



**Nemko Test Report:** 11785RUS1

**Applicant:** ION Geophysical Corporation  
850 Dorothy, Suite 504  
Richardson, Texas 75081  
USA

**Equipment Under Test:  
(E.U.T.)** FSU-2

**In Accordance With:** **FCC Part 90, Subpart I**

**Tested By:** Nemko USA Inc.  
802 N. Kealy  
Lewisville, TX 75057-3136

**TESTED BY:**

David Light, Senior Wireless Engineer

**DATE:** 31 March, 2008

**APPROVED BY:**

Mike Cantwell, Frontline Manager

**DATE:** 31 March, 2008

**Total Number of Pages: 32**

## **Table of Contents**

<b>SECTION 1.</b>	<b>SUMMARY OF TEST RESULTS</b>	<b>3</b>
<b>SECTION 2.</b>	<b>GENERAL EQUIPMENT SPECIFICATION</b>	<b>5</b>
<b>SECTION 3.</b>	<b>RF POWER OUTPUT</b>	<b>7</b>
<b>SECTION 4.</b>	<b>OCCUPIED BANDWIDTH</b>	<b>8</b>
<b>SECTION 5.</b>	<b>SPURIOUS EMISSIONS AT ANTENNA TERMINALS</b>	<b>10</b>
<b>SECTION 6.</b>	<b>FIELD STRENGTH OF SPURIOUS EMISSIONS</b>	<b>17</b>
<b>SECTION 7.</b>	<b>FREQUENCY STABILITY</b>	<b>18</b>
<b>SECTION 8.</b>	<b>TRANSIENT FREQUENCY BEHAVIOUR</b>	<b>20</b>
<b>SECTION 9.</b>	<b>TEST EQUIPMENT LIST</b>	<b>23</b>
<b>ANNEX A - TEST METHODOLOGIES</b>		<b>24</b>
<b>ANNEX B - TEST DIAGRAMS</b>		<b>29</b>

**Section 1. Summary of Test Results**

Manufacturer: ION Geophysical Corporation

Model No.: FSU-2

Serial No.: None

General: **All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 90, Subpart I.



New Submission



Production Unit



Class II Permissive Change



Pre-Production Unit

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

See "Summary of Test Data".

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This report applies only to the items tested.

**Summary Of Test Data**

<b>NAME OF TEST</b>	<b>PARA. NO.</b>	<b>SPEC.</b>	<b>RESULT</b>
RF Power Output	90.205	Table 1	Complies
Occupied Bandwidth	90.210	Mask D	Complies
Spurious Emissions at Antenna Terminals	90.210	Mask D	Complies
Field Strength of Spurious Emissions	90.210	Mask D	Complies
Frequency Stability	90.213	5 ppm	Complies
Transient Frequency Behavior	90.214	Mask	Complies

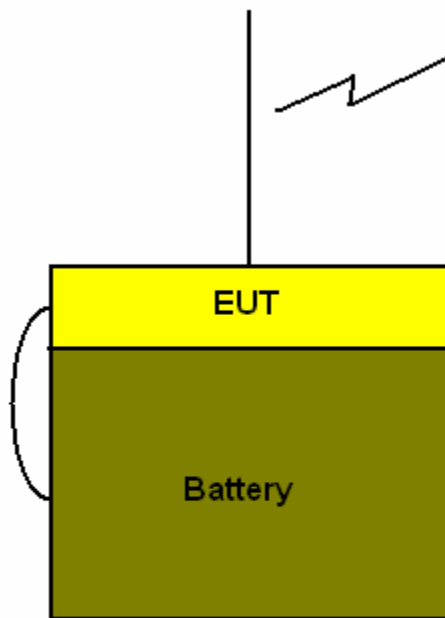
## **Section 2. General Equipment Specification**

<b>Supply Voltage Input:</b>	12 Vdc Nominal
<b>Frequency Range:</b>	151.25 to 173.5 MHz
<b>Necessary Bandwidth:</b>	12.5 kHz
<b>Emission Designator:</b>	12K5GXW
<b>Output Impedance:</b>	50 ohms
<b>RF Power Output (rated):</b>	2 Watts
<b>Channel Spacing(s):</b>	12.5 kHz
<b>Operator Selection of Operating Frequency:</b>	Software controlled
<b>Power Output Adjustment Capability:</b>	Software controlled

### **System Description**

Unit is a remote data collection system for Geophysical Survey utilizing a radio channel for command and control.

### **System Diagram**



**Section 3. RF Power Output**

NAME OF TEST: RF Power Output	PARA. NO.: 2.985
TESTED BY: David Light	DATE: 26 March 2008

**Measurement Results:** Complies.**Measurement Data:**

Frequency (MHz)	Measured Power (dBm)	Measured Power (Watts)	Rated Power (Watts)
151.25	33.18	2.08	2.0
160.5	33.21	2.09	2.0
173.5	32.97	1.98	2.0

**Measurement Conditions:**

Temperature: 20 °C

Humidity: 30 %

**Measurement Uncertainty:** +/- 1.7 dB**Test Equipment:** 1036-1082-1472-1469

**Section 4. Occupied Bandwidth**

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 2.989
TESTED BY: David Light	DATE: 28 March 2008

**Measurement Results:** Complies.

**Measurement Data:** See attached data

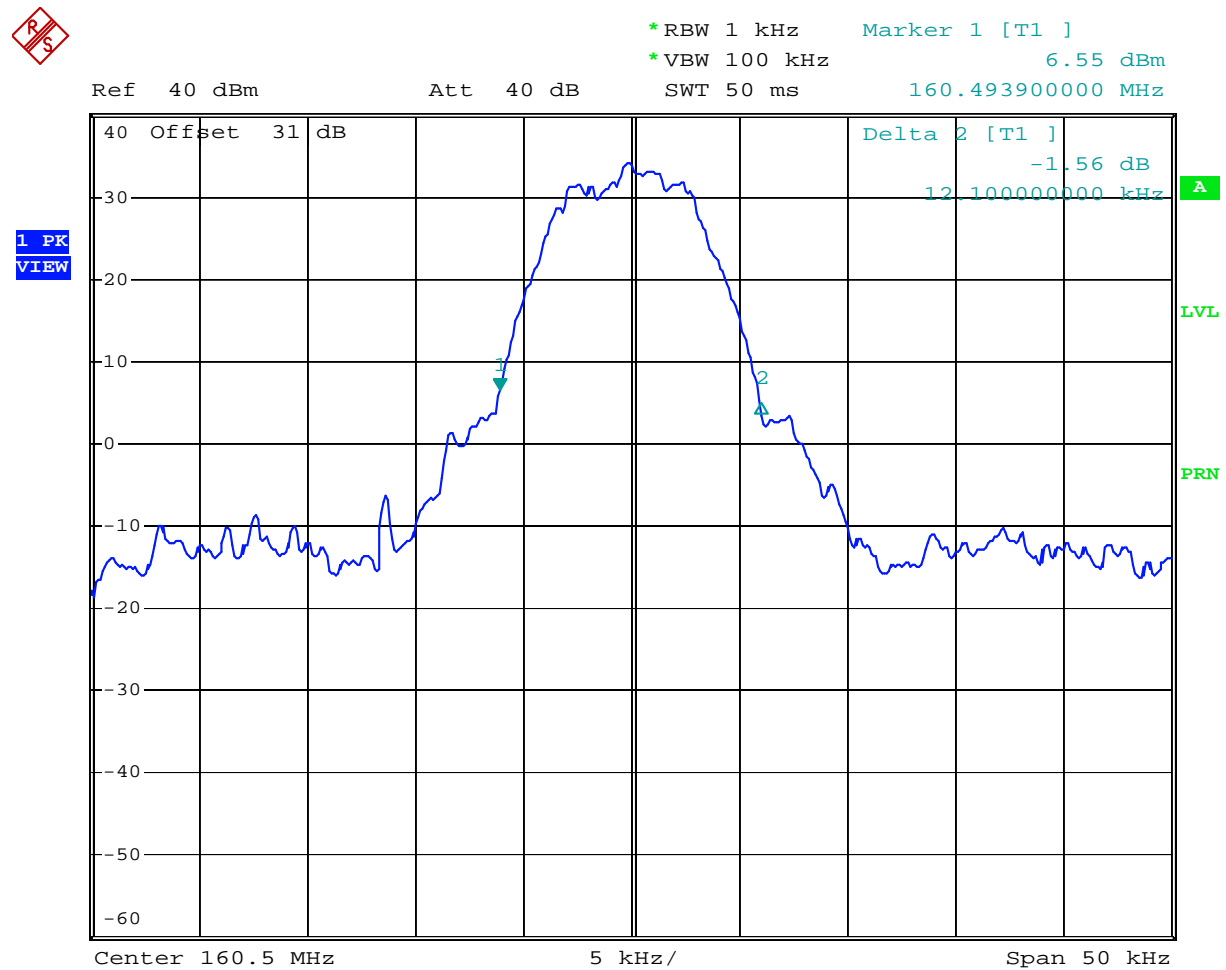
**Measurement Conditions:** Temperature: 20 °C  
Humidity: 30 %

**Measurement Uncertainty:** +/- 1 X 10<sup>-7</sup> ppm

**Test Equipment:** 1036-1082-1472-1469



## Test Data – 99% Occupied Bandwidth



Date: 28.MAR.2008 14:38:50

**Section 5. Spurious Emissions at Antenna Terminals**

NAME OF TEST: Spurious Emissions @ Antenna Terminals	PARA. NO.: 2.991
TESTED BY: David Light	DATE: 26 March 2008

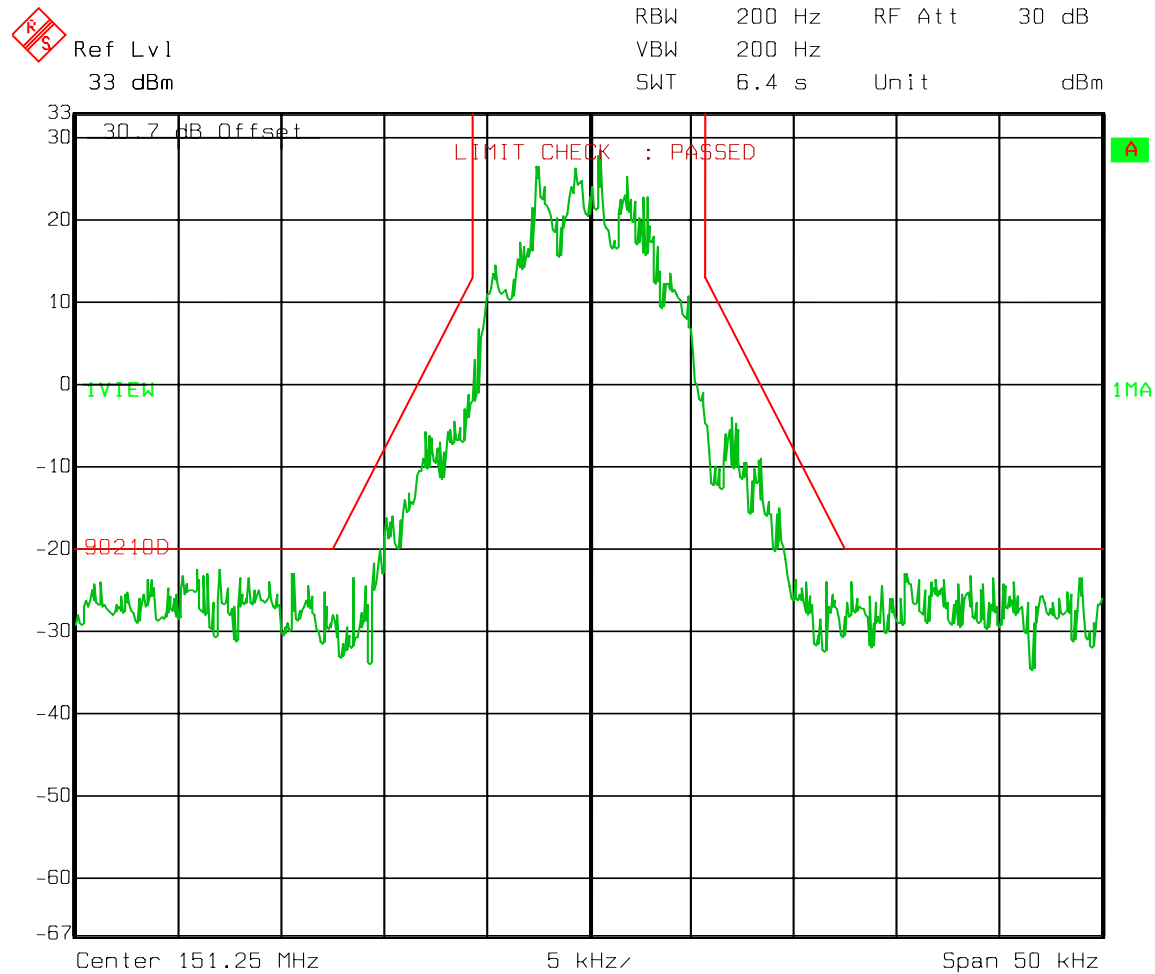
**Measurement Results:** Complies.

**Measurement Data:** See attached data

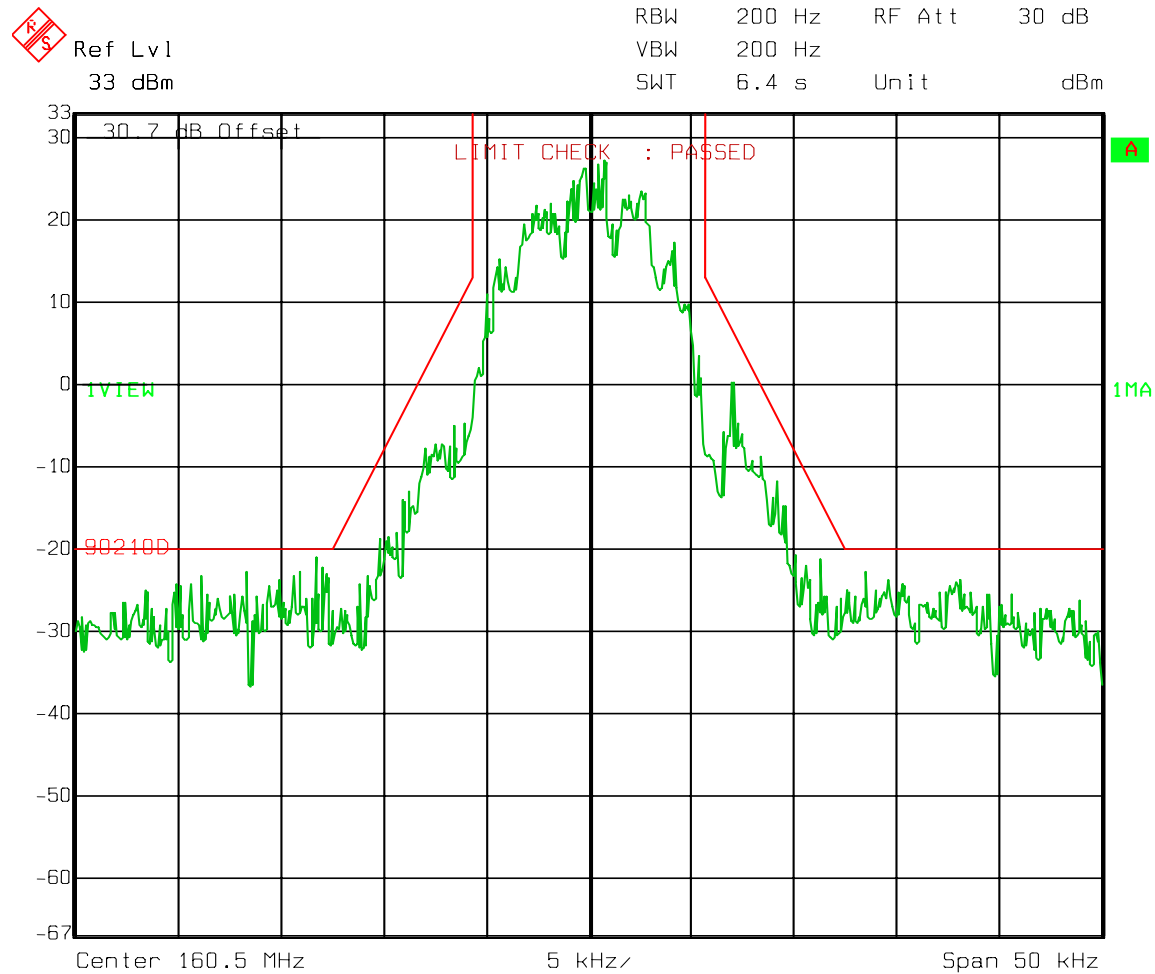
**Measurement Conditions:** Temperature: 20 °C  
Humidity: 30 %

**Measurement Uncertainty:** +/- 1.7 dB

**Test Equipment:** 1036-1082-1472-1469

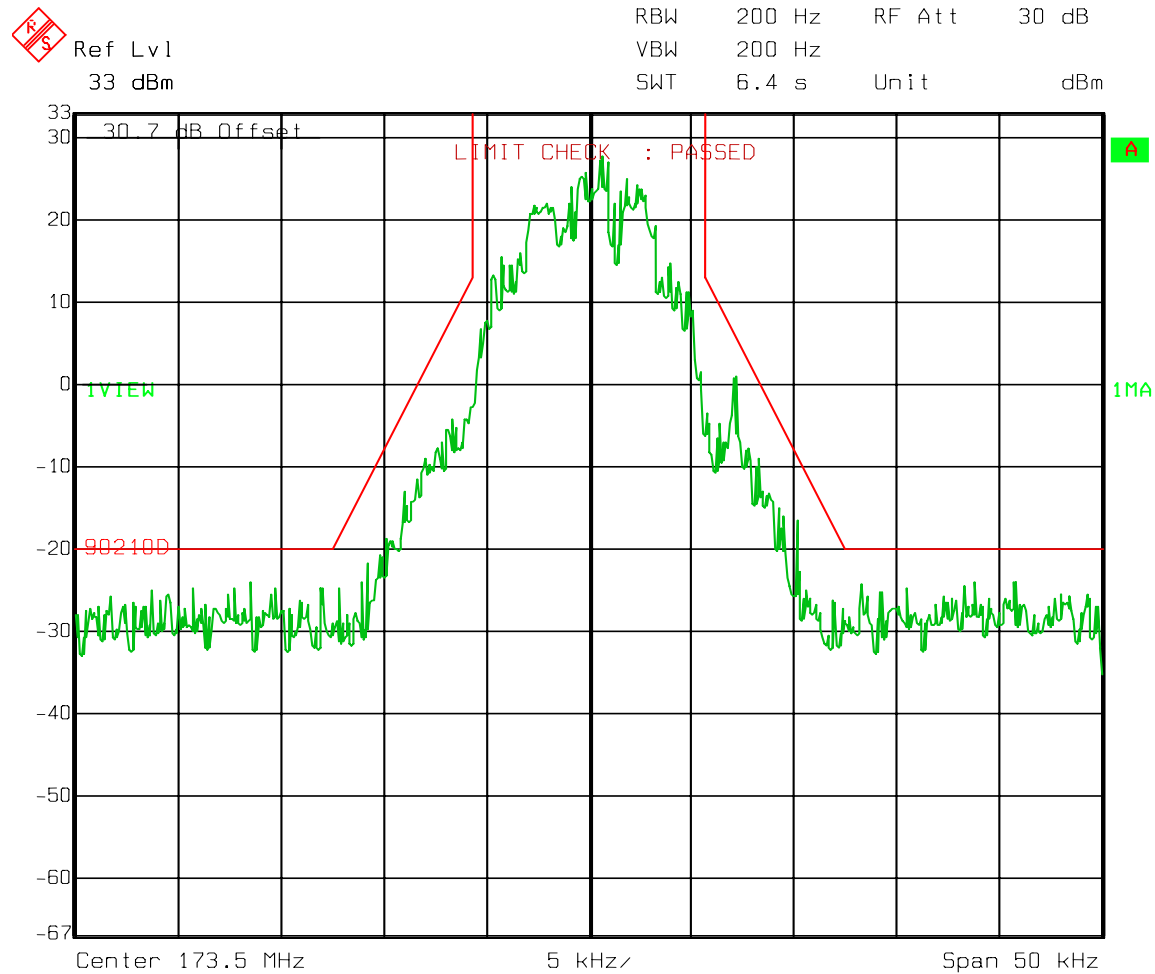
**Test Data – Spurious Emissions**MASK D  
LOW CHANNEL

Date: 26.MAR.2008 15:48:37

**Test Data – Spurious Emissions**MASK D  
MID CHANNEL

Date: 26.MAR.2008 15:54:23

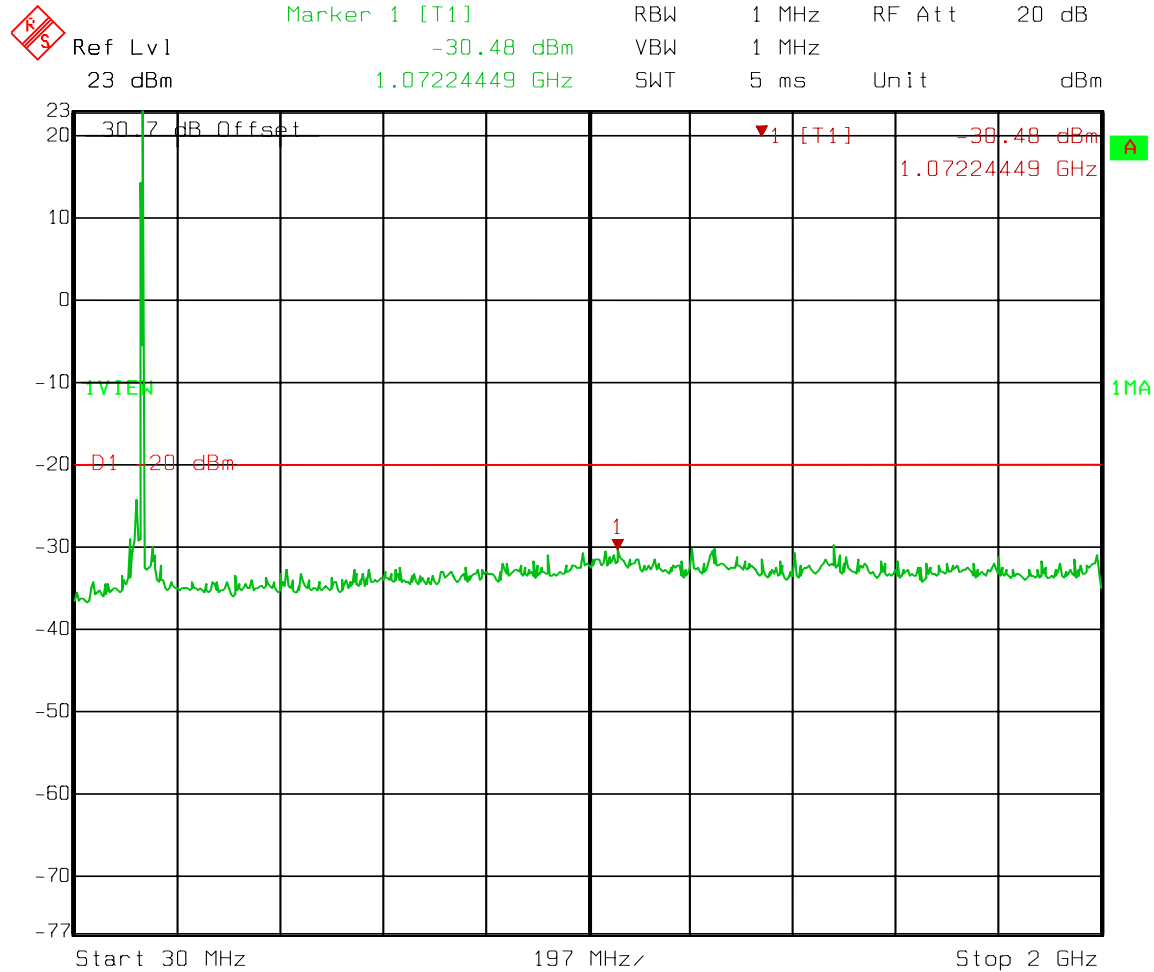
## Test Data – Spurious Emissions

MASK D  
HIGH CHANNEL

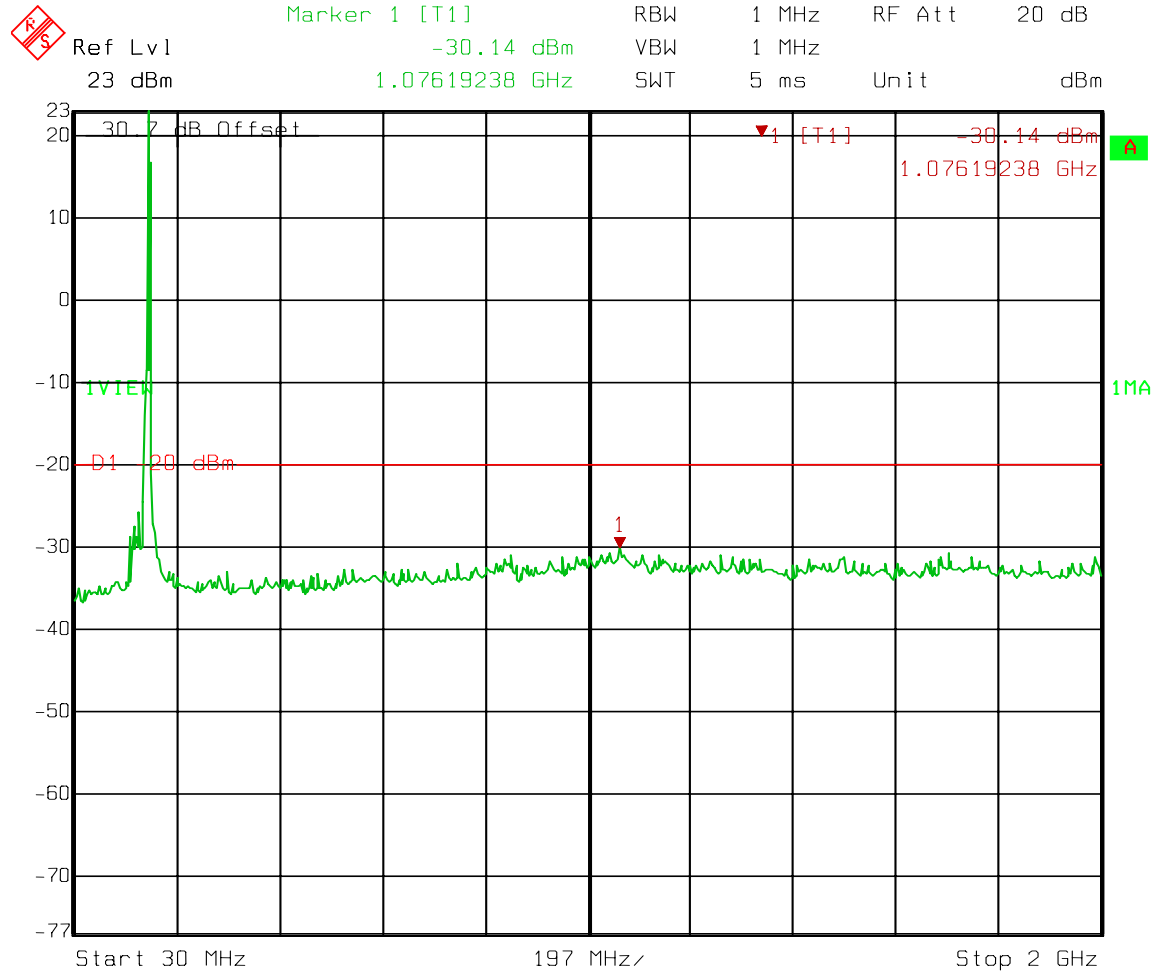
Date: 26.MAR.2008 16:00:36



## Test Data – Spurious Emissions

SPURS  
MIDCHANNEL

Date: 26.MAR.2008 15:55:13

**Test Data – Spurious Emissions****HIGH CHANNEL****SPURS**

Date: 26.MAR.2008 16:01:31



**Section 6. Field Strength of Spurious Emissions**

NAME OF TEST: Field Strength of Spurious Emissions	PARA. NO.: 2.993
TESTED BY: David Light	DATE: 27 March 2008

**Measurement Results:** Complies.

**Measurement Data:** There were no emissions detected within 20 dB of the specification limit of  $50 + 10 \log P$  (watts) therefore none are reported per 2.1051

The spectrum was searched from 30 MHz to 2 GHz

Analyzer settings were RBW/VBW = 1 MHz, Peak detector

**Measurement Conditions:** Temperature: 20 °C  
Humidity: 30 %

**Measurement Uncertainty:** +/- 1.7 dB

**Test Equipment:** 1464-1484-1485-993-1016

**Section 7. Frequency Stability**

NAME OF TEST: Frequency Stability	PARA. NO.: 2.995
TESTED BY: David Light	DATE: 28 March 2008

**Measurement Results:** Complies.

**Measurement Data:** See attached data

**Measurement Conditions:** Temperature: 20 °C  
Humidity: 30 %

**Measurement Uncertainty:** +/- 1 X 10<sup>-7</sup> ppm

**Test Equipment:** 1659-1082-1472-1469-283-619

## Test Data – Frequency Stability

<b>Frequency Stability</b>							
Page <u>1</u> of <u>1</u>							
Job No.: 11785		Date: 3/28/2008					
Specification: 90.213		Temperature(°C): <u>20</u>					
Tested By: <u>David Light</u>		Relative Humidity(%) <u>30</u>					
E.U.T.: <u>150 MHz transmitter</u>							
Configuration: <u>Tx CW</u>							
Sample Number <u>1</u>							
<b><u>Test Equipment Used</u></b>							
Antenna: _____		Directional Coupler: _____					
Pre-Amp: _____		Cable #1: <u>1082</u>					
Filter: _____		Cable #2: _____					
Receiver: <u>1659</u>							
Attenuator #1 <u>1469</u>							
Attenuator #2: <u>1472</u>							
Measurement Uncertainty: <u>1x10<sup>-17</sup> ppm</u>		Limit: +/- 5 ppm					
		Standard Test Frequency <u>160.500000</u> MHz					
Temp (°C)	Measured Frequency (MHz)		Test Voltage	Frequency Error (Hz)	Limit (+/-Hz)	Error (ppm)	Comment
20	160.499756		12.0	-244	802.5	-1.5	Nominal
20	160.499728		4.0	-272	802.5	-1.7	Battery cutoff
20	160.499756		15.0	-244	802.5	-1.5	Fully charged battery
50	160.499820		12.0	-180	802.5	-1.1	
40	160.499684		12.0	-316	802.5	-2.0	
30	160.499712		12.0	-288	802.5	-1.8	
10	160.499724		12.0	-276	802.5	-1.7	
0	160.499692		12.0	-308	802.5	-1.9	
-10	160.499660		12.0	-340	802.5	-2.1	
-20	160.499668		12.0	-332	802.5	-2.1	
-30	160.499656		12	-344	802.5	-2.1	
Notes:							

**Section 8.        Transient Frequency Behaviour**

NAME OF TEST: Transient Frequency Behavior	PARA. NO.: 90.214
TESTED BY: David Light	DATE: 27 March 2008

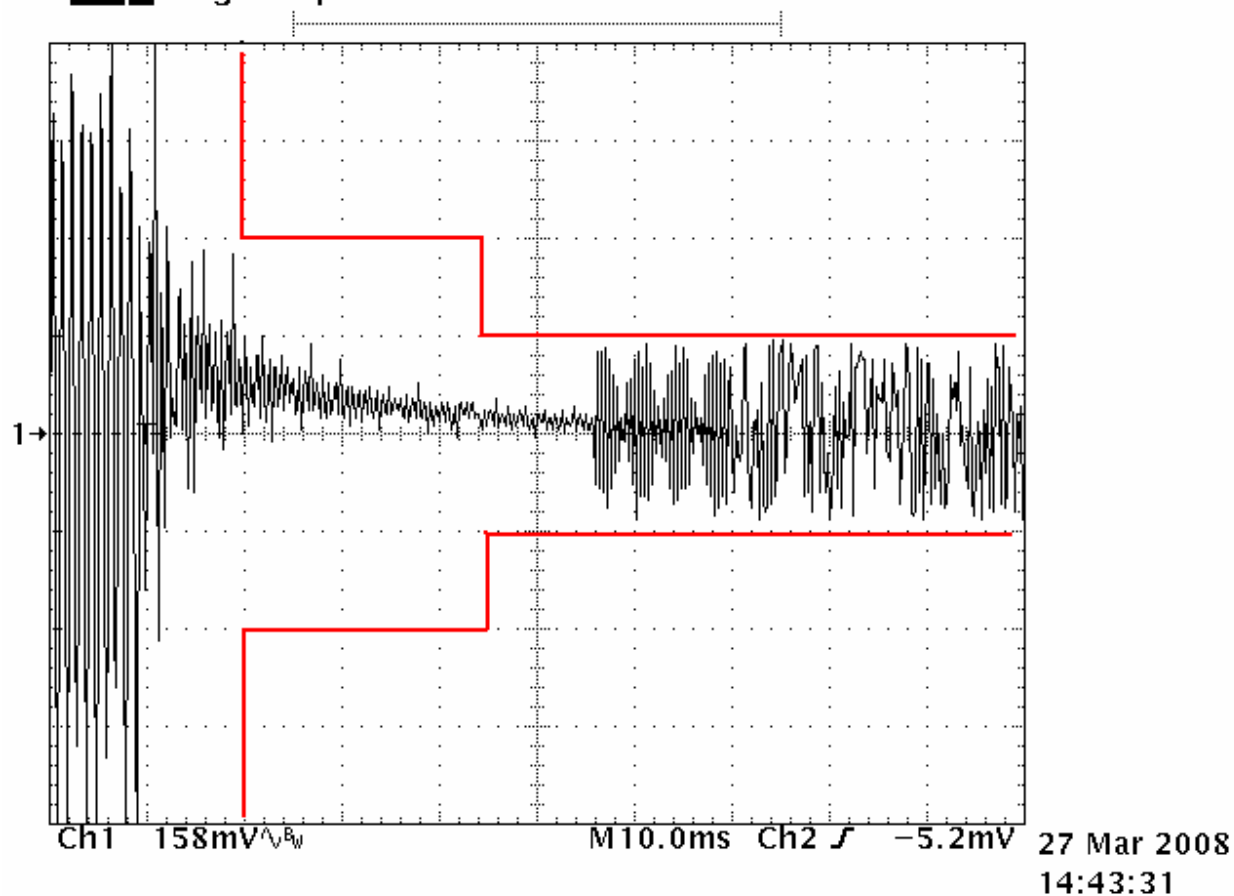
**Measurement Results:**            Complies.

**Measurement Data:**            See attached data

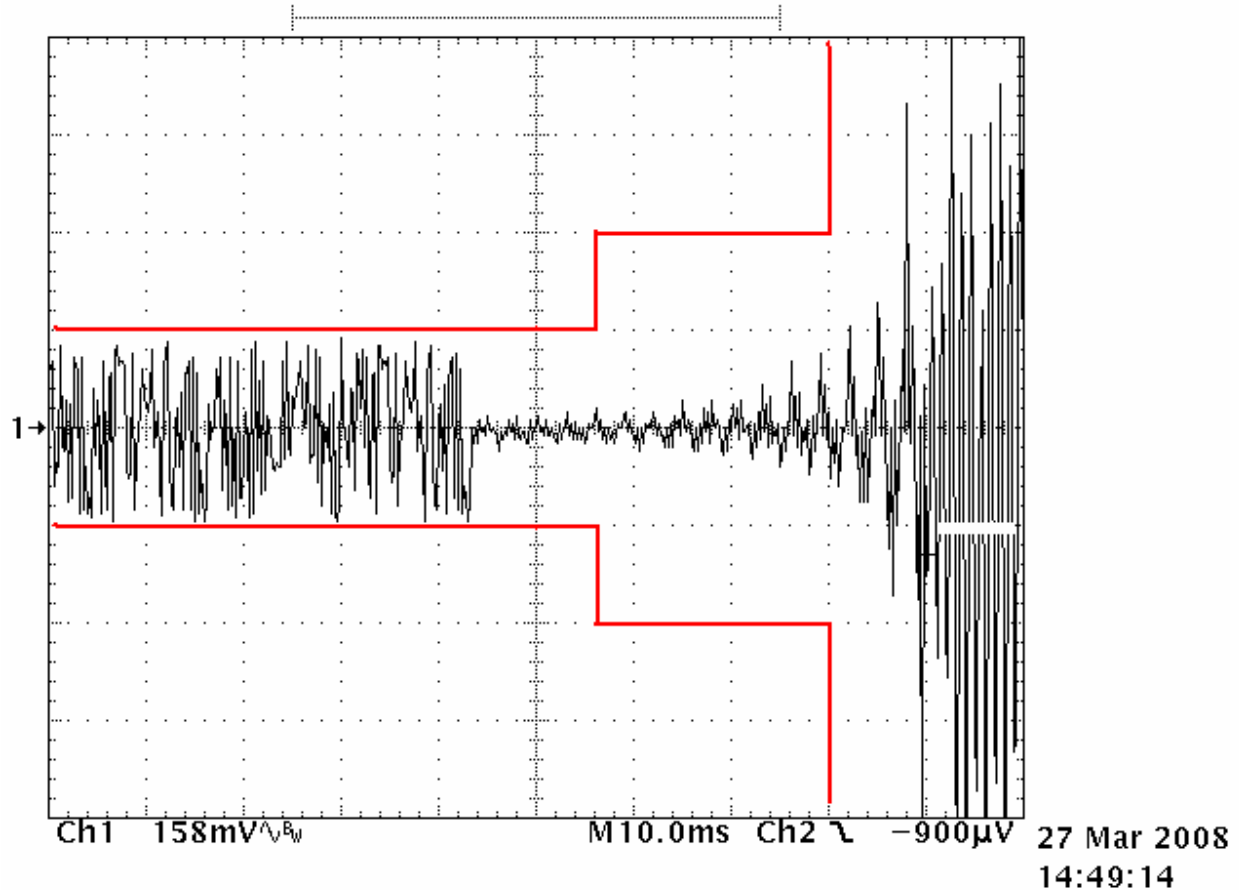
**Measurement Conditions:**      Temperature:    20 °C  
                                         Humidity:       30 %

**Test Data – Transient Frequency Behavior**

Tek **Stop:** Single Seq 5.00kS/s



## Test Data – Transient Frequency Behavior

Tek **Stop**: Single Seq 5.00kS/s

## Section 9. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1659	Spectrum Analyzer	Rhode & Schwarz FSP	973353	01/24/07	01/24/09
283	Environmental Chamber with controller # 1189006	ENVIROTRONICS SH27 & 2030-22844	129010083	NA	NA
619	THERMOMETER	FLUKE 51	4520028	03/01/07	02/29/08
1082	CABLE 2m	Astrolab 32027-2-29094-72TC	N/A	CBU	N/A
1472	20db Attenuator DC 18 Ghz	Omni Spectra 20600-20db	NONE	CBU	N/A
1469	10 db Attenuator DC 18 Ghz	MCL Inc. BW-S10W2 10db-2WDC	NONE	CBU	N/A
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	01/24/07	01/24/09
1484	Cable	Storm PR90-010-072	N/A	05/02/07	05/01/08
1485	Cable	Storm PR90-010-216	N/A	05/02/07	05/01/08
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	05/01/07	04/30/08
993	Horn antenna	A.H. Systems SAS-200/571	XXX	08/31/07	08/30/08
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	05/26/06	05/26/08

## **ANNEX A - TEST METHODOLOGIES**



**NAME OF TEST: RF Power Output****PARA. NO.: 2.985**

**Minimum Standard:** Para. No. 90.205(a). The maximum allowable station ERP is dependent upon the stations HAAT and required service area and will be authorized in accordance with Table 1 of 90.205(d).

**Method Of Measurement:**Detachable Antenna:

The peak power at antenna terminals is measured using an in-line peak power meter. Power output is measured with the maximum rated input level.

Integral Antenna:

If the antenna is not detachable from the circuit then the Peak Power Output is derived from the peak radiated field strength of the fundamental emission by using the plane wave relation  $GP/4\pi R^2 = E^2/120\pi$  and proceeding as follows:

$$P = \frac{E^2 R^2}{30G} = \frac{E^2 3^2}{30G}$$

where,

P = the equivalent isotropic radiated power in watts

E = the maximum measured field strength in V/m

R = the measurement range (3 meters)

G = the numeric gain of the transmit antenna in relation to an isotropic radiator

**NAME OF TEST: Occupied Bandwidth****PARA. NO.: 2.989****Minimum Standard:**  
mask.

Para. No. 90.210, see table 1 below for applicable

**Table 1**

Frequency Band (MHz)	Mask for equipment with Low Pass Filter	Mask for equipment without Low Pass Filter
Below 25	A or B	A or C
25 - 50	B	C
72 - 76	B	C
150 - 174	B, D or E	C, D or E
150 Paging only	B	C
220 - 222	F	F
421 - 512	B, D or E	C, D or E
450 paging only	B	H
806 - 821/ 851 - 866	B	G
821 - 824/ 866 - 869	B	H
896 - 901/ 935 - 940	I	J
902 - 928	K	K
929 - 930	B	G
Above 940	B	C
All other bands	B	C

**Test Method:**

RBW: 1% of emission bandwidth in 0 - 1 GHz range. 1 MHz at frequencies above 1 GHz.

VBW:  $\Rightarrow$  RBW

The spectrum is search up to 10 times the fundamental frequency.

**NAME OF TEST: Field Strength of Spurious****PARA. NO.: 2.993****Minimum Standard:** Para. No. 90.210, see table 1 for applicable mask.**Calculation of Field Strength Limit**

An example of attenuation requirement of  $50 + 10 \log P$  is equivalent to -20 dBm ( $1 \times 10^{-5}$  Watts) at the antenna terminal. We determine the field strength limit by using the plane wave relation.

$$GP/4\pi R^2 = E^2/120\pi$$

For emissions  $\leq 1$  GHz:

$G = 1.64$  (Dipole Gain)

$P = 10^{-5}$  Watts (Maximum spurious output power)

$R = 3m$  (Measurement Distance)

$$E = \frac{\sqrt{30GP}}{R} = E = \frac{\sqrt{30 \times 1.64 \times 10^{-5}}}{3} = 0.00739 \text{ V / m} = 77.4 \text{ dB}\mu\text{V / m}$$

For emissions  $> 1$  GHz:

$G = 1$  (Isotropic Gain)

$P = 1 \times 10^{-5}$  Watts (Maximum spurious output power)

$R = 3m$  (Measurement Distance)

$$E = 77.4 - 20 \log \sqrt{1.64} = 75.2 \text{ dB}\mu\text{V / m@3m}$$

MASK	Spurious Limit	FS Limit Below 1 GHz	FS Limit Above 1 GHz
A,B,C,G,H,I	-13dBm	84.4 dB $\mu$ V/m@3m	82.2 dB $\mu$ V/m@3m
D,J	-20dBm	77.4 dB $\mu$ V/m@3m	75.2 dB $\mu$ V/m@3m
E,F,K	-25dBm	72.4 dB $\mu$ V/m@3m	70.2 dB $\mu$ V/m@3m

**NAME OF TEST: Frequency Stability****PARA. NO.: 2.995**

**Minimum Standard:** Para. No. 990.213. The transmitter carrier frequency shall remain within the assigned frequency below in ppm.

**Table 2**

Frequency Band (MHz)	Fixed And Base Stations	Mobile Stations	
		> 2 Watts o/p pwr	< 2 Watts o/p pwr
Below 25	100	100	200
25 - 50	20	20	50
72 - 76	5	-	50
150 - 174	5	5	5
220 - 222	0.1	1.5	1.5
421 - 512	2.5	5	5
806 - 821	1.5	2.5	2.5
821 - 824	1.0	1.5	15
851 - 866	1.5	2.5	2.5
866 - 869	1.0	1.5	1.5
869 - 901	0.1	1.5	1.5
902 - 928	2.5	2.5	2.5
929 - 930	1.5	-	-
935 - 940	0.1	1.5	1.5
1427 - 1435	300	300	300
Above 2450	-	-	-

**NAME OF TEST: Transient Frequency Behaviour****PARA. NO.: 2.214****Minimum Standard:****Transient Frequency Behaviour for Equipment Designed to Operate on 25 kHz Channels**

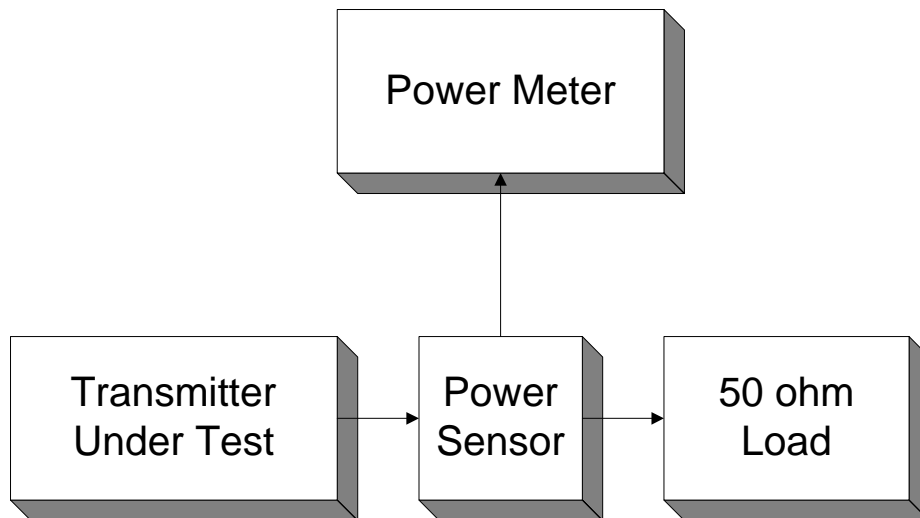
		Frequency ranges (MHz) All equipment					
Time intervals <sup>1,2</sup>	Maximum	Base station and portable radios			Mobile Radios		
	Frequency difference <sup>3</sup> (kHz)	150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)	150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)
t <sub>1</sub> <sup>4</sup>	± 25	5.0	10.0	20.0	5.0	10.0	5.0
t <sub>2</sub>	± 12	20.0	25.0	50.0	20.0	25.0	20.0
t <sub>3</sub> <sup>4</sup>	± 25	5.0	10.0	10.0	5.0	10.0	5.0

**Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz & 6.25 kHz Channels**

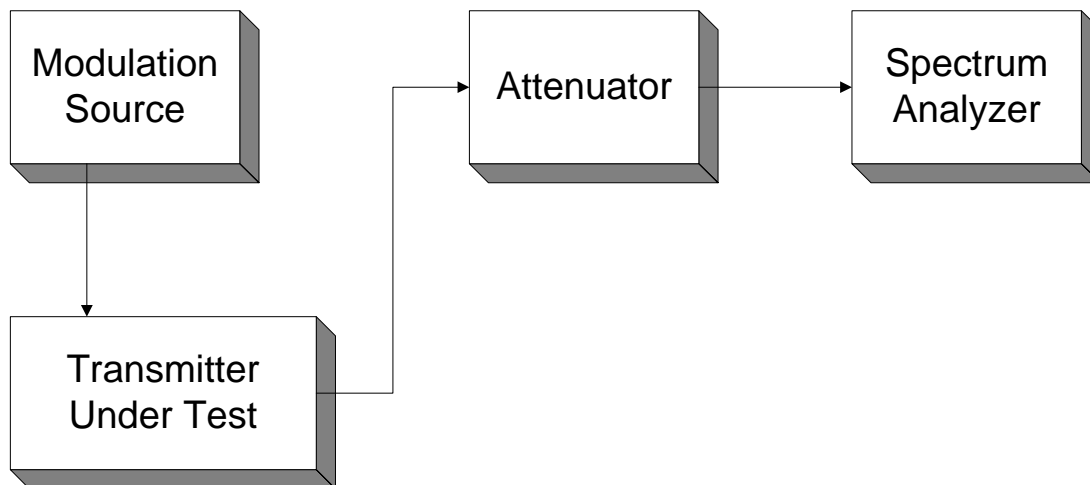
		Frequency ranges (MHz) All equipment		
Time intervals <sup>1,2</sup>	Maximum	150 - 174	450 - 500	500 - 512
	Frequency difference <sup>3</sup> (kHz)	(ms)	(ms)	(ms)
t <sub>1</sub> <sup>4</sup>	± 12.5 / ± 6.25	5.0	10.0	20.0
t <sub>2</sub>	± 6.25 / ± 3.125	20.0	25.0	50.0
t <sub>3</sub> <sup>4</sup>	± 12.5 / ± 6.25	5.0	10.0	10.0

## **ANNEX B - TEST DIAGRAMS**

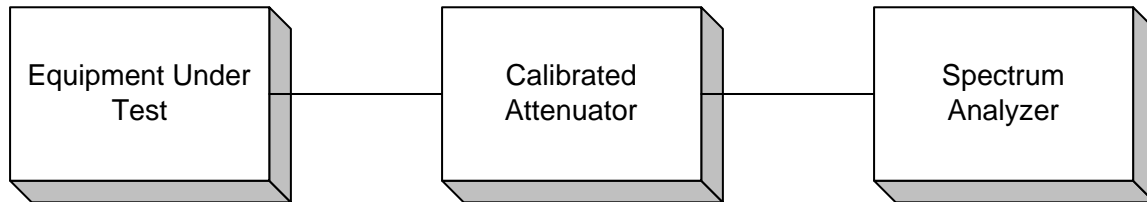
**Para. No. 2.985 - R.F. Power Output**



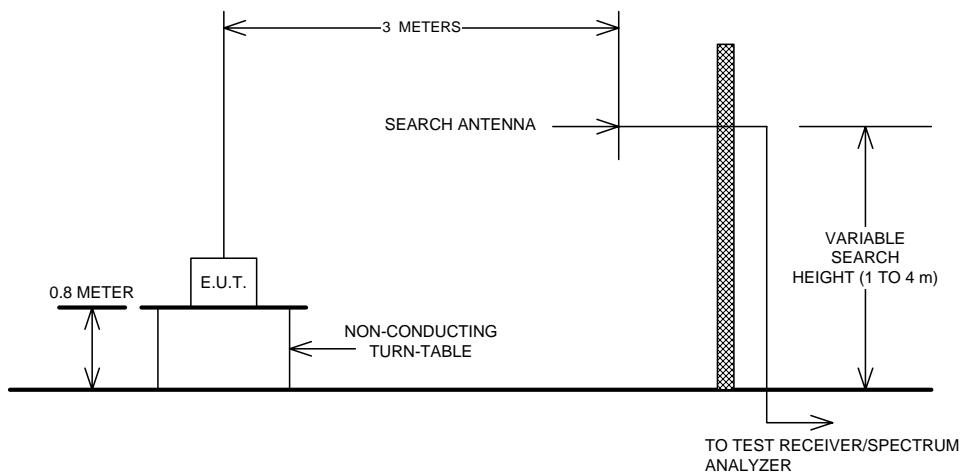
**Para. No. 2.989 - Occupied Bandwidth**



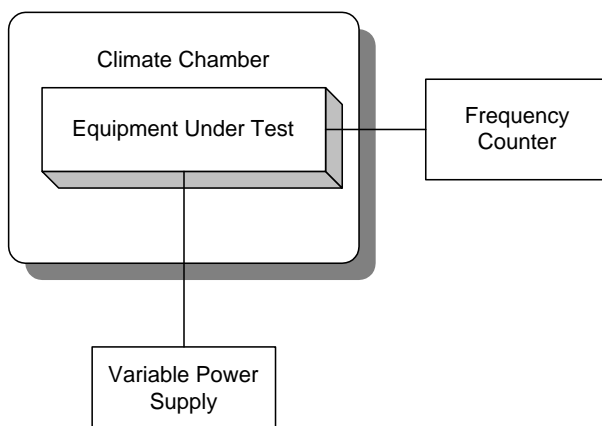
**Para. No. 2.991 - Spurious Emissions at Antenna Terminals**

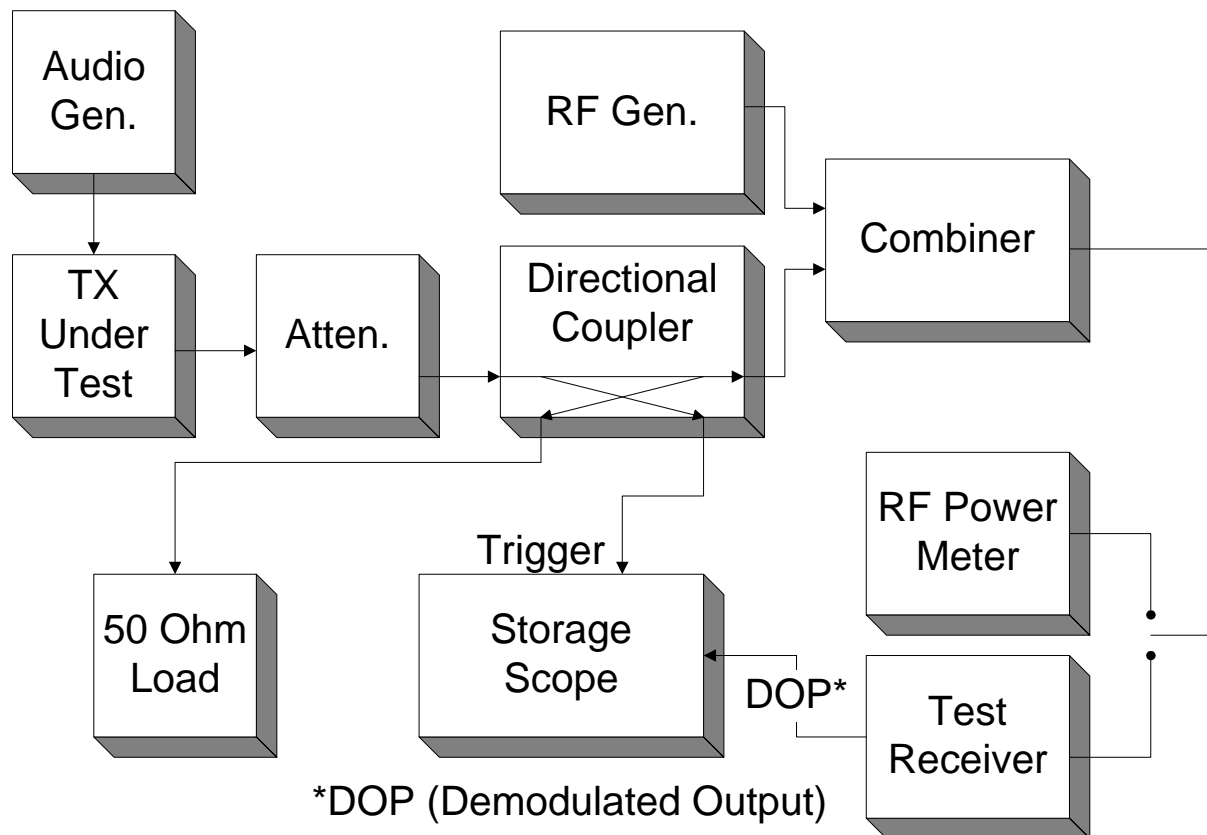


**Para. No. 2.993 - Field Strength of Spurious Radiation**



**Para. No. 2.995 - Frequency Stability**



**Para. No. 90.214 - Transient Frequency Behaviour****Voice**

This measurement was made using measurement procedure TIA/EIA Land Mobile FM or PM Communications Equipment Measurement and Performance Standards TIA/EIA-603 February 1993 Telecommunications Industry Association (American National Standard ANSI/TIA/EIA-603-1992 Approved: October 27, 1992) Para. no. 2.2 Methods of Measurement for Transmitters

Para. no. 2.2.19 Transient Frequency Behaviour (page no. 83).

**Data**

This measurement was made using measurement procedure TIA/EIA Digital C4FM/CQPSK Transceiver Measurement Methods TSB102.CAAA Para. no. 2.2.17 Transient Frequency Behaviour (page no. 74).