 GHz.
- Test distance: 0.009 to 30MHz: 10m; 30 to 1000 MHz: 3m
- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- The value measured at 10m shall be extrapolated as applicable to compare with limit and measurement distance specified in section 15.209(a).
- Measurements were performed at 100m and 30m distances to determine the proper extrapolation factor.

Maximum field strength level at 100m distance: 55.00 dBµV/m
Maximum field strength level at 30m distance: 87.51 dBµV/m

Extrapolation factor:
Difference of measurement between 100 m & 30 m: $\Delta E = 87.51 - 55.00 = 32.51$ dB
$\Delta E = 20 * \log(100/30)^x = 32.51$ dB or $x = 32.51 / (20*\log(100/30)) \approx 3$ ==> (60 dB/decade)

- Field strength limit of the fundamental 125 kHz at 300m distance is 20*log(2400/125) = 25.7 dBµV/m
- For frequency 125 kHz, the measured E-Field at 10m (column 3) will be extrapolated to 300m E-Field Level (column 4) using the extrapolation factor of 60*log(10/300) = -88.63 dB

| Frequency (MHz) | RF Peak Level @ 10m/3m (dBµV/m) | RF Average Level @ 10m/3m (dBµV/m) | Extrapolated R Level (dBµV/m) | Antenna Plane (H/V) | § 15.209 (a) Limits (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| **Fundamental Emissions** | | | | | | |
| 0.125 | 110.93 | 107.98 | 19.35 | V | 25.7 | -6.4 |
| 0.125 | 112.56 | 109.52 | 20.89 | H | 25.7 | -4.8 |
| **Harmonic/Spurious Emissions** | | | | | | |
| 0.009 - 0.490 | * | * | * | H / V | 25.7 | * |
| 0.490 - 1.705 | * | * | * | H / V | 45.7 | * |
| 1.705 - 30.0 | * | * | * | H / V | 29.5 | * |
| 30 - 88 | * | * | * | H / V | 40.0 | * |
| 88 - 216 | * | * | * | H / V | 43.5 | * |
| 216 - 960 | * | * | * | H / V | 46.0 | * |
| 960 - 1000 | * | * | * | H / V | 54.0 | * |

* No emission found.

### 5.7.3.2. For Fundamental Frequency at 433.92 MHz

**Remarks:**

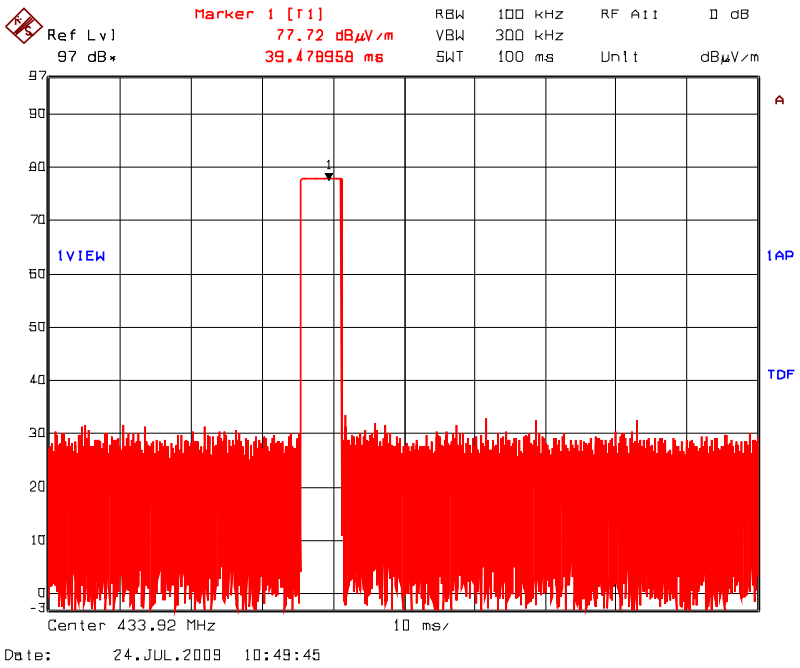
- The EUT complies with the transmission duration requirements specified in 15.231(e). The supervision transmissions to check system integrity is 1 second duration at time intervals (adjustable) from 1 to 254 hours.
- The measuring receiver shall be tuned over the frequency range 30 MHz to 4.5 GHz.
- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- In the restricted band per FCC 15.205: § 15.209 (a) limits applied
- Outside the restricted band per FCC 15.205: § 15.231 (e) limits or § 15.209 (a) applied, whichever allows higher field strength emission.
- Section 15.231(e) field strength limit of the fundamental at 433.92 MHz = 20 log [(16.67 x 433.92) - 2833.33] = 72.9 dBµV/m
- Spurious emissions limit is 20 dB below fundamental limit.
- Duty Cycle: measured maximum duty cycle is 5.81 %.
- The peak-average correction factor was obtained from the duty cycle calculation (see plots 5.7.3.2.1(i) & (ii) for detail).

Duty cycle correction factor = 20*log ($T_{ON}$/100 ms) = 20*log (5.811623 ms/100 ms) = -24.71 dB

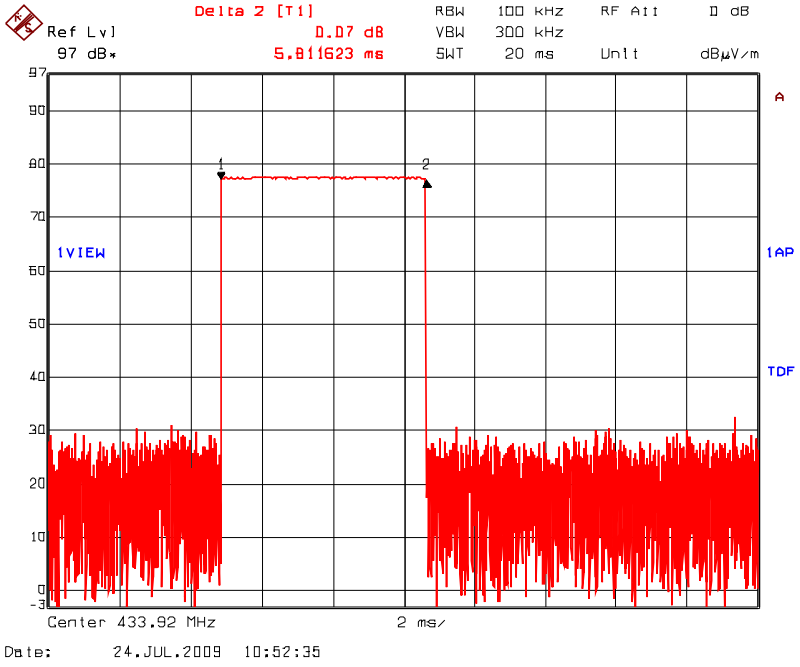
| Frequency (MHz) | Peak E-Field @ 3m (dBµV/m) | Average E-Field @ 3m (dBµV/m) | Antenna Plane (H/V) | § 15.231 (e) Limits @ 3m (dBµV/m) | § 15.209 (a) Limits @ 3m (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|
| **Fundamental Emissions** | | | | | | |
| **433.92** | **82.37** | **57.66** | **V** | **72.9** | **--** | **-15.2** |
| **433.92** | **84.81** | **60.10** | **H** | **72.9** | **--** | **-12.8** |
| **Harmonic/Spurious Emissions** | | | | | | |
| 867.84 | 61.06 | 36.35 | V | 52.9 | 46.0 | -16.5 |
| 867.84 | 57.81 | 33.10 | H | 52.9 | 46.0 | -19.8 |
| 3037.44 | 59.14 | 34.43 | V | 52.9 | 54.0 | -19.6 |
| 3905.28* | 71.81 | 47.10 | V | 52.9 | 54.0 | -6.9 |
| 3905.28* | 70.31 | 45.60 | H | 52.9 | 54.0 | -8.4 |
| 4339.20* | 61.70 | 36.99 | V | 52.9 | 54.0 | -17.0 |

* Emissions within the restricted bands.

**Plot 5.7.3.2.1(i) Duty Cycle in 100 ms (pulse train)**




**Plot 5.7.3.2.1 (ii) Duty Cycle (pulse length is 5.811623 ms)**



## 5.8. 20 dB BANDWIDTH [47 CFR 15.231(c)]

### 5.8.1. Limits

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

### 5.8.2. Method of Measurements

The measurements were performed in accordance with Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4:2003.

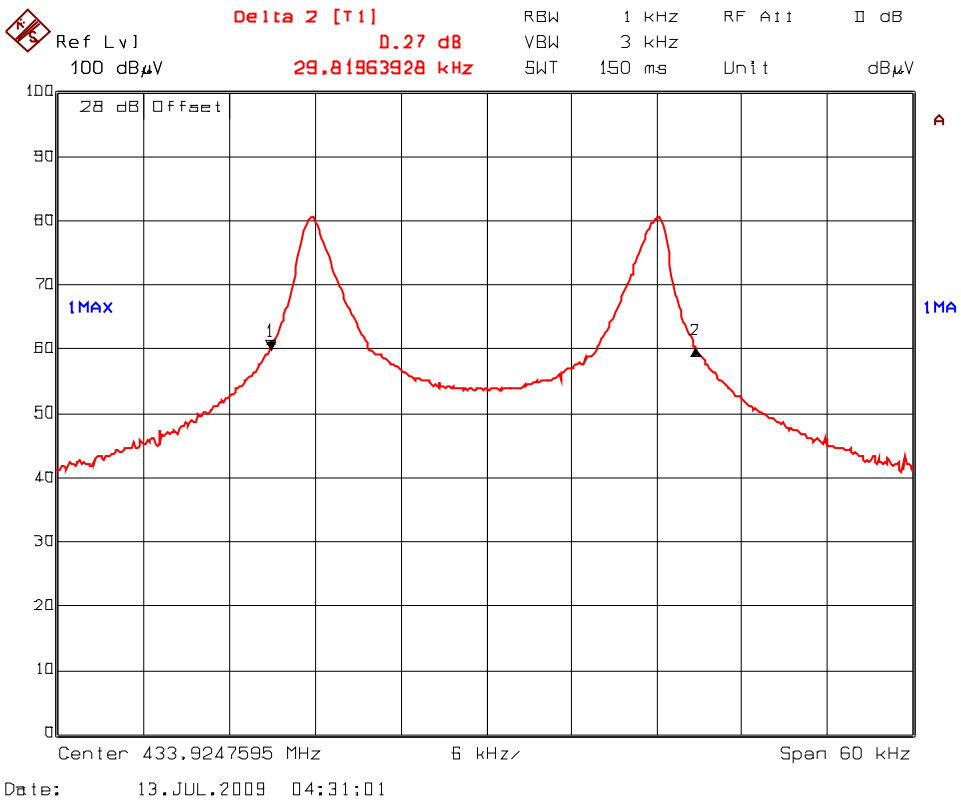
The transmitter output was loosely coupled to the spectrum analyzer through a receiving antenna. The bandwidth of the fundamental frequency was measured with the spectrum analyzer, with the resolution bandwidth of the spectrum analyzer set per ANSI 63.4, Section 13.1.7

### 5.8.3. Test Data

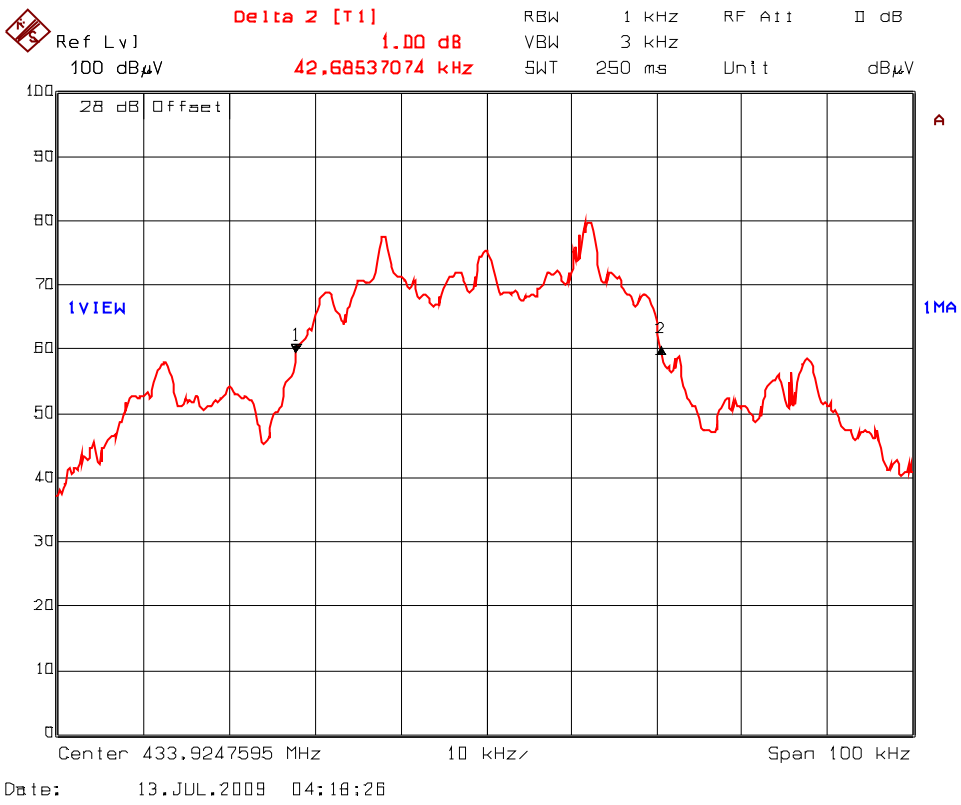
| Channel Frequency (MHz) | 20 dB Bandwidth (kHz) | Maximum Bandwidth Limit (kHz) |
|---|---|---|
| 433.92 | 42.7 | 1084.8 |

See the following plots for detail.

**Plot 5.8.3.1.** 20 dB Bandwidth
Fc: 433.92 MHz (FSK modulation with a rectangular signal at 1bps)



**Plot 5.8.3.2.** 20 dB Bandwidth
Fc: 433.92 MHz (FSK modulation with programmed message)



# EXHIBIT 6. TEST EQUIPMENT LIST

| Test Instruments | Manufacturer | Model No. | Serial No. | Operating Range |
|---|---|---|---|---|
| EMI-Test Receiver | Rohde & Schwarz | ESU40 | 100037 | 20 Hz- 40 GHz, build in amplifier |
| Loop Antenna | EMCO | 6502 | 2611 | 10 kHz – 30 MHz |
| Biconilog Antenna | EMCO | 3142 | 1005 | 26 MHz to 2 GHz |
| Horn Antenna | Emco | 3155 | 9701-5061 | 1 – 18 GHz |
| RF Amplifier | Com-Power | PA-103A | 161243 | 10 MHz – 1000 MHz |
| RF Amplifier | Hewlett Packard | 84498 | 3008A00769 | 1 – 26.5 GHz |
| Spectrum Analyzer/ EMI Receiver | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz |
| Transient Limiter | Hewlett Packard | 11947A | 310701998 | 9 kHz – 200 MHz 10 dB attenuation |
| L.I.S.N. | EMCO | 3825/2 | 89071531 | 9 kHz – 200 MHz 50 Ohms / 50 μH |
| RF Shielded Chamber | Braden Shielding | … | … | … |

# EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and LAB 34

## 7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION (Line Conducted) | PROBABILITY DISTRIBUTION | UNCERTAINTY (dB) | |
|---|---|---|---|
| | | 9-150 kHz | 0.15-30 MHz |
| EMI Receiver specification | Rectangular | ±1.5 | ±1.5 |
| LISN coupling specification | Rectangular | ±1.5 | ±1.5 |
| Cable and Input Transient Limiter calibration | Normal (k=2) | ±0.3 | ±0.5 |
| Mismatch: Receiver VRC $\Gamma_1$ = 0.03<br>LISN VRC $\Gamma_R$ = 0.8(9 kHz) 0.2 (30 MHz)<br>Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$) | U-Shaped | ±0.2 | ±0.3 |
| System repeatability | Std. deviation | ±0.2 | ±0.05 |
| Repeatability of EUT | -- | -- | -- |
| Combined standard uncertainty | Normal | ±1.25 | ±1.30 |
| Expanded uncertainty U | Normal (k=2) | ±2.50 | ±2.60 |

Sample Calculation for Measurement Accuracy in 450 kHz to 30 MHz Band:

$u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)} = \pm \sqrt{(1.5^2 + 1.5^2)/3 + (0.5/2)^2 + (0.05/2)^2 + 0.35^2} = \pm 1.30$ dB

$U = 2u_c(y) = \pm 2.6$ dB

## 7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION (Radiated Emissions) | PROBABILITY DISTRIBUTION | UNCERTAINTY (± dB) | |
|---|---|---|---|
| | | 3 m | 10 m |
| Antenna Factor Calibration | Normal (k=2) | ±1.0 | ±1.0 |
| Cable Loss Calibration | Normal (k=2) | ±0.3 | ±0.5 |
| EMI Receiver specification | Rectangular | ±1.5 | ±1.5 |
| Antenna Directivity | Rectangular | +0.5 | +0.5 |
| Antenna factor variation with height | Rectangular | ±2.0 | ±0.5 |
| Antenna phase center variation | Rectangular | 0.0 | ±0.2 |
| Antenna factor frequency interpolation | Rectangular | ±0.25 | ±0.25 |
| Measurement distance variation | Rectangular | ±0.6 | ±0.4 |
| Site imperfections | Rectangular | ±2.0 | ±2.0 |
| Mismatch: Receiver VRC $\Gamma_1$ = 0.2<br>Antenna VRC $\Gamma_R$ = 0.67(Bi) 0.3 (Lp)<br>Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$) | U-Shaped | +1.1<br>-1.25 | ±0.5 |
| System repeatability | Std. Deviation | ±0.5 | ±0.5 |
| Repeatability of EUT | | - | - |
| Combined standard uncertainty | Normal | +2.19 / -2.21 | +1.74 / -1.72 |
| Expanded uncertainty U | Normal (k=2) | +4.38 / -4.42 | +3.48 / -3.44 |

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB