

LABORATORY TEST REPORT

RADIO PERFORMANCE MEASUREMENTS

for the

TBCH3A Base Station Transceiver

Tested in accordance with:

FCC 47 CFR Parts 22 and 90

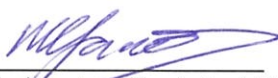
Report Revision: 1

Issue Date: 10 January 2018

PREPARED BY: L. M. White


Test Technician

CHECKED & APPROVED BY: M. C. James


Laboratory Technical Manager



FCC REGISTRATION: 838288

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation.

This document must not be reproduced except in full, without the written permission of the Compliance Laboratory Manager

TELTEST Laboratories (A Division of Tait Communications)
PO Box 1645, 558 Wairakei Road, Christchurch, New Zealand.

Telephone: 64 3 358 3399
FAX: 64 3 359 4632

TABLE OF CONTENTS

REVISION.....	3
INTRODUCTION	4
STATEMENT OF COMPLIANCE.....	5
MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS	6
TEST RESULTS	8
TRANSMITTER OUTPUT POWER (CONDUCTED).....	8
TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS	9
TRANSMITTER MODULATION LIMITING.....	10
TRANSMITTER OCCUPIED BANDWIDTH AND SPECTRUM MASKS	11
TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)	17
TRANSMITTER SPURIOUS EMISSIONS (RADIATED).....	21
TRANSIENT FREQUENCY BEHAVIOR	24
TRANSMITTER FREQUENCY STABILITY - TEMPERATURE	26
TRANSMITTER FREQUENCY STABILITY - VOLTAGE.....	27
TEST EQUIPMENT LIST	28
ANNEX A – TEST SETUP DETAILS	30

REVISION

Date	Revision	Comments
10 January 2018	1	Initial test report

Release of this report was delayed due to administrative issues with the laboratory obtaining FCC registration. All test equipment was within its calibration period when the testing occurred and no test procedures have been modified in the intervening time.

INTRODUCTION

Type approval testing of the TBCH3A, 50 Watt, Base Station transceiver in order to demonstrate compliance with FCC 47 Parts 22 & 90. This radio supports analogue, digital APCO P25 phase-1 and APCO P25 phase-2 modulations.

Type Approval Testing of the TBCH3A
Frequency range 470 → 520 MHz

in accordance with:
FCC 47 CFR Parts 22 and 90

REPORT PREPARED FOR

Tait Ltd
245 Wooldridge Road
Harewood
Christchurch 8051
New Zealand

DESCRIPTION OF SAMPLE

Manufacturer Tait Limited
Equipment: Base Station Transceiver
Type: TBCH3A

Modulation		Channel Spacing	Speech Channels	Symbol Rate (symbols/sec)	Data Rate (bps)
Analogue FM		12.5 kHz	1	-	-
APCO P25 Phase 1	C4FM (TIA 102)	12.5 kHz	1	4800	9600
APCO P25 Phase 1	LSM (TIA 102)	12.5 kHz	1	4800	9600
APCO P25 Phase 2	H-DQPSK (TIA 102)	12.5 kHz	2	6000	12000
APCO P25 Phase 2	H-D8PSK (TIA 102)	12.5 kHz	2	4000	12000

HARDWARE & SOFTWARE

Quantity: 1 of each

Description	Product Code	Serial Number	Firmware Version	Hardware Version
Reciter 470-520 MHz	T01-01103-MACA	18264259	P25-trunk.20171004T091024	01.00
Power Amplifier	T01-01121-MAAA	18264260	0.01.00.trunk.441497.20170816T 165224.0002	06.00
Power Management Unit	TBA30A0-0100	18264262	0316	01.00
Front Panel	T01-01110-BAAA	18264477	0.01.00.trunk.421900.20170816T 165224.0001	00.04

TEST CONDITIONS

All testing was performed between 18 → 25 October 2017, and under the following conditions:

Ambient temperature: 15°C → 30°C
Relative Humidity: 20% → 75%
Standard Test Voltage 120 V_{AC}

FCC ID: CASTBCH3A
IC : 737A-TBCH3A

STATEMENT OF COMPLIANCE

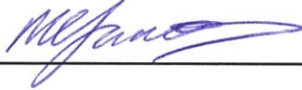
We, TELTEST LABORATORIES of 558 Wairakei Road, Christchurch, New Zealand, declare under our sole responsibility that the product:

Equipment: TBCH3A Base Station Transceiver

Description	Product Code	Serial Number
Reciter	T01-01103-MACA	18264259
Power Amplifier	T01-01121-MAAA	18264260
Power Management Unit	TBA30A0-0100	18264262
Front Panel	T01-01110-BAAA	18264477

to which this declaration relates, is in conformity with the following standards:

FCC 47 CFR Parts 22 and 90

Signature: 

Mike James
Technical Manager

Date: 10 January 2018

MODULATION TYPES, NECESSARY BANDWIDTH & EMISSION DESIGNATORS

MODULATION TYPES:

F3E	FM Analogue Voice	-	-
F1E	C4FM	4800 symbols/sec	9600 bps
F1D	C4FM	4800 symbols/sec	9600 bps
D1W	Digital Voice / Data	4800 symbols/sec	9600 bps
D7W	Digital Voice / Data	6000 symbols/sec	12000 bps
D7W	Digital Voice / Data	4000 symbols/sec	12000 bps

CHANNEL SPACING: 12.5 kHz

EMISSION DESIGNATORS:

Analogue Voice	11K0F3E
P25 Phase 1 Digital Voice	8K10F1E
P25 Phase 1 Digital Data	8K10F1D
LSM	8K70D1W
P25 Phase 2 H-DQPSK	9K80D7W
P25 Phase 2 H-D8PSK	6K80D7W

Equation: $B_n = 2M + 2Dk$

(M is highest modulating frequency; D is peak allowable deviation; k is a constant of 1 for FM)

Analogue Voice 12.5 kHz Channel Spacing

Necessary bandwidth

M = 3.0 kHz

D = 2.5 kHz

$$B_n = (2 \times 3.0) + (2 \times 2.5) \times 1$$

$$= 11.0 \text{ kHz}$$

Emission Designator

11K0F3E

F3E represents an FM voice transmission

APCO P25 Phase 1:

Digital Voice / Data (C4FM - 4 level frequency shift keying)

Digital Voice/data transmissions use a 4 level frequency shift keying modulation scheme. The necessary bandwidth has been measured using the 99% energy rule, and in accordance with FCC KDB 971168 D01.

Digital Voice 12.5 kHz Channel Spacing

99% bandwidth
= 8.1 kHz

Emission Designator

8K10F1E

F1E represents a digital FM voice transmission

Digital Data 12.5 kHz Channel Spacing

99% bandwidth
= 8.1 kHz

Emission Designator

8K10F1D

F1D represents an digital FM data transmission

Linear Simulcast Modulation (LSM):

Digital Voice/data transmissions use a 4 level frequency shift keying modulation scheme. The necessary bandwidth has been measured using the 99% energy rule, and in accordance with FCC KDB 971168 D01.

CQPSK Digital Data 12.5 kHz Bandwidth

99% bandwidth
= 8.7 kHz

Emission Designator

8K70D1W

D1W represents a single channel containing quantized or digital information combining two modulation modes simultaneously (amplitude + angle) for a data or telephony combination.

APCO P25 Phase II:

H-DQPSK Digital Data 12.5 kHz Bandwidth

99% bandwidth
= 9.8 kHz

Emission Designator

9K80D7W

D7W represents two or more channels containing quantized or digital information combining of two modulation modes simultaneously (amplitude + angle) for a data/telephony combination.

H-D8PSK Digital Data 12.5 kHz Bandwidth

99% bandwidth
= 6.8 kHz

Emission Designator

6K80D7W

D7W represents two or more channels containing quantized or digital information combining of two modulation modes simultaneously (amplitude + angle) for a data/telephony combination.

TEST RESULTS

TRANSMITTER OUTPUT POWER (CONDUCTED)

SPECIFICATION: FCC 47 CFR 2.1046

GUIDE: TIA-102.CAAA-C 2.2.1

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. The coaxial attenuator has an impedance of 50 Ohms.
3. The unmodulated output power was measured with an RF Power meter.

MEASUREMENT RESULTS:

Manufacturer's Rated Output Power:

Switchable: 50 W and 5 W

Nominal 50 W	495.1 MHz
Measured	51.9
Variation (%)	3.9
Variation (dB)	0.2

Nominal 5 W	495.1 MHz
Measured	4.6
Variation (%)	-7.7
Variation (dB)	-0.3
Measurement Uncertainty	± 0.6 dB

LIMIT CLAUSES:

FCC 47 CFR 90.205 (s)

The output power shall not exceed by more than 20%... the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

TRANSMITTER AUDIO FREQUENCY RESPONSE - PRE-EMPHASIS

SPECIFICATION: FCC 47 CFR 2.1047 (a)

GUIDE: TIA/EIA-603E 2.2.6

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. An audio input tone of 1000 Hz was applied with the level set to obtain 20% of maximum deviation. This was used as the 0 dB reference point.
3. The AF was varied while the audio level was held constant.
4. The response in dB relative to 1000 Hz was measured.

MEASUREMENT RESULTS:

See the plot below for 12.5 kHz channel spacing tested at 50 W transmit power.

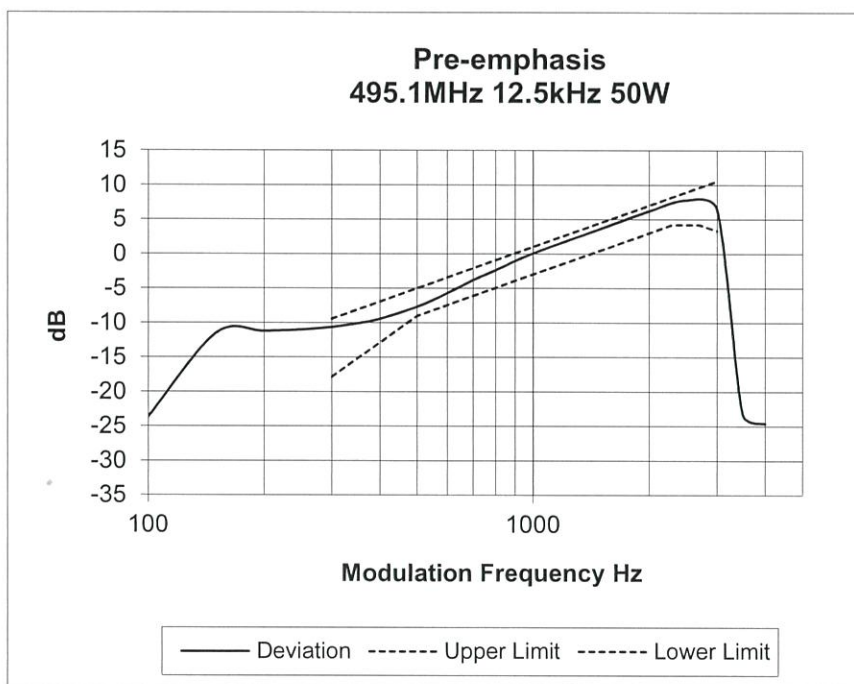
LIMIT CLAUSE: TIA/EIA-603E 3.2.6

MEASUREMENT UNCERTAINTY: $\pm 1.5\%$

SPECIFICATION: FCC CFR 2.1047 (a)

Tx FREQUENCY: 495.1 MHz

12.5 kHz Channel Spacing



TRANSMITTER MODULATION LIMITING

SPECIFICATION: FCC 47 CFR 2.1047 (b)

GUIDE: TIA/EIA-603E 2.2.3

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment set up.
2. The modulation response was measured at three audio frequencies while varying the input level.
3. Measurements were made for both Positive and Negative Deviation.

MEASUREMENT RESULTS:

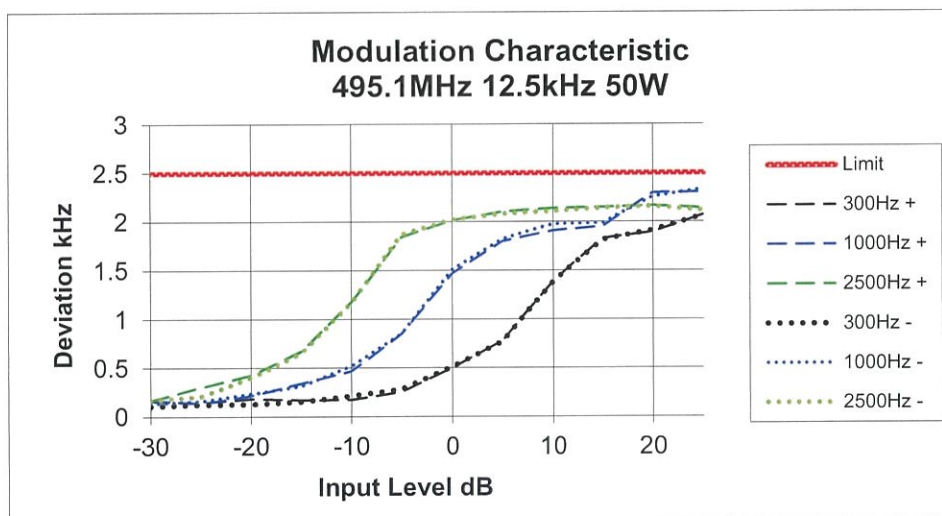
See the plot below for 12.5 kHz channel spacing.

LIMIT CLAUSE: TIA/EIA-603E 1.3.4.4

MEASUREMENT UNCERTAINTY: $\pm 1.5\%$

Tx FREQUENCY: 495.1 MHz

12.5 kHz Channel Spacing



TRANSMITTER OCCUPIED BANDWIDTH AND SPECTRUM MASKS

SPECIFICATION: FCC 47 CFR 2.1049 (c)

GUIDE: TIA/EIA-603E 2.2.11 (Analog)
TIA-102.CAAA-C 2.2.5 (Digital)

MEASUREMENT PROCEDURE:

1. Refer Annex A for Equipment Set up.
The EUT was modulated with an internally generated pseudo random bit sequence at the appropriate Baud rates.
2. The Occupied Bandwidth was measured on the Spectrum Analyser, with bandwidth settings as follows.
Emission Mask D – Resolution Bandwidth = 100 Hz, Video Bandwidth = 1 kHz

MEASUREMENT RESULTS:

See the plots on the following pages for 12.5 kHz channel spacing.

MEASUREMENT UNCERTAINTY 95% $\pm 0.65\text{dB}$

LIMIT CLAUSE: FCC 47 CFR 90.210

EMISSION MASKS

Emission Mask D	12.5 kHz Channel Spacing	Analog, Digital Voice/Data
-----------------	--------------------------	----------------------------

DATA SPEED

Digital Voice/Data	12.5 kHz Channel Spacing	9600 bps (P25 Phase I)
Digital Voice/Data	12.5 kHz Channel Spacing	12000 bps (P25 Phase II)

Occupied Bandwidth and Spectrum Masks

Analog Modulation
SPECIFICATION:

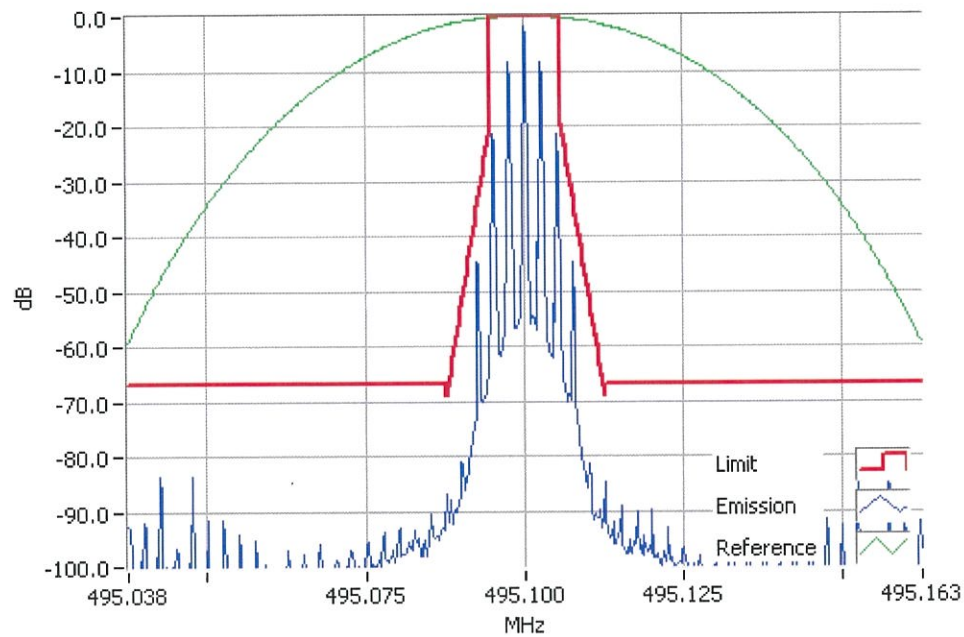
FCC CFR 2.1049 (c)

Tx FREQUENCY:

495.1 MHz

50 W

12.5 kHz Channel Spacing



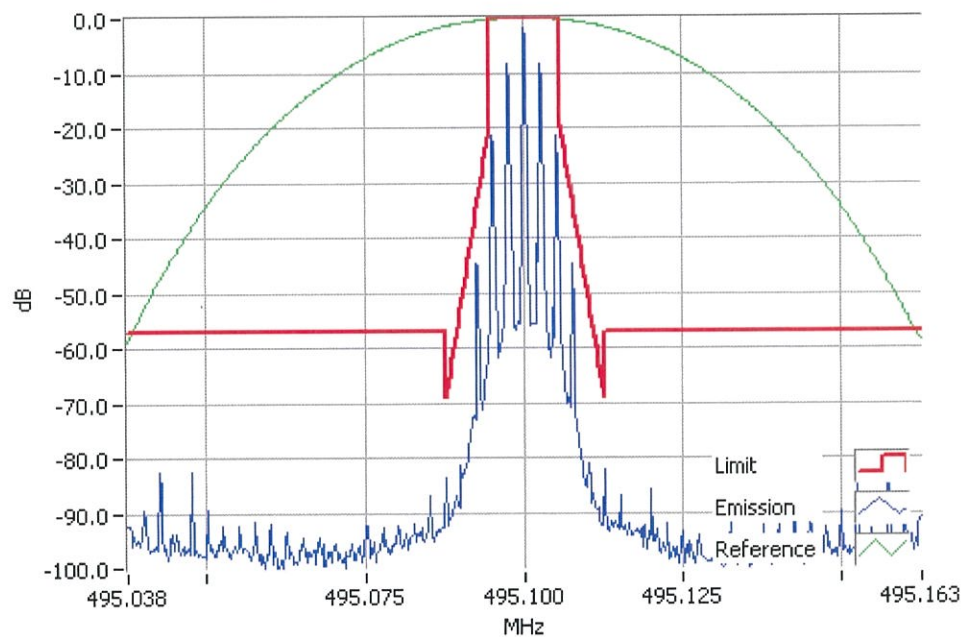
Analogue Modulation 495.1000MHz Mask D 50W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY:

495.1 MHz

5 W

12.5 kHz Channel Spacing



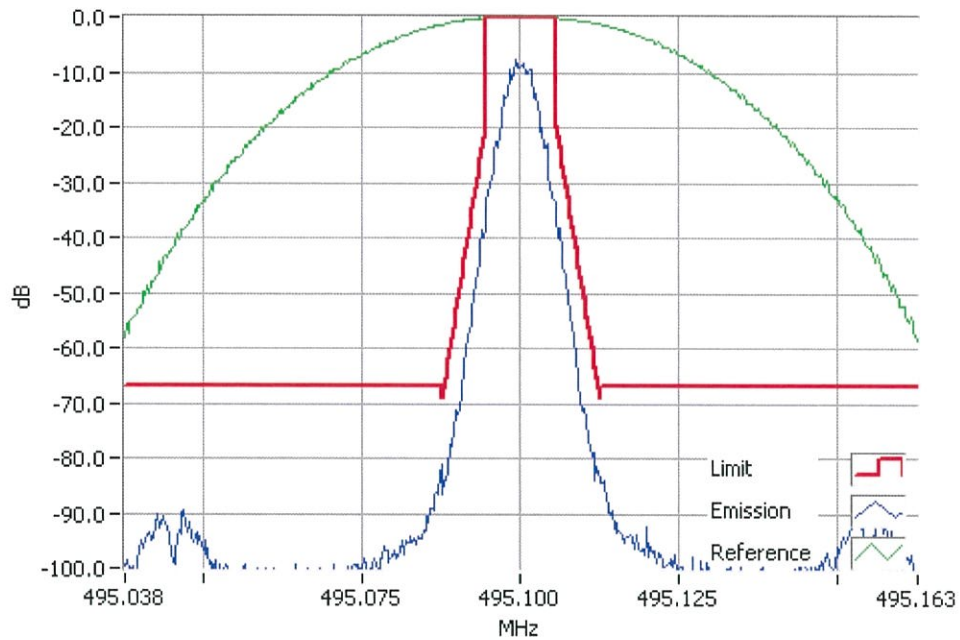
Analogue Modulation 495.1000MHz Mask D 5W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I C4FM modulation

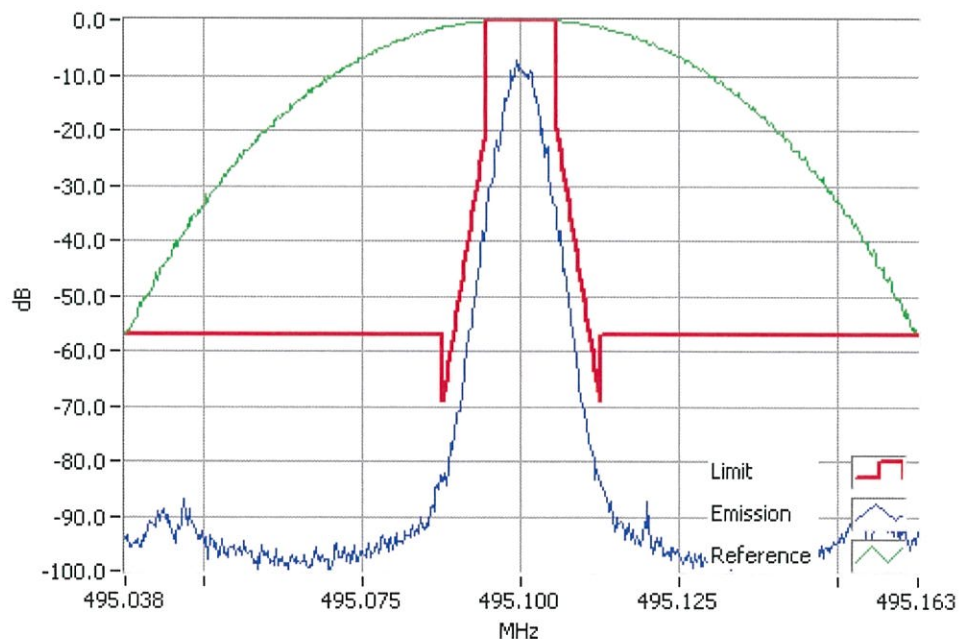
SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 495.1 MHz 50 W 12.5 kHz Channel Spacing



P25I,C4FM 495.1000MHz Mask D 50W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 495.1 MHz 5 W 12.5 kHz Channel Spacing



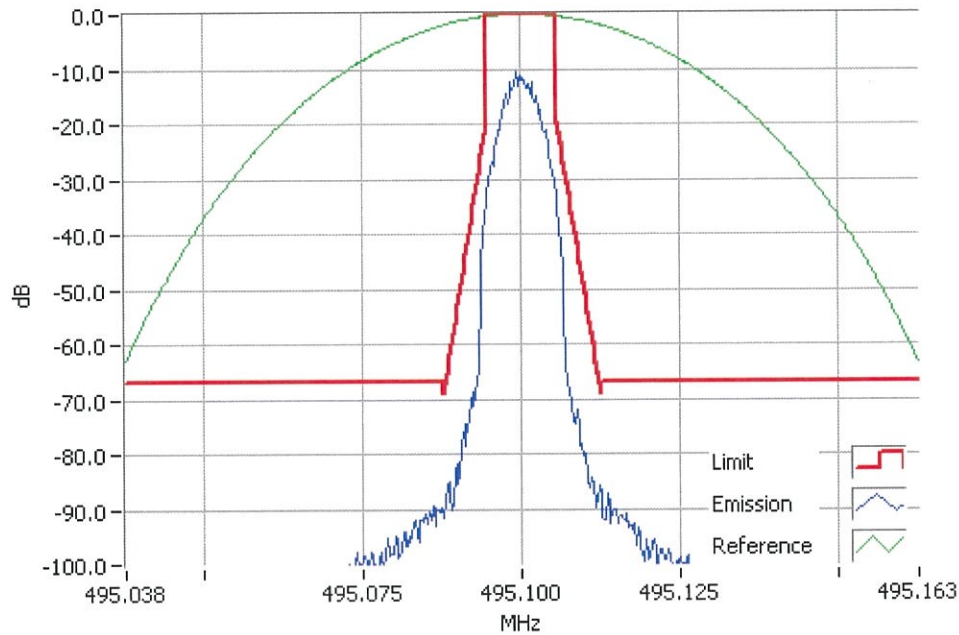
P25I,C4FM 495.1000MHz Mask D 5W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase I LSM modulation

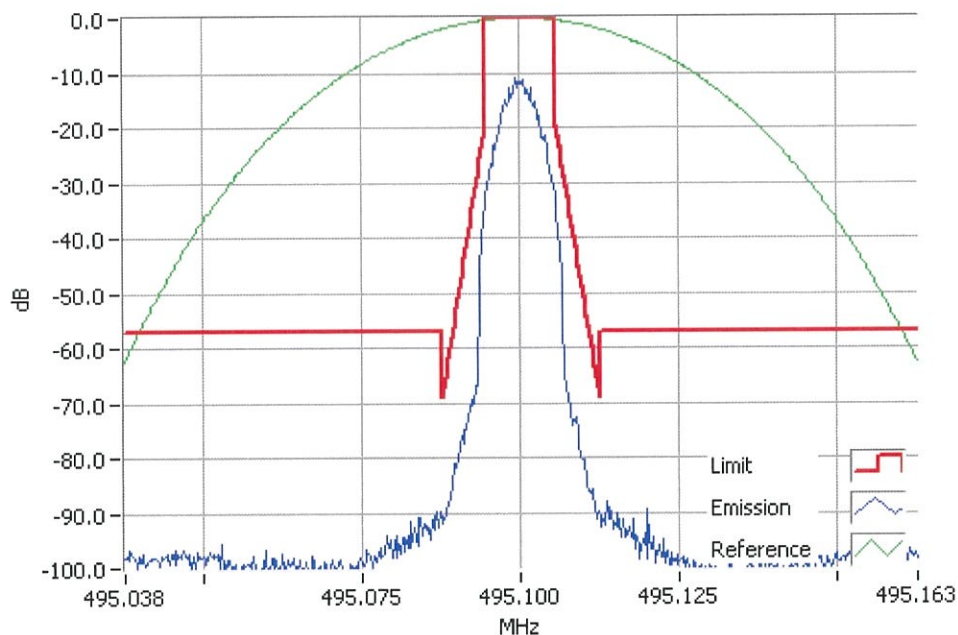
SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 495.1 MHz 50 W 12.5 kHz Channel Spacing



P25I,LSM 495.1000MHz Mask D 50W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 495.1 MHz 5 W 12.5 kHz Channel Spacing

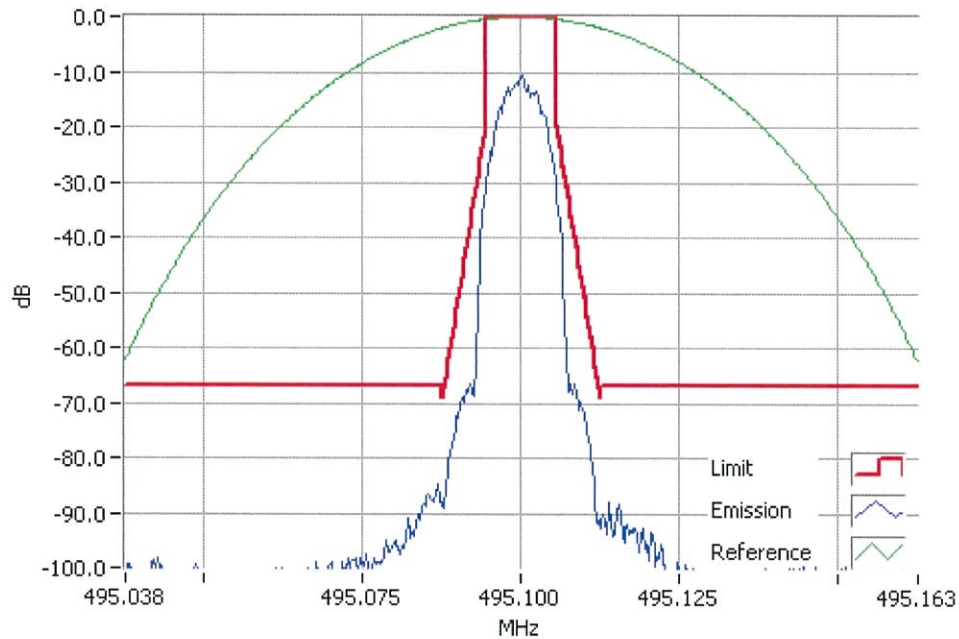


P25I,LSM 495.1000MHz Mask D 5W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

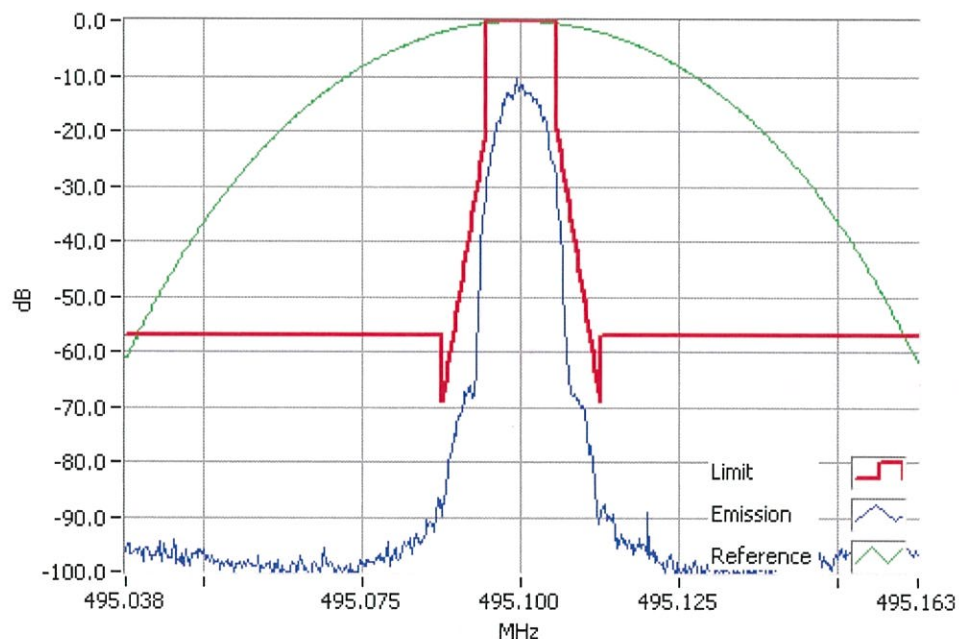
P25 Phase II H-DQPSK modulation
SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 495.1 MHz 50 W 12.5 kHz Channel Spacing



P25II,H-DQPSK 495.1000MHz Mask D 50W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 495.1 MHz 5 W 12.5 kHz Channel Spacing



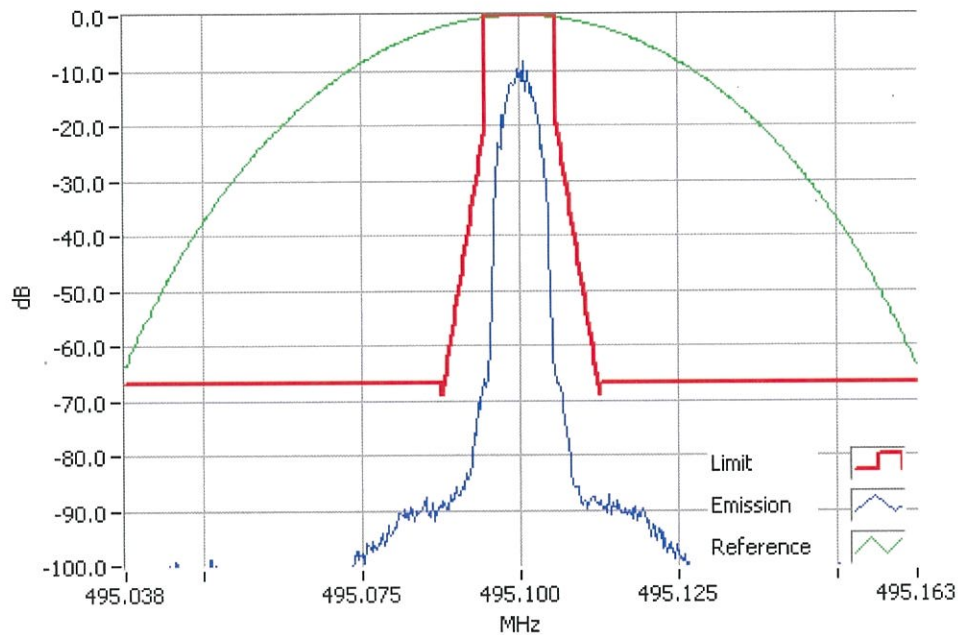
P25II,H-DQPSK 495.1000MHz Mask D 5W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Occupied Bandwidth and Spectrum Masks

P25 Phase II H-D8PSK modulation

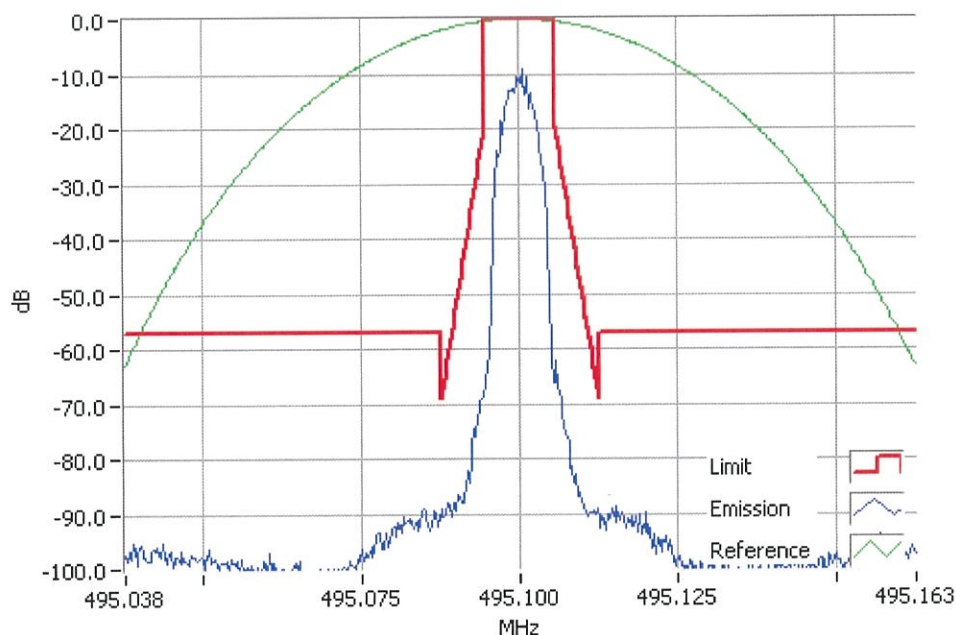
SPECIFICATION: FCC CFR 2.1049 (c)

Tx FREQUENCY: 495.1 MHz 50 W 12.5 kHz Channel Spacing



P25II,H-D8PSK 495.1000MHz Mask D 50W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

Tx FREQUENCY: 495.1 MHz 5 W 12.5 kHz Channel Spacing



P25II,H-D8PSK 495.1000MHz Mask D 5W
RBW=100Hz, VBW=1000Hz, Detector Mode=Peak
Result=Pass

TRANSMITTER SPURIOUS EMISSIONS (CONDUCTED)

SPECIFICATIONS: FCC 47 CFR 2.1051

GUIDE: TIA-102.CAAA-C 2.2.7

MEASUREMENT PROCEDURE:

1. Refer Annex A for equipment set up.
2. The frequency range examined was from the lowest frequency generated within the EUT, to a frequency higher than the 10th Harmonic: 100 kHz to Fc-BW
Fc+ BW to 10Fc GHz
3. A Pre-scan is performed with a resolution bandwidth of 1 kHz, and a video bandwidth of 3 kHz. If any emissions are found to be within 20 dB of the limit a second measurement is made with the carrier modulated, and a resolution bandwidth of 10 kHz, and a video bandwidth of 30 kHz.

Spurious emissions which were attenuated by more than 20 dB below the limit were not recorded.

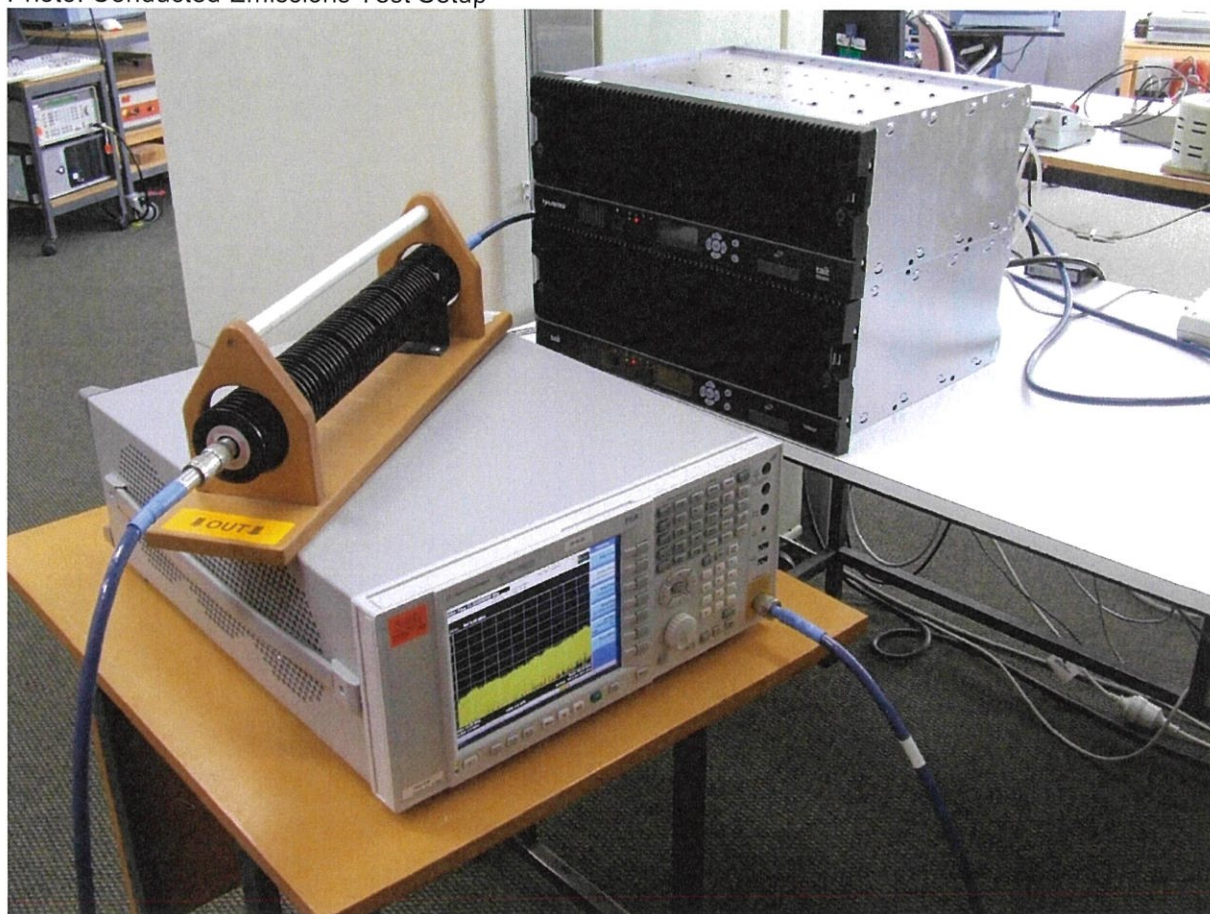
A photograph of the test set-up is included below.

MEASUREMENT RESULTS:

See the tables and plots on the following pages for 12.5 kHz channel spacing.

LIMIT CLAUSES: FCC 47 CFR 90.210

Photo: Conducted Emissions Test Setup



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC CFR 2.1051

Tx FREQUENCY: 495.1 MHz

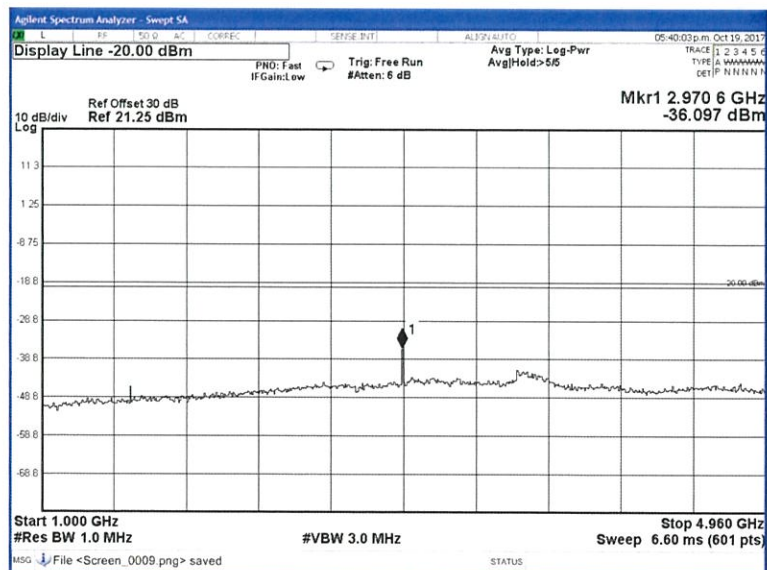
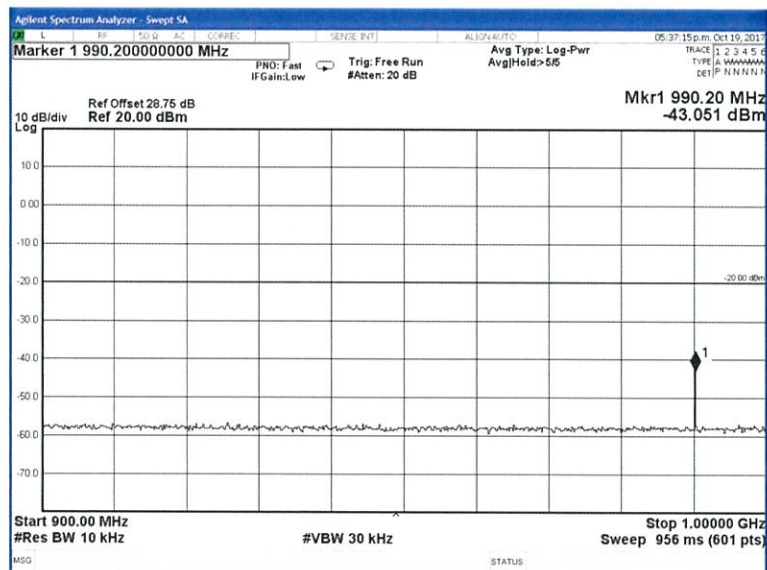
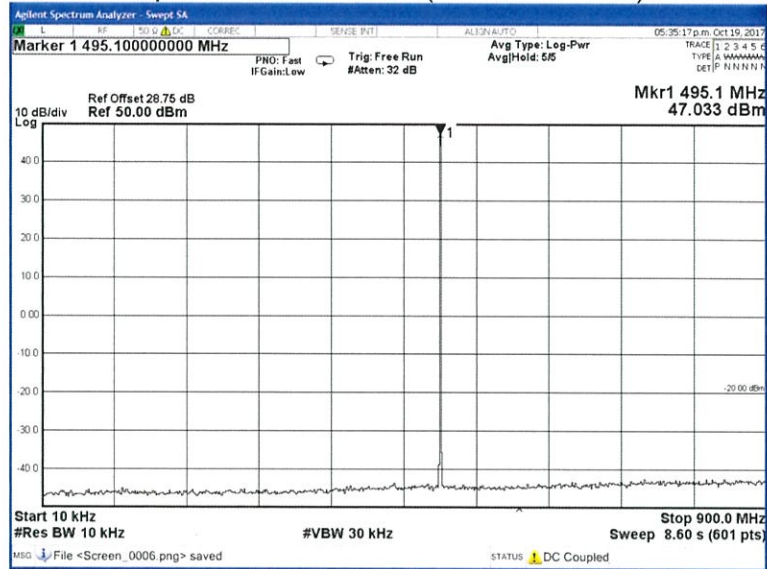
12.5 kHz Channel Spacing 495.1 MHz @ 50 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
2970.5996	-36.0	-83.0

12.5 kHz Channel Spacing 495.1 MHz @ 5 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty:	≤2.75 GHz ± 3.0 dB	
No other emissions were detected at a level greater than 20 dB below the limit.		

Spurious Emissions (Tx Conducted)



Spurious Emissions (Tx Conducted)

SPECIFICATION: FCC CFR 2.1051

LIMITS: FCC 47 CFR 90.210

Carrier Output Power	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \log_{10} (P_{\text{Watts}})$	
	-20 dBm	-67 dBc
50 W	-20 dBm	-67 dBc
5 W	-20 dBm	-57 dBc

TRANSMITTER SPURIOUS EMISSIONS (RADIATED)

SPECIFICATION: FCC 47 CFR 2.1053

GUIDE: TIA-102.CAAA-C 2.2.6

MEASUREMENT PROCEDURE:

Initial Scan:

1. The EUT is placed in the S-Line TEM cell and emissions are measured from 30 MHz to 800 MHz. Any emission within 20 dB of the limit is then re-tested on the OATS.
2. The EUT is placed in the reverberation chamber and emissions are measured from 800 MHz to the upper frequency required. Any emission within 20 dB of the limit is then re-tested on the OATS.
3. The harmonics emissions up to the 6th harmonic of the fundamental frequency are measured on the OATS

OATS Measurement:

1. The EUT is placed on a wooden turntable at a distance of three metres from the test antenna. The output terminal is connected to an RF dummy load.
2. The test antenna is raised from 1 m to 4 m to obtain a maximum reading; the turntable is then rotated through 360° to obtain the maximum response of each spurious emission. Valid emissions are determined by switching the EUT on and off.
3. The EUT is then replaced by a signal generator and substitution antenna to make measurements by the substitution method.

MEASUREMENT RESULTS:

See the tables on the following pages

LIMIT CLAUSE: FCC 47 CFR 90.210

Spurious Emissions (Tx Radiated)

SPECIFICATION: FCC CFR 2.1053

12.5 kHz Channel Spacing 495.1 MHz @ 50 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
990.2	-35.8	-82.8

12.5 kHz Channel Spacing 495.1 MHz @ 5 W Emission Mask D

Emission Frequency (MHz)	Level (dBm)	Level (dBc)
~	~	~
Measurement Uncertainty	± 4.6 dB	
No other emissions were detected at a level greater than 20 dB below the limit.		

LIMITS: FCC CFR 2.1053

Carrier Output Power	Emission Mask D 12.5 kHz Channel Spacing $50 + 10 \log_{10}(P_{\text{Watts}})$	
50 W	-20 dBm	-67 dBc
5 W	-20 dBm	-57 dBc