

Nemko Test Report: 3L0083RUS1

Applicant: ExCell RF, Inc.
6400 Windcrest Drive Suite # 1226
Plano, TX 75024

**Equipment Under Test:
(E.U.T.)** Model 100-AS
SMR Band RF Repeater

FCC ID:

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

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

Authorized By:



Tom Tidwell, Frontline Manager

Date: 5/16/03

Total Number of Pages: 37

Table of Contents

Section 1.	Summary of Test Results	3
Section 2.	General Equipment Specification.....	5
Section 3.	RF Power Output.....	7
Section 4.	Occupied Bandwidth	8
Section 5.	Spurious Emissions at Antenna Terminals	13
Section 6.	Field Strength of Spurious Emissions.....	24
Section 7.	Test Equipment List	27
ANNEX A - TEST METHODOLOGIES		28
ANNEX B - TEST DIAGRAMS		34

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

Section 1. Summary of Test Results

Manufacturer: ExCell RF, Inc.

Model No.: 100-AS

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



Equipment Code

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".

Nemko Dallas Inc. authorizes the above named company to reproduce this report provided it is reproduced in its entirety and for use by the company's employees only.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Nemko Dallas Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report applies only to the items tested.

EQUIPMENT: 100-AS**TEST REPORT NO.: 3L0083RUS1**

Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	RESULT
RF Power Output	90.205	500 Watts ERP	Complies
Audio Frequency Response	TIA EIA-603.3.2.6	N/A	N/A
Audio Low-Pass Filter Response	TIA EIA-603.3.2.6	N/A	N/A
Modulation Limiting	TIA EIA-603.3.2.6	N/A	N/A
Occupied Bandwidth	90.210	Input/Output	Complies
Spurious Emissions at Antenna Terminals	90.210	50+10log(P) Watts (-20 dBm)	Complies
Field Strength of Spurious Emissions	90.210	50+10log(P) Watts (-20 dBm)	Complies
Frequency Stability	90.213	N/A	
Transient Frequency Behavior	90.214	N/A	N/A

Footnotes For N/A's:

- (1) Since the E.U.T. does not contain modulation circuitry modulation testing was not performed.
- (2) Since the E.U.T. is not a keyed carrier system, Transient Frequency Behavior was not performed.

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

Section 2. General Equipment Specification**Transmitter**

Supply Voltage Input: 120 Vac

Frequency Range:	Uplink	806.0085 to 820.9915 MHz
	Downlink	851.0085 to 865.9915 MHz

Tunable Bands:

Type(s) of Modulation:	F3E	F1D	F2D	D7W (QAM)	Other
	☒	☐	☐	☐	☐

Maximum Input: -40 dBm (100µW)

Output Impedance: 50 ohms

RF Power Output (rated):	Single:	27 dBm (501 mW)
	Composite:	17 dBm (50.1 mW)

Channel Spacing(s): 25 kHz

Operator Selection of Operating Frequency: None

Power Output Adjustment Capability: Attenuators

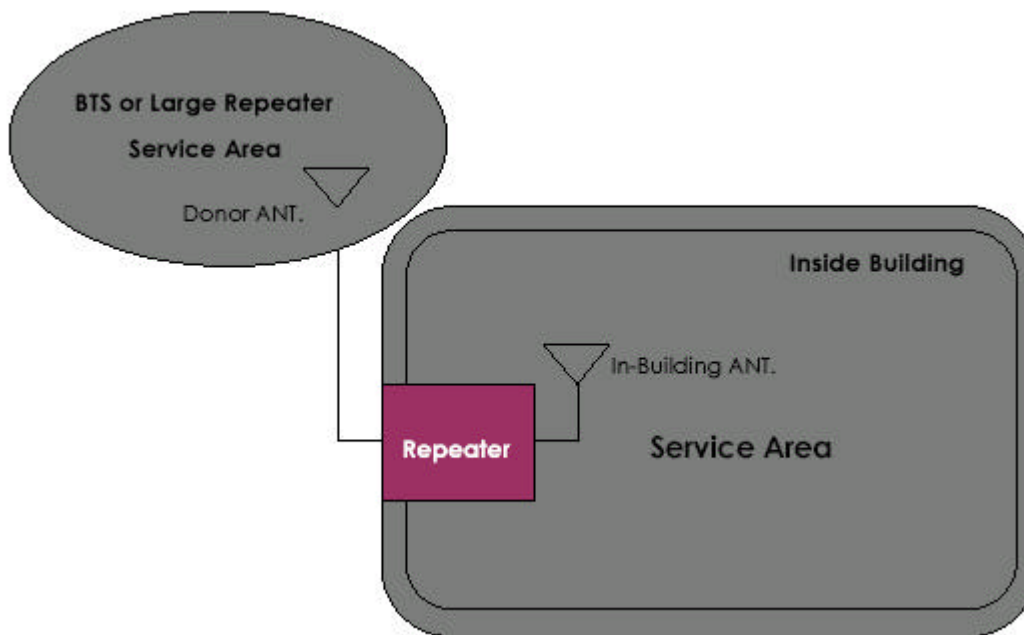
Frequency Translation:	F1-F1	F1-F2	N/A
	☒	☐	☐

Band Selection:	Software	Duplexer Change	Fullband Coverage
	☐	☐	☒

Theory of Operation

The Model 100-AS repeater is a compact, high-gain bi-directional amplifier that can be used to amplify RF signals in the 800 MHz SMR band. The Model 100-AS repeater can solve wireless coverage problems for most indoor and outdoor applications

System Diagram



EQUIPMENT: **100-AS**TEST REPORT NO.: **3L0083RUS1**

Section 3. RF Power Output

NAME OF TEST: RF Power Output	PARA. NO.: 2.985
TESTED BY: David Light	DATE: 5/15/03

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

Frequency (MHz)	Measured Power (dBm)	Rated Power (dBm)	Measured/Rated (dB)
815	27 dBm	27 dBm	1
860	27 dBm	27 dBm	1

EQUIPMENT: **100-AS**

TEST REPORT NO.: **3L0083RUS1**

Section 4. Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 2.989
TESTED BY: David Light	DATE:5/15/03

Test Results: Complies.

Test Data: See attached graph(s).

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

Test Plots – Occupied Bandwidth



Nemko Dallas, Inc.

Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Data Plot		Spurious Emissions at Antenna Terminals	
Page 1 of 2		Complete _____	
Job No.: 3L0083R	Date: 5/15/2003	Preliminary: _____	
Specification: PART 90	Temperature(°C): 22		
Tested By: David Light	Relative Humidity(%): 40		
E.U.T.: SMR AMPLIFIER			
Configuration: TX			
Sample Number: 2			
Location: Lab 1	RBW: Refer to plots	Measurement	
Detector Type: Peak	VBW: Refer to plots	Distance: NA m	
Test Equipment Used			
Antenna: _____	Directional Coupler: _____		
Pre-Amp: _____	Cable #1: 1628		
Filter: _____	Cable #2: _____		
Receiver: 1036	Cable #3: _____		
Attenuator #1: 1064	Cable #4: _____		
Attenuator #2: 1604	Mixer: _____		
Additional equipment used: _____			
Measurement Uncertainty: +/-1.7 dB			
Date: 15.MAY 2003 08:59:00			
Notes: OUTPUT SIGNAL (UPLINK) 2.5 kHz Tone / 2 kHz Deviation			

EQUIPMENT: 100-AS

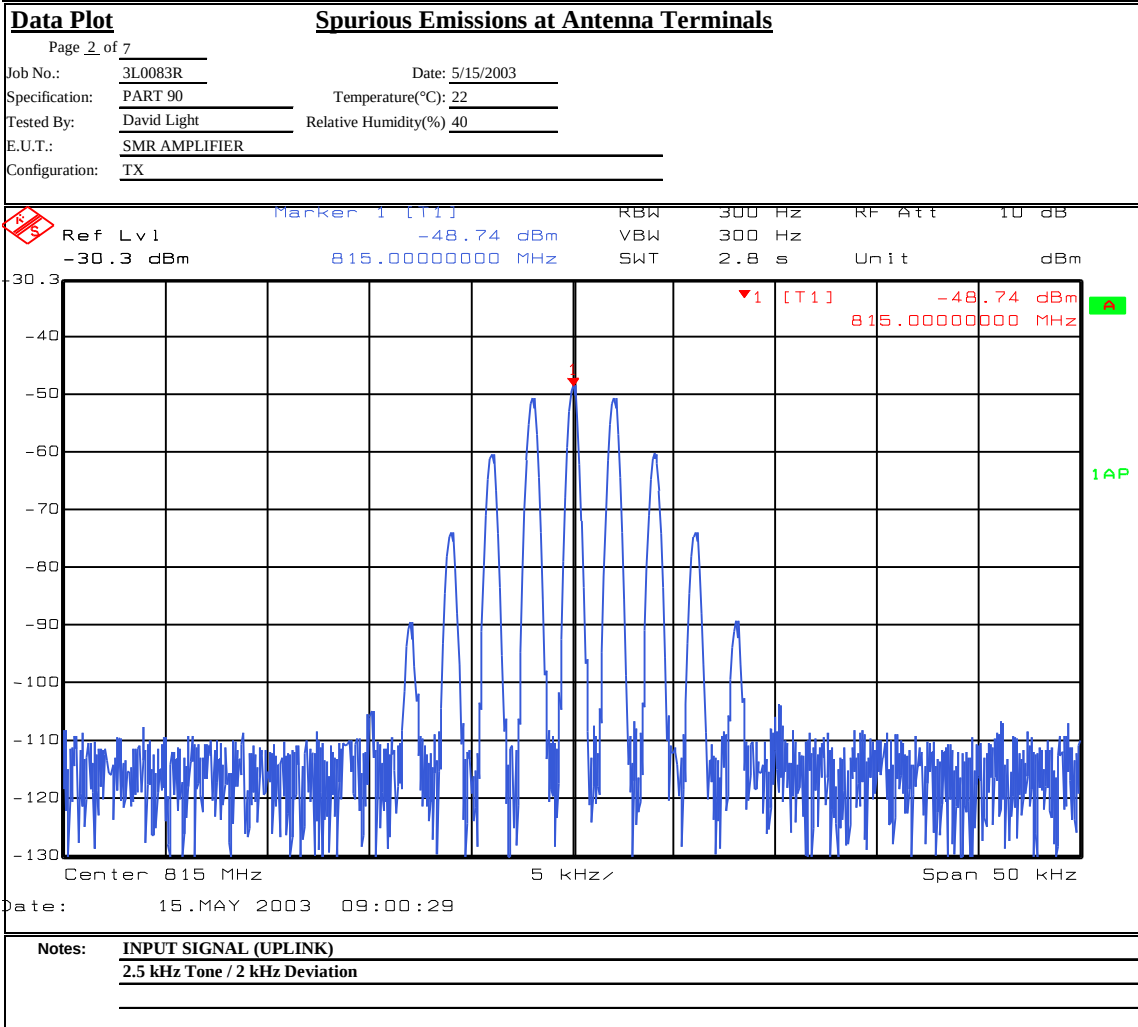
TEST REPORT NO.: 3L0083RUS1

Test Plots – Occupied Bandwidth



Dallas Headquarters:
802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

Test Plots – Occupied Bandwidth



Nemko Dallas, Inc.

Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Data Plot		Spurious Emissions at Antenna Terminals	
Page 1 of 2			
Job No.: 3L0083R	Date: 5/13/2003	Complete	
Specification: PART 90	Temperature(°C): 22	Preliminary:	
Tested By: David Light	Relative Humidity(%): 40		
E.U.T.: SMR AMPLIFIER			
Configuration: TX			
Sample Number: 1			
Location: Lab 1	RBW: Refer to plots	Measurement	
Detector Type: Peak	VBW: Refer to plots	Distance: NA	m
Test Equipment Used			
Antenna:	Directional Coupler:		
Pre-Amp:	Cable #1: 1628		
Filter:	Cable #2:		
Receiver: 1036	Cable #3:		
Attenuator #1: 1064	Cable #4:		
Attenuator #2: 1604	Mixer:		
Additional equipment used:			
Measurement Uncertainty: +/-1.7 dB			
Date: 12.MAY 2003 11:41:29			
Notes: OUTPUT SIGNAL (DOWNLINK) 2.5 kHz Tone / 2 kHz Deviation			

EQUIPMENT: 100-AS

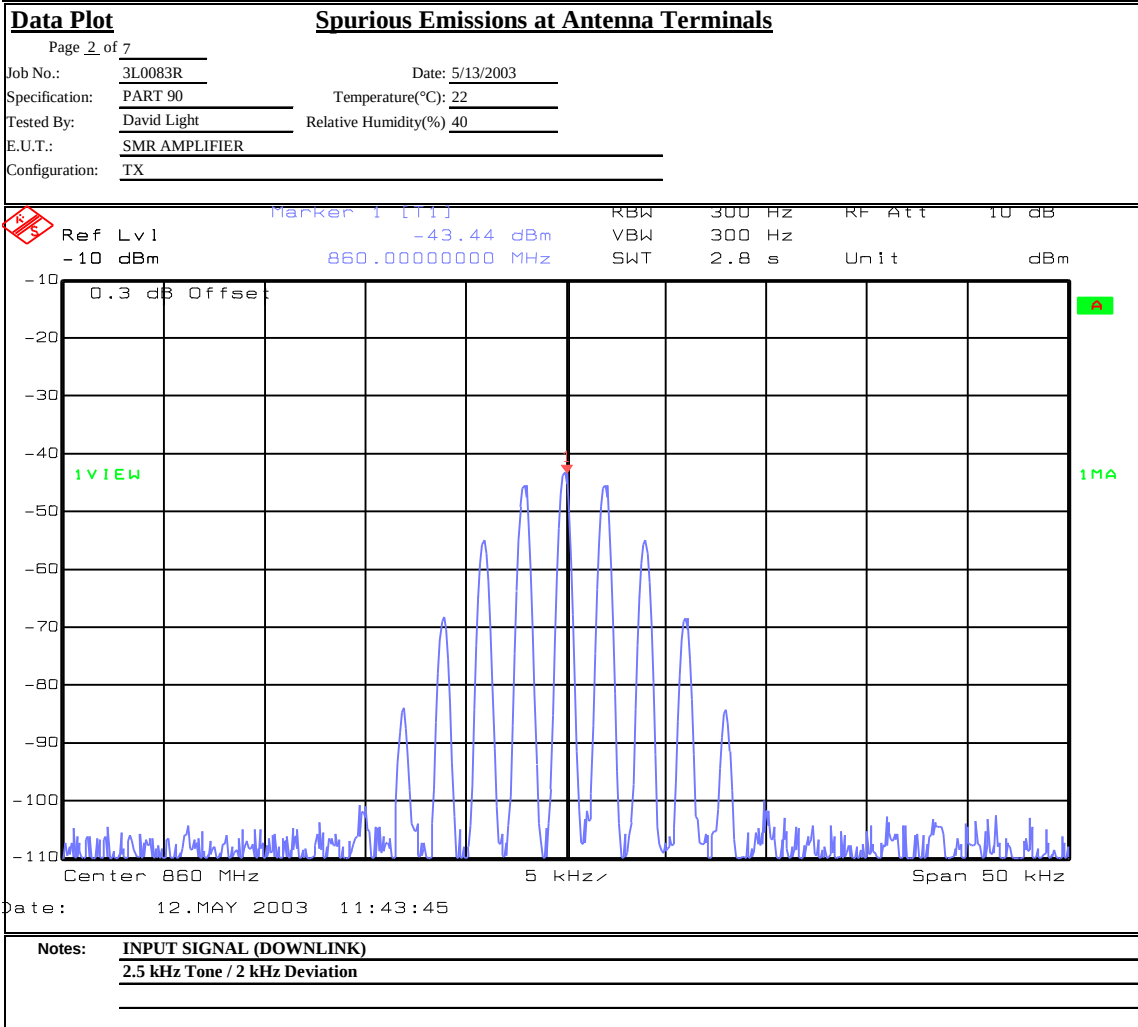
TEST REPORT NO.: 3L0083RUS1

Test Plots – Occupied Bandwidth



Dallas Headquarters:
802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: **100-AS**

TEST REPORT NO.: **3L0083RUS1**

Section 5. Spurious Emissions at Antenna Terminals

NAME OF TEST: Spurious Emissions @ Antenna Terminals	PARA. NO.: 2.991
TESTED BY: David Light	DATE: 5/15/03

Test Results: Complies.

Test Data: See attached graph(s).

EQUIPMENT: 100-AS

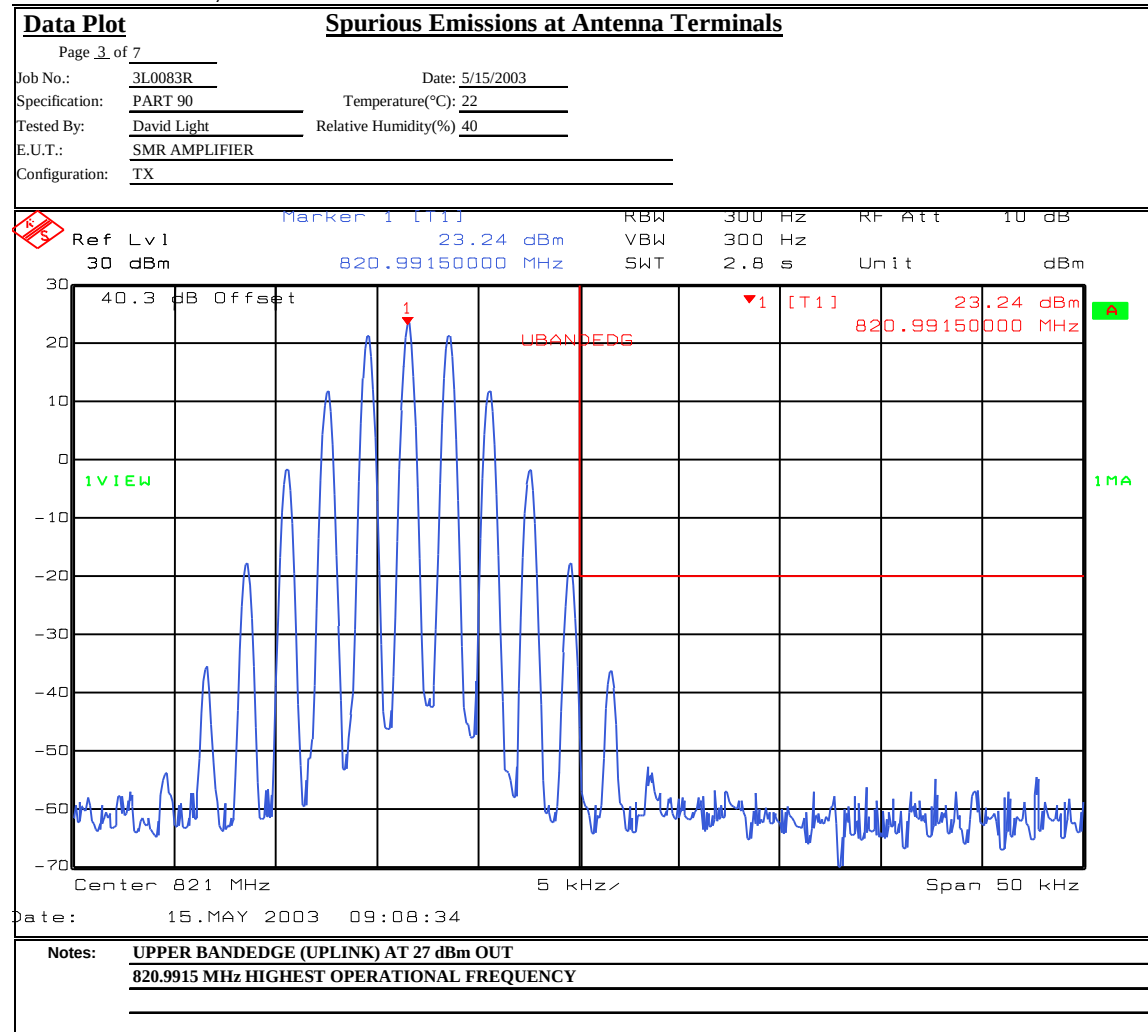
TEST REPORT NO.: 3L0083RUS1

Test Plots – Spurious Emissions at Antenna Terminals



Nemko Dallas, Inc.

Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

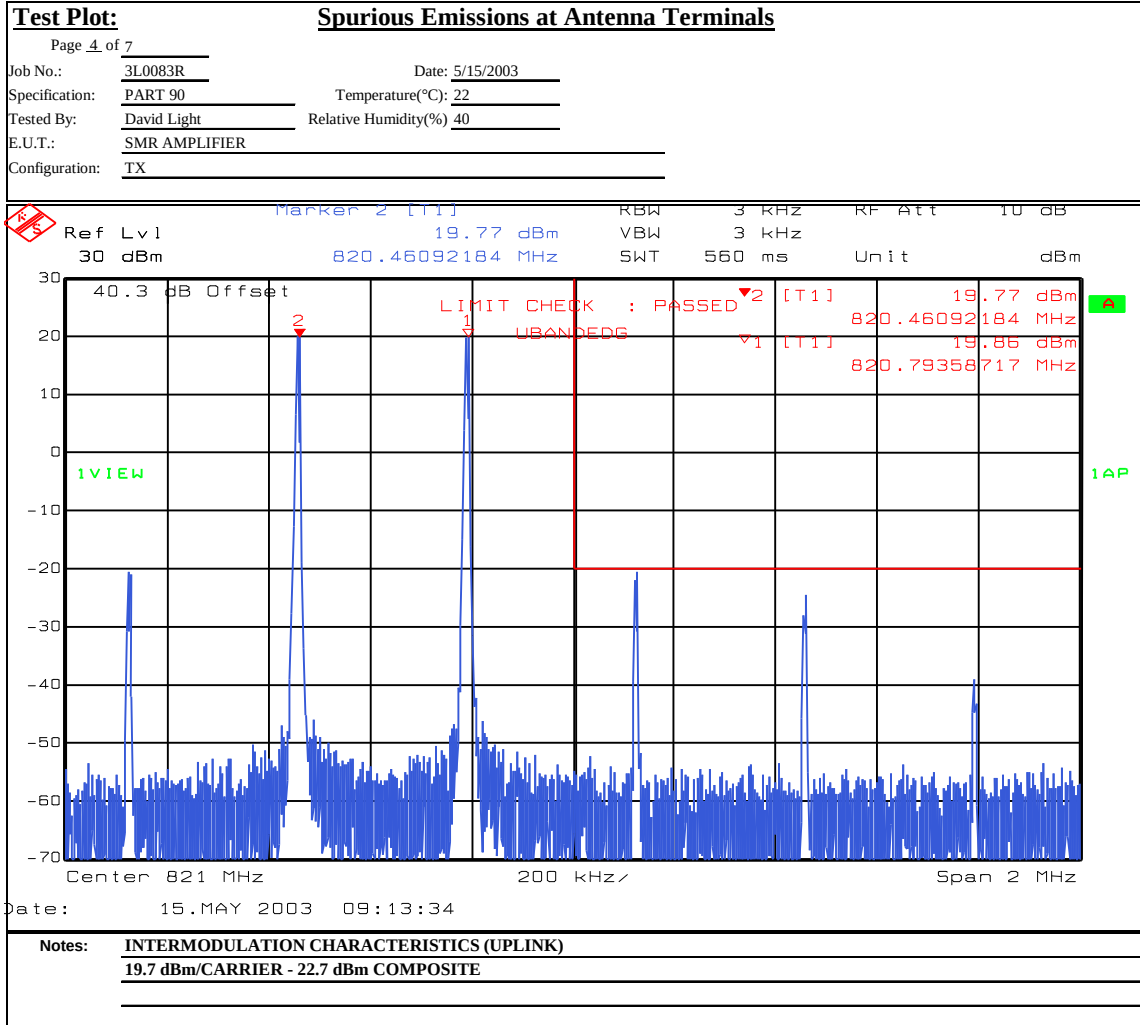
Test Plots – Spurious Emissions at Antenna Terminals



Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

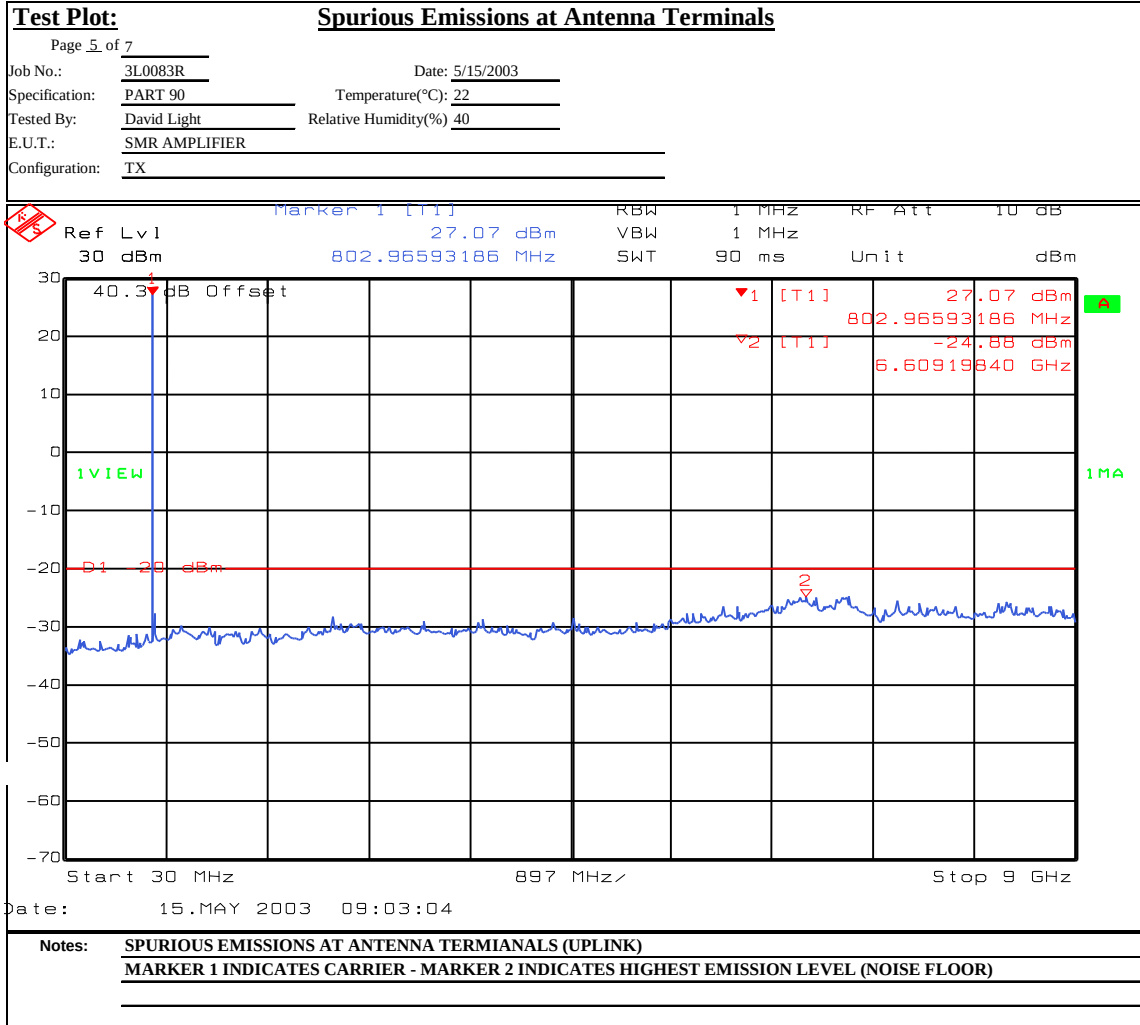
Test Plots – Spurious Emissions at Antenna Terminals



Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

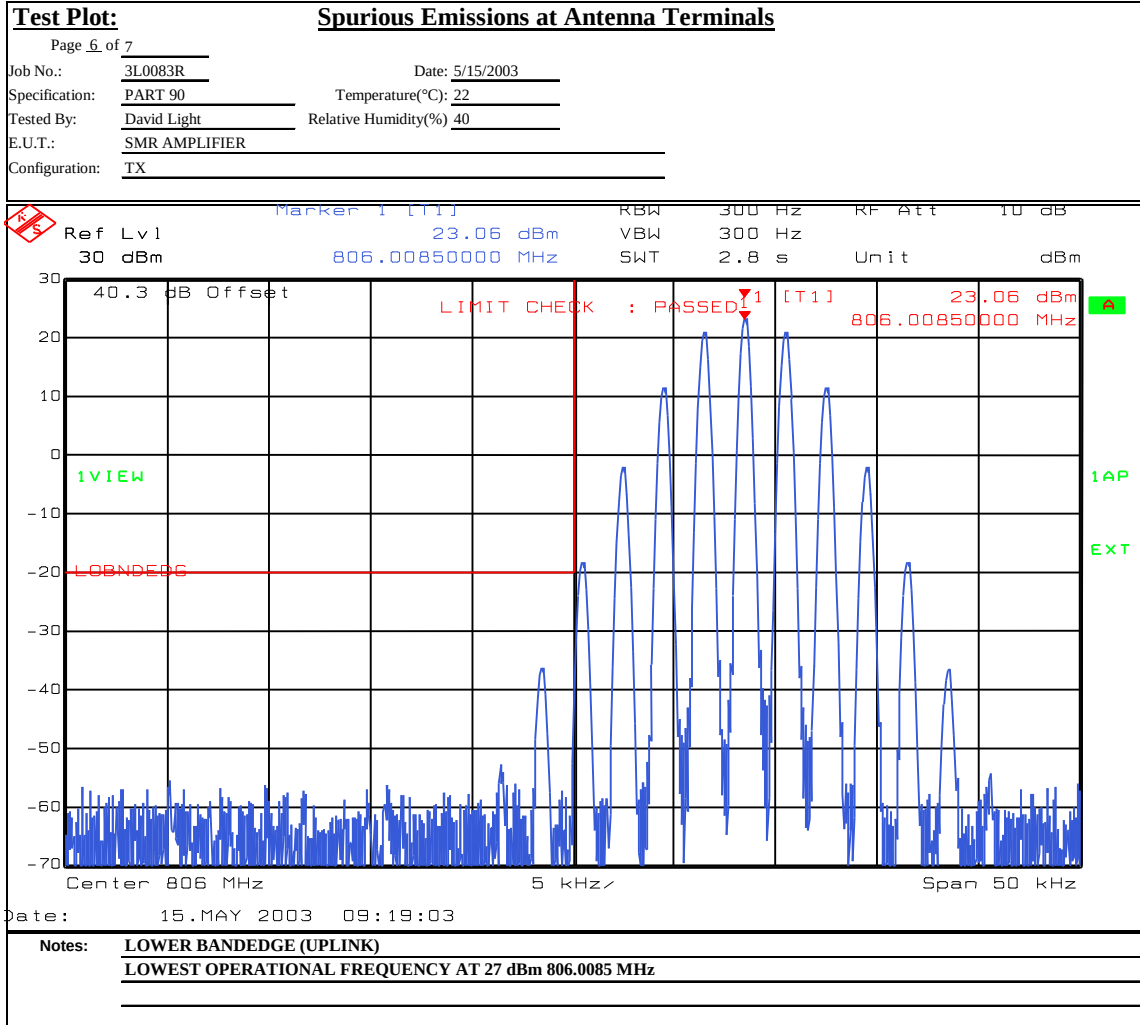
Test Plots – Spurious Emissions at Antenna Terminals



Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: 100-AS

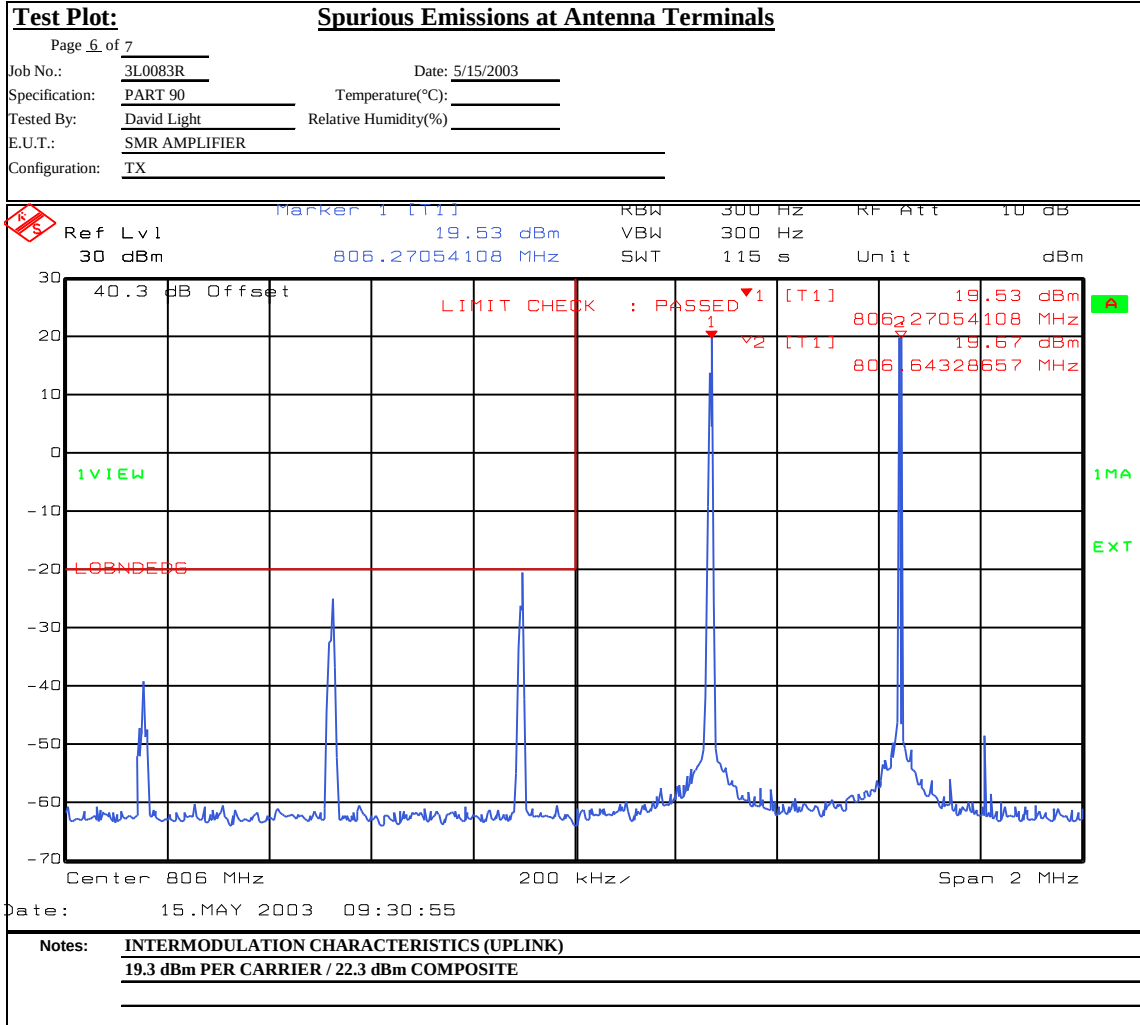
TEST REPORT NO.: 3L0083RUS1

Test Plots – Spurious Emissions at Antenna Terminals



Nemko Dallas, Inc.

Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

EQUIPMENT: 100-AS

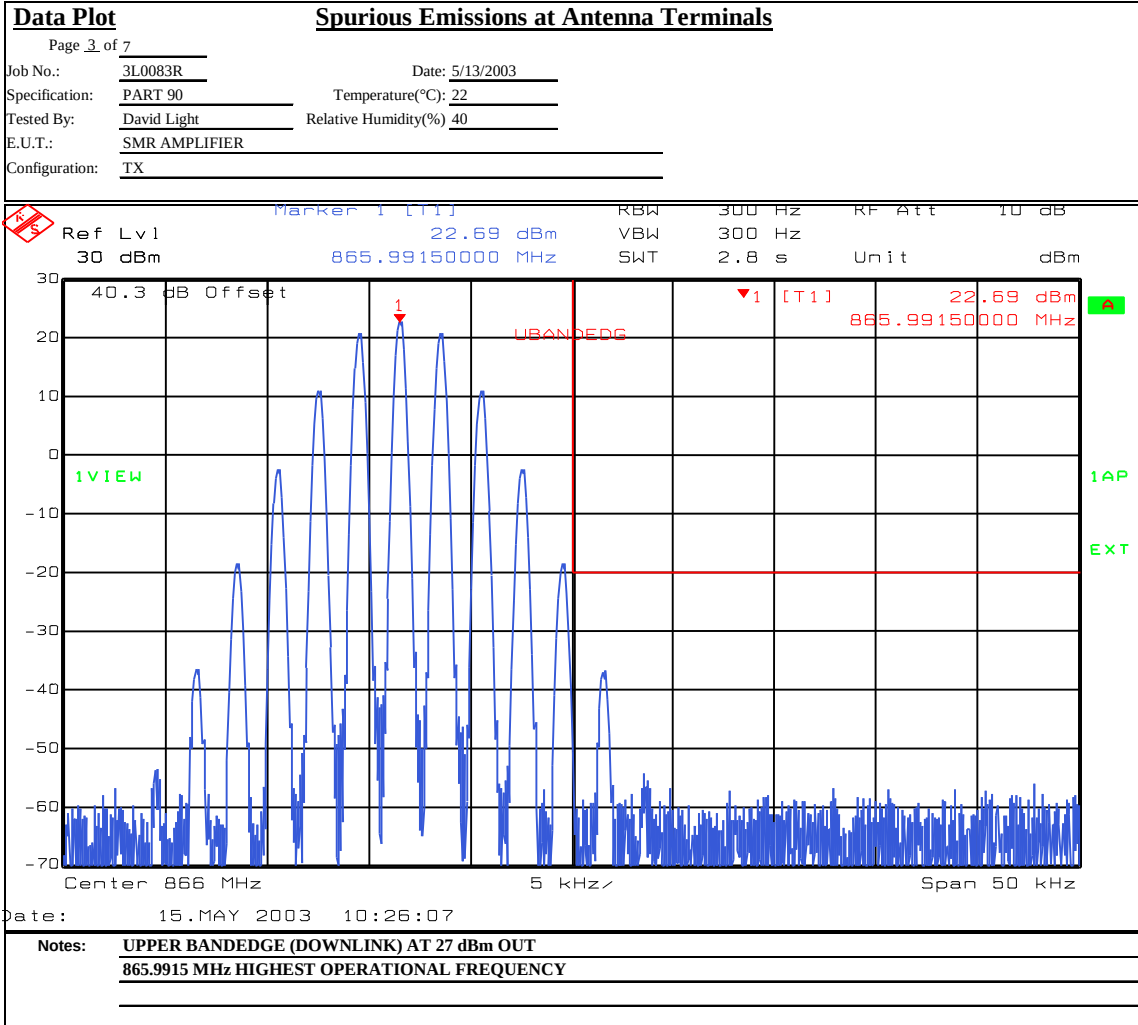
TEST REPORT NO.: 3L0083RUS1

Test Plots – Spurious Emissions at Antenna Terminals



Nemko Dallas, Inc.

Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

Test Plots – Spurious Emissions at Antenna Terminals



Dallas Headquarters:

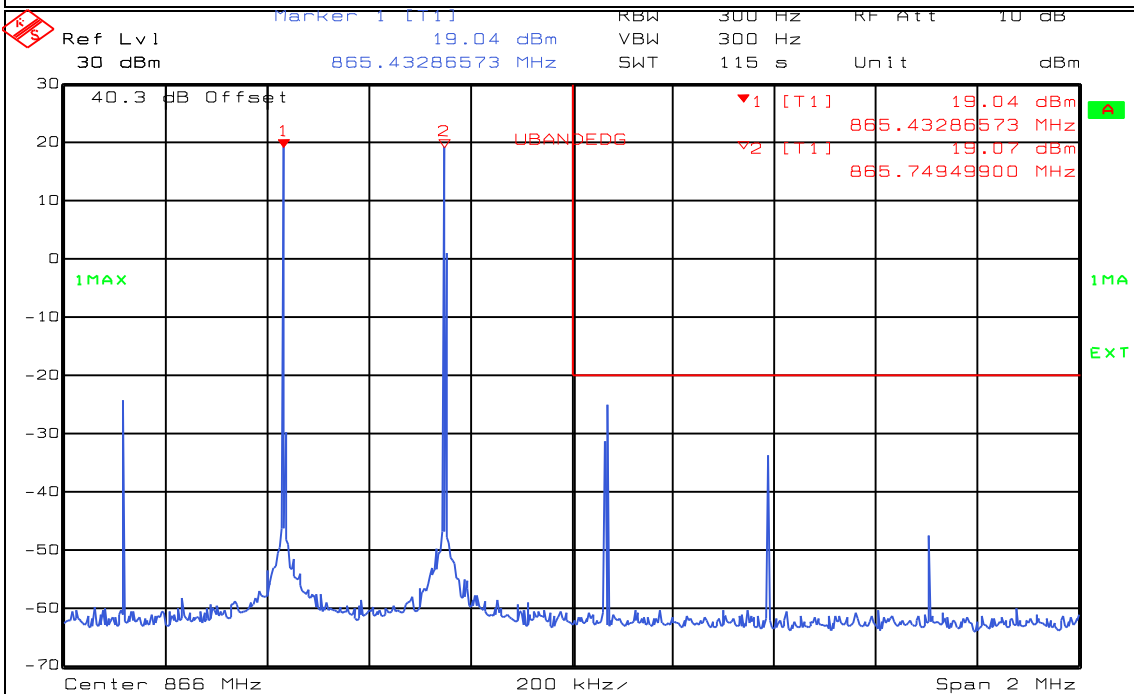
802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.

Test Plot:

Spurious Emissions at Antenna Terminals

Page 4 of 7
Job No.: 3L0083R Date: 5/13/2003
Specification: PART 90 Temperature(°C): 22
Tested By: David Light Relative Humidity(%) 40
E.U.T.: SMR AMPLIFIER
Configuration: TX



Date: 15.MAY 2003 10:33:47

Notes: INTERMODULATION CHARACTERISTICS (DOWNLINK)

18.3 dBm/CARRIER - 21.3 dBm COMPOSITE

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

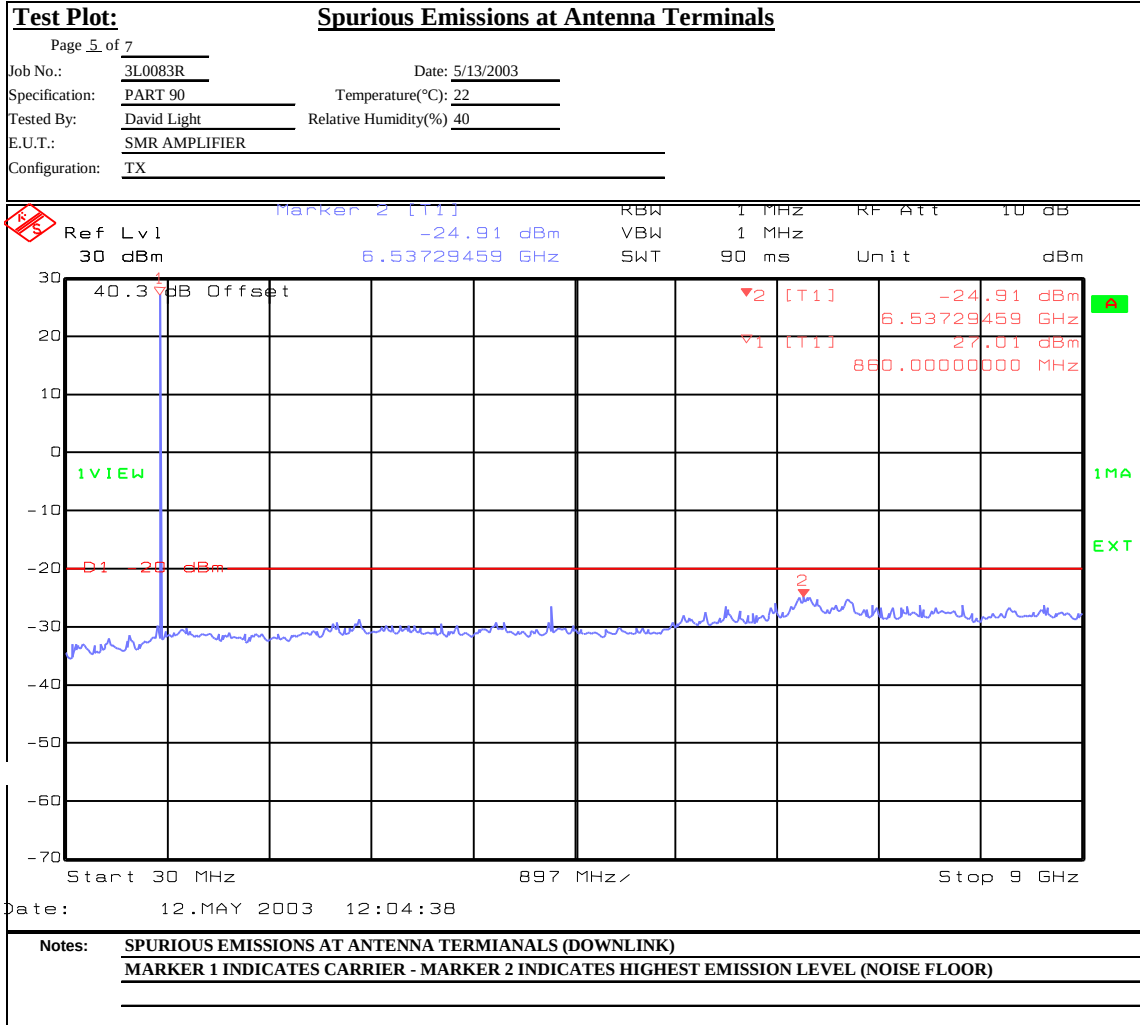
Test Plots – Spurious Emissions at Antenna Terminals



Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

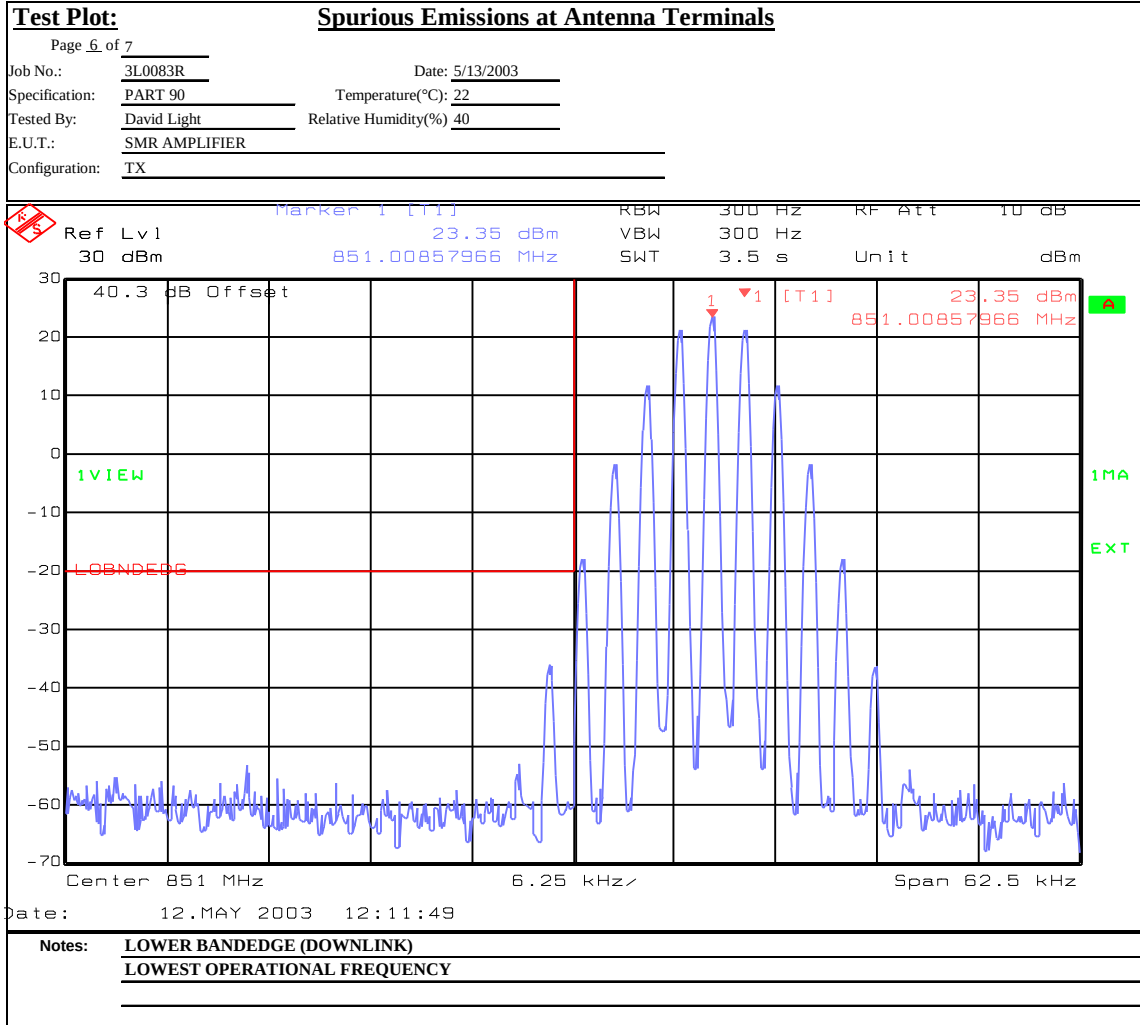
Test Plots – Spurious Emissions at Antenna Terminals



Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

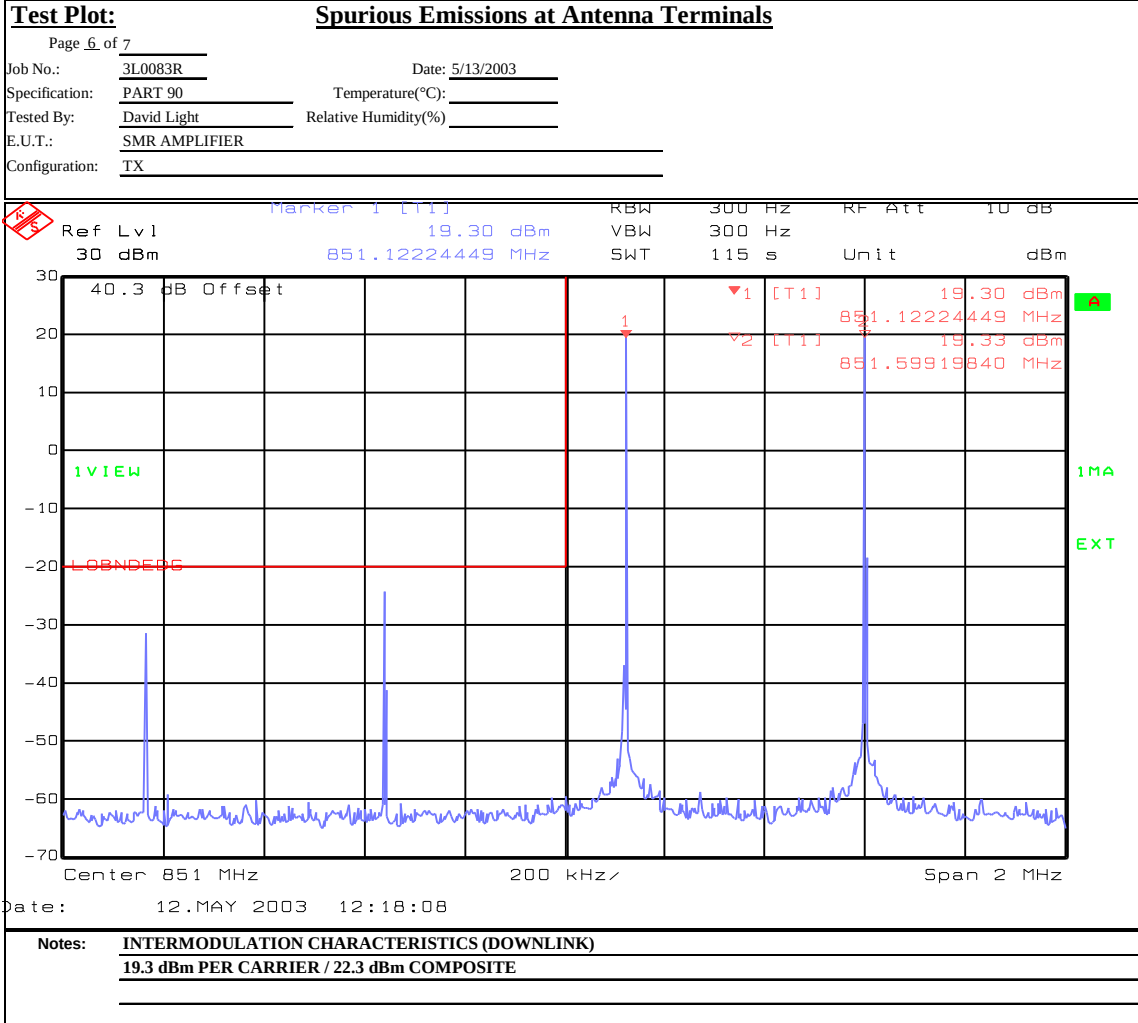
Test Plots – Spurious Emissions at Antenna Terminals



Dallas Headquarters:

802 N. Kealy
Lewisville, TX 75057
Tel: (972) 436-9600
Fax: (972) 436-2667

Nemko Dallas, Inc.



EQUIPMENT: **100-AS**

TEST REPORT NO.: **3L0083RUS1**

Section 6. Field Strength of Spurious Emissions

NAME OF TEST: Field Strength of Spurious Emissions	PARA. NO.: 2.993
TESTED BY: David Light	DATE: 5/15/03

Test Results: Complies.

Test Data: See attached table.

Note: See page A5 for applicable limit.

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

Test Data - Radiated Emissions



Nemko Dallas, Inc.

Dallas Headquarters:

 802 N. Kealy
 Lewisville, TX 75057
 Tel: (972) 436-9600
 Fax: (972) 436-2667

ERP Substitution Method

Page 1 of 1

Job No.: 3L0083R Date: 5/15/03 Complete X
 Preliminary _____

Specification: PART 90 Temperature(°C): 22
 Tested By: Tom Tidwell Relative Humidity(%) 40
 E.U.T.: SMR REPEATER

Configuration: TX
 Sample No: 1
 Location: AC 3 RBW: 1 MHz Measurement
 Detector Type: Peak VBW: 1 MHz Distance: 3 m

Test Equipment Used

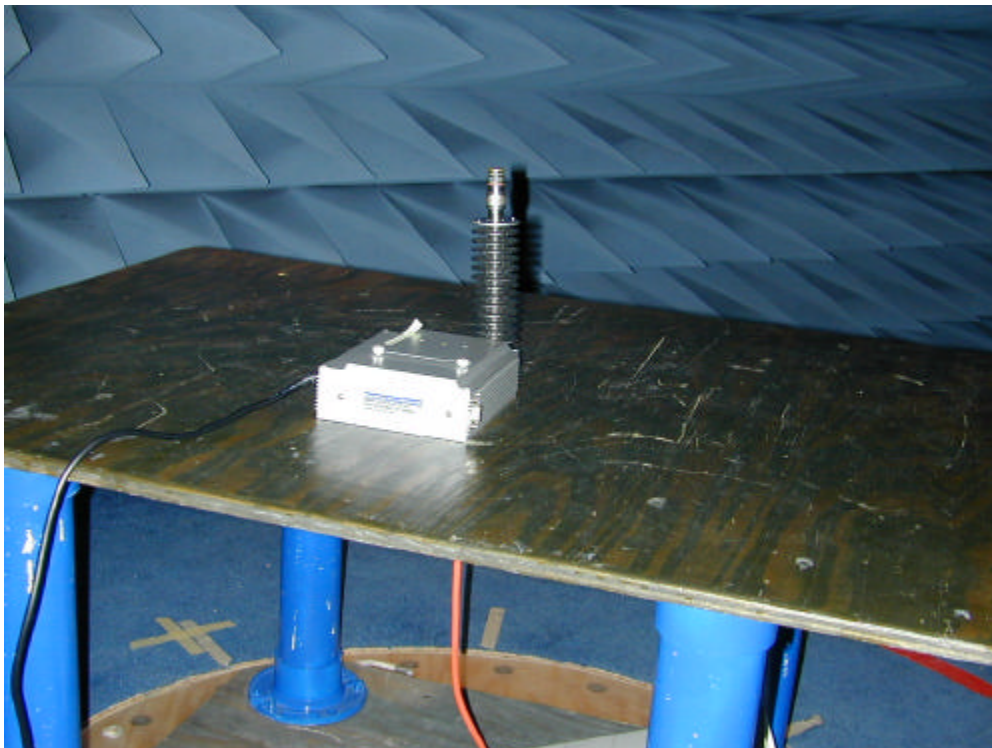
Antenna: 1304 Directional Coupler: _____
 Pre-Amp: 1016 Cable #1: 1484
 Filter: _____ Cable #2: 1485
 Receiver: 1464 Cable #3: _____
 Attenuator #1: _____ Cable #4: _____
 Attenuator #2: _____ Mixer: _____

Additional equipment used: _____
 Measurement Uncertainty: +/-1.7 dB

Frequency (MHz)	Meter Reading (dBm)	Substitution Level (dBm)		Pre-Amp Gain (dB)	Substitution Antenna Gain (dBd)	ERP (dBm)	Limit (dBm)	Margin (dB)	Polarity	Comments
										Downlink @ 860 MHz
1720	-62.2	-64.1		32.9	7.3	-64.1	-20.0	-44.1000	V	Noise floor
8600	-65.0	-53.7		33.5	9.4	-53.7	-20.0	-33.6667	V	Noise floor
1720	-62.2	-62.1		32.9	7.3	-62.1	-20.0	-42.1000	H	Noise floor
8600	-65.0	-56.3		33.5	9.4	-56.3	-20.0	-36.3333	H	Noise floor
										Uplink @ 815 MHz
1630	-62.6	-62.5		32.9	7.3	-62.5	-20.0	-42.5000	H	Noise floor
8150	-66.0	-57.0		33.5	9.1	-57.0	-20.0	-37.0000	H	Noise floor
1630	-62.6	-64.5		32.9	7.3	-64.5	-20.0	-44.5000	V	Noise floor
8150	-66.0	-56.7		33.5	9.1	-56.7	-20.0	-36.6667	V	Noise floor

Notes: No emissions were detected above the noise floor which was at least 20 dB below the specification limit
 Searched spectrum to the 10th harmonic of carrier.

Photographs of Test Setup



EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

Section 7. Test Equipment List

Nemko ID	Description	Manufacturer Model Number	Serial Number	Calibration Date	Calibration Due
1036	SPECTRUM ANALYZER	ROHDE & SCHWARZ FSEK30	830844/006	12/18/01	12/19/03
1064	ATTENUATOR	NARDA 776B-20	NONE	CBU	N/A
1604	ATTENUATOR	NARDA 776B-20	NONE	N/A	N/A
1629	CABLE, 6 ft	MEGAPHASE 10311 1GVT4	N/A	CBU	N/A
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428	02/11/03	02/11/05
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A	07/15/02	07/15/03
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A	07/15/02	07/15/03
1304	HORN ANTENNA	ELECTRO METRICS RGA-60	6151	07/30/01	07/31/03
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159	07/15/02	07/15/03

ANNEX A - TEST METHODOLOGIES

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

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

Nemko Dallas

FCC PART 90, SUBPART I
PRIVATE LAND MOBILE REPEATER

EQUIPMENT: **100-AS**

TEST REPORT NO.: **3L0083RUS1**

NAME OF TEST: Spurious Emissions at Antenna Terminals	PARA. NO.: 2.991
--	-------------------------

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

VBW: $\Rightarrow$ RBW

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

EQUIPMENT: **100-AS**TEST REPORT NO.: **3L0083RUS1**

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

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

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 (1×10^{-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 ≤ 1 GHz:

G = 1.64 (Dipole Gain)

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

R = 3m (Measurement Distance)

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

For emissions > 1 GHz:

G = 1 (Isotropic Gain)

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

R = 3m (Measurement Distance)

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

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

EQUIPMENT: 100-AS

TEST REPORT NO.: 3L0083RUS1

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	-	-	-

Nemko Dallas

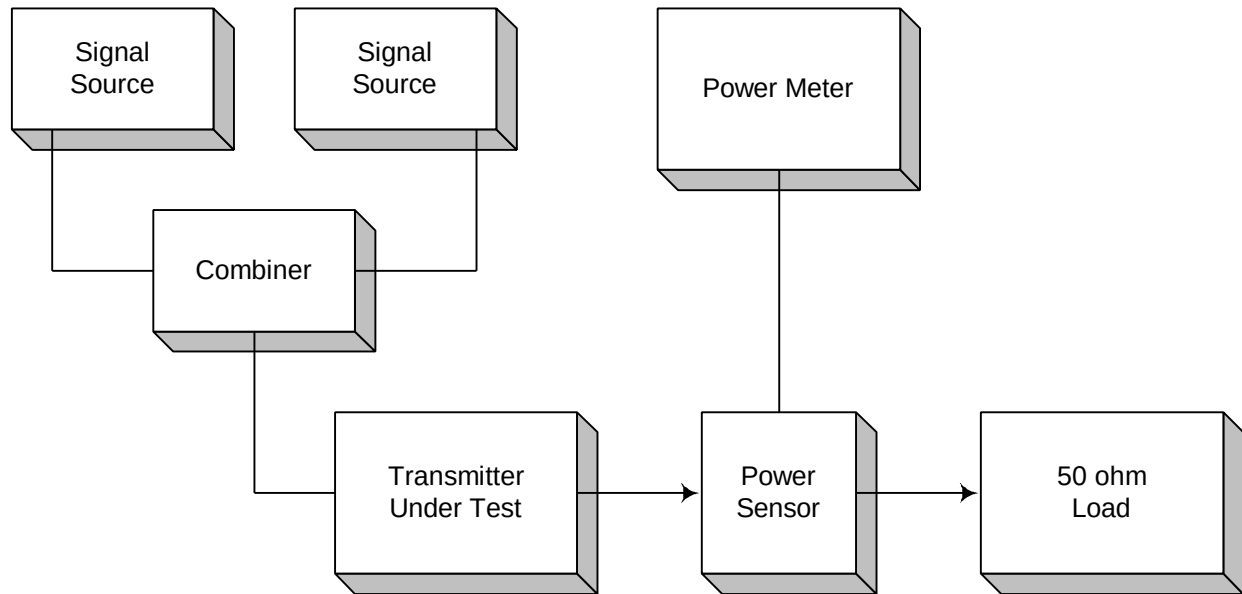
FCC PART 90, SUBPART I
PRIVATE LAND MOBILE REPEATER

EQUIPMENT: **100-AS**

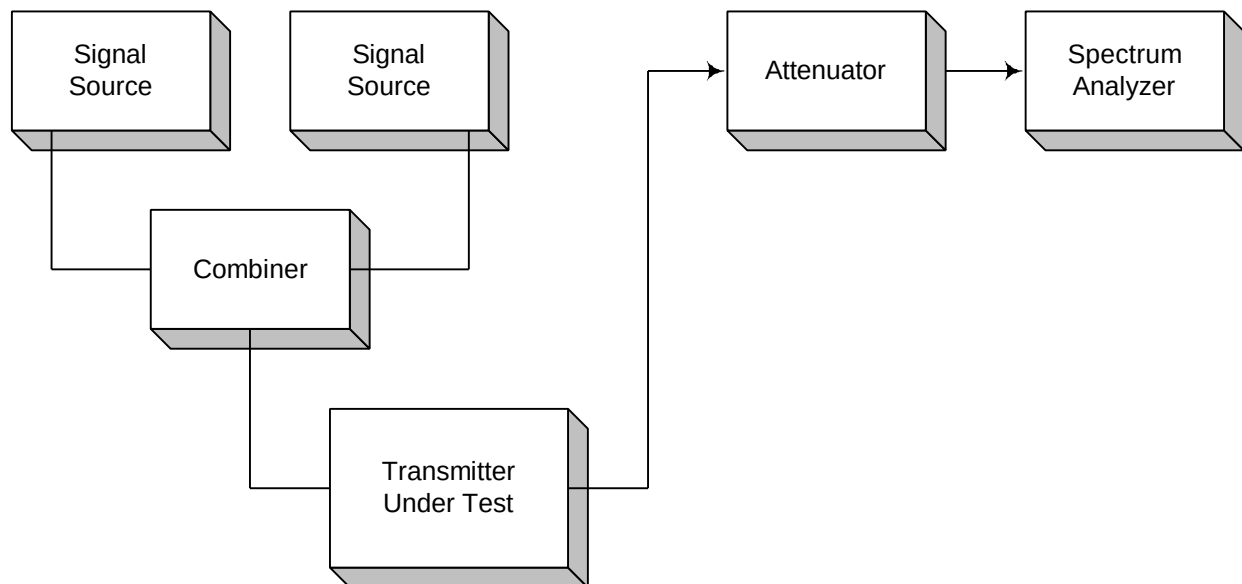
TEST REPORT NO.: **3L0083RUS1**

ANNEX B - TEST DIAGRAMS

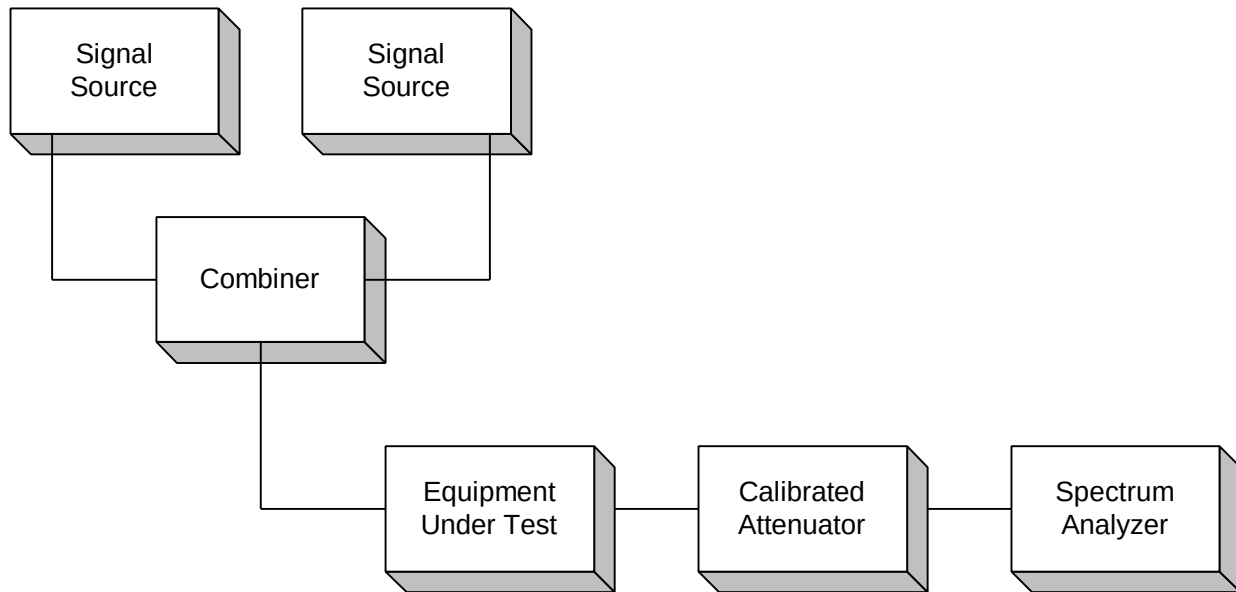
Para. No. 2.985 - R.F. Power Output



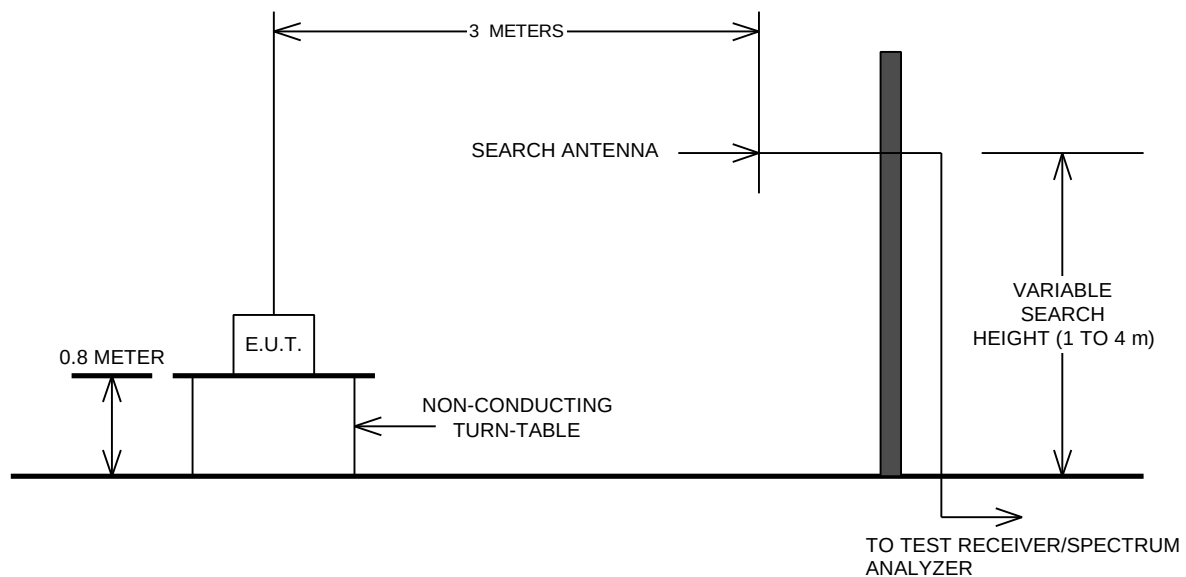
Para. No. 2.989 - Occupied Bandwidth



Para. No. 2.991 - Spurious Emissions at Antenna Terminals



Para. No. 2.993 - Field Strength of Spurious Radiation



EQUIPMENT: **100-AS**

TEST REPORT NO.: **3L0083RUS1**

Para. No. 2.995 - Frequency Stability

