Nemko Test Report:	2014 267003 FCC PT90
Applicant:	The Charles Machine Works, Inc. 1959 W. Fir Ave Perry, OK 73077 USA
Equipment Under Test: (E.U.T.)	TR21-464-5-12.5K Transceiver
FCC Identifier:	ITQ-TR21
In Accordance With:	**CFR 47 Part 90, Subpart I** Private Land Mobile Radio Services
Tested By:	Nemko USA Inc. 2210 Faraday Ave. Ste 150 Carlsbad, CA 92008

TESTED BY: _____ DATE: 30 October 2014

David Light, Wireless Engineer

APPROVED BY: _____ DATE: 30 October 2014

Bruce Ketterling, EMC Manager

Total Number of Pages: 30

Table of Contents

Section 1. Summary of Test Results

Manufacturer: The Charles Machine Works, Inc.

Model No.: TR21-464-5-12.5K Transceiver

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 CFR 47 Part 90, Subpart .

☒ New Submission ☒ Production Unit

☐ Modification Filing ☐ 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".

NVLAP Lab Code 200116-0

Summary of Test Data

NAME OF TEST	PARA. NO.	RESULT
RF Power Output	90.205	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	NA
Occupied Bandwidth	90.210	NA
Spurious Emissions at Antenna Terminals	90.210	NA
Radiated Spurious Emissions	90.210	NA
Frequency Stability	90.213	NA
Transient Frequency Behavior	90.214	NA
Exemption from Technical Standards	90.217	Complies

Footnotes:

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Section 2. General Equipment Specification

Supply Voltage Input:	3 Vdc
Tunable Bands:	466.0375 to 466.3625 MHz (USA)

Type(s) of Modulation:

F3E (Voice)	F1D	F2D	D7W (QAM)	Other
☐	☒	☐	☐	☐

Emission Designator:	6K20F1D
Necessary BW:	(2 x 2.5 kHz dev). + 2 x (1200bps/2) = 6.20 kHz
Output Impedance:	50 ohms
RF Power Output (rated):	100 mW
Channel Spacing(s):	12.5 kHz
Operator Selection of Operating Frequency:	Dependent on receiver. Frequency selections are pre-programmed and user may only select from pre-programmed channels.
Power Output Adjustment Capability:	None

System Description

Narrow Band FM Multi-channel UHF Transceiver

Section 3. RF Power Output

NAME OF TEST: RF Power Output	PARA. NO.: 90.205
TESTED BY: David Light	DATE: 18 August 2014

Measurement Results: Complies.

Measurement Data:

Frequency (MHz)	Measured Power (dBm)	Measured Power (mW)	Limit (mW)
466.0375	20.37	109	120

Spectrum Analyzer Settings:

RBW: 1 MHz
VBW: 1 MHz
Detector: Max Peak

Measurement Conditions:

Temperature: 22 °C
Humidity: 30 %

Test Equipment Used: 1036

Measurement Uncertainty: +/- 1.7 dB

Section 4. Spurious Emissions at Antenna Terminals

NAME OF TEST: Spurious Emissions @ Antenna	PARA. NO.: 90.210
TESTED BY: David Light	DATE: 18 August 2014

Measurement Results: Complies.

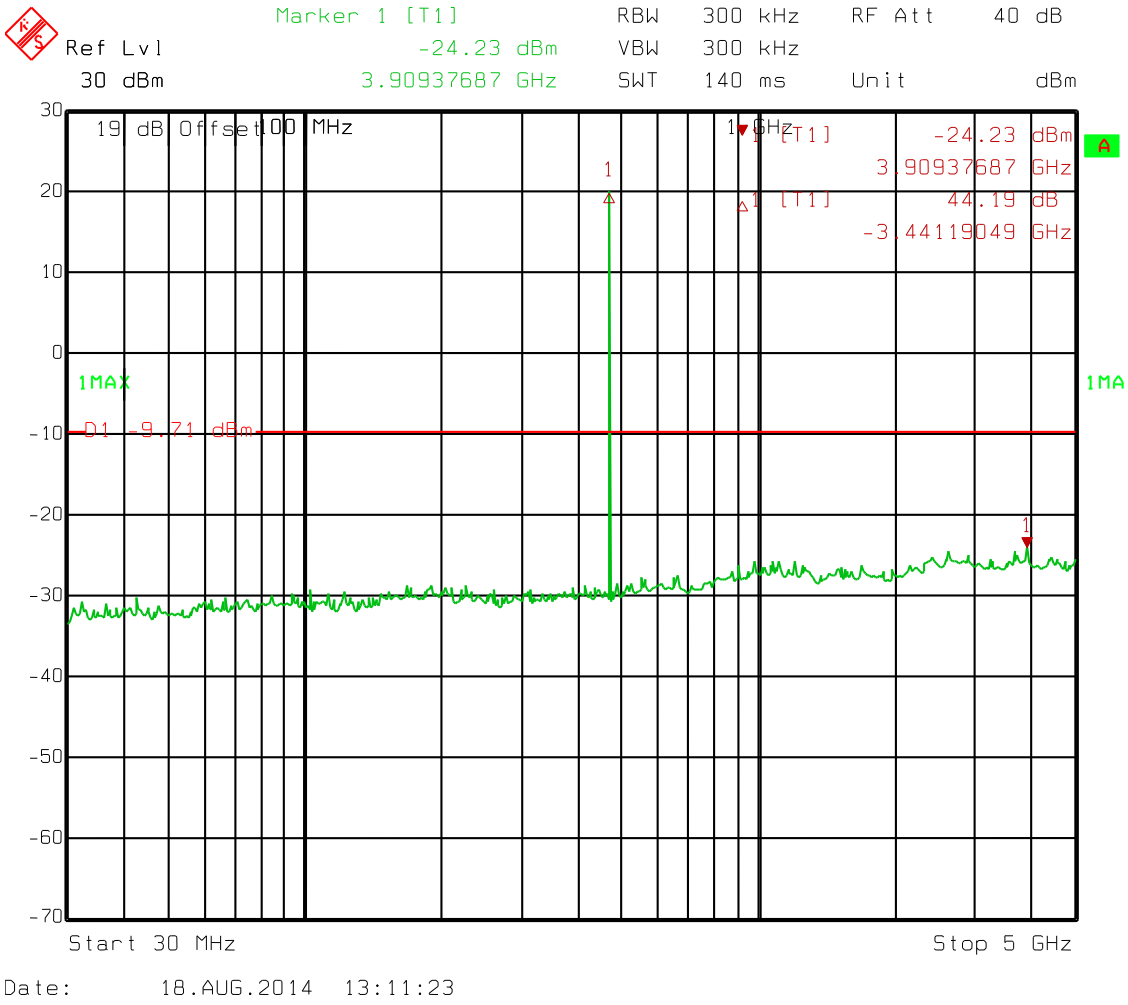
Measurement Data: See attached data

Measurement Conditions: Temperature: 22 °C
Humidity: 30 %

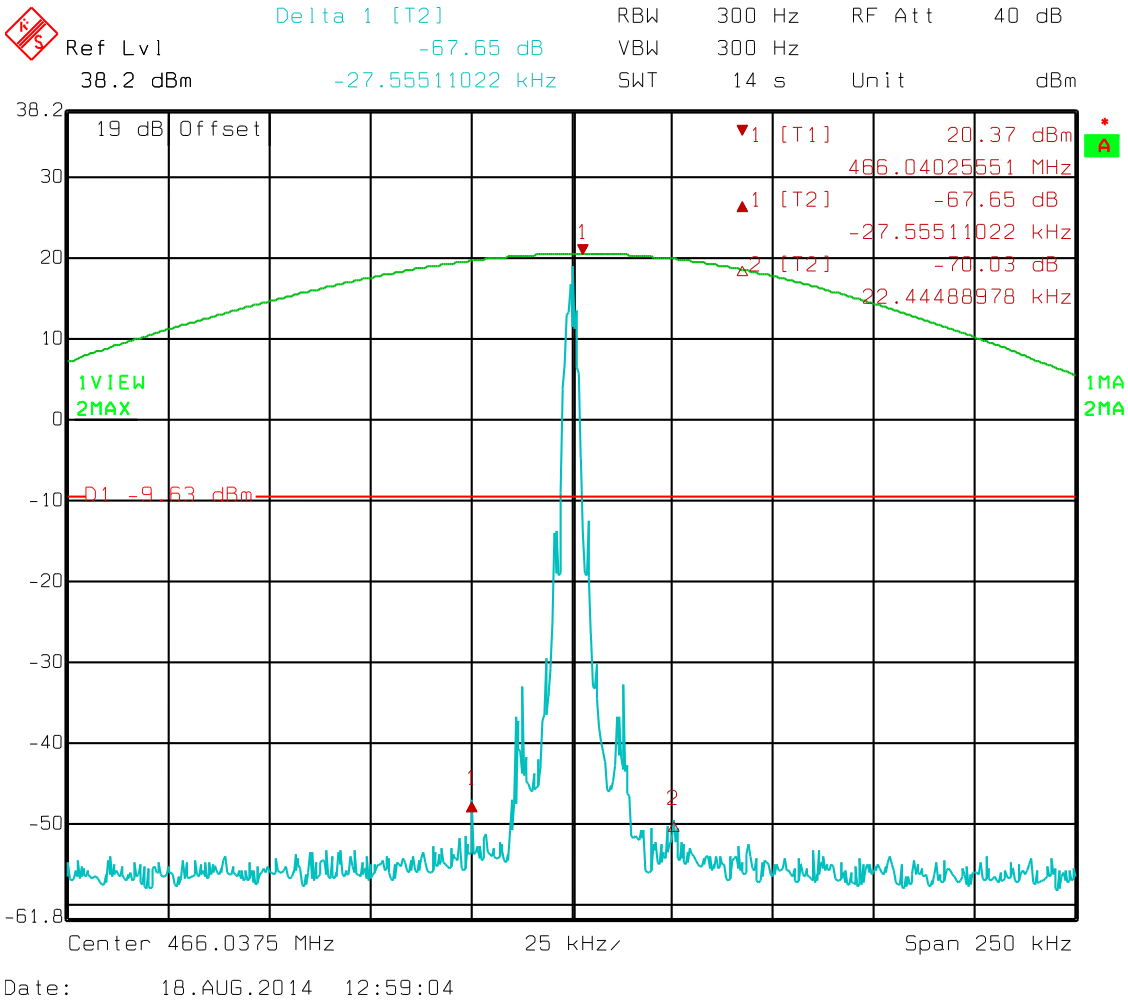
Measurement Uncertainty: +/- 1.7 dB

Test Equipment Used: 1036

Test Data – Spurious Emissions at Antenna Terminals



Test Data – Spurious Emissions at Antenna Terminals



Section 5. Field Strength of Spurious Emissions

NAME OF TEST: Field Strength of Spurious Emissions	PARA. NO.: 90.210
TESTED BY: David Light	DATE: 18 August 2014

Test Results: Complies.

Test Data: There were no emissions detected above the noise floor which was at least 20 dB below the specification limit. The spectrum was searched from 30 MHz to 5 GHz.

Equipment Used: 1480-1036-529-1016-901

Measurement Uncertainty: +/-1.7 dB

Temperature: 22 °C

Relative Humidity: 35 %

Note: See page A5 for applicable limit.

Section 6. Test Equipment List

Asset Tag	Description	Manufacturer	Model	Serial #	Last Cal	Next Cal
529	Antenna, DRWG	EMCO	3115	2505	31-Oct-2012	31-Oct-2014
901	Preamplifier	Sonoma	310 N	130607	21-Nov-2013	21-Nov-2014
1016	Preamplifier	Hewlett Packard	8449A	2749A00159	20-Aug-2013	20-Aug-2014
1036	Spectrum Analyzer	Rohde & Schwartz	FSEK30	830844/006	15-Jul-2013	15-Jul-2015
1480	Antenna, Bilog	Schaffner-Chase	CBL6111C	2572	02-Apr-2014	02-Apr-2015

ANNEX A - TEST METHODOLOGIES

NAME OF TEST: RF Power Output PARA. NO.: 90.205 / 5.4

Minimum Standard: Typical transmitter output powers are 110 watts for base and/or fixed stations (paging transmitters excepted), and 30 watts for mobiles stations. Higher powers may be certified, but it should be noted that mobile stations are normally only licensed up to 30 watts.

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

NAME OF TEST: Occupied Bandwidth PARA. NO.: 90.210 / 5.8

Minimum Standard: 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: 100 Hz
VBW: $\Rightarrow$ RBW

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

NAME OF TEST: Frequency Stability PARA. NO.: 90.213 / 5.3

Minimum Standard: 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.: 90.214 / 5.9

Minimum Standard:

Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels

		Frequency ranges (MHz) All equipment					
	Maximum	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 Behavior for Equipment Designed to Operate on 12.5 kHz & 6.25 kHz Channels

	Maximum	Frequency ranges (MHz) All equipment		
Time intervals [1,2]	Frequency difference[3] (kHz)	150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)
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

NAME OF TEST: Exemption from Technical Standards PARA. NO.: 90.217

Minimum Standard:

Except as noted herein, transmitters used at stations licensed below 800 MHz on any frequency listed in subparts B and C of this part or licensed on a business category channel above 800 MHz which have an output power not exceeding 120 milliwatts are exempt from the technical requirements set out in this subpart, but must instead comply with the following:

(a) For equipment designed to operate with a 25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 40 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

(b) For equipment designed to operate with a 12.5 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 25 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

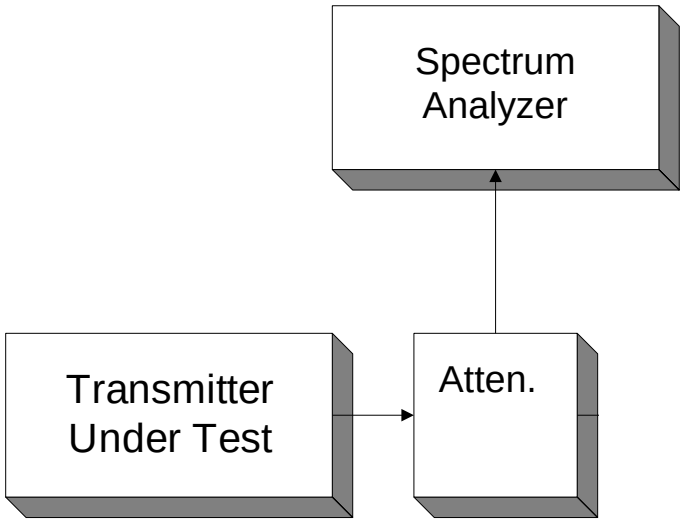
(c) For equipment designed to operate with a 6.25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 12.5 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

(d) Transmitters may be operated in the continuous carrier transmit mode.

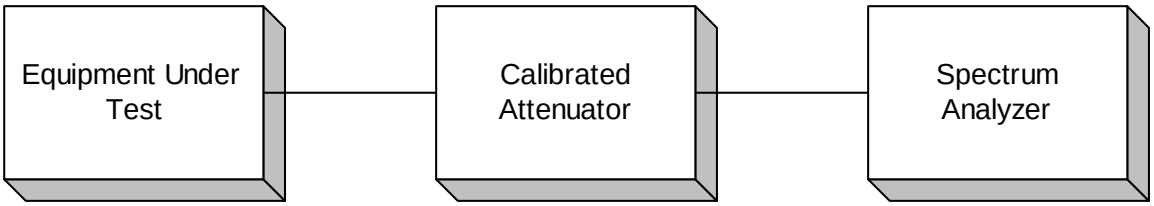
(e) Transmitters used for wireless microphone operations and operating on frequencies allocated for Federal use must comply with the requirements of §90.265(b).

ANNEX B - TEST DIAGRAMS

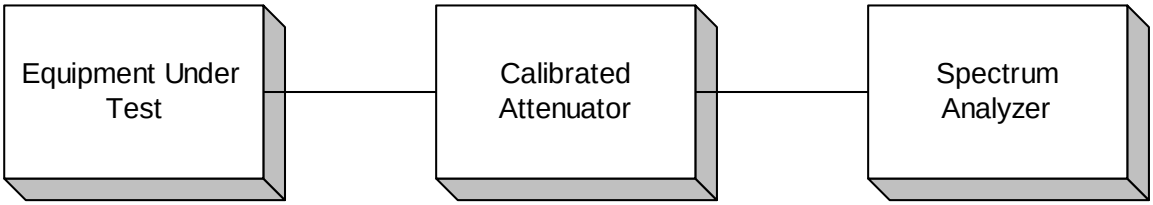
R.F. Power Output



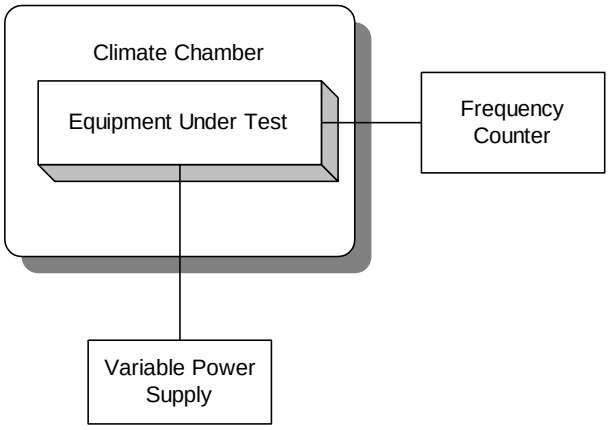
Occupied Bandwidth



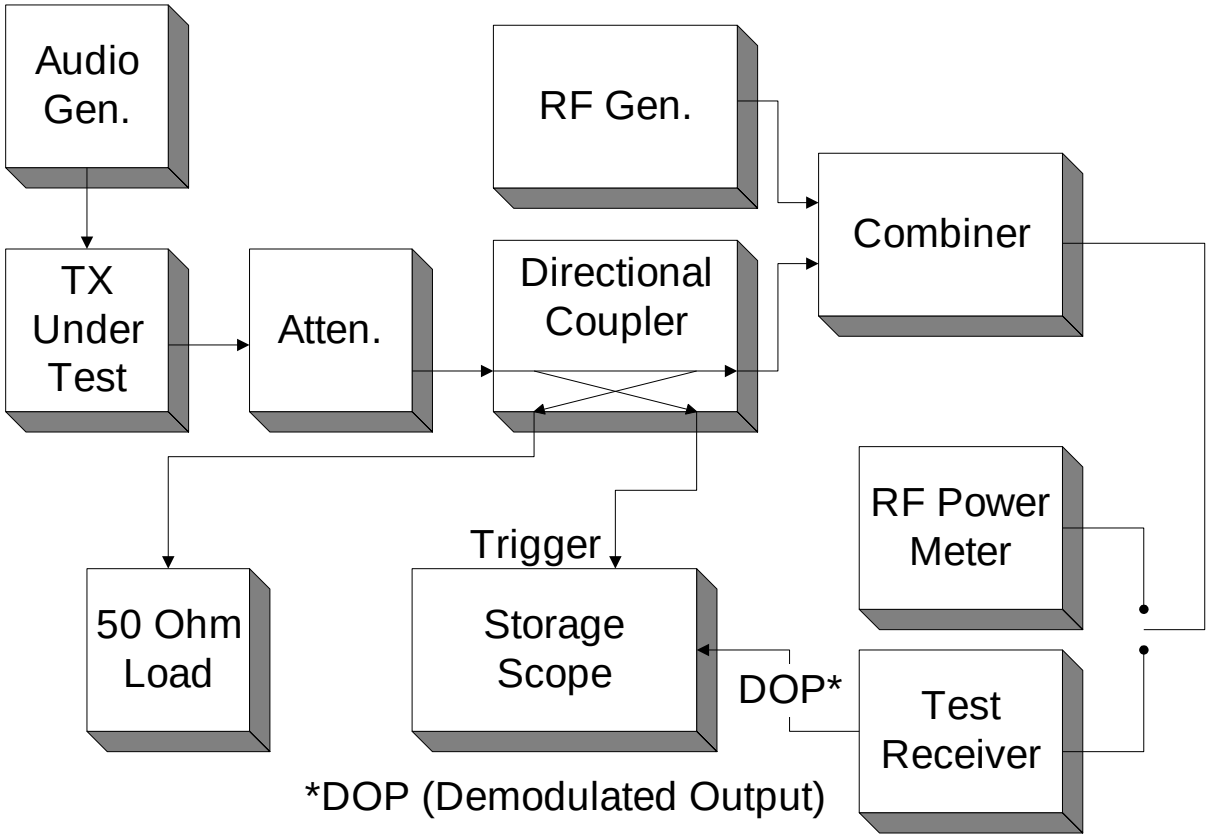
Spurious Emissions at Antenna Terminals



Frequency Stability



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