



**Nemko Test Report:** 41012RUS1

**Applicant:** EF Johnson Company  
123 N. State St.  
Waseca, MN 56093  
USA


**Equipment Under Test:** 242-2607-100 Land Mobile Repeater  
(E.U.T.)

**In Accordance With:** FCC Part 90, Subpart I  
Private Land Mobile Transmitter

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

TESTED BY:   
David Light, Senior Wireless Engineer

DATE: 09 February 2010

APPROVED BY:   
Tom Tidwell, Telecom Direct

DATE: 15 February 2010

**Total Number of Pages: 32**

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EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

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## Section 1. Summary of Test Results

Manufacturer: EF Johnson Co.

Model No.: 242-2607-100 Land Mobile Repeater

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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*EQUIPMENT:*    [242-2607-100 Land Mobile Repeater](#)    *PROJECT NO.:*    [41012RUS1](#)

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**Summary of Test Data**

NAME OF TEST	PARA. NO.	RESULT
RF Power Output	90.541	Complies
Audio Frequency Response	TIA EIA-603.3.2.6	NA
Audio Low-Pass Filter Response	TIA EIA-603.3.2.6	NA
Modulation Limiting	TIA EIA-603.3.2.6	Complies
Occupied Bandwidth	90.210	Complies
Spurious Emissions at Antenna Terminals	90.210 & 90.543	Complies
Field Strength of Spurious Emissions	90.210	Complies
Frequency Stability	90.539	Complies
Transient Frequency Behavior	90.214	Complies

**Footnotes:**

[The DUT has no audio components.](#)

.

## Section 2. General Equipment Specification

**Supply Voltage Input:** 120 Vac

**Frequency Range:** 769 to 774 MHz

**Necessary Bandwidth:** 8.1 kHz

Type(s) of Modulation:	F3E (Voice)	F1D	F2D	D7W (QAM)	Other
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Emission Designator: 8K10F1D

**Output Impedance:** 50 ohms

**RF Power Output (rated):** 75 to 175 Watts

**Channel Spacing(s):** 12.5 kHz

**Operator Selection of Operating Frequency:**

<b>Power Output Adjustment Capability:</b>	Software
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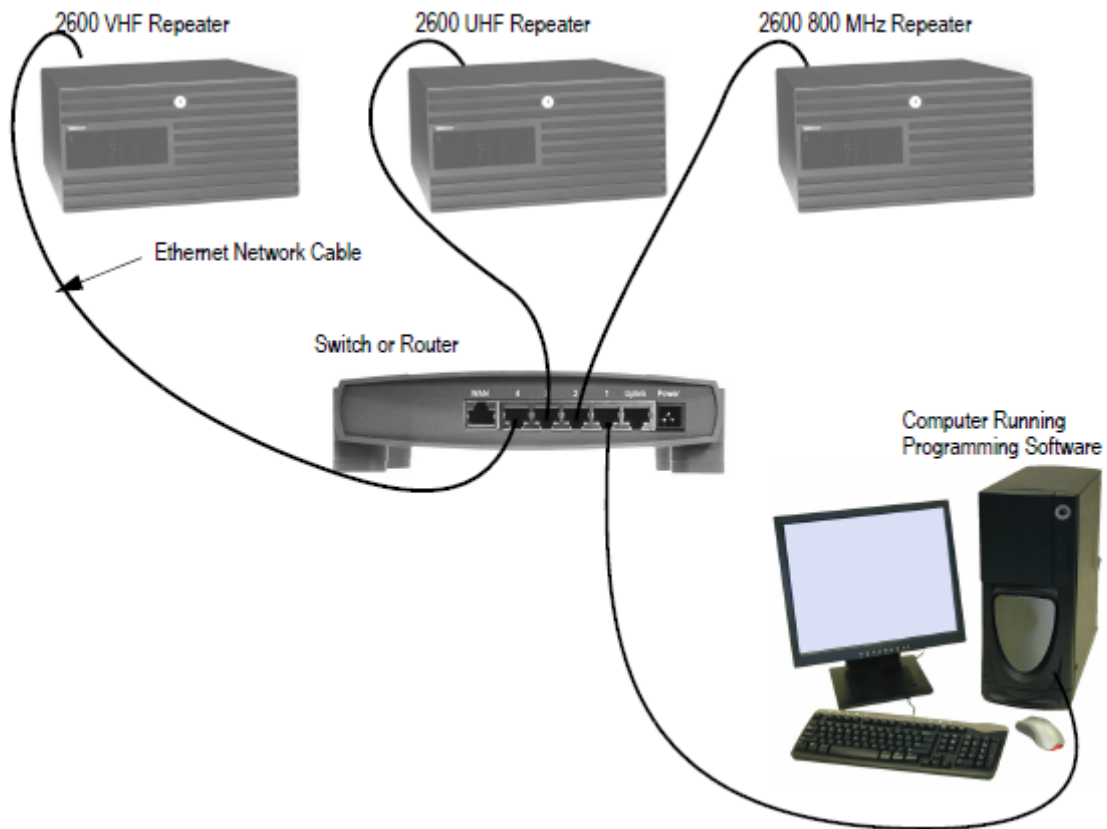
*EQUIPMENT:*    242-2607-100 Land Mobile Repeater    *PROJECT NO.:*    41012RUS1

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## **System Description**

700 MHz Project 24 land mobile repeater.

## **System Diagram**



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*EQUIPMENT:* 242-2607-100 Land Mobile Repeater      *PROJECT NO.:* 41012RUS1

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**Section 3.      RF Power Output**

NAME OF TEST: RF Power Output	PARA. NO.: 2.985
TESTED BY: David Light	DATE: 21 January 2010

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

Frequency (MHz)	Measured Power (dBm)	Measured Power (Watts)	Rated Power (Watts)
770	52.5	178	175
770	49.2	83	75

Spectrum Analyzer Settings:

RBW: 1 MHz

VBW: 1 MHz

Detector: Max Peak

**Measurement Conditions:**

Temperature: 22 °C

Humidity: 31 %

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

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*EQUIPMENT:*    242-2607-100 Land Mobile Repeater    *PROJECT NO.:*    41012RUS1

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**Section 4.            Modulation Characteristics**

NAME OF TEST: Modulation Characteristics	PARA. NO.: 2.987
TESTED BY: David Light	DATE: 21 January 2010

**Measurement Results:**            Complies.**Measurement Data:**            Maximum deviation for non-voice  
modulation 2.4 kHz.

Limit: 12 kHz

**Measurement Conditions:**      Temperature:    22 °C  
   Humidity:      45 %**Measurement Uncertainty:**    +/-    1.7 dB**Description of modulation:**    2FSK**Test Equipment Used:**    1036-1082-1469-1472**Measurement Uncertainty:**    +/-    1.7 dB



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## Section 5. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 2.989
TESTED BY: David Light	DATE: 25 January 2010

**Measurement Results:** Complies.

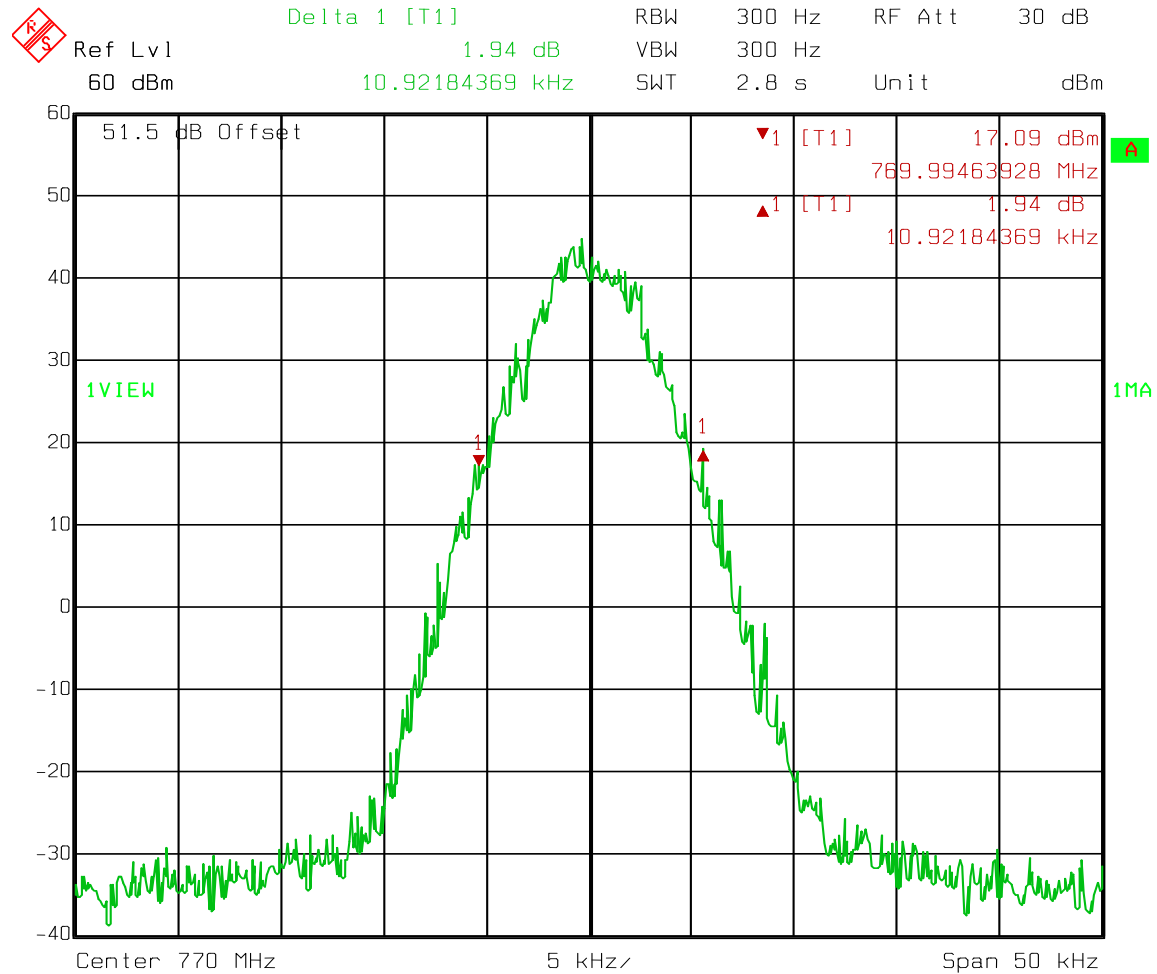
**Measurement Data:** Attached

**Measurement Conditions:** Temperature: 22 °C  
Humidity: 31 %

**Measurement Uncertainty:** +/- 1X10<sup>-7</sup> ppm

EQUIPMENT: 242-2607-100 Land Mobile Repeater

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**Test Data – 99% Occupied Bandwidth  
Low Power**

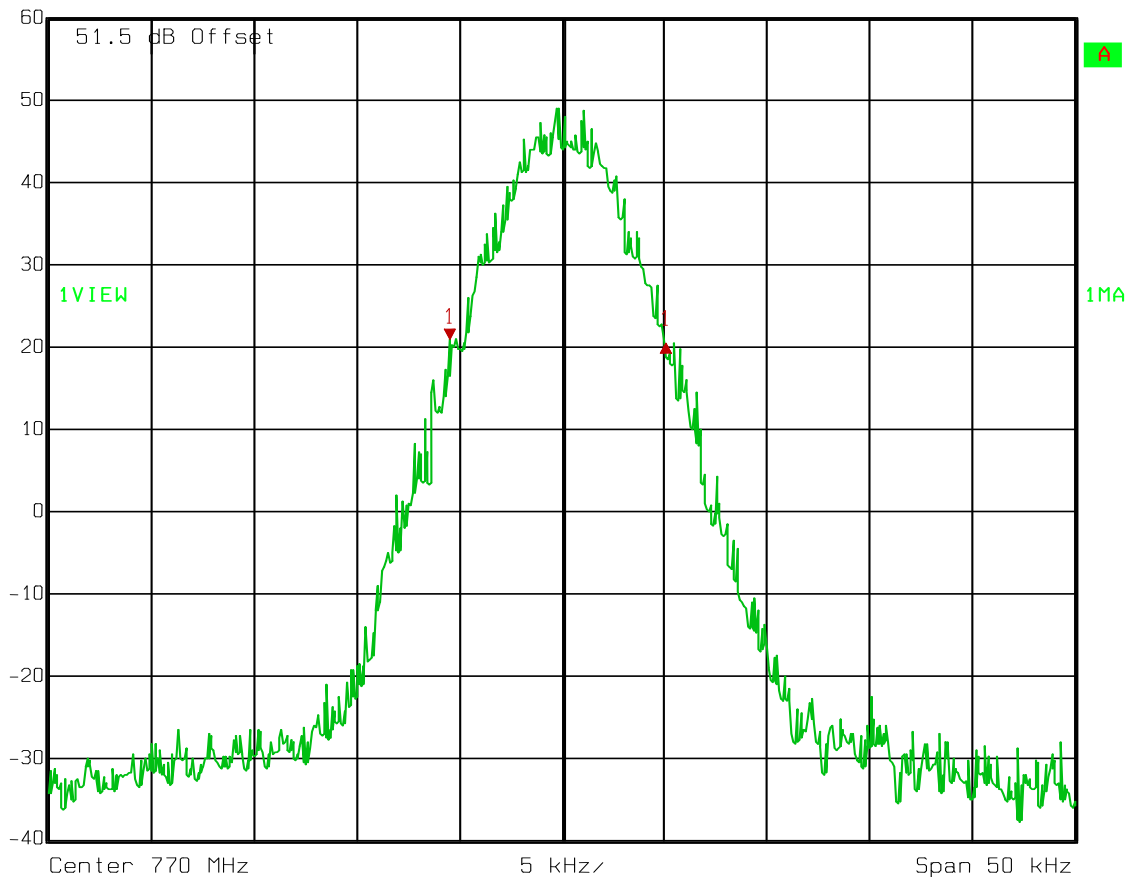
Date: 21.JAN.2010 10:51:12

EQUIPMENT: 242-2607-100 Land Mobile Repeater

PROJECT NO.: 41012RUS1

**Test Data – 99% Occupied Bandwidth****High Power**

Delta 1 [T1] RBW 300 Hz RF Att 30 dB  
Ref Lvl -0.14 dB VBW 300 Hz  
60 dBm 10.52104208 kHz SWT 2.8 s Unit dBm



Date: 20.JAN.2010 14:12:02

*EQUIPMENT:* 242-2607-100 Land Mobile Repeater      *PROJECT NO.:* 41012RUS1

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## Section 6.            Spurious Emissions at Antenna Terminals

NAME OF TEST: Spurious Emissions @ Antenna Terminals	PARA. NO.: 2.991
TESTED BY: David Light	DATE: 25 January 2010

**Measurement Results:**    Complies.

**Measurement Data:**        See attached data

**Measurement Conditions:**      Temperature: 22 °C  
   Humidity: 31 %

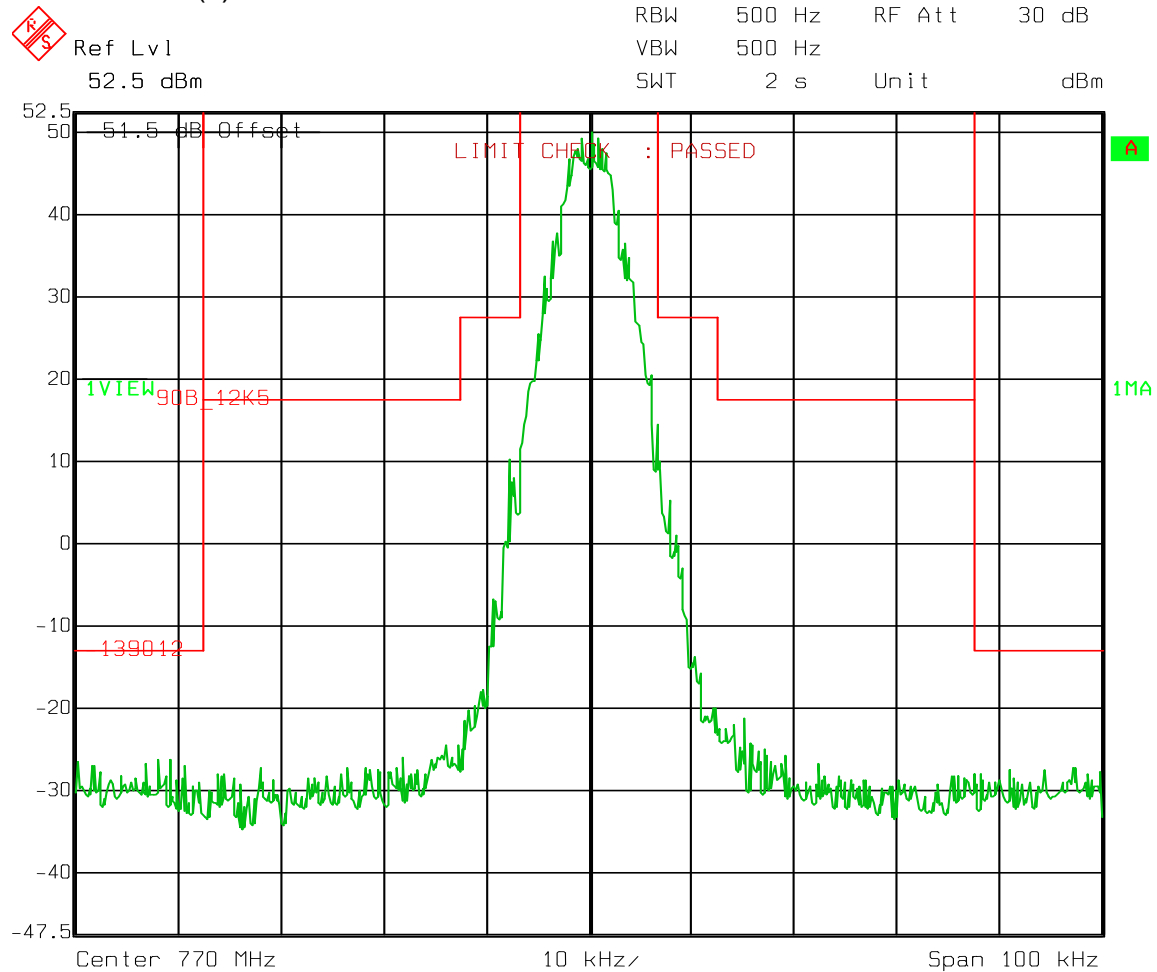
**Measurement Uncertainty:**    +/-    1.7 dB

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

EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

# Test Data – Spurious Emissions at Antenna Terminals

Highest Power  
Mask 90.201(c)

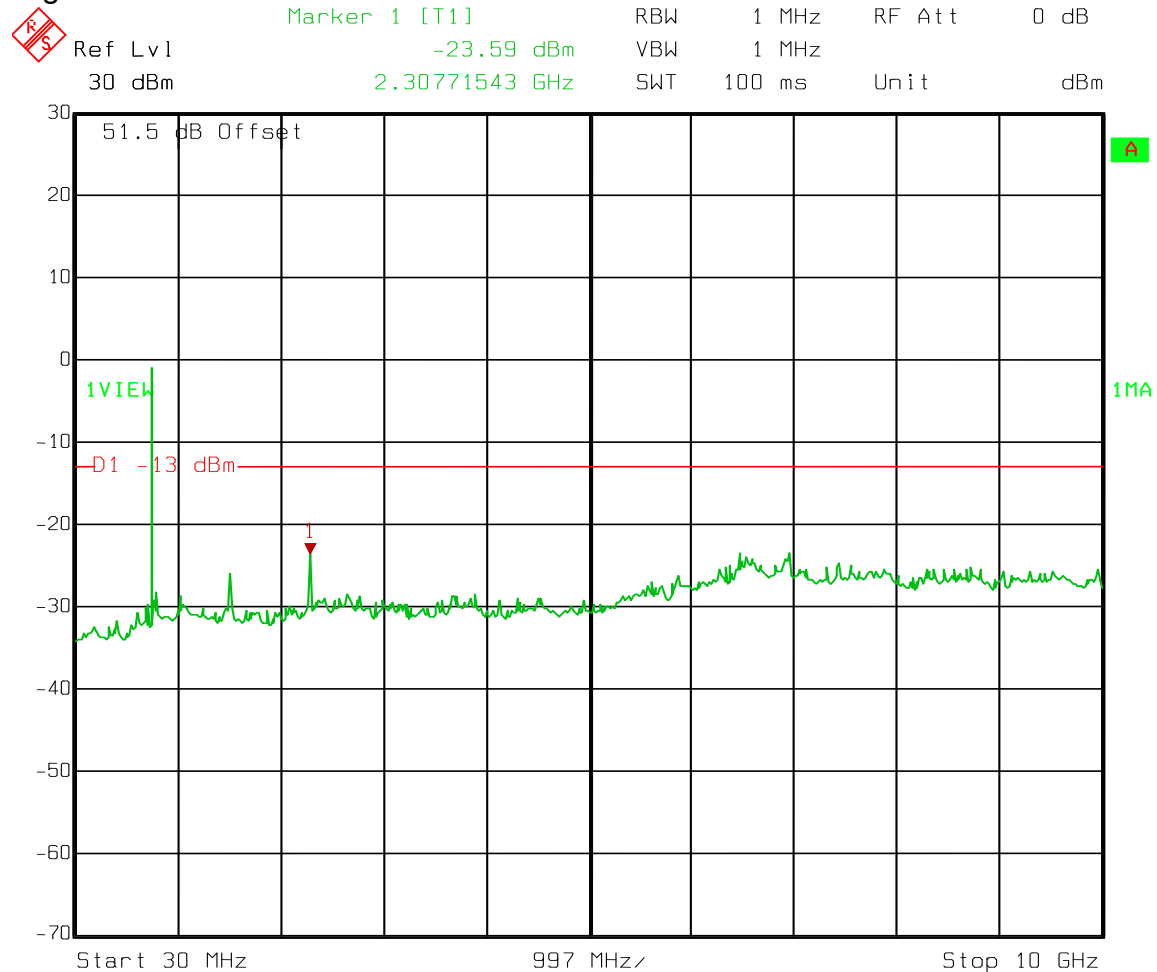


Date: 21.JAN.2010 10:58:39

EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

# Test Data – Spurious Emissions at Antenna Terminals

## Highest Power



Date: 20.JAN.2010 14:06:20

Carrier notched.

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**Test Data – Spurious Emissions at Antenna Terminals**

90.543 requirements.

Project 25 Digital  
Highest Power

Offset from center Frequency (kHz)	Measurement Bandwidth (kHz)	Maximum ACP (dBc)	Measured ACP (dBc)
9.375	6.25	-40	-42.5
15.625	6.25	-60	-71.3
21.875	6.25	-60	-75.4
37.5	25.00	-60	-69
62.5	25.00	-65	-67
87.5	25.00	-65	-71
150.0	100	-65	-67
250.0	100	-65	-71
350.0	100	-65	-71
>400 to 12 MHz	30 (s)	-80	99.6
12 MHz to paired RX band	30 (s)	-80	102.6
In the paired RX band	30 (s)	-100	-101

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**Section 7.            Field Strength of Spurious Emissions**

NAME OF TEST: Field Strength of Spurious Emissions	PARA. NO.: 2.993
TESTED BY: David Light	DATE: 25 January 2010

**Measurement Results:**    Complies.**Measurement Data:**        There were no emissions observed within 20 dB of the specification limit of -20 dBm erp.

The spectrum was searched from 30 to 5000 MHz.

Below 1000 MHz	RBW=VBW=100 kHz	Peak detector
Above 1000 MHz	RBW=VBW=1 MHz	Peak detector

**Measurement Conditions:**      Temperature: 22 °C  
   Humidity: 31 %**Measurement Uncertainty:**        +/- 1.7 dB**Test Equipment Used:**    1464-1484-1485-1016-993-1480-791



EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

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## Section 8. Frequency Stability

NAME OF TEST: Frequency Stability	PARA. NO.: 2.995
TESTED BY: David Light	DATE: 25 January 2010

**Measurement Results:** Complies.

**Measurement Data:** See attached data

**Measurement Conditions:** Temperature: 22 °C  
Humidity: 31 %

**Test Equipment Used:** 1036-1082-1469-1472-283

**Measurement Uncertainty:** +/-  $1 \times 10^{-7}$  ppm

EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

## Test Data – Frequency Stability

Measurement Uncertainty:	$1 \times 10^{-17}$ ppm		Standard Test Frequency		769.999720	MHz	
Temp (°C)	Measured Frequency (MHz)		Test Voltage	Frequency Error (Hz)	Limit (+/-Hz)	Error (ppm)	Comment
20	769.999720		120	0	1155.0	0	
20	769.999720		102	0	1155.0	0.0	
20	769.999720		138	0	1155.0	0.0	
50	769.999770		120	50	1155.0	0.1	
40	769.999770		120	50	1155.0	0.1	
30	769.999740		120	20	1155.0	0.0	
10	769.999770		120	50	1155.0	0.1	
0	769.999780		120	60	1155.0	0.1	
-10	769.999750		120	30	1155.0	0.0	
-20	769.999760		120	40	1155.0	0.1	
-30	769.999740		120	20	1155.0	0.0	
Notes:							

Limit +/- 1.5 ppm

EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

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## Section 9. Transient Frequency Behavior

NAME OF TEST: Transient Frequency Behavior	PARA. NO.: 90.214
TESTED BY: David Light	DATE: 05 February 2010

**Measurement Results:** Complies.

**Measurement Data:** See attached data

**Measurement Conditions:** Temperature: 22 °C  
Humidity: 31 %

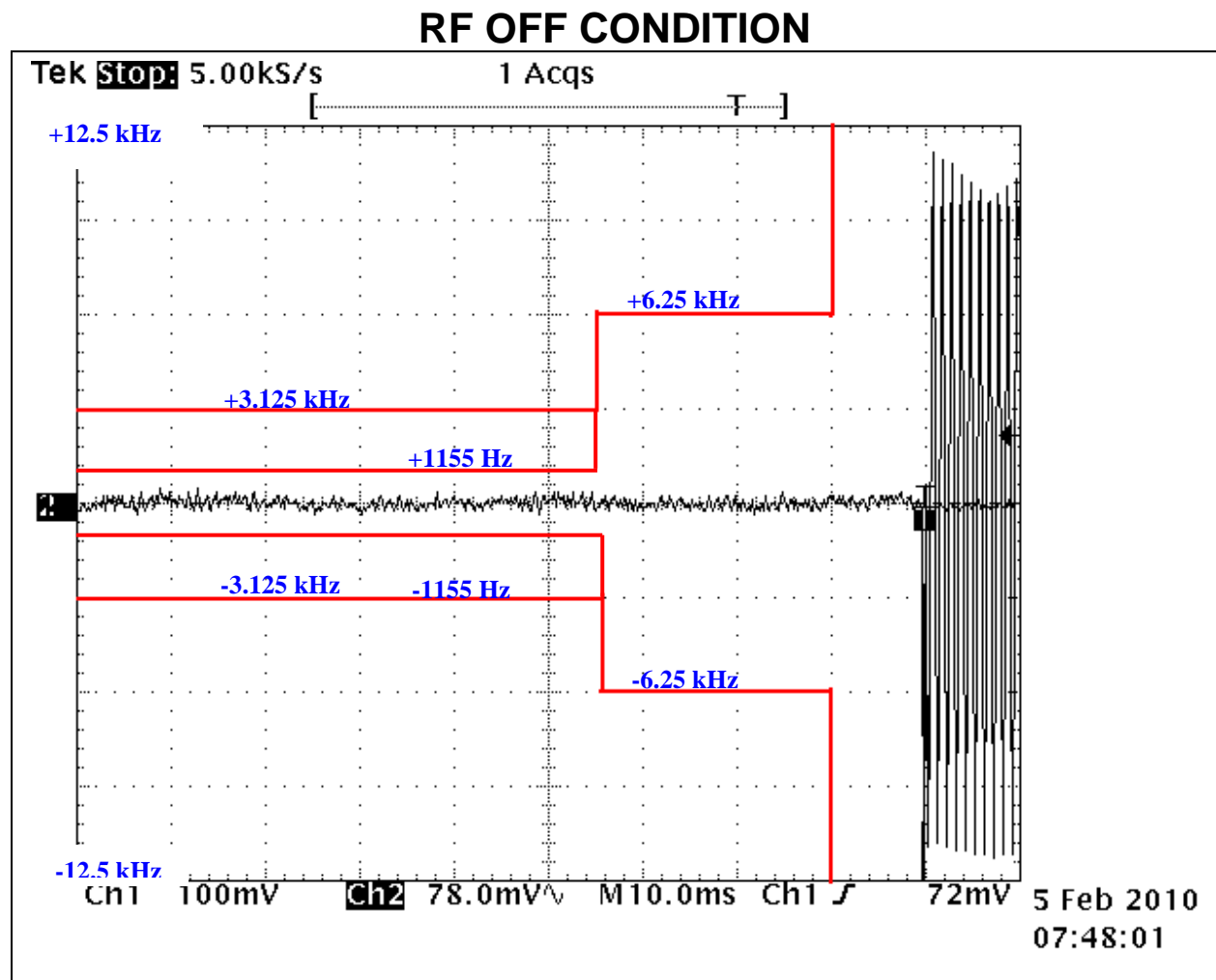
**Test Equipment Used:** 1463-1082-1054-1093

**Measurement Uncertainty:** +/-  $1 \times 10^{-7}$  ppm

EQUIPMENT: 242-2607-100 Land Mobile Repeater

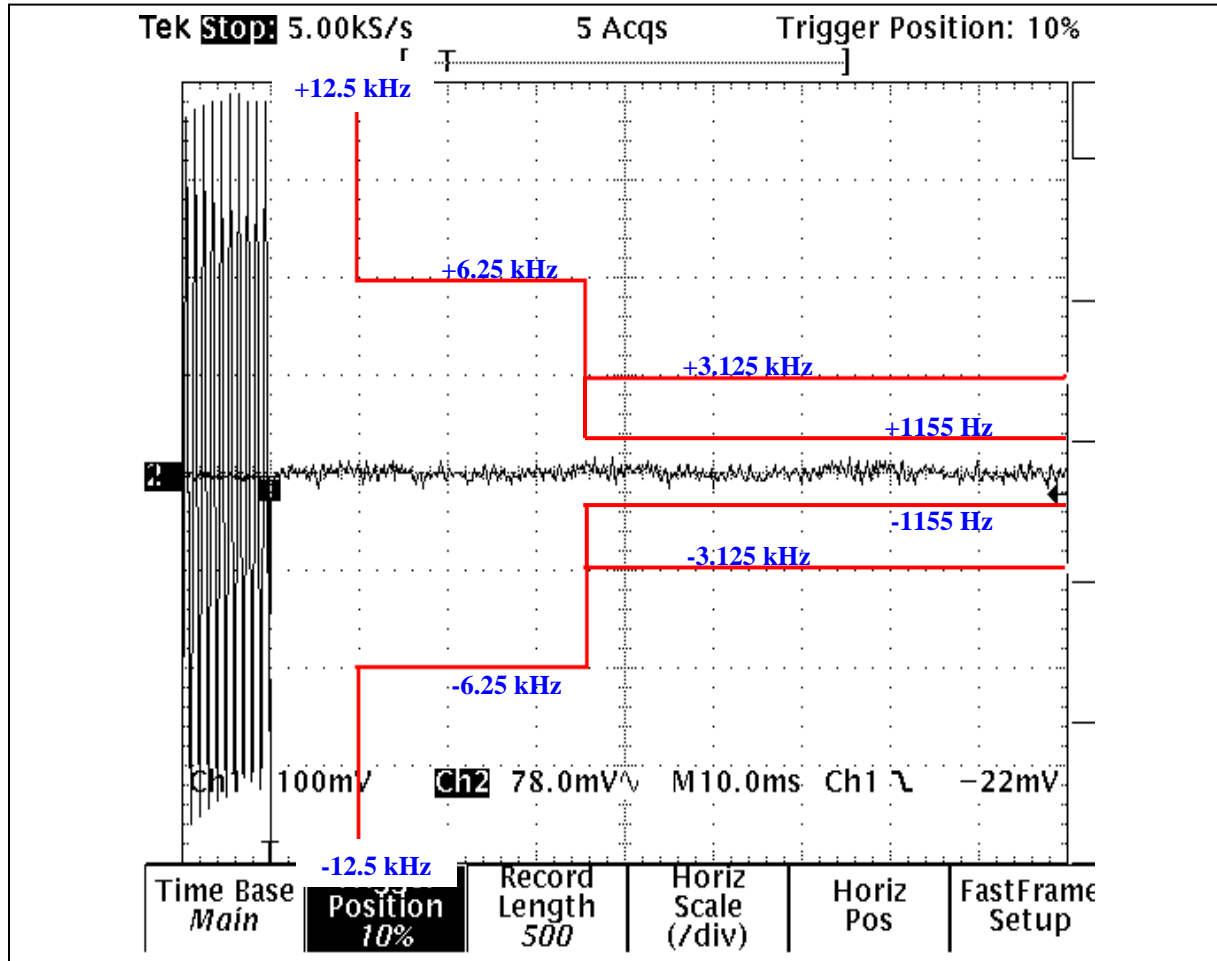
PROJECT NO.: 41012RUS1

## Test Data – Transient Frequency Behavior



EQUIPMENT: 242-2607-100 Land Mobile Repeater

PROJECT NO.: 41012RUS1

**RF ON CONDITION**

EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

**Section 10. Test Equipment List**

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	01/19/09	01/20/11
1082	CABLE 2m	Astrolab 32027-2-29094-72TC	N/A	CBU	N/A
1469	10 db Attenuator DC 18 Ghz	MCL Inc. BW-S10W2 10db-2WDC	NONE	CBU	N/A
1472	20db Attenuator DC 18 Ghz	Omni Spectra 20600-20db	NONE	CBU	N/A
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	02/27/09	02/28/11
1484	Cable	Storm PR90-010-072	N/A	06/23/09	06/23/10
1485	Cable	Storm PR90-010-216	N/A	06/23/09	06/23/10
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	06/23/09	06/23/10
993	Horn antenna	A.H. Systems SAS-200/571	XXX	09/09/09	09/09/11
1480	Bilog Antenna	Schaffner-Chase CBL6111C	2572	01/18/10	01/18/11
791	PREAMP, 25dB	Nemko USA, Inc. LNA25	398	05/28/09	05/28/10
283	Environmental Chamber with controller # 1189006	ENVIROTRONICS SH27 & 2030-22844	129010083	10/06/09	10/06/10
1463	Color 4 Ch Digitizing Oscilloscope	Tektronix TDS684A	B010460	06/17/09	06/17/10
1054	DUAL DIRECTIONAL COUPLER	NARDA 3020A	34366	CBU	N/A
1093	COMBINER	MINI-CIRCUITS ZFSC-3-4	NONE	CBU	N/A

## **ANNEX A - TEST METHODOLOGIES**

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*EQUIPMENT:* 242-2607-100 Land Mobile Repeater      *PROJECT NO.:* 41012RUS1

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<b>NAME OF TEST: RF Power Output</b>	<b>PARA. NO.: 2.985</b>
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**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 a spectrum analyzer with the IF bandwidth filter set to a level greater than the 20 dB bandwidth of the measured rf waveform. 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



EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

**NAME OF TEST: Occupied Bandwidth****PARA. NO.: 2.989****Minimum Standard:** Para. No. 90.210, see table 1 below for applicable mask.**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.

*EQUIPMENT:* 242-2607-100 Land Mobile Repeater      *PROJECT NO.:* 41012RUS1

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

Field strength of spurious emissions is measured using the substitution antenna method as described in EIA/TIA IS-603C

EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

**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 Behavior****PARA. NO.: 2.214****Minimum Standard:****Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels**

Time intervals <sup>1,2</sup>	Maximum Frequency difference <sup>3</sup> (kHz)	Frequency ranges (MHz) All equipment					
		Base station and portable radios			Mobile Radios		
		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 Behavior for Equipment Designed to Operate on 12.5 kHz & 6.25 kHz Channels**

Time intervals <sup>1,2</sup>	Maximum Frequency difference <sup>3</sup> (kHz)	Frequency ranges (MHz) All equipment		
		150 - 174 (ms)	450 - 500 (ms)	500 - 512 (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

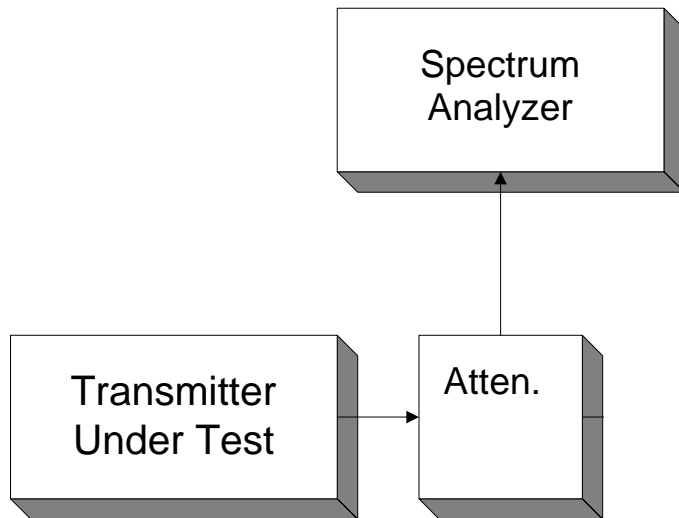
## **ANNEX B - TEST DIAGRAMS**

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*EQUIPMENT:*    [242-2607-100 Land Mobile Repeater](#)    *PROJECT NO.:*    [41012RUS1](#)

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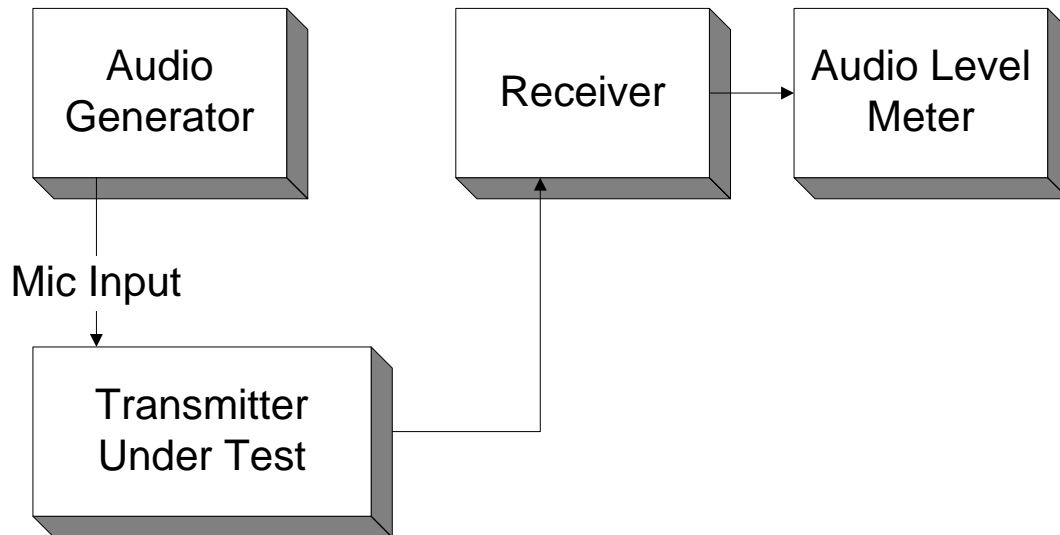
**Para. No. 2.985 - R.F. Power Output**



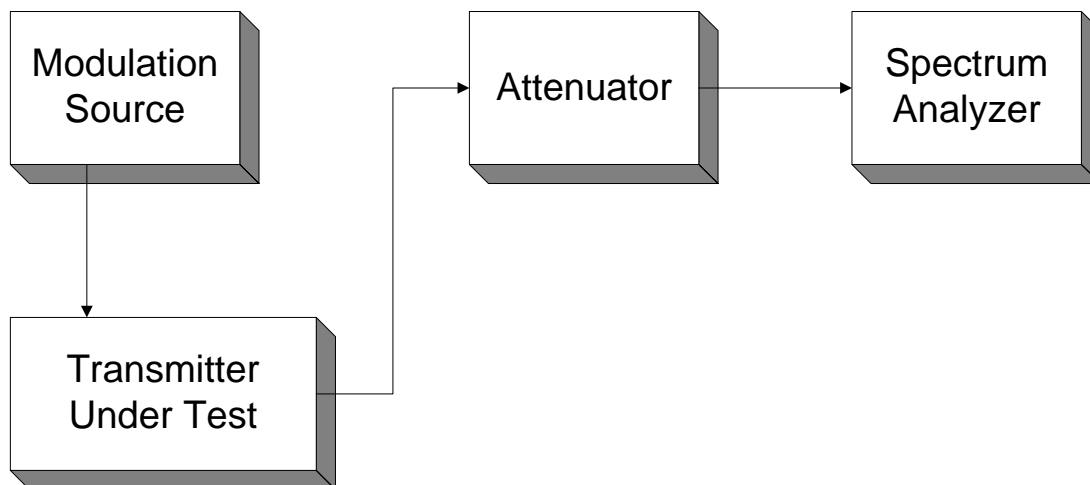
EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

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**Para. No. 2.987(b) - Modulation Limiting**

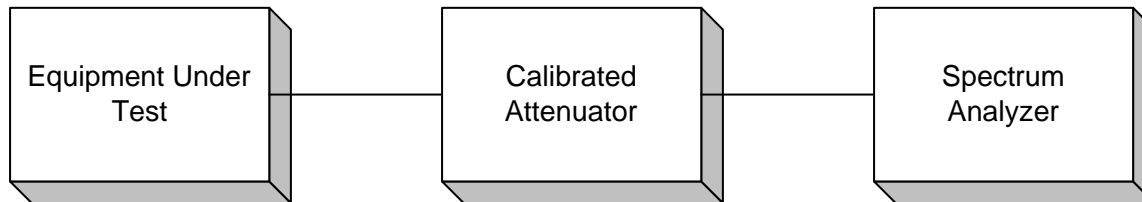


**Para. No. 2.989 - Occupied Bandwidth**

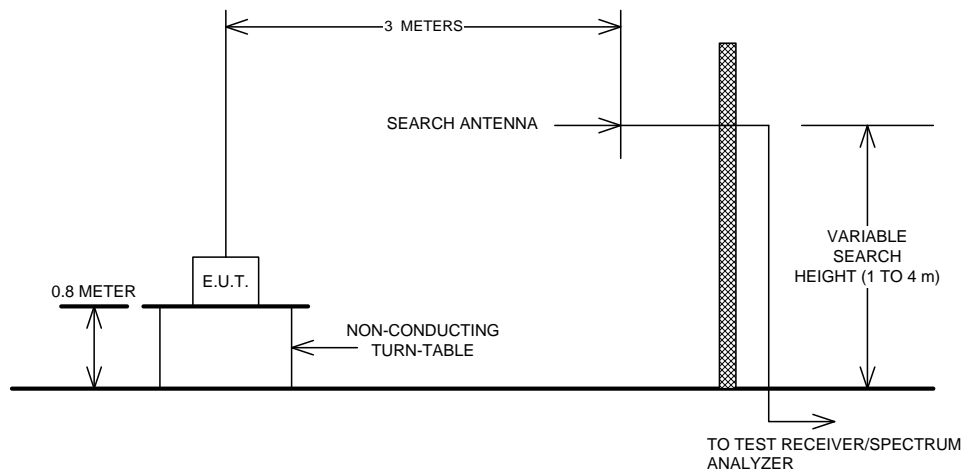


EQUIPMENT: 242-2607-100 Land Mobile Repeater PROJECT NO.: 41012RUS1

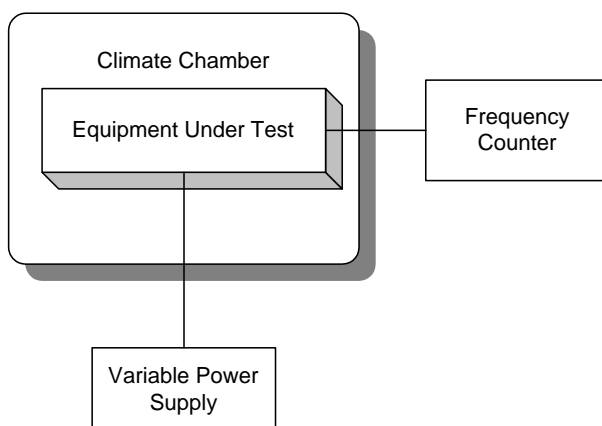
**Para. No. 2.991 - Spurious Emissions at Antenna Terminals**

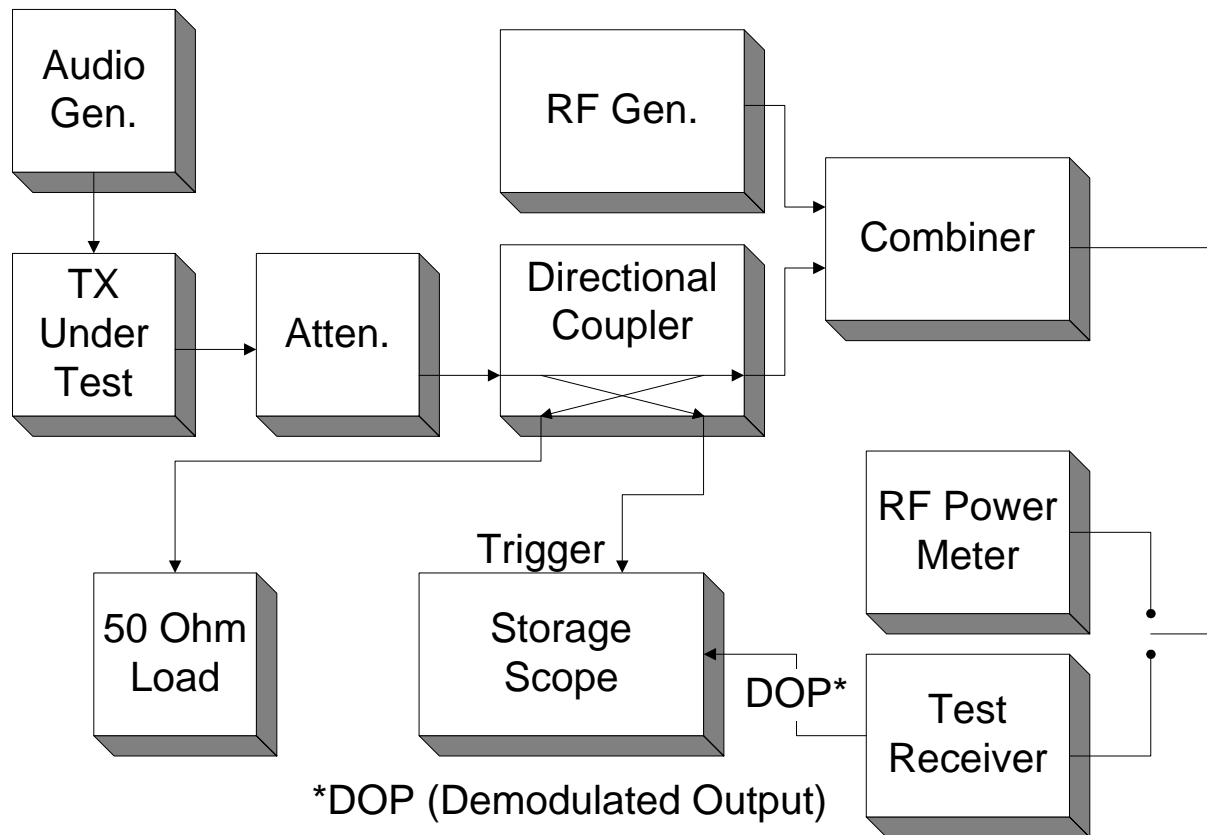


**Para. No. 2.993 - Field Strength of Spurious Radiation**



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



**Para. No. 90.214 - Transient Frequency Behavior****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 Behavior (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 Behavior