

Nemko Test Report: 2L0630RUS1

Applicant: Matrics, Inc.
8850 Stanford Blvd. Suite 3000
Columbia, Md. 21045

**Equipment Under Test:
(E.U.T.)** Long Range Reader

In Accordance With: **FCC Part 90**

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

Authorized By: 
Tom Tidwell, Frontline Manager

Date: 2/6/03

Total Number of Pages: 27

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EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1**

Section 1. Summary of Test Results

Manufacturer: Matrics, Inc.

Model No.: Long Range Reader

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. None
See “ Summary of Test Data”.

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EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1**

Summary Of Test Data

NAME OF TEST	PARA. NO.	SPEC.	RESULT
RF Power Output	90.205	Determined at licensing	
Audio Frequency Response	TIA EIA-603.3.2.6		N/A
Audio Low-Pass Filter Response	TIA EIA-603.3.2.6		N/A
Modulation Limiting	TIA EIA-603.3.2.6		N/A
Occupied Bandwidth	90.210	Mask K (-25 dBm)	Complies
Spurious Emissions at Antenna Terminals	90.210	Mask K (-25 dBm)	Complies
Field Strength of Spurious Emissions	90.210	Mask K (-25 dBm)	Complies
Frequency Stability	90.213	N/A	N/A
Transient Frequency Behavior	90.214		N/A

Frequency stability test not required per 90.213 note 13: [Fixed non-multilateration transmitters with an authorized bandwidth that is more than 40 kHz from the band edge, intermittently operated hand-held readers, and mobile transponders are not subject to frequency stability restrictions.](#)

EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1**

Section 2. General Equipment Specification

Transmitter

Supply Voltage Input:	24 Vdc										
Frequency Range:	911.85 MHz to 919.85 MHz										
Tunable Bands:	911.85 MHz to 919.85 MHz Frequency hopper										
Necessary Bandwidth:	253 kHz										
Type(s) of Modulation:	<table><thead><tr><th>F3E (Voice)</th><th>F1D</th><th>F2D</th><th>D7W (QAM)</th><th>Other</th></tr></thead><tbody><tr><td>☐</td><td>☒</td><td>☐</td><td>☐</td><td>☐</td></tr></tbody></table>	F3E (Voice)	F1D	F2D	D7W (QAM)	Other	☐	☒	☐	☐	☐
F3E (Voice)	F1D	F2D	D7W (QAM)	Other							
☐	☒	☐	☐	☐							
Emission Designator:	253KF1D										
Output Impedance:	50 ohms										
RF Power Output (rated):	2 Watts										
Channel Spacing(s):	500 kHz										
Operator Selection of Operating Frequency:	None										
Power Output Adjustment Capability:	None										

Modifications Made During Testing

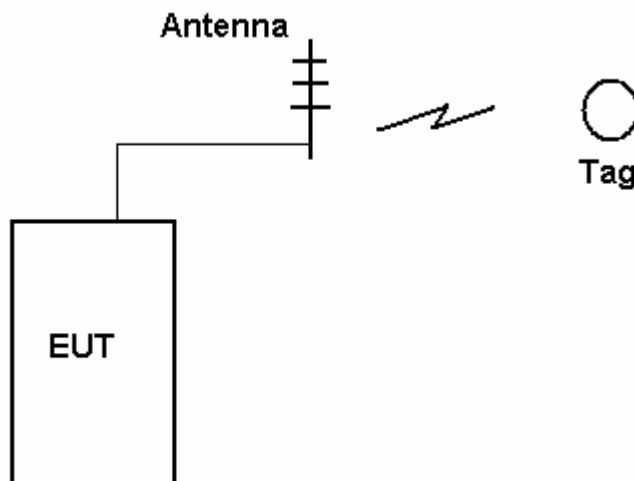
A high pass filter was added to eliminate spurious emissions.

System Description

The **Matrics Long Range Reader** (PN: RDR-090) is an industrial strength fixed Reader targeted to indoor applications, such as warehouses. The Reader offers superior and robust read range capabilities, anti-collision features, and very high data read rates unmatched by other systems. It can be easily mounted in areas of ingress and egress where large numbers of tagged objects are inbound or outbound in a logistics process. It is packaged ready to be interfaced to your host computer, and can easily be programmed to perform specific tasks.

The Reader provides all of the RF and control functions required to power and communicate with Matrics passive RFID tags (PN: SDR-001 and DDS-001.) It sends digital data to the tag (through one antenna at any given time) on a pulse width modulated On Off Keyed (OOK) transmitter signal, demodulates the identification signal received from the tag, and then sends the data to your host computer.

System Diagram



EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1**

Section 3. RF Power Output

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

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

Frequency (MHz)	Measured Power (dBm)	Rated Power (dBm)	Measured/Rated (dB)
915.37	33.5	33	1.02

Note: The input supply voltage was varied +/- 15% with no effect on output power.

Measurement Uncertainty: +/- 1.7 dBm

EQUIPMENT: Long Range Reader

PROJECT NO.: 2L0630RUS1

Test Plot – RF Power Output



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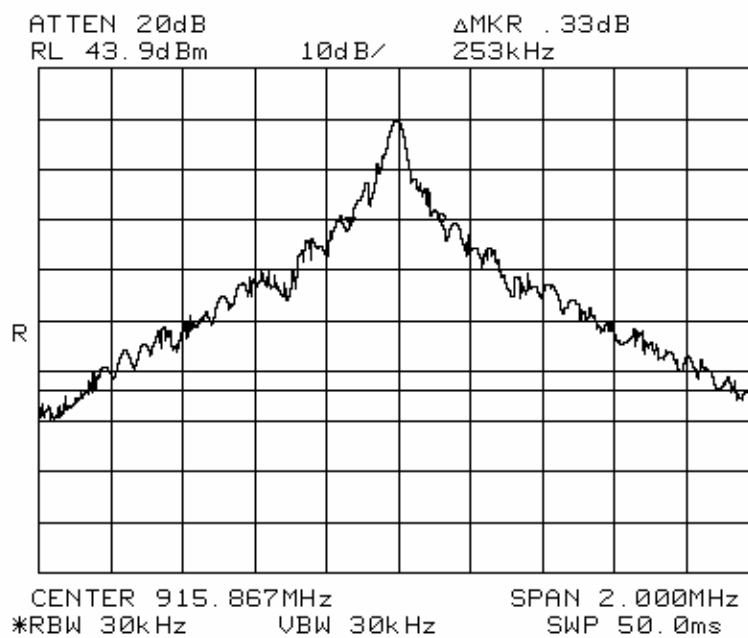
Data Plot		Power Output			
Page <u>1</u> of <u>1</u>				Complete <u>X</u>	
Job No.: 2L0630R	Date: 1/29/2003	Preliminary: _____			
Specification: PART 90	Temperature(°C): 22				
Tested By: David Light	Relative Humidity(%): 25				
E.U.T.: 900 MHz TRANSMITTER					
Configuration: TX CENTER BAND					
Sample Number: 1					
Location: Lab 2	RBW: 100 kHz	Measurement			
Detector Type: Peak	VBW: 100 kHz	Distance: <u>NA</u> m			
Test Equipment Used					
Antenna: _____	Directional Coupler: _____				
Pre-Amp: _____	Cable #1: 1628				
Filter: _____	Cable #2: _____				
Receiver: 1464	Cable #3: _____				
Attenuator #1: 1064	Cable #4: _____				
Attenuator #2: 1604	Mixer: _____				
Additional equipment used: _____					
Measurement Uncertainty: +/-1.7 dB					
ATTEN 10dB MKR 33.50dBm RL 40.00dBm 915.362MHz 10dB/ CENTER 915.370MHz SPAN 5.000MHz *RBW 100kHz VBW 100kHz SWP 50.0ms					
Notes: Input power varied +/- 15% - No effect on output power					

EQUIPMENT: Long Range Reader

PROJECT NO.: 2L0630RUS1

Section 4. Occupied Bandwidth

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

Measurement Results: Complies.**Measurement Data:** See attached data**Test Equipment Used:** 1464

EQUIPMENT: **Long Range Reader**

PROJECT NO.: **2L0630RUS1**

Section 5. Spurious Emissions at Antenna Terminals

NAME OF TEST: Spurious Emissions @ Antenna Terminals	PARA. NO.: 2.991
TESTED BY: David Light	DATE: 1/17/2003

Measurement Results: Complies.

Measurement Data: See attached data

EQUIPMENT: Long Range Reader

PROJECT NO.: 2L0630RUS1

Test Plots – Spurious Emissions



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Data Plot		Bandedges	
Page <u>1</u> of 2		Complete <u>X</u>	
Job No.: 2L0630	Date: <u>1/7/2003</u>	Preliminary: _____	
Specification: 90.210(k)(3)	Temperature(°C): <u>22</u>	Measurement Distance: <u>NA</u> m	
Tested By: David Light	Relative Humidity(%): <u>40</u>		
E.U.T.: 900 MHz transmitter			
Configuration: Tx modulated signal - full power			
Sample Number: <u>1</u>		RBW: Refer to plots VBW: Refer to plots	
Location: <u>Lab 2</u>			
Detector Type: <u>Peak</u>			
Test Equipment Used			
Antenna: _____	Directional Coupler: _____		
Pre-Amp: _____	Cable #1: <u>1045</u>		
Filter: _____	Cable #2: _____		
Receiver: <u>1464</u>	Cable #3: _____		
Attenuator #1: <u>1474</u>	Cable #4: _____		
Attenuator #2: <u>1472</u>	Mixer: _____		
Additional equipment used: _____			
Measurement Uncertainty: <u>+/-1.7 dB</u>			

ATTEN 10dB MKR 35.00dBm
RL 41.0dBm 10dB/ 919.85MHz

MKR 919.85 MHz
35.00 dBm

R

CENTER 921.75MHz SPAN 10.00MHz
*RBW 100kHz VBW 100kHz SWP 50.0ms

Notes:	Upper band edge
	Highest operating frequency 919.87 MHz

EQUIPMENT: Long Range Reader

PROJECT NO.: 2L0630RUS1

Test Plots – Spurious Emissions



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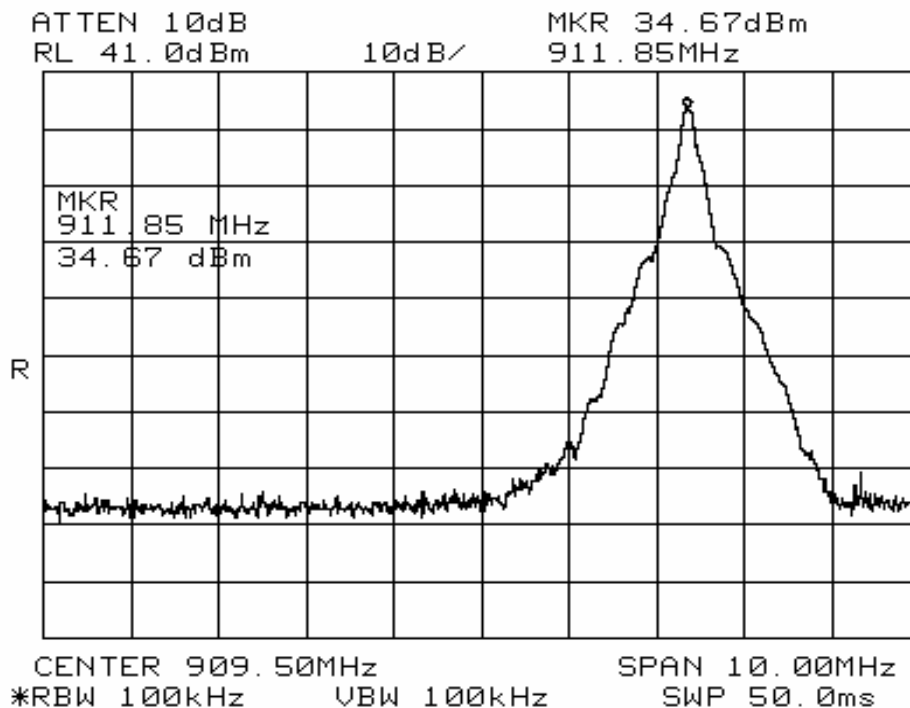
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Data Plot

Page 2 of 2

Job No.:	2L0630	Date:	1/7/2003
Specification:	90.210(k)(3)	Temperature(°C):	22
Tested By:	David Light	Relative Humidity(%)	40
E.U.T.:	900 MHz transmitter		
Configuration:	Tx modulated signal - full power		

Bandedges



Notes: Lower Band edge
Lowest operating frequency 911.87 MHz

EQUIPMENT: Long Range Reader

PROJECT NO.: 2L0630RUS1

Test Plots – Spurious Emissions

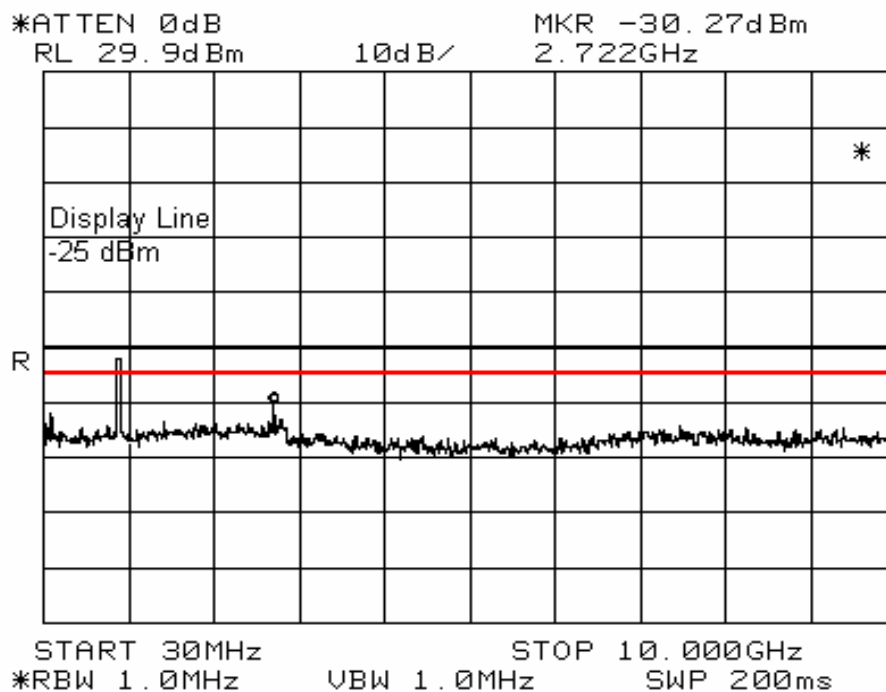


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Data Plot		Spurious Emissions at Antenna Terminals	
Page 1 of 1		Complete	_____
Job No.: 210390r	Date: 1/30/2003	Preliminary:	_____
Specification: pt90	Temperature(°C): 22		
Tested By: David Light	Relative Humidity(%): 40		
E.U.T.: 900 MHz transmitter			
Configuration: Tx full power			
Sample Number: 1			
Location: Lab 2	RBW: 100 kHz	Measurement	
Detector Type: Peak	VBW: 100 kHz	Distance: na	m
Test Equipment Used			
Antenna: _____	Directional Coupler: _____		
Pre-Amp: _____	Cable #1: 1083		
Filter: 1601	Cable #2: _____		
Receiver: 1464	Cable #3: _____		
Attenuator #1: _____	Cable #4: _____		
Attenuator #2: _____	Mixer: _____		
Additional equipment used: _____			
Measurement Uncertainty: +/-1.7 dB			



Notes: Marker indicates highest emission
Carrier notched

EQUIPMENT: **Long Range Reader**

PROJECT NO.: **2L0630RUS1**

Section 6. Field Strength of Spurious Emissions

NAME OF TEST: Field Strength of Spurious Emissions	PARA. NO.: 2.993
TESTED BY: David Light	DATE: 1/30/03

Measurement Results: Complies.

Measurement Data: See attached data

EQUIPMENT: Long Range Reader

PROJECT NO.: 2L0630RUS1

Test Data - Radiated Emissions



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ERP Substitution Method

Page 1 of 1

Job No.: 2L0630R Date: 1/29/2003 Complete X
Preliminary _____

Specification: PART 90 Temperature(°C): 22
Tested By: David Light Relative Humidity(%) 25
E.U.T.: TAG READER

Configuration: TX AT CENTER BAND - FULL POWER - LYING FLAT (WORST CASE)

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
1831	-47.5	-47.4		32.9	7.3	-47.4	-20.0	-27.4000	H	
2746.11	-60.6	-58.2		33.1	8.0	-58.2	-20.0	-38.2000	H	
3661.48	-67.3	-64.5		32.7	8.6	-64.5	-20.0	-44.5000	H	
4576.85	-68.3	-66.2		33.4	8.7	-66.2	-20.0	-46.2000	H	
5492.22	-71.0	-65.7		33	8.2	-65.7	-20.0	-45.6667	H	
6407.59	-72.6	-65.4		31.5	9.6	-65.4	-20.0	-45.4333	H	
7322.96	-74.0	-66.6		32.9	8.8	-66.6	-20.0	-46.5667	H	
8238.33	-73.0	-63.4		32.9	9.1	-63.4	-20.0	-43.4000	H	
9153.7	-72.0	-63.7		34	9.6	-63.7	-20.0	-43.6667	H	
1830.74	-53.8	-55.7		32.9	7.3	-55.7	-20.0	-35.7000	V	
2746.11	-58.6	-56.2		33.1	8.0	-56.2	-20.0	-36.2000	V	
3661.48	-57.7	-47.1		32.7	8.6	-47.1	-20.0	-27.0667	V	
4576.85	-66.5	-55.9		33.4	8.7	-55.9	-20.0	-35.9000	V	
5492.22	-70.0	-61.7		33	8.2	-61.7	-20.0	-41.6667	V	
6407.59	-70.0	-61.0		31.5	9.6	-61.0	-20.0	-41.0000	V	
7322.96	-71.8	-63.9		32.9	8.8	-63.9	-20.0	-43.8667	V	
8238.33	-72.5	-62.6		32.9	9.1	-62.6	-20.0	-42.5667	V	
9153.7	-72.0	-64.7		34	9.6	-64.7	-20.0	-44.6667	V	

Notes: Searched spectrum 30 MHz to 10 GHz

EQUIPMENT: **Long Range Reader**

PROJECT NO.: **2L0630RUS1**

Photographs of Test Setup



EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1****Section 7. Test Equipment List**

Nemko ID	Description	Manufacturer Model Number	Serial Number
1464	Spectrum analyzer	Hewlett Packard 8563E	3551A04428
1484	Cable 2.0-18.0 Ghz	Storm PR90-010-072	N/A
1485	Cable 2.0-18.0 Ghz	Storm PR90-010-216	N/A
1304	HORN ANTENNA	ELECTRO METRICS RGA-60	6151
1016	Pre-Amp	HEWLETT PACKARD 8449A	2749A00159
1474	20db Attenuator DC 18 Ghz	MCL Inc. BW-S20W2	NONE
1472	20db Attenuator DC 18 Ghz	Omni Spectra 20600-20db	NONE
1064	ATTENUATOR	NARDA 776B-20	NONE
1604	ATTENUATOR	NARDA 776B-20	NONE

ANNEX A - TEST METHODOLOGIES

EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1**

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

EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1**

NAME OF TEST: Audio Frequency Response**PARA. NO.: 2.987(a)****Test Method:** TIA/EIA-603**Minimum Standard:** TIA/EIA-603, Para. 3.2.6 from 300 Hz to 3000 Hz. The transmitter audio frequency response shall have a nominal 6 dB per octave pre-emphasis characteristic.**NAME OF TEST: Audio Low-Pass Filter Frequency Response****PARA. NO.: 2.987(a)****Test Method:** TIA/EIA-603**Minimum Standard:** TIA/EIA-603**NAME OF TEST: Modulation Limiting****PARA. NO.: 2.987(a)****Test Method:** TIA/EIA-603**Minimum Standard:** TIA/EIA-603

EQUIPMENT: **Long Range Reader**PROJECT NO.: **2L0630RUS1****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: **Long Range Reader**PROJECT NO.: **2L0630RUS1**

NAME OF TEST: Field Strength of Spurious	PARA. NO.: 2.993
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Test Method: TIA/EIA-603-1992, Section 2.2.12

The antenna substitution method was used to determine the equivalent radiated power at spurious frequencies. The spurious emissions were measured at a distance of 3 meters. The EUT was then replaced with a reference substitution antenna with a known gain referenced to a dipole. This antenna was fed with a signal at the spurious frequency. The level of the signal was adjusted to repeat the previously measured level. The resulting erp is the signal level fed to the reference antenna corrected for gain referenced to a dipole.

EQUIPMENT: Long Range Reader

PROJECT NO.: 2L0630RUS1

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**

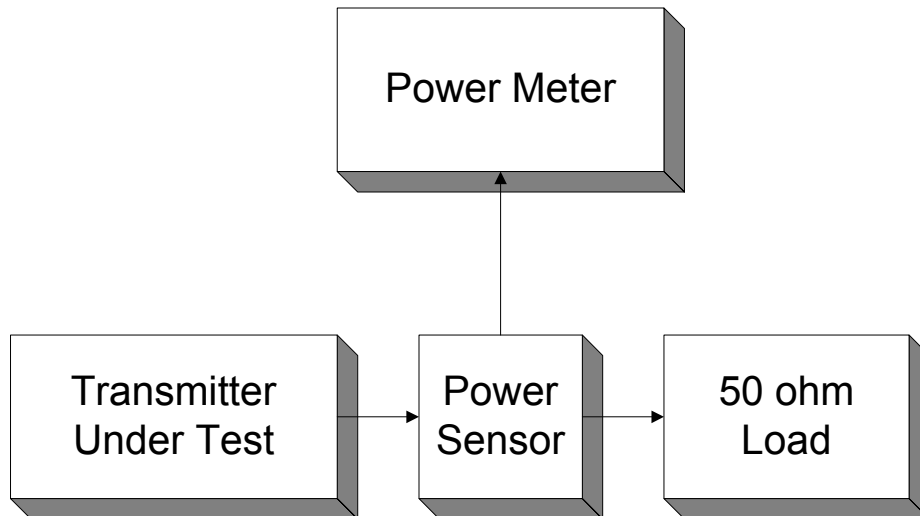
	Maximum	Frequency ranges (MHz) All equipment					
		Base station and portable radios			Mobile Radios		
Time intervals ^{1,2}	Frequency difference ³ (kHz)	150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)	150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)
t ₁ ⁴	± 25	5.0	10.0	20.0	5.0	10.0	5.0
t ₂	± 12	20.0	25.0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

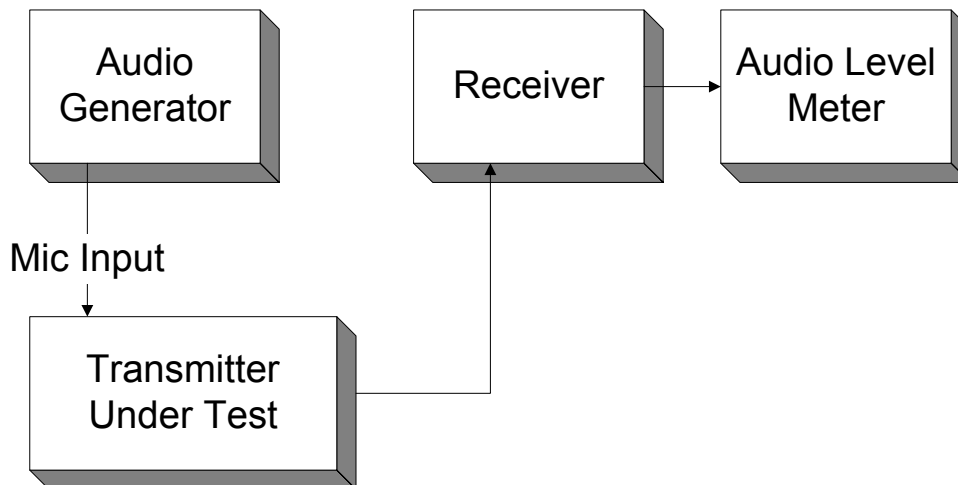
	Maximum	Frequency ranges (MHz) All equipment		
		150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)
Time intervals ^{1,2}	Frequency difference ³ (kHz)			
t ₁ ⁴	± 12.5 / ± 6.25	5.0	10.0	20.0
t ₂	± 6.25 / ± 3.125	20.0	25.0	50.0
t ₃ ⁴	± 12.5 / ± 6.25	5.0	10.0	10.0

ANNEX B - TEST DIAGRAMS

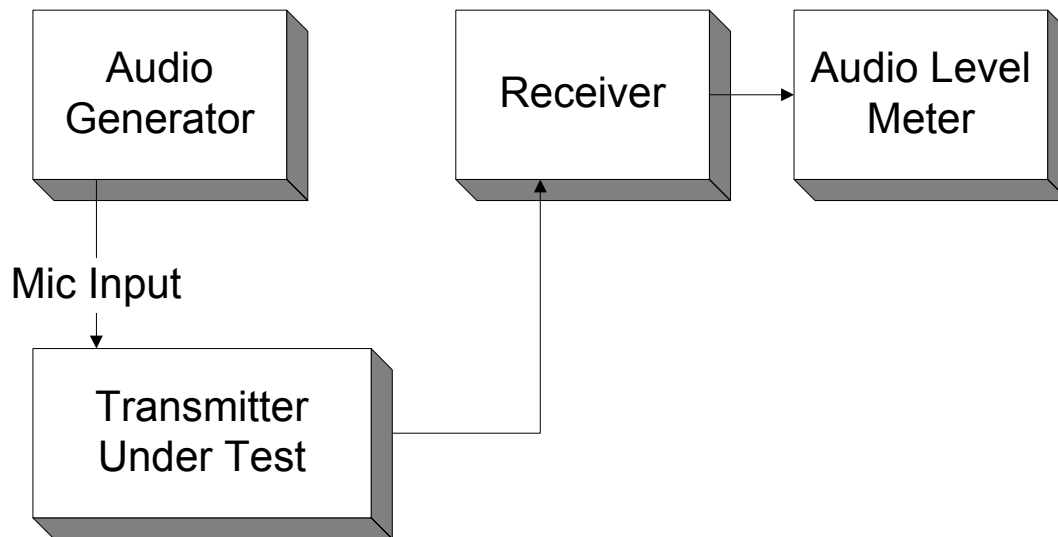
Para. No. 2.985 - R.F. Power Output



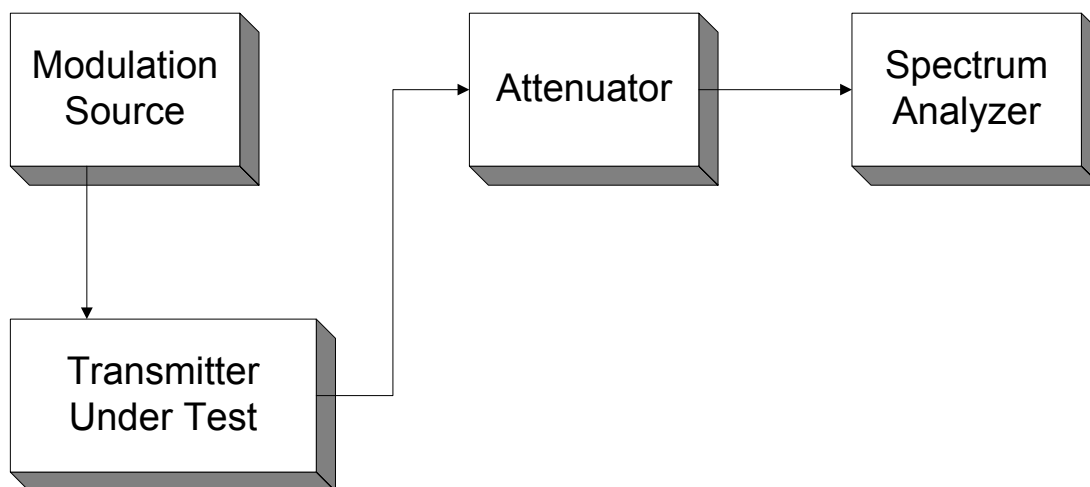
Para. No. 2.987(a) - Audio Frequency Response



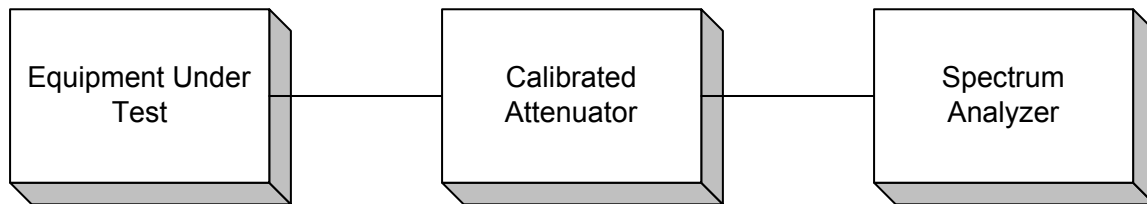
Para. No. 2.987(b) - Modulation Limiting



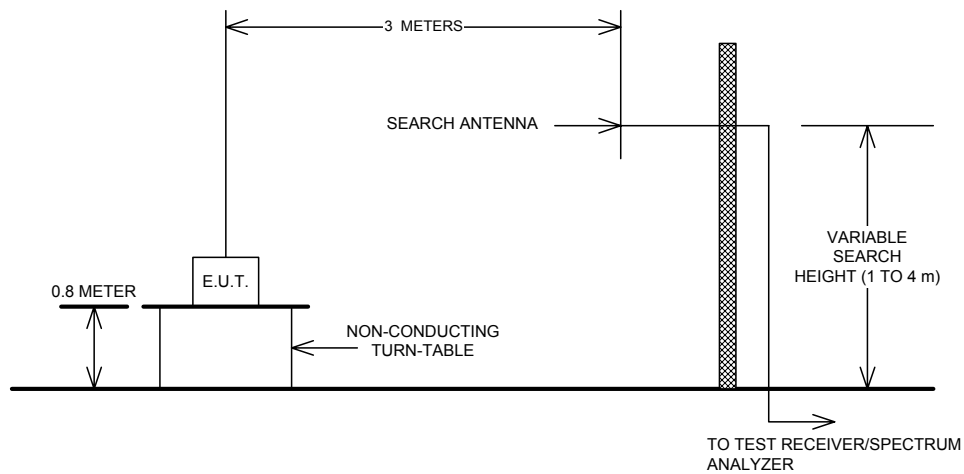
Para. No. 2.989 - Occupied Bandwidth



Para. No. 2.991 - Spurious Emissions at Antenna Terminals



Para. No. 2.993 - Field Strength of Spurious Radiation



Para. No. 2.995 - Frequency Stability

