



# Nemko

**Test Report:** 5W55095 Issue 2

**Applicant:** Nera SatCom AS  
Bergerveien 12,  
1375 Billingstad, Norway

**Apparatus:** L-Band Satellite Terminal

**FCC ID:** TSF107020

**In Accordance With:** FCC Part 25, Satellite Communications  
Subpart C, Technical Standards

**Tested By:** Nemko Canada Inc.  
303 River Road  
Ottawa, Ontario  
K1V 1H2

**Authorized By:**   
Sim Jagpal, Resource Manager

**Date:** December 7, 2005

**Total Number of Pages:** 49

## Report Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 25 Subpart C. Radiated tests were conducted in accordance with ANSI C63.4-2003. Radiated emissions are made on an open area test site. A description of the test facility is on file with the FCC.

The assessment summary is as follows:

<b>Apparatus Assessed:</b>	L-Band Satellite Terminal
<b>Specification:</b>	FCC Part 25 Subpart C
<b>Compliance Status:</b>	Complies
<b>Exclusions:</b>	None
<b>Non-compliances:</b>	None
<b>Report Release History:</b>	Original Release

Author: Roman Kuleba, EMC/Wireless Specialist

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025.

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## Section 1: Equipment Under Test

### 1.1 Product Identification

The Equipment Under Test was identified as follows: Nera WorldPro 1000 L-band Satellite Terminal

### 1.2 Samples Submitted for Assessment

The following samples of the apparatus have been submitted for type assessment:

Sample No.	Description	Serial No.
Item 1 & 2	Inmarsat Satellite Terminal Nera WorldPro 1000	Prototype 1 & 2 (d122/56)
Item 3	USB Cable	–
Item 5	AC/DC Adapter (100-240VAC, 50-60 Hz, 800 mA)	S/N: 36120-0006109

The first samples were received on: November 7, 2005

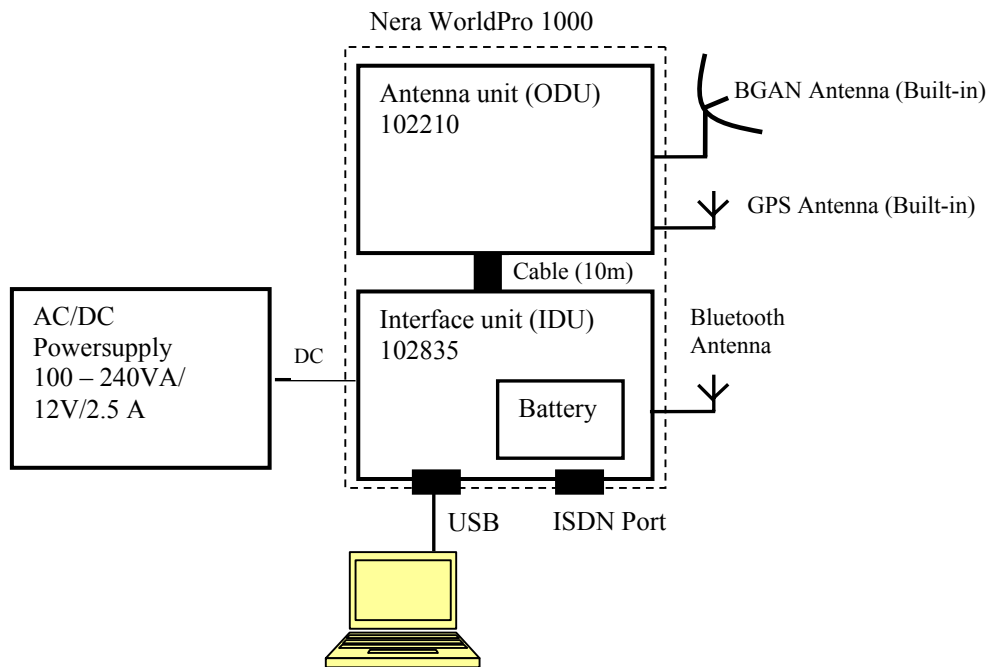
### 1.3 Theory of Operation

The Nera WorldPro 1000 satellite terminal is a lightweight satellite terminal that provides broadband data and voice transmission via Inmarsat’s BGAN (Broad-band Global Area Network) satellite service in microwave L-band. Voice and data connections can be used simultaneously. Type of modulation used:  $\pi/4$  QPSK. All services are supported in spot beam.

### 1.4 Technical Specifications of the EUT

<b>Manufacturer:</b>	Nera SatCom AS
<b>Operating Frequency:</b>	Up-link (Earth-to-space): 1626.5 – 1660.5 MHz Down-link (Space-to-Earth): 1525.0 – 1559.0 MHz
<b>Peak Output Power:</b>	Conducted: 34.83 dBm (3.04 W) EIRP: 43.33 dBm (21.53 W)
<b>Emission Designator</b>	190K G7W
<b>Rated Power:</b>	Minimum Conducted Mean Power: 25.5 dBm Maximum Conducted Mean Power: 32.5 dBm Mean EIRP: 40 dBm
<b>Modulation:</b>	$\pi/4$ QPSK
<b>Antenna Data:</b>	8.5 dBi Micro-strip Patch

### 1.5 Block Diagram of the EUT:



## Section 2 : Test Conditions

### 2.1 Specifications

The apparatus was assessed against the following specifications:

FCC Part 25 Subpart C, Mobile Satellite Station

### 2.2 Deviations From Laboratory Test Procedures

No deviations were made from laboratory test procedures.

### 2.3 Test Environment

All tests were performed under the following environmental conditions:

Temperature range	:	15 – 30 °C
Humidity range	:	20 - 75 %
Pressure range	:	86 - 106 kPa
Power supply range	:	+/- 5% of rated voltages

### 2.4 Test Equipment

Equipment	Manufacturer	Model No.	Asset/Serial No.	Last Cal.	Next Cal.
Spectrum Analyzer	Rhode & Schwarz	FSP40	FA001920	Mar. 22, 05	Mar. 22, 06
Signal Generator	Rohde & Schwarz	SMR40	FA001879	July 13, 05	July 13, 06
Power Meter	Hewlett Packard	E4418B	FA001678	Mar 8, 05	Mar 8, 06
Power Sensor	Hewlett Packard	8487A	FA001419	Apr. 29, 05	Apr. 29, 06
RF AMP	JCA	4-8 GHz	FA001497	COU*	COU*
RF AMP	JCA	2-4 GHz	FA001496	COU*	COU*
RF AMP	Narda	5 - 18GHz	FA001409	COU*	COU*
RF AMP	Narda	18 - 26.5GHz	FA001550	COU*	COU*
High Pass Filter (3.9GHz)	K&L	11SH10-4000	FA001340	COU*	COU*
Attenuator, 20 dB	Narda	776B-20	FA001153	COU*	COU*
Biconical (1) Antenna	EMCO	3109	FA000805	April 22/05	April 22/06
Log Periodic Antenna #1	EMCO	LPA-25	FA000477	Aug. 29/05	Aug. 29/06
Horn Antenna	EMCO #2	3115	FA000825	Dec. 14, 04	Dec. 14, 05
Horn Antenna	EMCO #1	3115	FA000649	Dec. 22, 04	Dec. 22, 05
Spectrum Analyzer	Hewlett-Packard	8566B	FA001309	May 18, 05	May 18, 06
Spectrum Analyzer Display	Hewlett-Packard	85662A	FA001309	May 18, 05	May 18, 06

\* COU (Calibrate on Use)

\*\* NCR (No Calibration Required)

## **Section 3 : Observations**

### **3.1 Modifications Performed During Assessment**

No modifications were performed during assessment.

### **3.2 Record Of Technical Judgements**

No technical judgements were made during the assessment.

### **3.3 EUT Parameters Affecting Compliance**

The user of the apparatus could not alter parameters that would affect compliance.

### **3.4 Test Deleted**

No Tests were deleted from this assessment.

## **Section 4: Results Summary**

This section contains the following:

FCC Part 25 Subpart C: Test Results

The column headed 'Required' indicates whether the associated clauses were invoked for the apparatus under test. The following abbreviations are used:

- N No : not applicable / not relevant.
- Y Yes : Mandatory i.e. the apparatus shall conform to these tests.
- N/T Not Tested, mandatory but not assessed. (See section 3.4 Test deleted)

The results contained in this section are representative of the operation of the apparatus as originally submitted.



**4.1 FCC Part 25 Subpart C: Test Results**

Part 25	Test Description	Required	Result
§25.204 & §2.1046	RF Power Output and Power Limits	Y	PASS
§25.202(f) & §2.1051	Unwanted Emissions at Antenna Terminals	Y	PASS
§25.202(f) & §2.1053	Radiated Spurious Emissions	Y	PASS
§25.202(d) & §2.1055	Frequency Stability	Y	PASS
§25.216(h)(i)(j)	Protection of Aeronautical Radio-navigation Satellite Service	Y	PASS

Notes:

## Appendix A: Test Results

### RF Power Output

#### Criteria: §25.204 Power Limits and §2.1046 RF Power Output Measurement

§25.204 Power limits.

(a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station, other than an ESV, operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) of this section:

+40 dBW in any 4 kHz band for  $\theta: 0^\circ$

+40 + 3· $\theta$  dBW in any 4 kHz band for  $0^\circ < \theta \leq 5^\circ$

where  $\theta$  is the angle of elevation of the horizon viewed from the center of radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

(c) For angles of elevation of the horizon greater than  $5^\circ$  there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

(d) Notwithstanding the e.i.r.p. and e.i.r.p. density limits specified in the station authorization, each earth station transmission shall be conducted at the lowest power level that will provide the required signal quality as indicated in the application and further amended by coordination agreements.

§2.1046 Measurements required: RF power output.

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

#### Test Conditions:

<b>Sample Number:</b>	1	<b>Temperature:</b>	23 °C
<b>Date:</b>	November 8, 2005	<b>Humidity:</b>	36 %
<b>Modification State:</b>	0	<b>Tester:</b>	Roman Kuleba
		<b>Laboratory:</b>	Ottawa

**Test Results:** See Attached Table and Plots.

#### Additional Observations:

The peak output power of the EUT was measured by means of spectrum analyzer set in ‘Peak’ detector mode and bandwidths set to: RBW > Emission BW and VBW ≥ 3·RBW.

The mean RF output power was measured both; with powermeter and with spectrum analyzer set in ‘RMS’ detector mode and bandwidths set as above. The difference between both methods was within measurement uncertainty.

RF Power Output, continued

**Measured Output Power:**

**Modulation:  $\pi/4$  QPSK**

**Symbol Rate:  $0.5 \times 33.6$  kS/s, Identifier: R20T0.5**

Freq. (MHz)	Ant.Gain (dBi)	P <sub>TX</sub> -peak (dBm)	EIRP-peak (dBm)	P <sub>TX</sub> -mean (dBm)	EIRP-mean (dBm)
1626.590	8.5	34.09	42.59	30.77	39.27
1643.500	8.5	33.54	42.04	30.47	38.97
1660.330	8.5	34.31	42.81	31.04	39.54

P<sub>TX</sub> – output RF power measured at antenna terminal

**Modulation:  $\pi/4$  QPSK**

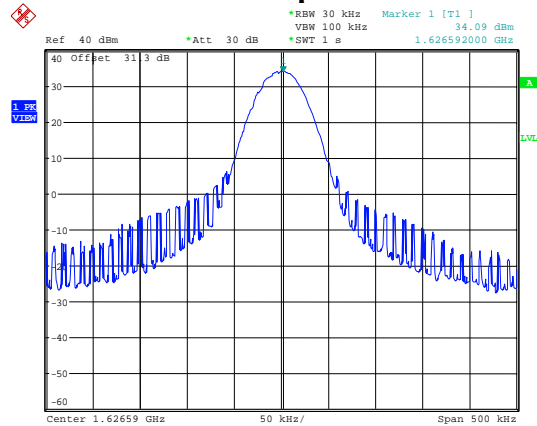
**Symbol Rate:  $4.5 \times 33.6$  kS/s, Identifier: R20T4.5Q**

Freq. (MHz)	Ant.Gain (dBi)	P <sub>TX</sub> -peak (dBm)	EIRP-peak (dBm)	P <sub>TX</sub> -mean (dBm)	EIRP-mean (dBm)
1626.760	8.5	34.77	43.27	31.06	39.56
1643.500	8.5	34.04	42.54	30.63	39.13
1660.330	8.5	34.83	43.33	31.25	39.75

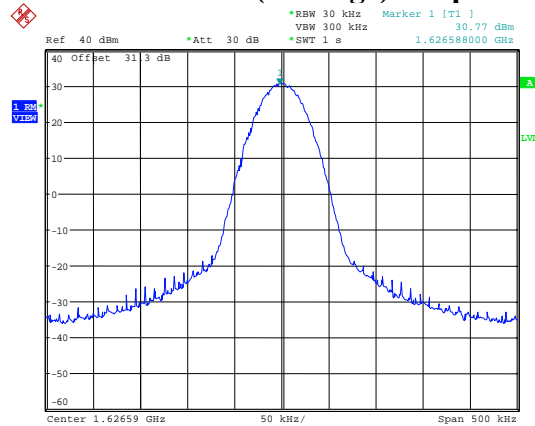
P<sub>TX</sub> – output RF power measured at antenna terminal

RF Power Output, continued

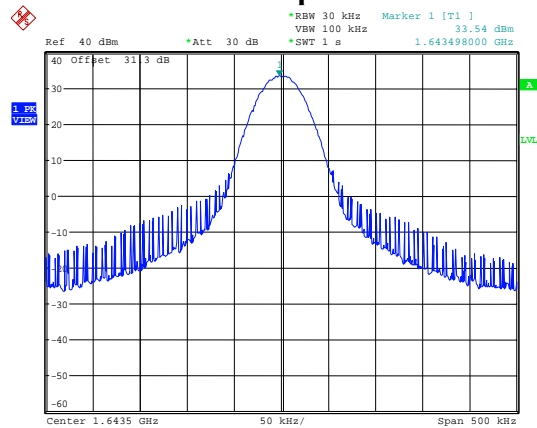
**Modulation:  $\pi/4$  QPSK**  
**Symbol Rate:  $0.5 \times 33.6$  kS/s, Identifier: R20T0.5Q**  
**TX Frequency: 1626.59 MHz**  
**Conducted Peak Output Power**



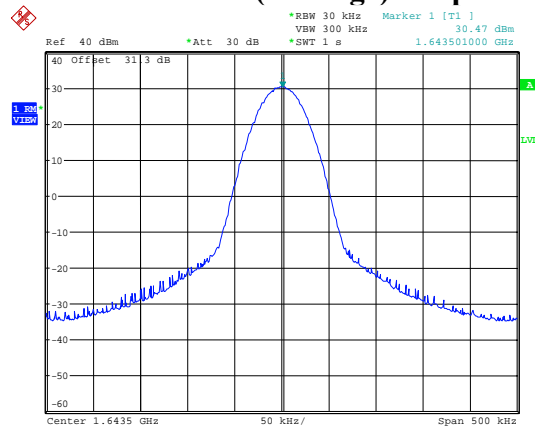
**Conducted Mean (Average) Output Power**



**Modulation:  $\pi/4$  QPSK**  
**Symbol Rate:  $0.5 \times 33.6$  kS/s, Identifier: R20T0.5Q**  
**TX Frequency: 1643.50 MHz**  
**Conducted Peak Output Power**

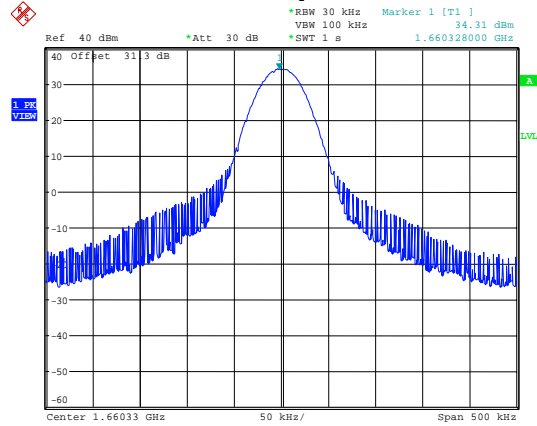


**Conducted Mean (Average) Output Power**

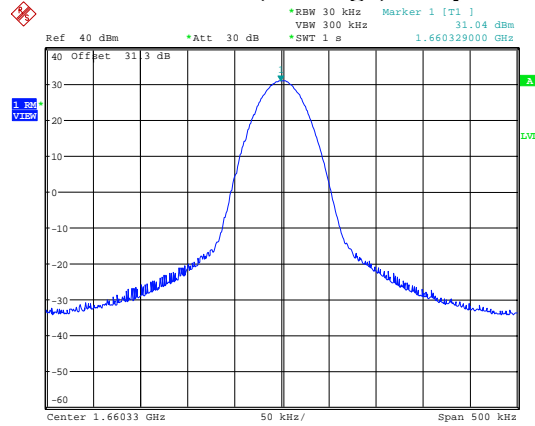


RF Power Output, continued

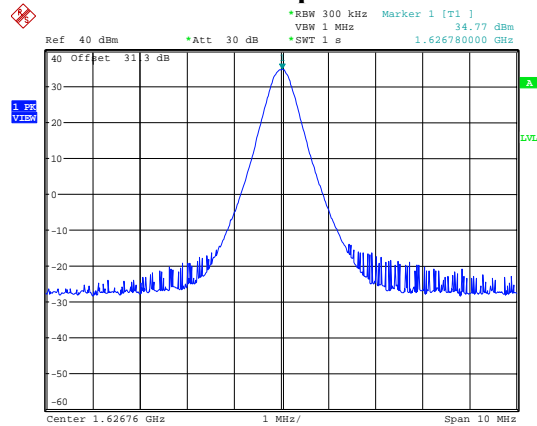
**Modulation:  $\pi/4$  QPSK**  
**Symbol Rate:  $0.5 \times 33.6$  kS/s, Identifier: R20T0.5Q**  
**TX Frequency: 1660.33 MHz**  
**Conducted Peak Output Power**



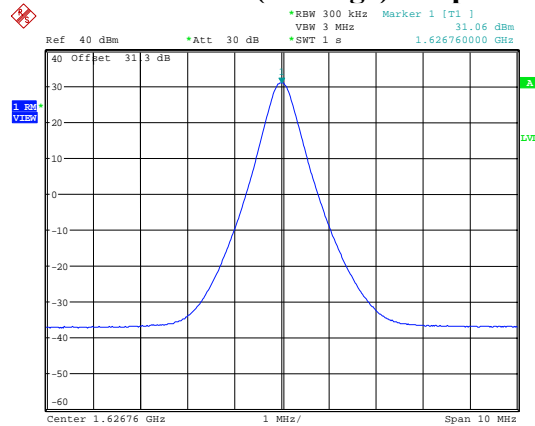
**Conducted Mean (Average) Output Power**



**Modulation:  $\pi/4$  QPSK**  
**Symbol Rate:  $4.5 \times 33.6$  kS/s, Identifier: R20T4.5Q**  
**TX Frequency: 1626.76 MHz**  
**Conducted Peak Output Power**

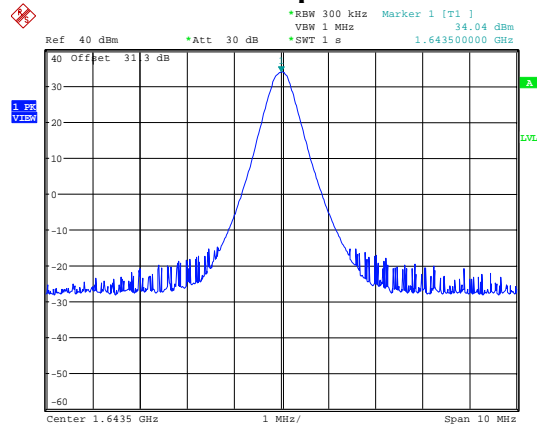


**Conducted Mean (Average) Output Power**

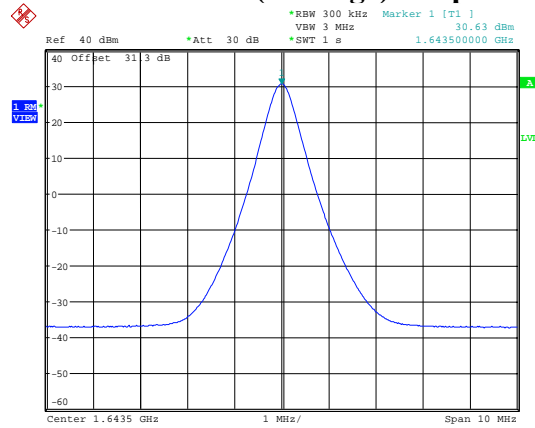


RF Power Output, continued

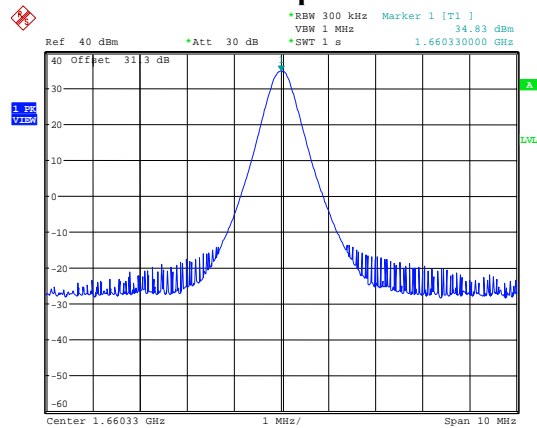
**Modulation:  $\pi/4$  QPSK**  
**Symbol Rate:  $4.5 \times 33.6$  kS/s, Identifier: R20T4.5Q**  
**TX Frequency: 1643.50 MHz**  
**Conducted Peak Output Power**



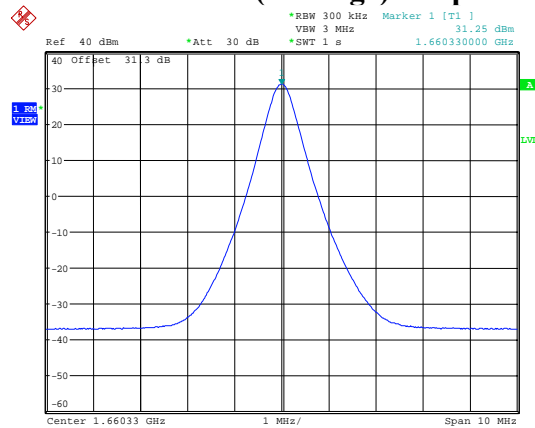
**Conducted Mean (Average) Output Power**



**Modulation:  $\pi/4$  QPSK**  
**Symbol Rate:  $4.5 \times 33.6$  kS/s, Identifier: R20T4.5Q**  
**TX Frequency: 1660.33 MHz**  
**Conducted Peak Output Power**



**Conducted Mean (Average) Output Power**



**Unwanted Emissions at Antenna Terminals**

**Criteria: Clause §25.202(f) Emission Limitations and §2.1051 Measurements required: Spurious emissions at antenna terminals.**

§25.202 Emission limitations.  
 (f) The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:  
 (1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50% up to and including 100% of the authorized bandwidth: 25 decibels;  
 (2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth: 35 decibels;  
 (3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250% of the authorized bandwidth: an amount equal to 43 decibels plus 10 times the logarithm (to the base 10) of the transmitter power in watts.

§2.1051 Measurements required: Spurious emissions at antenna terminals.  
 The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

**Test Conditions:**

<b>Sample Number:</b>	1	<b>Temperature:</b>	23 °C
<b>Date:</b>	November 8 – 10, 2005	<b>Humidity:</b>	36 %
<b>Modification State:</b>	0	<b>Tester:</b>	Roman Kuleba
		<b>Laboratory:</b>	Ottawa

**Test Results:**

See Attached Tables and Plots

**Additional Observations:**

The Spectrum was searched from 30 MHz to the 10<sup>th</sup> Harmonic.

Because the measurements were performed with 300 Hz and 3 kHz RBW the limits had to be additionally corrected (reduced) by  $10 \cdot \log_{10} (RBW/4kHz)$ .

Unwanted Emissions at Antenna Terminals, continued

**Emissions Limits:**

Symbol Rate: 0.5×33.6 kS/s (Identifier: R20T0.5Q)

Authorized Bandwidth (Inmarsat Specification): 21 kHz

Measured Emission Bandwidth: 20.85 kHz (see Occupied Bandwidth measurement data below)

Measured Mean Power: 31.04 dBm

**Mask:**

Frequencies removed less than 10.5 kHz (50% of authorized BW) from the carrier:

$$\begin{aligned} \text{Limit (dBm)} &= P_{TX} \text{ (dBm)} \\ \text{Limit} &= 31.04 \text{ dBm} \end{aligned}$$

Frequencies removed 10.5 kHz – 21.0 kHz (50% – 100% of authorized BW) from the carrier:

$$\begin{aligned} \text{Limit (dBm)} &= P_{TX} \text{ (dBm)} - A \text{ (dB)} + CF \text{ (dB)} \\ \text{Limit} &= 31.04 \text{ dBm} - 25 \text{ dB} - 11.25 \text{ dB} = -5.21 \text{ dBm} \end{aligned}$$

Frequencies removed 21.0 kHz – 52.5 kHz (100% – 250% of authorized BW) from the carrier:

$$\begin{aligned} \text{Limit (dBm)} &= P_{TX} \text{ (dBm)} - A \text{ (dB)} + CF \text{ (dB)} \\ \text{Limit} &= 31.04 \text{ dBm} - 35 \text{ dB} - 11.25 \text{ dB} = -15.21 \text{ dBm} \end{aligned}$$

Frequencies removed more than 52.5 kHz (250% of authorized BW) from the carrier:

$$\begin{aligned} \text{Limit (dBm)} &= P_{TX} \text{ (dBm)} - [43 + 10 \cdot \log_{10}(P_{TX}/Watt)] \text{ (dB)} + CF \text{ (dB)} \\ \text{Limit} &= 31.04 \text{ dBm} - (43 + 1.04) \text{ dB} - 11.25 \text{ dB} = -13 \text{ dBm} - 11.25 \text{ dB} = -24.25 \text{ dBm} \end{aligned}$$

- Limit : Limit value for mean power of emissions (dBm)
- $P_{TX}$  : Mean output power of transmitter (dBm)
- A : Required attenuation below mean output TX power (dB)
- CF : 4 kHz to 300 Hz RBW correction (dB):  $10 \cdot \log_{10}(300\text{Hz}/4000\text{Hz}) = -11.25 \text{ dB}$
- $P_{TX}/Watt$  : Mean output power of transmitter expressed in Watts (W)



Unwanted Emissions at Antenna Terminals, continued
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**Emissions Limits:**

Symbol Rate: 4.5×33.6 kS/s (Identifier: R20T4.5Q)

Authorized Bandwidth (Inmarsat Specification): 189 kHz

Measured Emission Bandwidth: 189.0 kHz (see Occupied Bandwidth measurement data below)

Measured Mean Power: 31.25 dBm

**Mask:**

Frequencies removed less than 94.5 kHz (50% of authorized BW) from the carrier:

$$\text{Limit (dBm)} = P_{\text{TX}} \text{ (dBm)}$$

$$\text{Limit} = 31.25 \text{ dBm}$$

Frequencies removed 94.5 kHz – 189.0 kHz (50% – 100% of authorized BW) from the carrier:

$$\text{Limit (dBm)} = P_{\text{TX}} \text{ (dBm)} - A \text{ (dB)} + CF \text{ (dB)}$$

$$\text{Limit} = 31.25 \text{ dBm} - 25 \text{ dB} - 1.25 \text{ dB} = +5.0 \text{ dBm}$$

Frequencies removed 189.0 kHz – 472.5 kHz (100% – 250% of authorized BW) from the carrier:

$$\text{Limit (dBm)} = P_{\text{TX}} \text{ (dBm)} - A \text{ (dB)} + CF \text{ (dB)}$$

$$\text{Limit} = 31.25 \text{ dBm} - 35 \text{ dB} - 1.25 \text{ dB} = -5.0 \text{ dBm}$$

Frequencies removed more than 472.5 kHz (250% of authorized BW) from the carrier:

$$\text{Limit (dBm)} = P_{\text{TX}} \text{ (dBm)} - [43 + 10 \cdot \log_{10}(P_{\text{TX}}/W_{\text{att}})] \text{ (dB)} + CF \text{ (dB)}$$

$$\text{Limit} = 31.25 \text{ dBm} - (43 + 1.25) \text{ dB} - 1.25 \text{ dB} = -13 \text{ dBm} - 1.25 \text{ dB} = -14.25 \text{ dBm}$$

Limit : Limit value for mean power of emissions (dBm)

$P_{\text{TX}}$  : Mean output power of transmitter (dBm)

A : Required attenuation below mean output TX power (dB)

CF : 4 kHz to 3 kHz RBW correction (dB):  $10 \cdot \log_{10}(3\text{kHz}/4\text{kHz}) = -1.25 \text{ dB}$

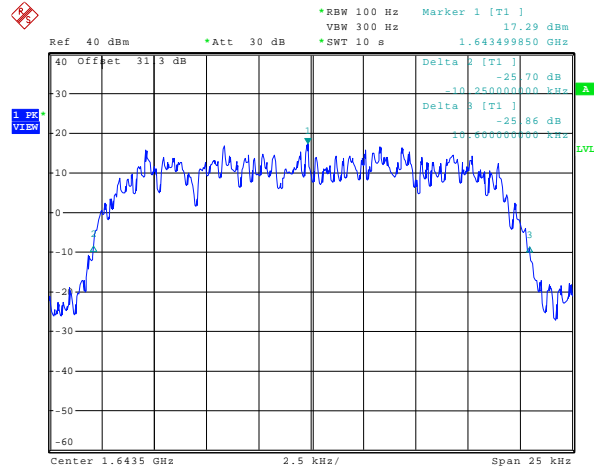
$P_{\text{TX}}/W_{\text{att}}$  : Mean output power of transmitter expressed in Watts (W)

Occupied Bandwidth

**26 dB Occupied Bandwidth**

**Symbol Rate: 0.5×33.6 kS/s (Identifier: R20T0.5Q)**

OccBW = 10.25 kHz + 10.60 kHz = 20.85 kHz

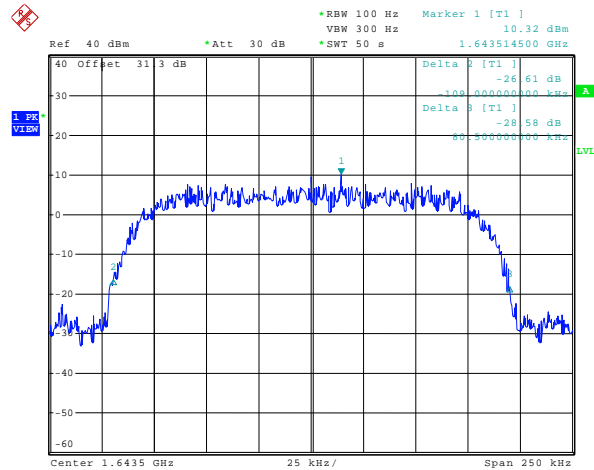


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**26 dB Occupied Bandwidth**

**Symbol Rate: 4.5×33.6 kS/s (Identifier: R20T4.5Q)**

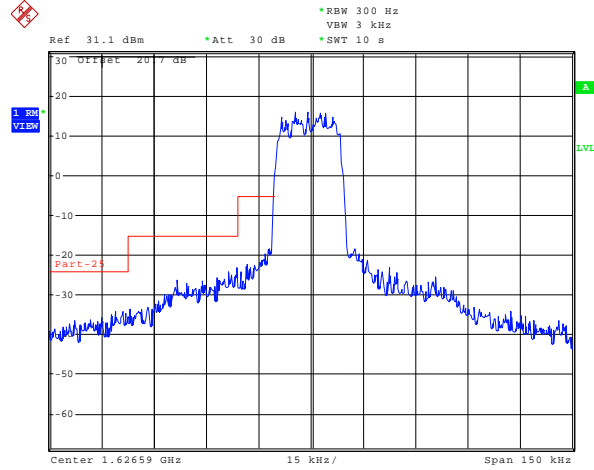
OccBW = 109.0 kHz + 80.0 kHz = 189.0 kHz



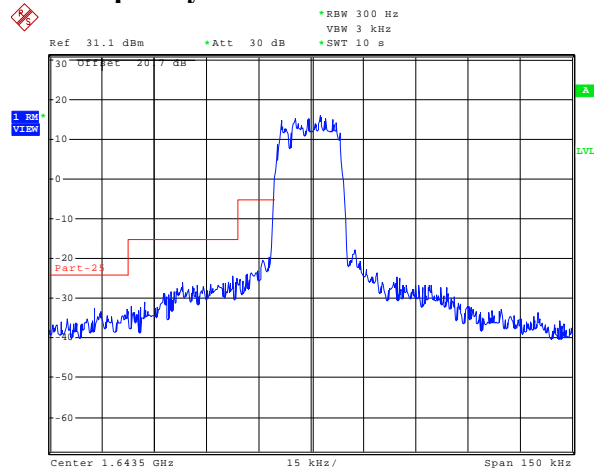
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Out-of-band Emissions

Symbol Rate:  $0.5 \times 33.6$  kS/s (Identifier: R20T0.5Q)  
TX-frequency: 1626.59 MHz

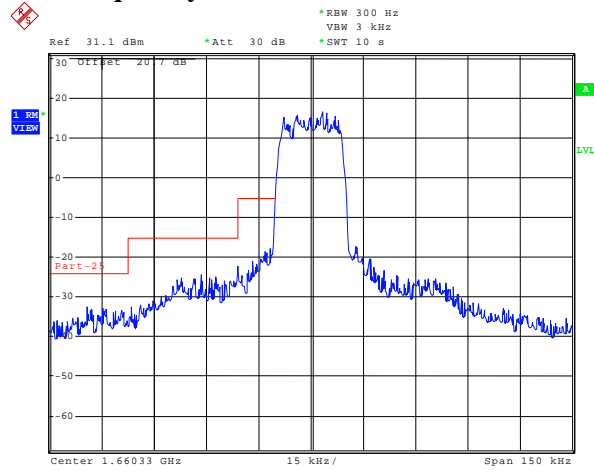


Symbol Rate:  $0.5 \times 33.6$  kS/s (Identifier: R20T0.5Q)  
TX-frequency: 1643.50 MHz

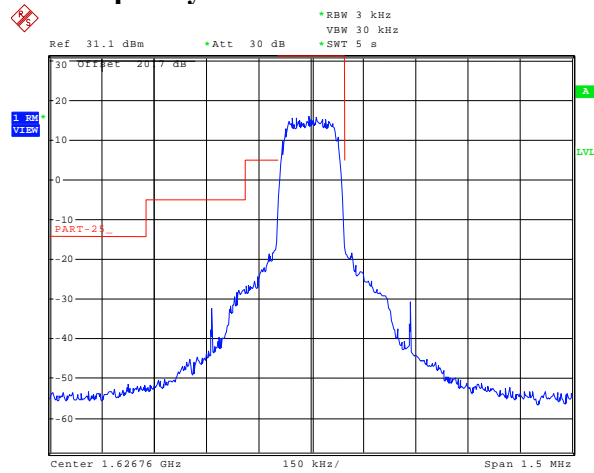


Out-of-band Emissions

Symbol Rate:  $0.5 \times 33.6$  kS/s (Identifier: R20T0.5Q)  
TX-frequency: 1660.33 MHz

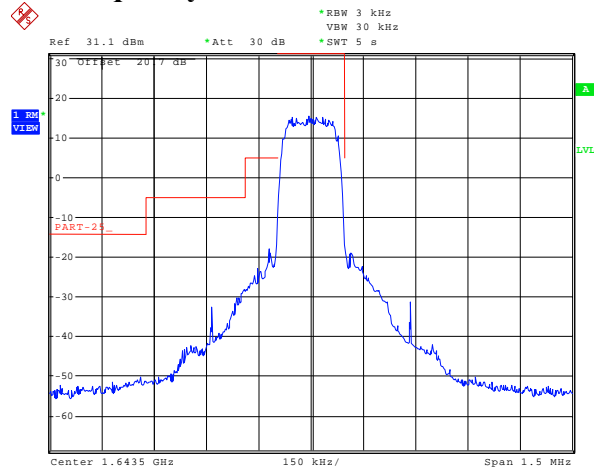


Symbol Rate:  $4.5 \times 33.6$  kS/s (Identifier: R20T4.5Q)  
TX-frequency: 1626.76 MHz

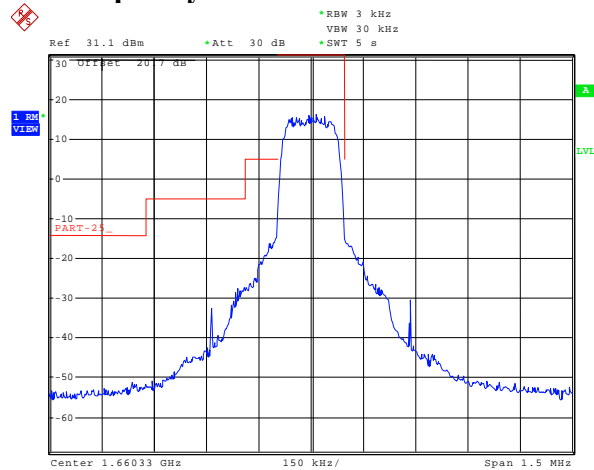


Out-of-band Emissions

Symbol Rate:  $4.5 \times 33.6$  kS/s (Identifier: R20T4.5Q)  
TX-frequency: 1643.50 MHz

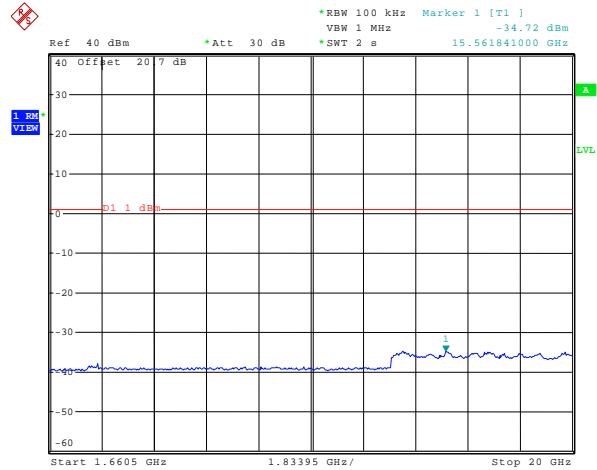
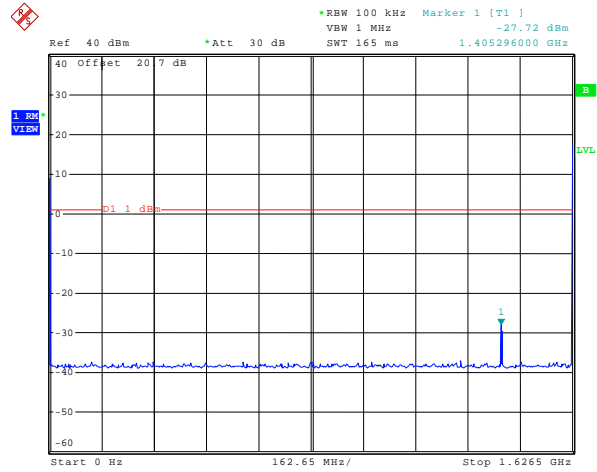


Symbol Rate:  $4.5 \times 33.6$  kS/s (Identifier: R20T4.5Q)  
TX-frequency: 1660.33 MHz



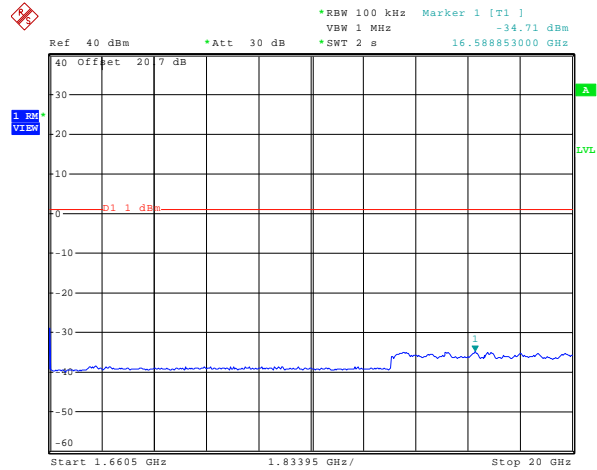
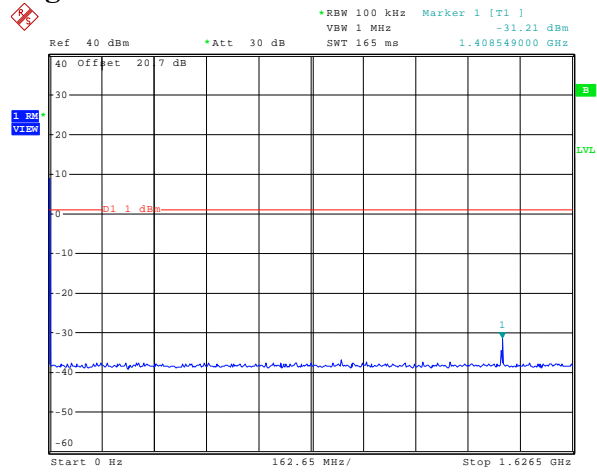
Conducted Spurious Emissions at Antenna Terminal

Symbol Rate: 0.5×33.6 kS/s (Identifier: R20T0.5Q)  
Low Channel: 1626.59 MHz



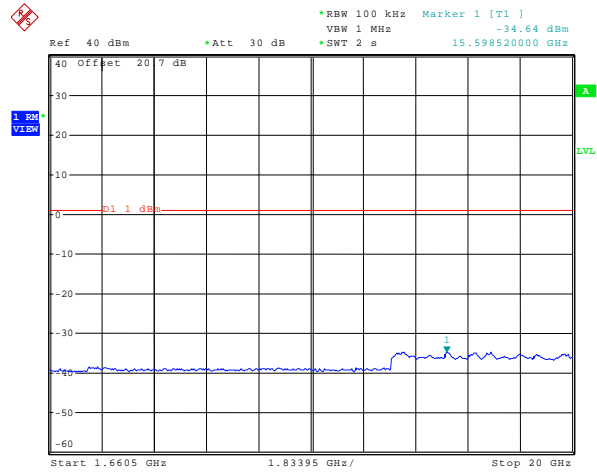
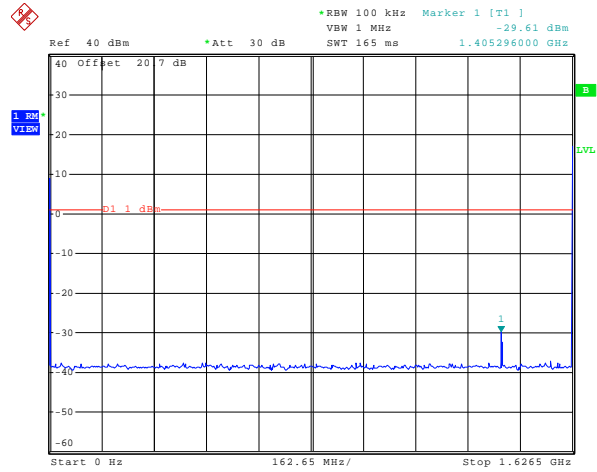
Conducted Spurious Emissions at Antenna Terminal

Symbol Rate:  $0.5 \times 33.6$  kS/s (Identifier: R20T0.5Q)  
High Channel: 1660.33 MHz



Conducted Spurious Emissions at Antenna Terminal

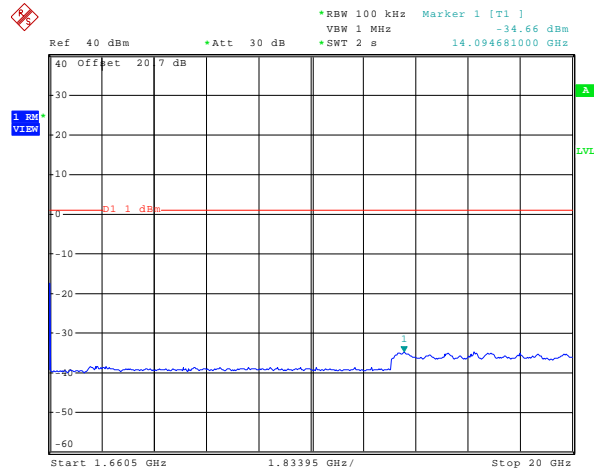
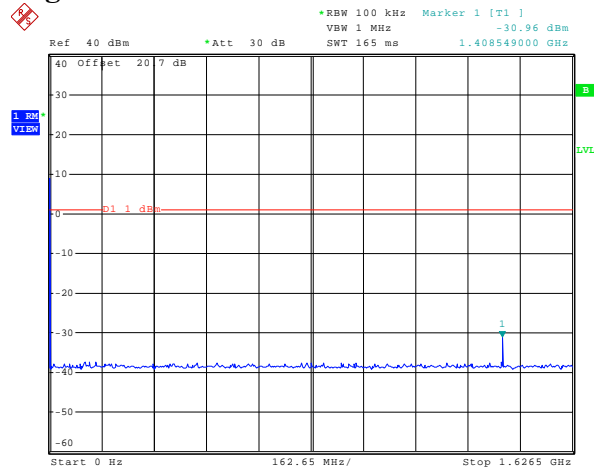
Symbol Rate: 4.5×33.6 kS/s (Identifier: R20T4.5Q)  
Low Channel: 1626.76 MHz





Conducted Spurious Emissions at Antenna Terminal

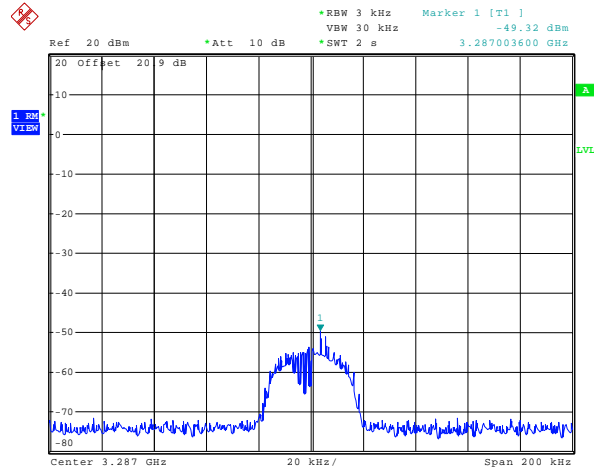
Symbol Rate: 4.5×33.6 kS/s (Identifier: R20T4.5Q)  
High Channel: 1660.33 MHz



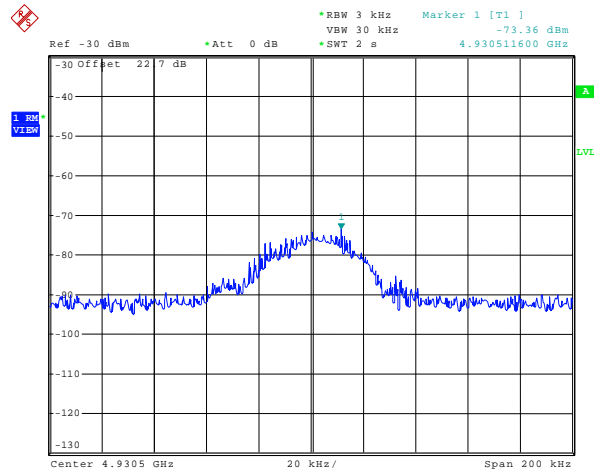
Harmonics

Limit: -14.25 dBm  
Symbol Rate: 0.5×33.6 kS/s (Identifier: R20T0.5Q)

2<sup>nd</sup> Harmonic



3<sup>rd</sup> Harmonic

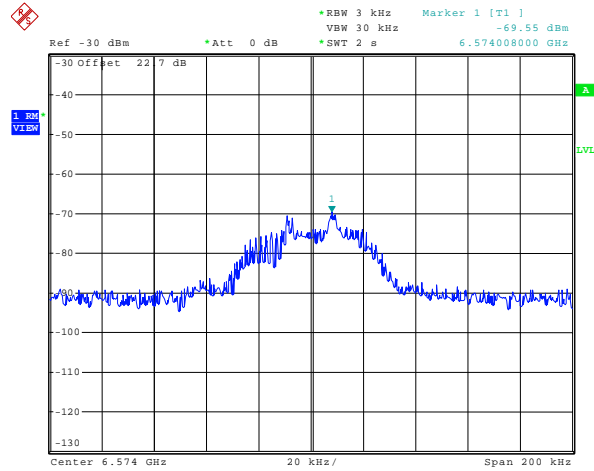


Harmonics

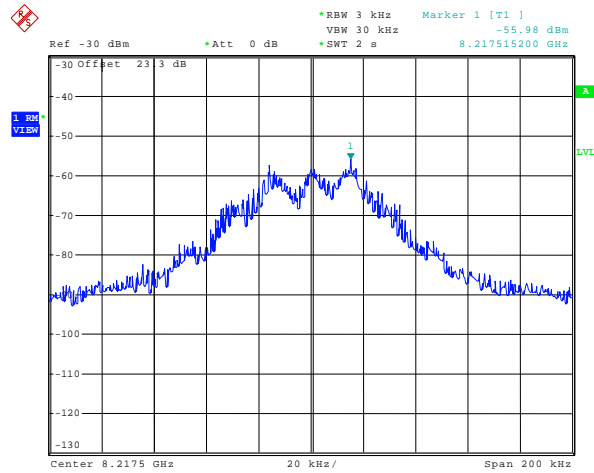
Limit: -14.25 dBm

Symbol Rate: 0.5×33.6 kS/s (Identifier: R20T0.5Q)

4<sup>th</sup> Harmonic



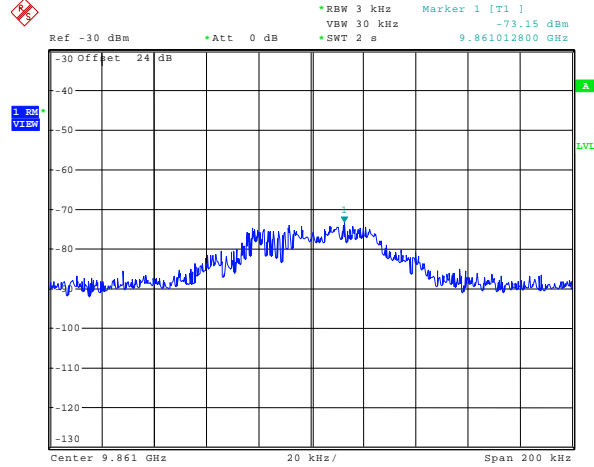
5<sup>th</sup> Harmonic



Harmonics

Limit: -14.25 dBm  
Symbol Rate: 0.5×33.6 kS/s (Identifier: R20T0.5Q)

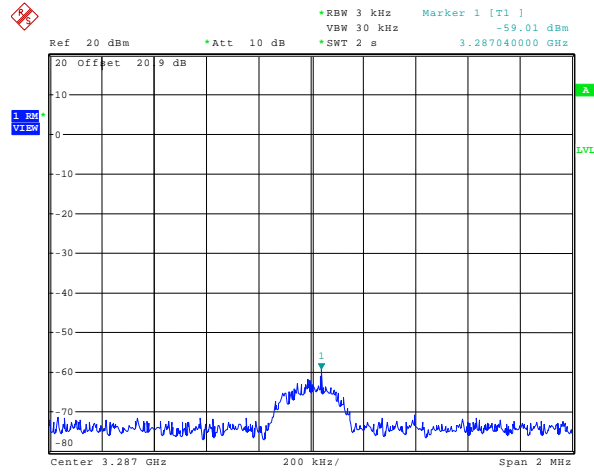
6<sup>th</sup> Harmonic



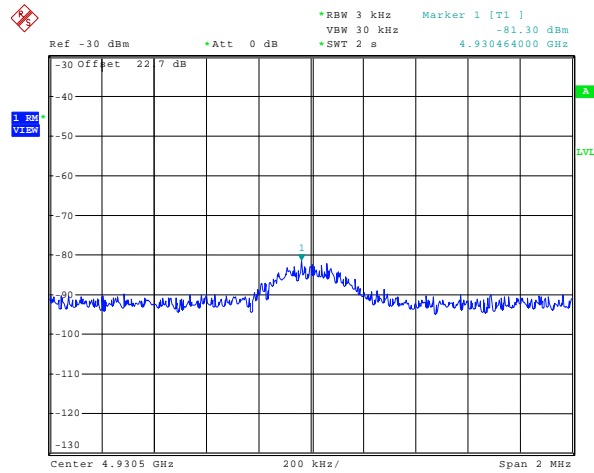
Harmonics

Limit: -14.25 dBm  
Symbol Rate: 4.5×33.6 kS/s (Identifier: R20T4.5Q)

2<sup>nd</sup> Harmonic



3<sup>rd</sup> Harmonic

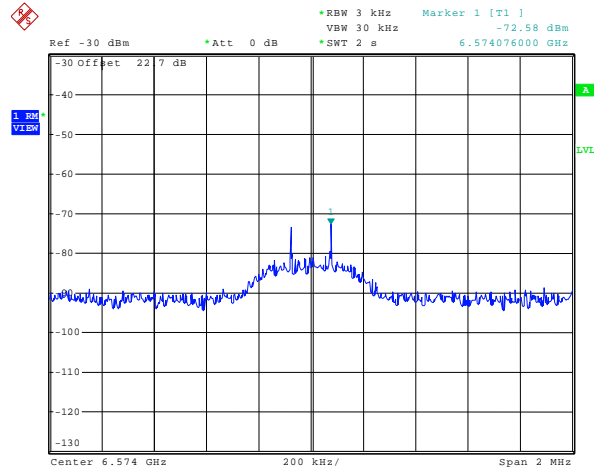


Harmonics

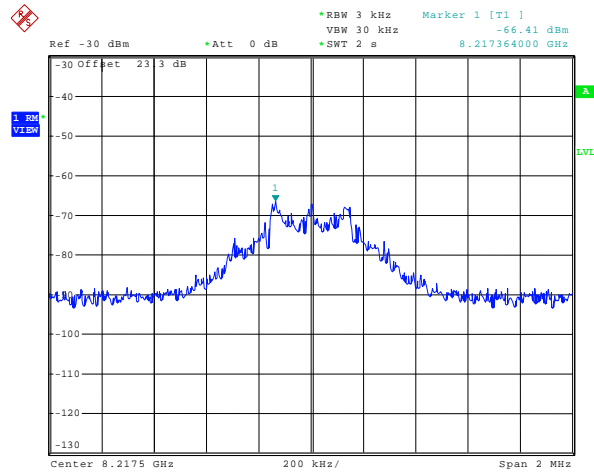
Limit: -14.25 dBm

Symbol Rate: 4.5×33.6 kS/s (Identifier: R20T4.5Q)

4<sup>th</sup> Harmonic



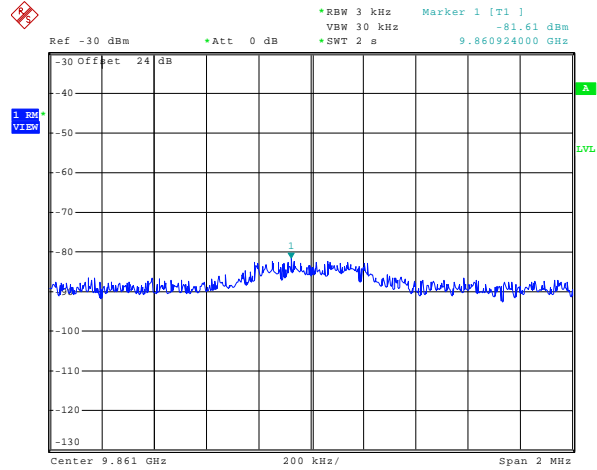
5<sup>th</sup> Harmonic



Harmonics

Limit: -14.25 dBm  
Symbol Rate: 4.5×33.6 kS/s (Identifier: R20T4.5Q)

6<sup>th</sup> Harmonic



**Radiated Spurious Emissions**

**Criteria: §25.202(f) Emission limitations and §2.1053 Measurements required: Field strength of spurious radiation.**

§25.202 Emission limitations.  
 (f) The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:  
 (1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50% up to and including 100% of the authorized bandwidth: 25 decibels;  
 (2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth: 35 decibels;  
 (3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250% of the authorized bandwidth: an amount equal to 43 decibels plus 10 times the logarithm (to the base 10) of the transmitter power in watts.

§2.1053 Measurements required: Field strength of spurious radiation.  
 (a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.  
 (b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:  
 (1) Those in which the spurious emission are required to be 60 dB or more below the mean power of the transmitter.  
 (2) All equipment operating on frequencies higher than 25 MHz.  
 (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.  
 (4) Other types of equipment as required, when deemed necessary by the Commission.

**Test Conditions:**

<b>Sample Number:</b>	1	<b>Temperature:</b>	23 °C
<b>Date:</b>	November 11, 2005	<b>Humidity:</b>	36 %
<b>Modification State:</b>	0	<b>Tester:</b>	Roman Kuleba
		<b>Laboratory:</b>	Ottawa

**Test Results:**

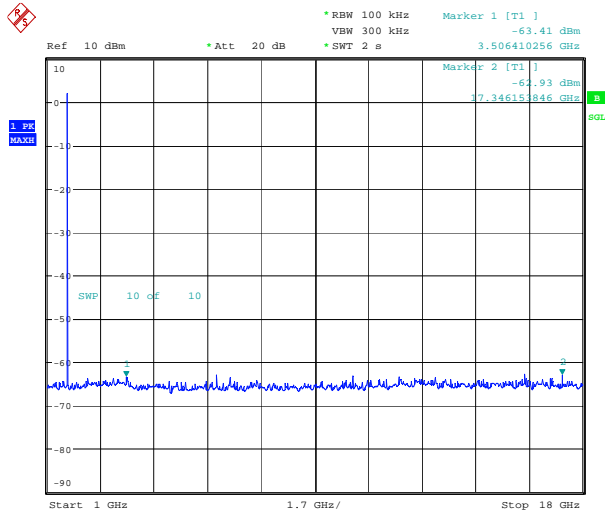
See Attached Tables and Plots

**Additional Observations:**

The Spectrum was searched from 30 MHz to the 10<sup>th</sup> Harmonic.  
 The EUT was measured on three orthogonal axes.  
 All measurements were performed at 3 m distance.



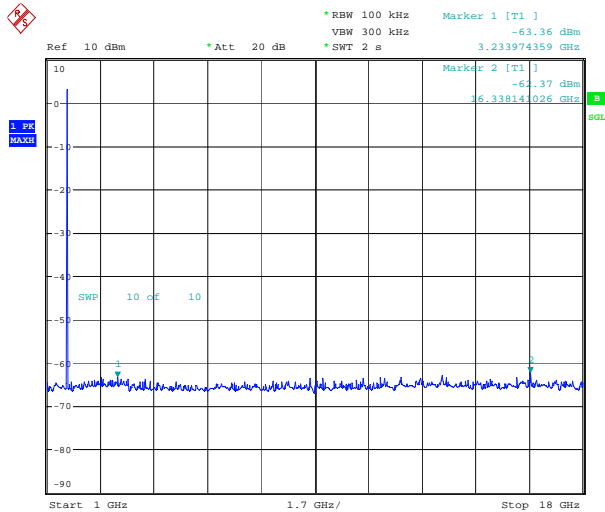
Radiated Spurious Emissions, continued



**Low Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 19:28:03

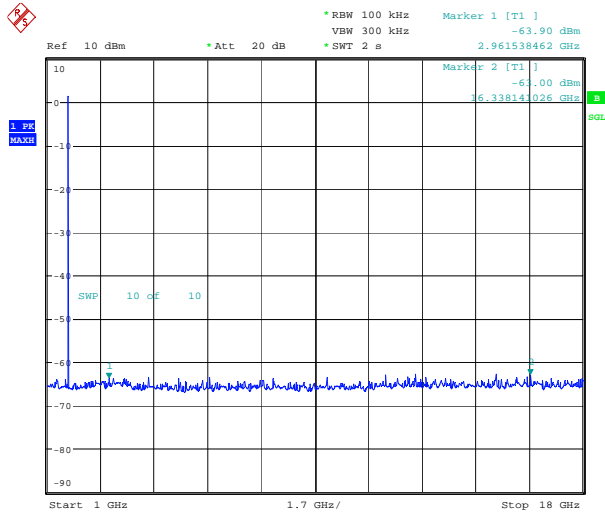


**Low Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

**Polarization: Horizontal**

Date: 11.NOV.2005 19:31:24

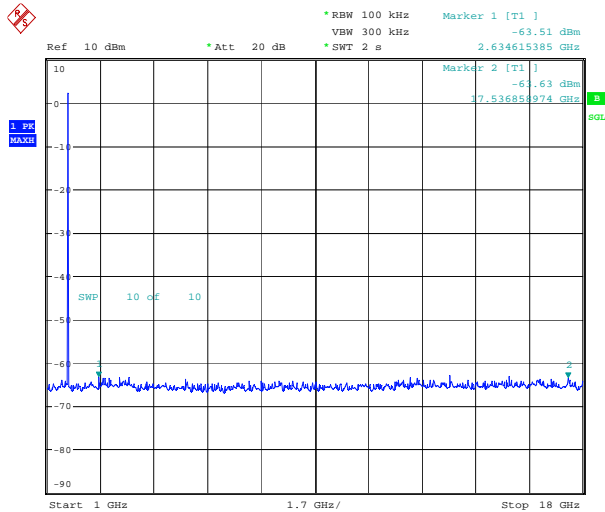
Radiated Spurious Emissions, continued



**High Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 19:15:25

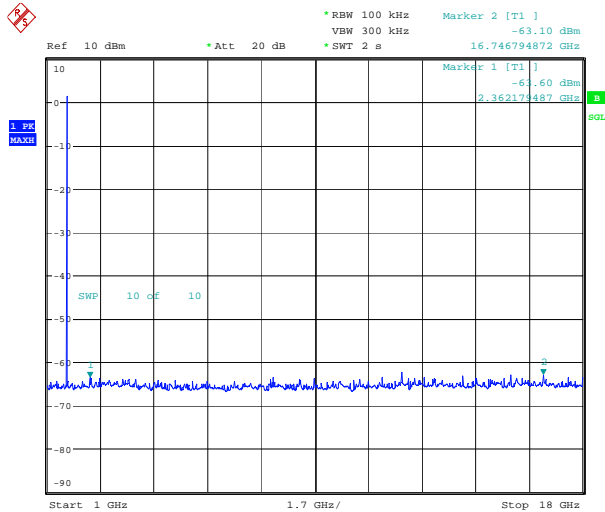


**High Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

**Polarization: Horizontal**

Date: 11.NOV.2005 19:13:16

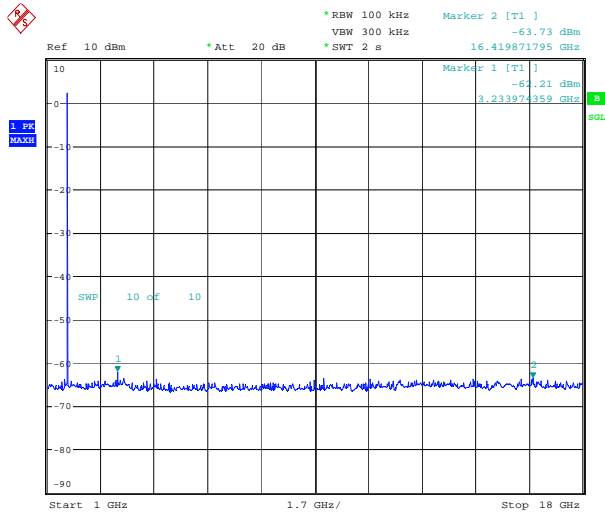
Radiated Spurious Emissions, continued



**Low Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 18:54:03

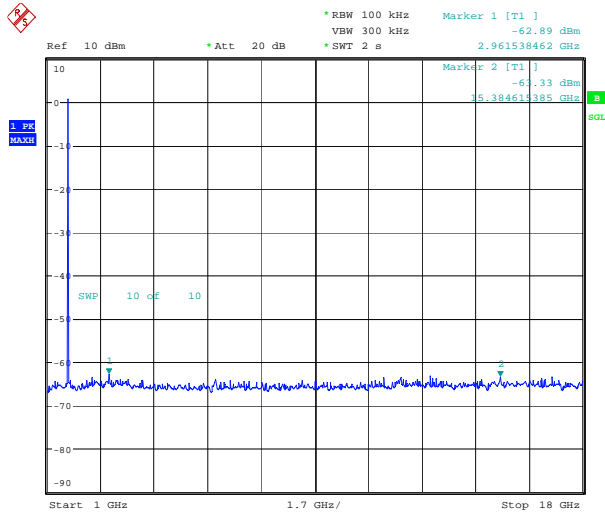


**Low Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

**Polarization: Horizontal**

Date: 11.NOV.2005 18:56:15

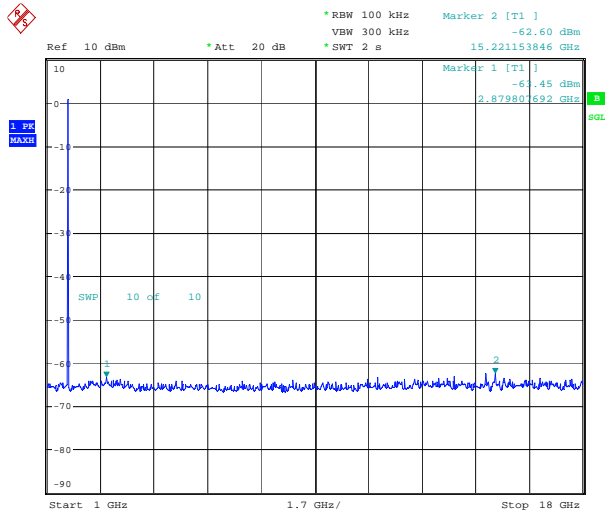
Radiated Spurious Emissions, continued



**High Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 18:50:26



**Low High Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

**Polarization: Horizontal**

Date: 11.NOV.2005 18:48:37

Radiated Spurious Emissions, continued

**Radiated emissions below 1 GHz:**

Freq. (MHz)	Antenna	Polarity	RCVD Signal (dBuV)	Sig. Sub. Factor	Emission Level (dBm)	Limit (dBm)	Margin (dB)	Detector	RBW (kHz)
38.40	BC1	V	21.8	-87.3	-65.5	1.0	66.5	Peak	100
99.53	BC1	V	22.9	-90.2	-67.3	1.0	68.3	Peak	100
298.58	LP1	V	39.5	-70.8	-31.3	1.0	32.3	Peak	100

Note 1: Antenna Legend: BC = Biconical, BL = Bilog, LP = Log-Periodic, Horn = Horn, ED = EMCO Dipole  
 Note 2: Quasi Peak detector used

$$\text{Limit (dBm)} = \text{EIRP}_{\text{TX}} - [43 + 10 \cdot \log_{10}(\text{EIRP}_{\text{TX Watt}})] + 10 \cdot \log_{10}(100\text{kHz}/4\text{kHz})$$

$$\text{Limit} = 39.75 \text{ dBm} - (43 + 9.75) \text{ dB} + 14 \text{ dB} = 1 \text{ dBm EIRP}$$

**Frequency Stability**

**Criteria: Clause §25.202(d) Frequency Tolerance, Earth Stations and §2.1055 Measurements required: Frequency stability.**

§25.202 (d) Frequency tolerance, earth stations.  
 The carrier frequency of each earth station transmitter authorized in these services shall be maintained within 0.001% (10 ppm) of the reference frequency.

§2.1055 Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:  
 (1) From -30° to +50° C for all equipment except that specified in paragraphs (a)(2) and (3) of this section.  
 (b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(d) The frequency stability shall be measured with variation of primary supply voltage as follows:  
 (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.  
 (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.  
 (3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

**Test Conditions:**

<b>Sample Number:</b>	1	<b>Temperature:</b>	-30 °C to +50 °C
<b>Date:</b>	November 7, 2005	<b>Humidity:</b>	0 %
<b>Modification State:</b>	0	<b>Tester:</b>	Roman Kuleba
		<b>Laboratory:</b>	Ottawa

**Test Results:**            See Attached Tables

Frequency Stability, continued

Nominal Channel Frequency: 1.643 500 000 GHz  
 Reference Frequency (measured at 20°C and nominal voltage): 1.643 500 009 GHz  
 Criteria (Limit): ±10 ppm

AC supply voltage was varied from 85 to 115 percent of the nominal value (120 VAC) at reference temperature (20 °C).

DC supply voltage was reduced from nominal value to battery operating end point.

In both cases there was no measurable deviation from the reference frequency (1.643 500 009 GHz).

**Voltage: Nominal (120 VAC)**

Ambient Temperature ( °C)	Measured Frequency (GHz)	Deviation (ppm)
-30	1.643501738	1.052023
-20	1.643501428	0.863401
-10	1.643500488	0.291451
0	1.643500598	0.358382
10	1.643500418	0.248859
<b>20</b>	<b>1.643500009</b>	<b>0.000000</b>
30	1.643499898	-0.067539
40	1.643500048	0.023730
50	1.643500168	0.096745
55	1.643500398	0.236690

**Protection of Aeronautical Radio-navigation Satellite Service**

**Criteria: §25.216(h)(i)(j) Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service.**

§25.216 Limits on emissions from mobile earth stations for protection of aeronautical radionavigation-satellite service.

(h) Mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FCC 03-283 (from November 6, 2003) with assigned uplink frequencies in the 1626.5-1660.5 MHz band shall suppress the power density of emissions in the 1605-1610 MHz band-segment to an extent determined by linear interpolation from -70 dBW/MHz at 1605 MHz to -46 dBW/MHz at 1610 MHz, averaged over any 2 millisecond active transmission interval. The e.i.r.p of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed a level determined by linear interpolation from -80 dBW at 1605 MHz to -56 dBW at 1610 MHz, averaged over any 2 millisecond active transmission interval.

(i) The e.i.r.p density of carrier-off state emissions from mobile earth stations manufactured more than six months after Federal Register publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies between 1 and 3 GHz shall not exceed -80 dBW/MHz in the 1559-1610 MHz band averaged over any two millisecond interval.

(j) A Root-Mean-Square detector shall be used for all power density measurements.

**Test Conditions:**

<b>Sample Number:</b>	1	<b>Temperature:</b>	23 °C
<b>Date:</b>	November 17, 2005	<b>Humidity:</b>	36 %
<b>Modification State:</b>	0	<b>Tester:</b>	Roman Kuleba
		<b>Laboratory:</b>	Ottawa

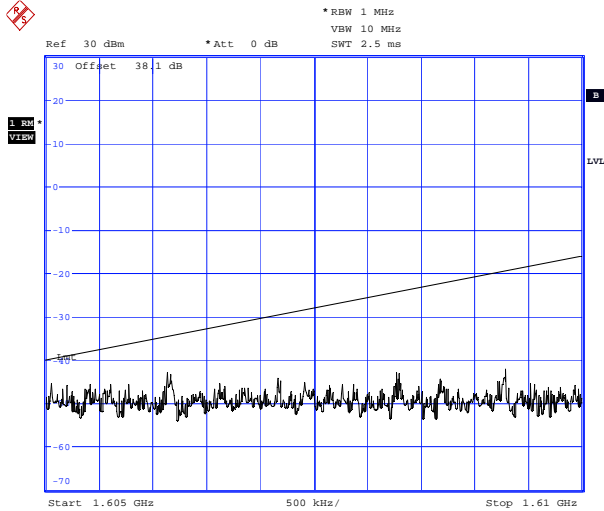
**Test Results:** See Attached Plots



Protection of Aeronautical Radio-navigation Satellite Service, continued

Wide-band Emissions, Transmitter ON

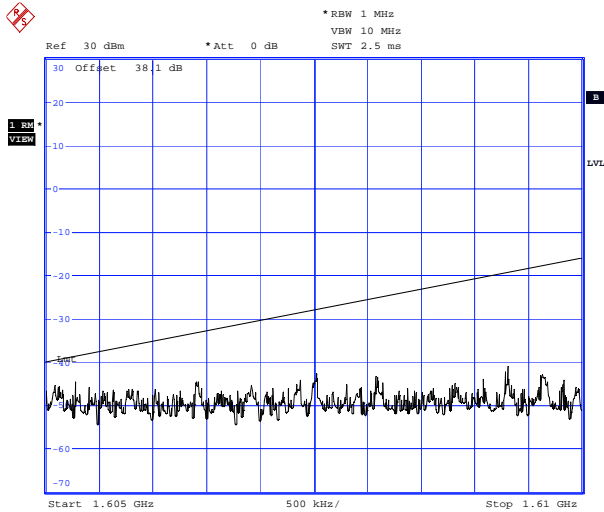
Criteria: Linear interpolation from -40 dBm/MHz at 1605 MHz to -16 dBm at 1610 MHz



**Low Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 20:04:57



**Low Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

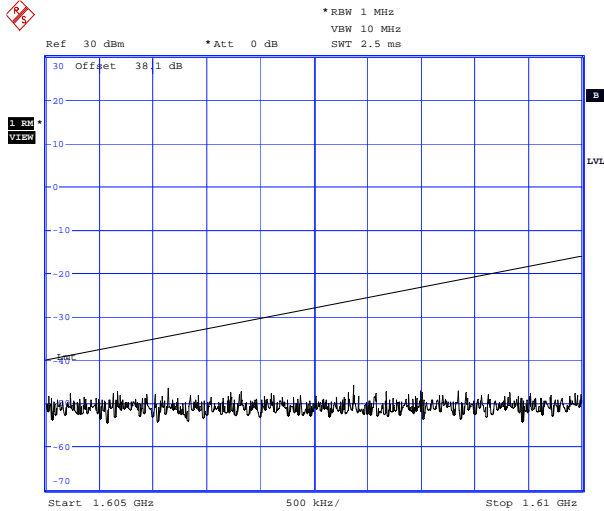
**Polarization: Horizontal**

Date: 11.NOV.2005 20:05:58

Protection of Aeronautical Radio-navigation Satellite Service, continued

Wide-band Emissions, Transmitter ON

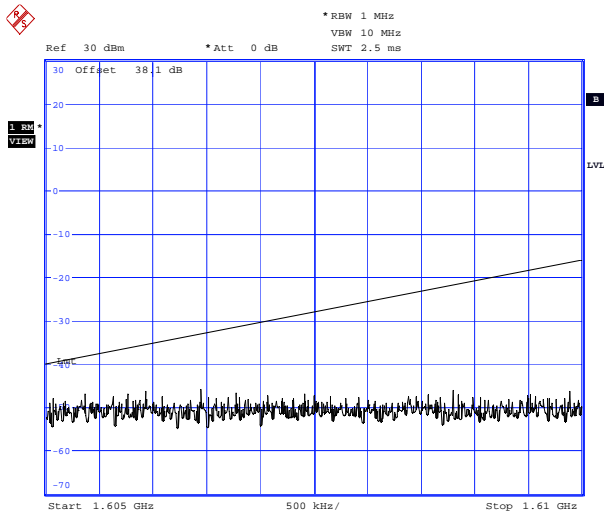
Criteria: Linear interpolation from -40 dBm/MHz at 1605 MHz to -16 dBm at 1610 MHz



**High Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 20:07:43



**High Channel**  
**Symbol Rate: 0.5×33.6 kS/s**  
**Identifier: R20T0.5Q**

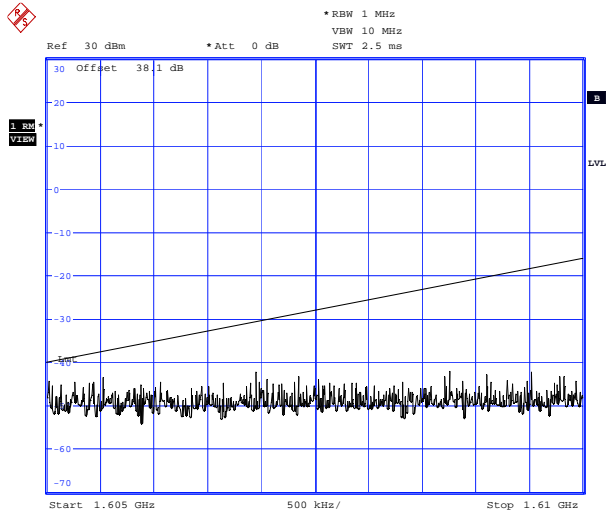
**Polarization: Horizontal**

Date: 11.NOV.2005 20:08:38

Protection of Aeronautical Radio-navigation Satellite Service, continued

Narrow-band Emissions, Transmitter ON

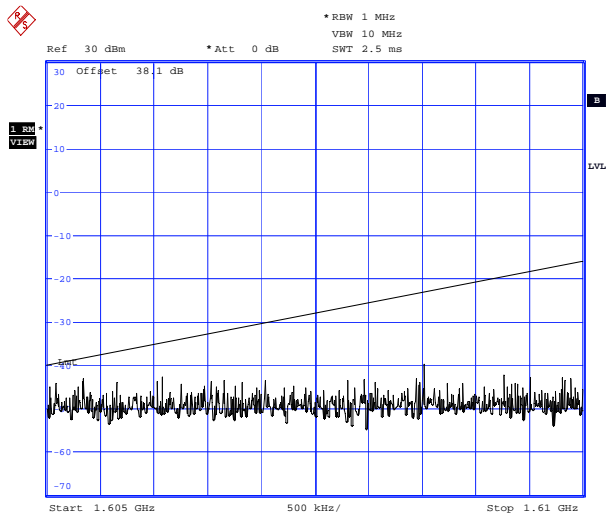
Criteria: Linear interpolation from -50 dBm/MHz at 1605 MHz to -26 dBm at 1610 MHz



**Low Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 20:12:19



**Low Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

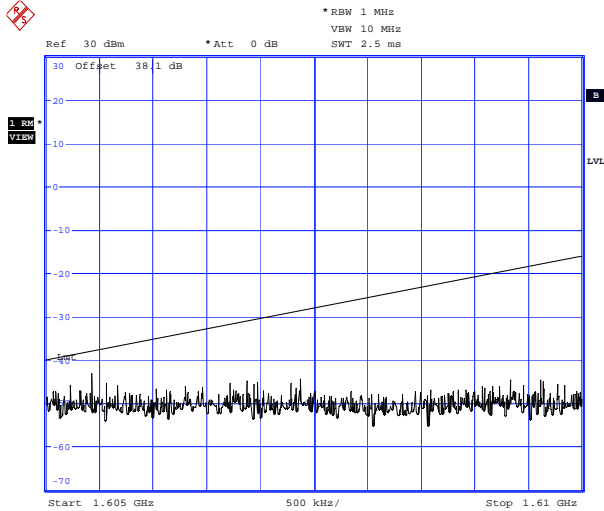
**Polarization: Horizontal**

Date: 11.NOV.2005 20:10:53

Protection of Aeronautical Radio-navigation Satellite Service, continued

Narrow-band Emissions, Transmitter ON

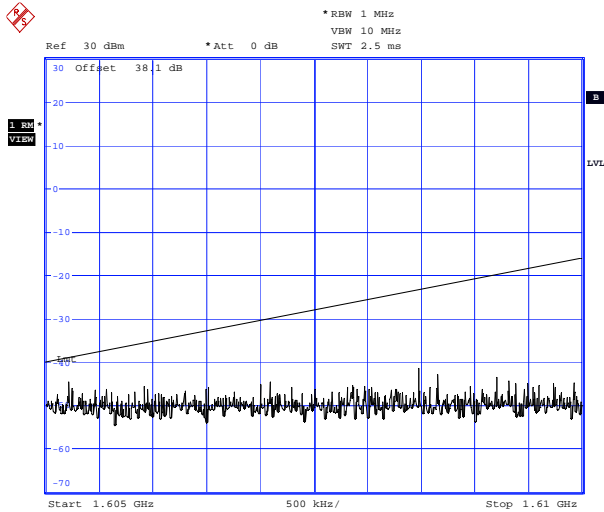
Criteria: Linear interpolation from -50 dBm/MHz at 1605 MHz to -26 dBm at 1610 MHz



**High Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

**Polarization: Vertical**

Date: 11.NOV.2005 20:14:31



**High Channel**  
**Symbol Rate: 4.5×33.6 kS/s**  
**Identifier: R20T4.5Q**

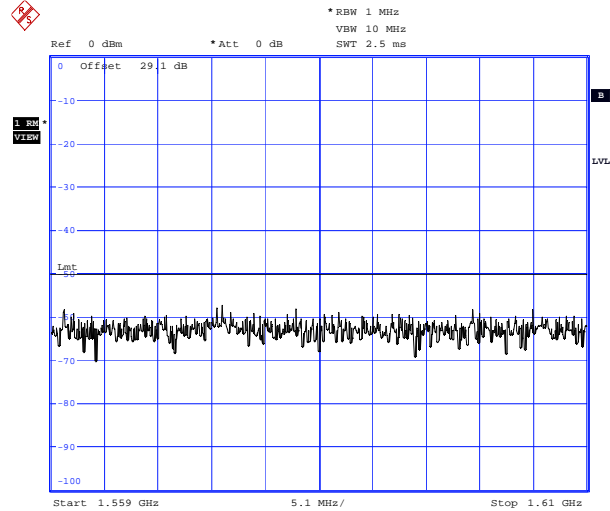
**Polarization: Horizontal**

Date: 11.NOV.2005 20:15:36

Protection of Aeronautical Radio-navigation Satellite Service, continued

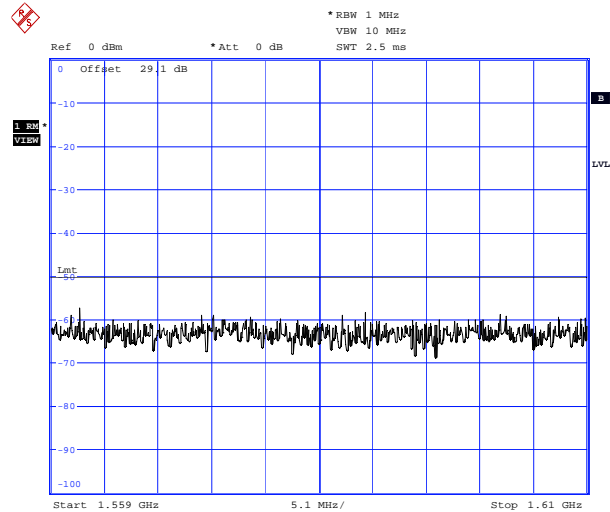
Wide-band Carrier-off-state Emissions  
Criteria: -50 dBm/MHz in 1559 – 1610 MHz band

Polarization: Vertical



Date: 11.NOV.2005 21:11:23

Polarization: Horizontal



Date: 11.NOV.2005 21:13:54

## **Appendix B : Setup Photographs**

### **Conducted Emissions Setup:**

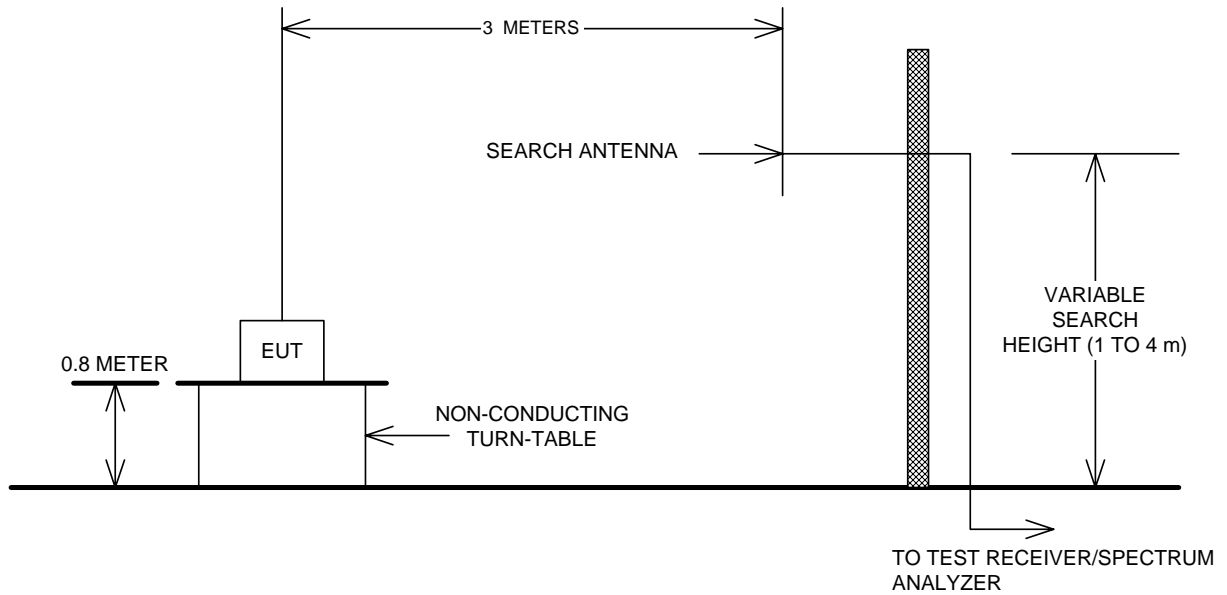


### **Radiated Emissions Setup:**

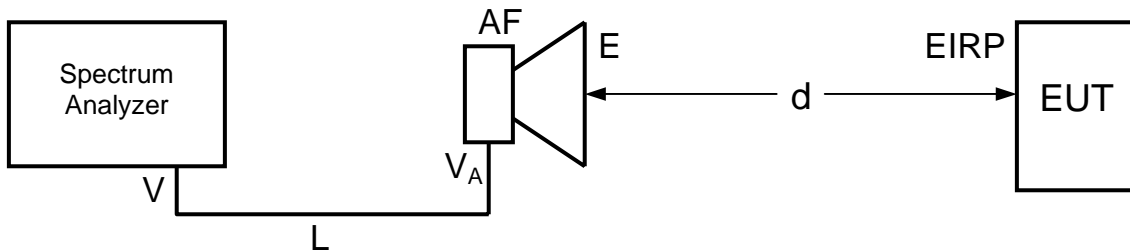


### Appendix C: Block Diagrams of Test Setups

#### Test Site For Field Strength of Radiated Emissions



#### EIRP of Radiated Emissions



Determining Off-set Correction Factor (in dB) needed to read EIRP of measured radiated emissions (in dBm) directly on Spectrum Analyzer:

$$E(V/m) = \frac{\sqrt{30 \cdot EIRP(W)}}{d(m)} \Rightarrow E(dB\mu V/m) = 90 + 10 \cdot \log_{10} 30 + EIRP(dBm) - 20 \cdot \log_{10} d(m)$$

$$E(dB\mu V/m) = V(dB\mu V/m) + L(dB) + AF(dB) = P_{Read}(dBm) + 106.99 + L(dB) + AF(dB)$$

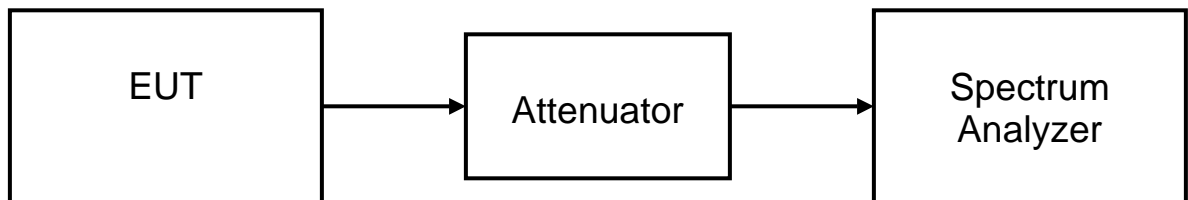
$$EIRP(dBm) = P_{Read}(dBm) + 2.22 + L(dB) + AF(dB) + 20 \cdot \log_{10} d(m)$$

$$EIRP(dBm) = P_{Read}(dBm) + \text{Off-set (dB)}$$

$$\text{Off-set (dB)} = 2.22 + L(dB) + AF(dB) + 20 \cdot \log_{10} d(m)$$

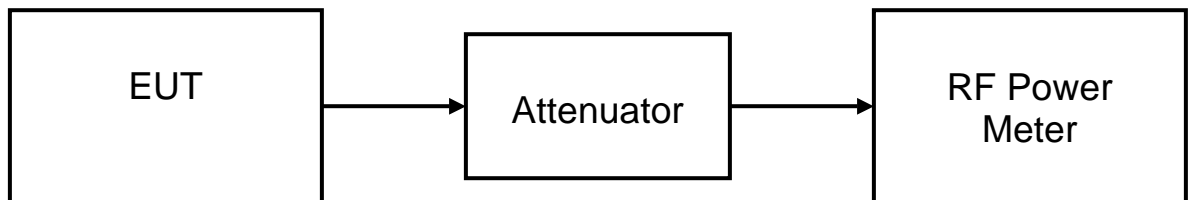
- EIRP : Equivalent Isotropically Radiated Power transmitted from EUT
- E : Electric Field Strength measured at distance d from EUT
- d : Distance (m)
- V : Voltage at Spectrum Analyzer Input (dBμV/m)
- P<sub>Read</sub>(dBm) : Reading on Spectrum Analyzer (dBm)
- L : Cable Loss (dB)
- AF : Antenna Factor (dB)
- Off-set : Off-set Correction Factor (in dB) needed to read EIRP of radiated emissions (in dBm) directly on Spectrum Analyzer

### Conducted Emissions





**R.F. Power Output**



**Frequency Stability**

