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FCC Certification Test Report
For the
ELVA-1 Ltd.
PPC-10G

FCC ID: 2AIXT-PPC-10G-E

WLL JOB# **14825-01 Rev 1**
June 9, 2017

Re-issued June 29, 2017

Prepared for:

ELVA-1 Microwave Handelsbolag
c/o Hornlund
Kungsgatan 54
Furulund Sweden 244

Prepared By:

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[redacted]

Testing Certificate AT-1448

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Prepared by:

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President

Reviewed by:

Mike Violette
CEO

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Abstract

This report has been prepared on behalf of ELVA-1 Ltd. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Mobile Transmitter under Part 101 of the FCC Rules and Regulations. This Certification Test Report documents the test configuration and test results for the ELVA-1 Ltd. PPC-10G.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The ELVA-1 Ltd. PPC-10G complies with the limits for a Transmitter device under FCC Part 101.

Revision History	Description of Change	Date
Rev 0	Initial Release	June 9, 2017
Rev 1	Revised per comments from ACB	June 29, 2017

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1.0 Introduction

1.1 Compliance Statement

The ELVA-1 Ltd. PPC-10G complies with the limits for Transmitter device under FCC Part 101.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with the 2015 version of ANSI C63.26. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	ELVA-1 Microwave Handelsbolag c/o Hornlund Kungsgatan 54 Furulund Sweden 24462
Purchase Order Number:	766993
Quotation Number:	66398

1.4 Test Dates

Testing was performed on the following date(s):	1/26/2017 – 5/26/2017

1.5 Test and Support Personnel

Washington Laboratories, LTD	John Repella, Steve Koster
Client Representative	Daniel Korneev

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1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**c**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

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2.0 Equipment Under Test

2.1 EUT Identification & Description

The Elva-1 Wireless 10Gbps Ethernet Bridge is intended for full duplex 10Gbps communication between two remote points. It is composed of two subscriber transceivers which are operated within line-of-sight conditions at working frequencies within mm-wave range 71-76/81-86GHz.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	ELVA-1 Ltd.
FCC ID:	2AIXT-PPC-10G-E
Model:	PPC-10G
FCC Rule Parts:	§101
TX Frequency Range:	71-76/81-86 GHz (E-band)
RX Frequency Range:	71-76/81-86 GHz (E-band)
Maximum Output Power:	20 dBm
Modulation:	from BPSK to QAM-256
Occupied Bandwidth:	2000 MHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	1
Power Output Level	Fixed
Antenna Type	Cassegrain type
Interface Cables:	10GBase-LR Fiber optical
Power Source & Voltage:	From 36 to 60 Volt DC
Emissions Designator	2G00D1D

2.2 Test Configuration

The PPC-10G was configured to continuously transmit at 74.75 GHz and 84.75 GHz for the high and low units.

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2.3 Testing Algorithm

The PPC-10G was programmed to transmit a signal via proprietary software driven by a laptop. A link is established between two transceiver units.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.26-2015 American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

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Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a, b, c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	4.55 dB

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3.0 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List (Elva)

Test equipment	Type	Manufacture	Serial	Calibration due
Spectrum analyzer	E4448A	Agilent	MY49341227	05.04.2017
Power meter	N1912A	Agilent	MY50000714	05.04.2017
Sensor Module	N5532S-550	Agilent	MY49341228	05.04.2017
Power Meter Indicator	DPM	Elva-1	R-1312/09	calibrated Elva-1
Power Sensor E-Band		Elva-1	R-1212/19	calibrated Elva-1
Direct reading attenuator	DA-035E	Elva-1	5035E33-01	calibrated Elva-1
Fixed attenuator WR-12	FA-035E/2C	Elva-1	5035E33-15	calibrated Elva-1
Directional coupler WR-12	DS3-035E/10-S	Elva-1	3035E8414	calibrated Elva-1
90GHz Signal Generator	RG4-14		N/A	Calibrated Elva-1*

*traceable to Gosstandard of Russia

Table 4: Test Equipment List (WLL)

Test Name:	**Radiated Emissions**	Test Date:	**2/3/2017**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
528	AGILENT -E4446A	3HZ -44GHZ ANALYZER SPECTRUM	8/10/2017
869	Mini circuits	High Frequency Cable	5/25/2017
865	Storm	High Frequency Cable	5/22/2017
55	AGILENT -11970W	MIXER HARMONIC 75-110GHZ	CNR
83	AGILENT -11970U	MIXER HARMONIC 40 -60GHZ	CNR
54	AGILENT -11970V	MIXER HARMONIC 50-75GHZ	CNR
210	NARDA -V638	HORN STANDARD GAIN	CNR
209	NARDA -V637	HORN STANDARD GAIN	CNR
103	OLESON MICROWAVE LABS -M06HW	D-BAND HARMONICS MIXER	CNR
104	OLESON MICROWAVE LABS -M05HW	MIXER G-BAND HARMONICS	CNR

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Test Results

3.1 RF Power Output: (FCC Part §2.1046)

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

As per CFR 101.113, in no event shall the average equivalent isotropically-radiated power (EIRP), as referenced to an isotropic radiator, exceed the level of 55dBW. With the maximum conducted transmit level of 100mW (20dBm), the maximum gain antenna cannot exceed 65dBi.

Table 5: RF Power Output EIRP (Maximum)

Frequency (GHz)	Measured Power	Max Antenna Gain (dB)	Level (dBW)	Limit (dBW)	Pass/Fail
74.75	20 dBm	50	40	55	Pass
84.75	19.8	50	39.8	55	Pass

Table 6: RF Power Output and Occupied Bandwidth

Modulation	128QAM	64QAM	32QAM	16QAM	QPSK	BPSK	BPSK	BPSK
Channel BW MHz	2000	2000	2000	2000	2000	2000	1000	500
Tx Power dBm	10	12	15	17	20	20	20	20
Rx_Sens dBm	-46	-50	-53	-57	-64	-67	-70	-73
Data rate Mbps	10000	8100	6500	5000	2600	1280	640	320

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3.2 Emission Designator: (FCC Part §2.201)

The emission designator is determined from the necessary bandwidth, the type of modulation and the information conveyed in the signal.

- First symbol, type of modulation of the main carrier: D
- Second symbol, nature of the signal modulating the main carrier: 1
- Third Symbol, type of information to be transmitted: D

The necessary bandwidth, B_n is taken to be the bandwidth of the signal: for 2000 MHz Bandwidth we have 2G00D1D

3.3 Occupied Bandwidth: (FCC Part §2.1049) Limit 101.109

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

At full modulation, the occupied bandwidth was measured as shown:

Table 7 provides a summary of the Occupied Bandwidth Results.

Table 7: Occupied Bandwidth Results

Frequency	Bandwidth (Max)	Limit	Pass/Fail
74.75	2000	5000	Pass
84.75	2000	5000	Pass

Table 8: Occupied Bandwidth and Output Power for Modulations Used

Modulation	128QAM	64QAM	32QAM	16QAM	QPSK	BPSK	BPSK	BPSK
Channel BW MHz	2000	2000	2000	2000	2000	2000	1000	500
Tx Power dBm	10	12	15	17	20	20	20	20
Rx_Sens dBm	-46	-50	-53	-57	-64	-67	-70	-73
Data rate Mbps	10000	8100	6500	5000	2600	1280	640	320

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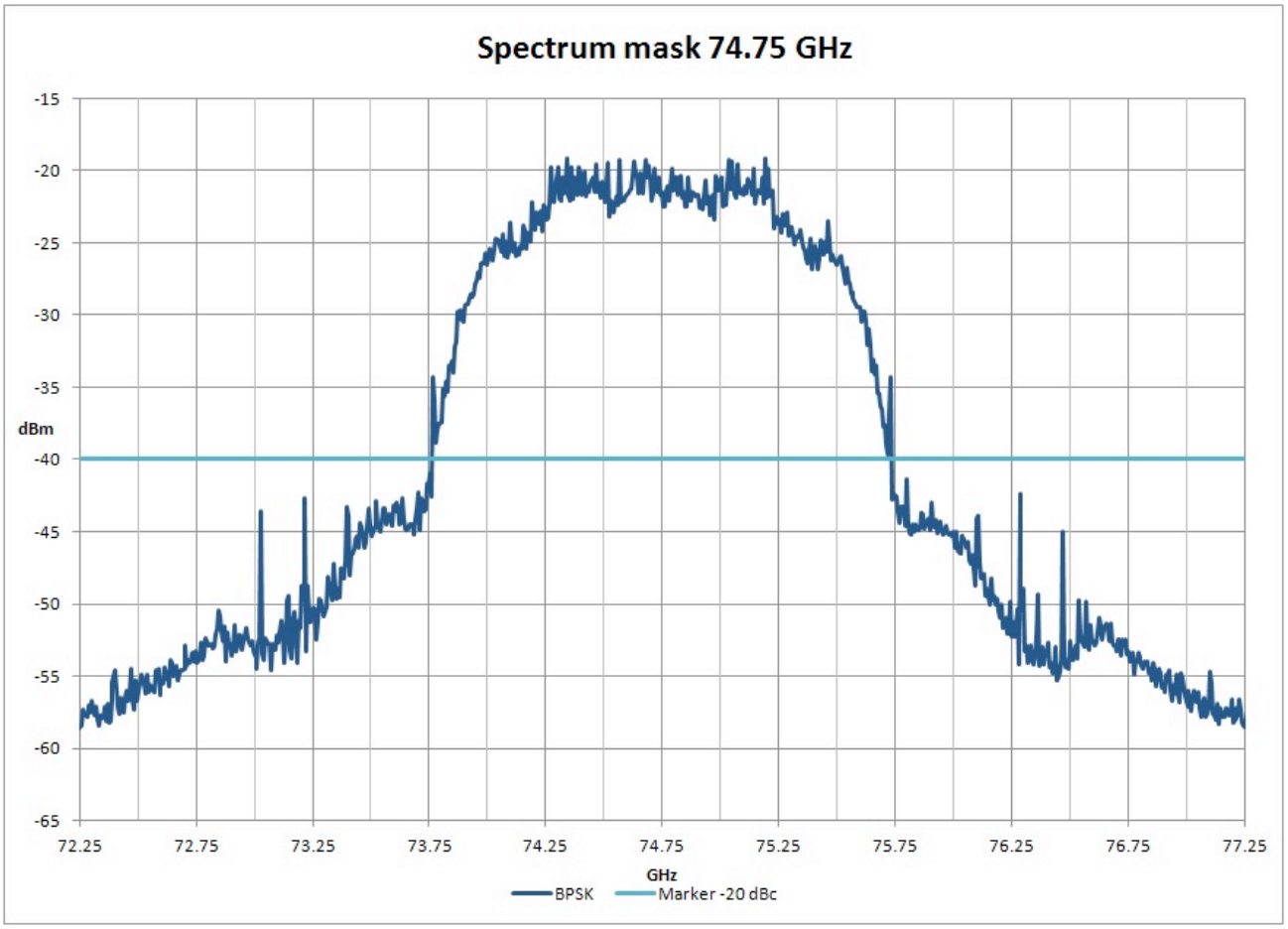

Figure 1: Occupied Bandwidth

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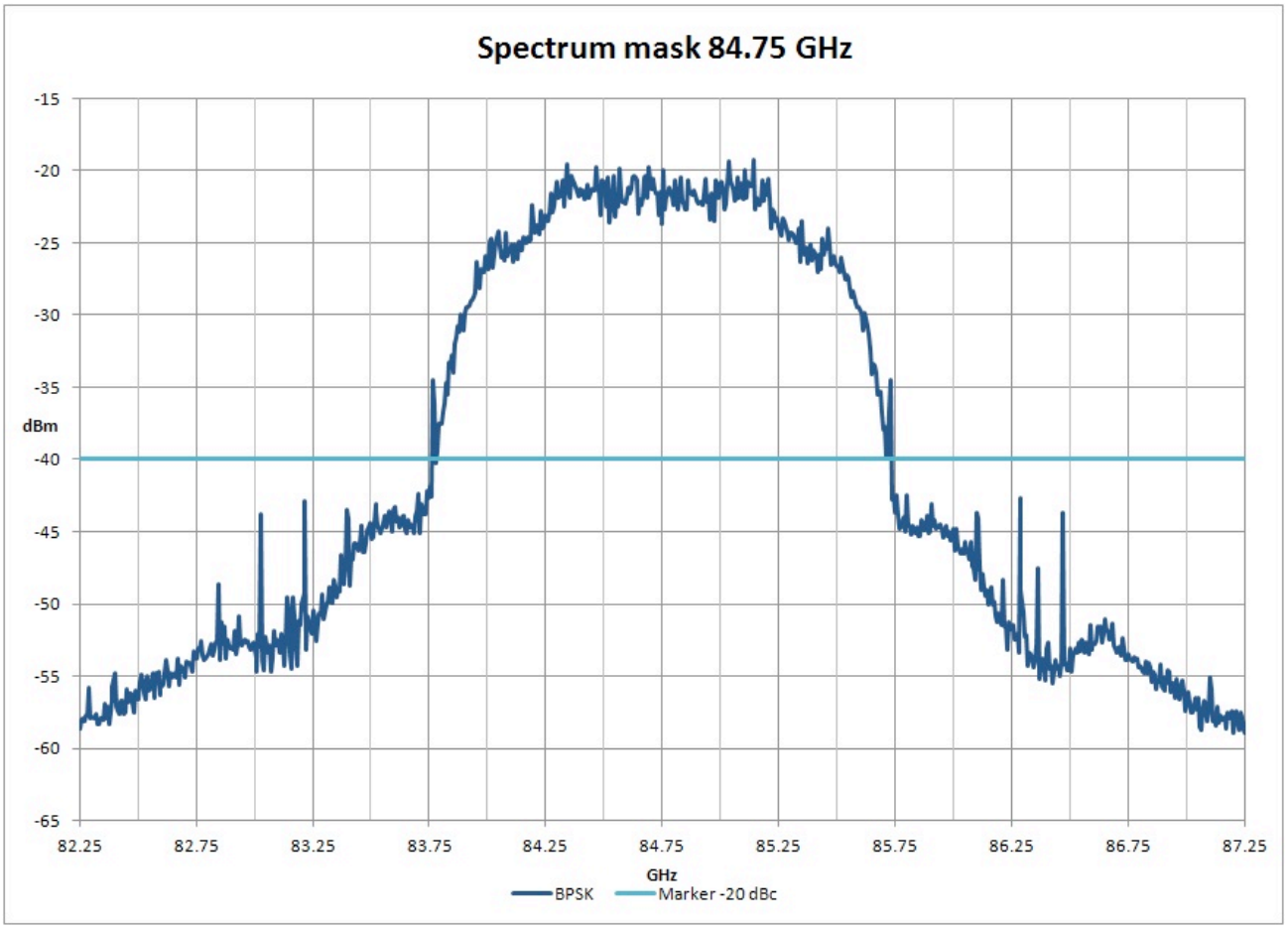

Figure 2: Occupied Bandwidth

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3.4 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051) Limit 101.111a)2)ii and v).

For operating frequencies above 15 GHz, in any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

A = 11 + 0.4(P¥50) + 10 Log10 B. (Attenuation greater than 56 decibels or to an absolute power of less than -13dBm/1MHz is not required.)

The emission mask for the 71–76 GHz, 81–86 GHz, 92–94 GHz, and 94.1–95GHz bands used in the equation in paragraph (a)(2)(ii) of this section applies only to the edge of each channel, but not to sub-channels established by licensees. The value of P in the equation is for the percentage removed from the carrier frequency and assumes that the carrier frequency is the center of the actual bandwidth used. The value of B will always be 500 MHz. In the case where a narrower sub-channel is used within the assigned bandwidth, such sub-carrier will be located sufficiently far from the channel edges to satisfy the emission levels of the mask. The mean output power used in the calculation is the sum of the output power of a fully populated channel.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through an appropriate attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 100 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit. The emissions outside of the allocated frequency band were then scanned from 30 MHz up to 200 GHz.

Test methods for spurious emissions may be in accordance with clause 5.2.9 of ETSI EN 301 126-1 (V1.1.2) (09-1999).

The calibration of the measurement system is shown below. The RG4-14 signal generator supplies a signal at 93.35 GHz. The HMC-T220 provides a signal at 15 GHz which is multipled by 6 times and mixed with the 93.35 GHz signal, providing a difference frequency of 3.5 GHz. The resultant products are amplified and provided to the spectrum analyzer which displays the result in its receive band.

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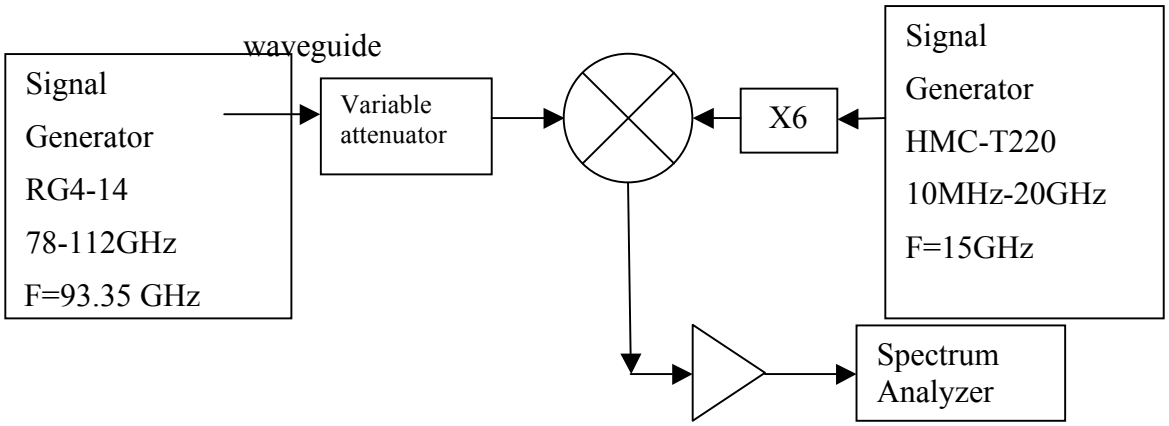

The measurements are performed according to the above figure.

The following equipment was used to make the measurements.

- Signal Generator 78-112 GHz (Model RG4-14)
- variable attenuator waveguide
- Down converter (mixer, 6X multiplier)
- Signal Generator 10 MHz-20 GHz (Model HMC-T2200)
- Spectrum analyzer

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On the RG4-14 set frequency 93.35GHz and measured output power. Pout=5dBm.

The waveguide attenuator was set to 30 dB.

The down-converter conversion gain is 15dB.

On the HMC-T2200, set 15 GHz

The spectrum analyzer display shows the down-converted signal in its baseband range. Figure 3 shows the resultant power readings.

The plots are representative of all channels and modulations.

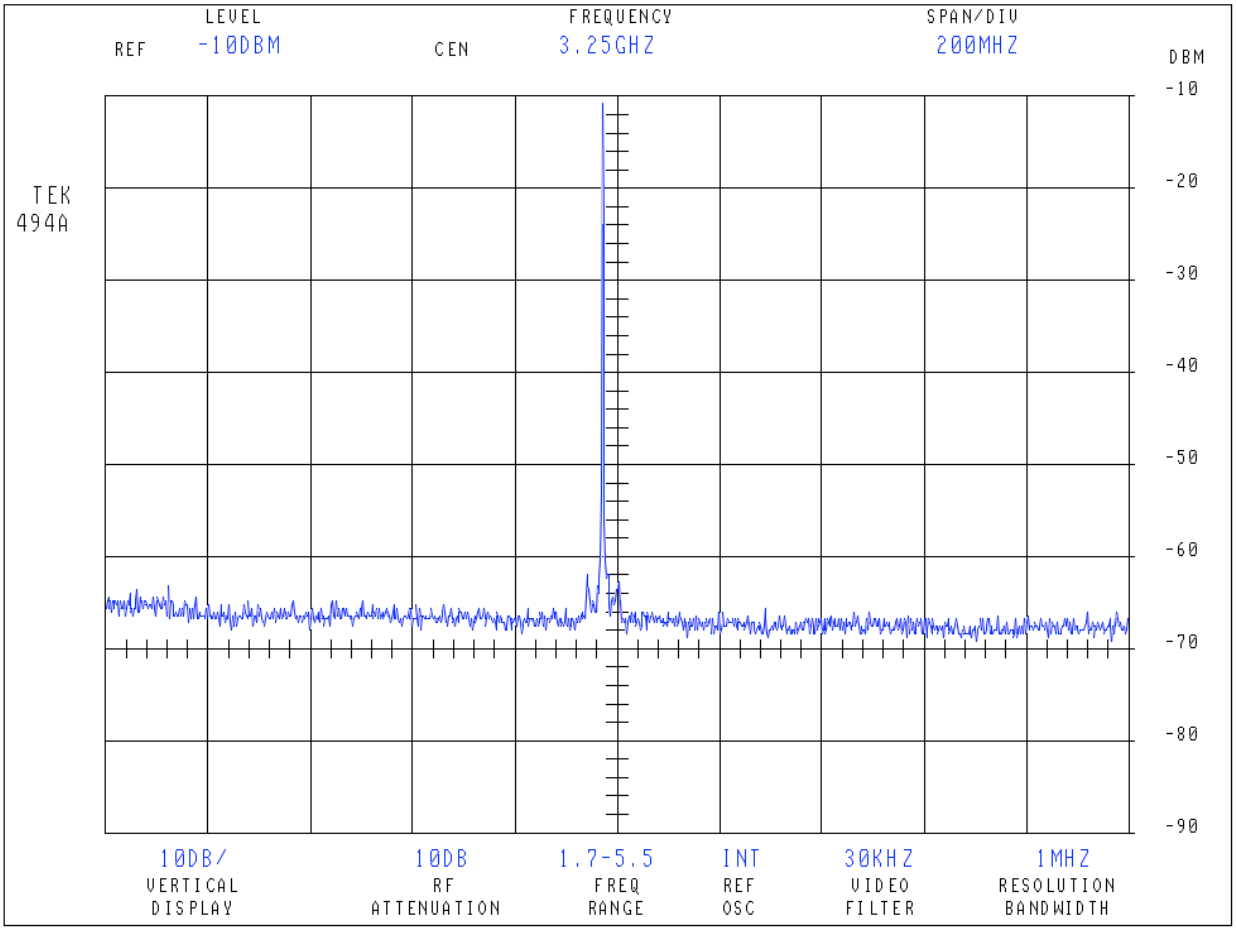

Figure 3. PPC-10G - Spurious Emissions Close to Carrier

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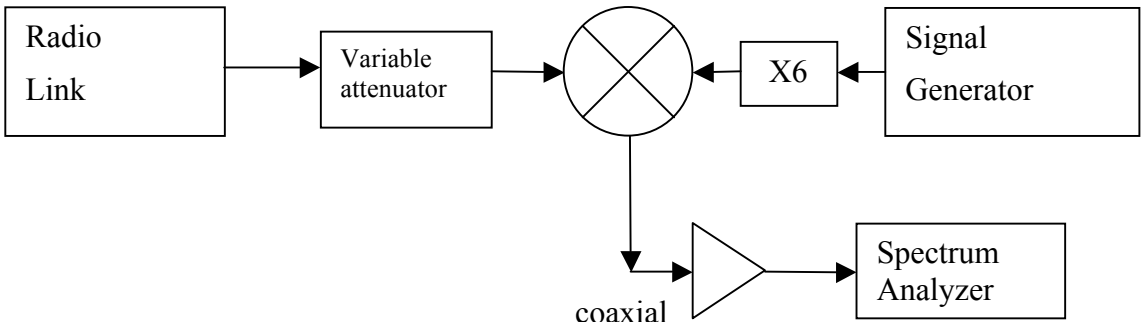
Second step - Emissions radio link.

Change RG4-14 on the radio link like shown in figure below.



Figures 3-5 display the result of the spurious emissions

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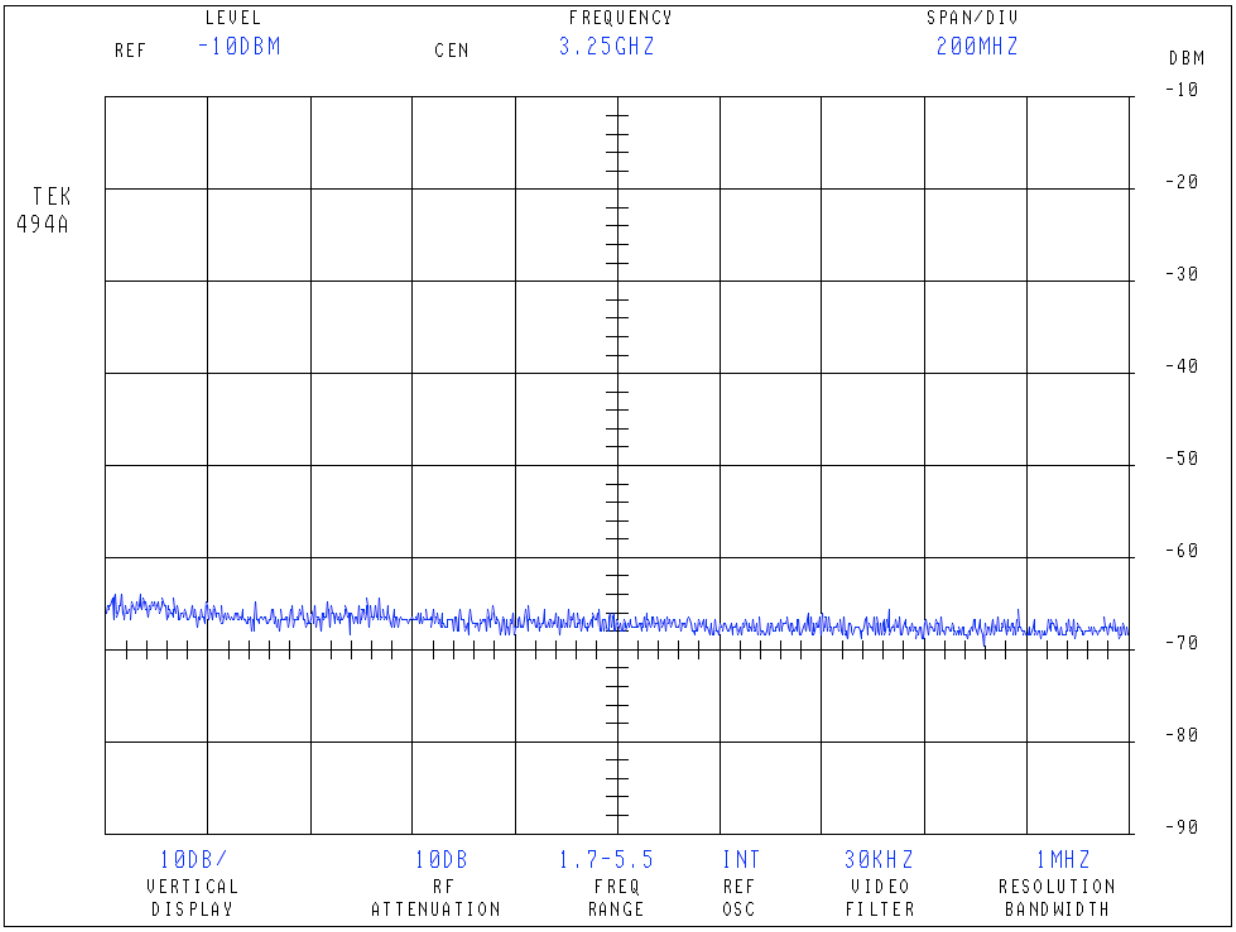

Figure 4. PPC-10G - Spurious Emissions: Low Band

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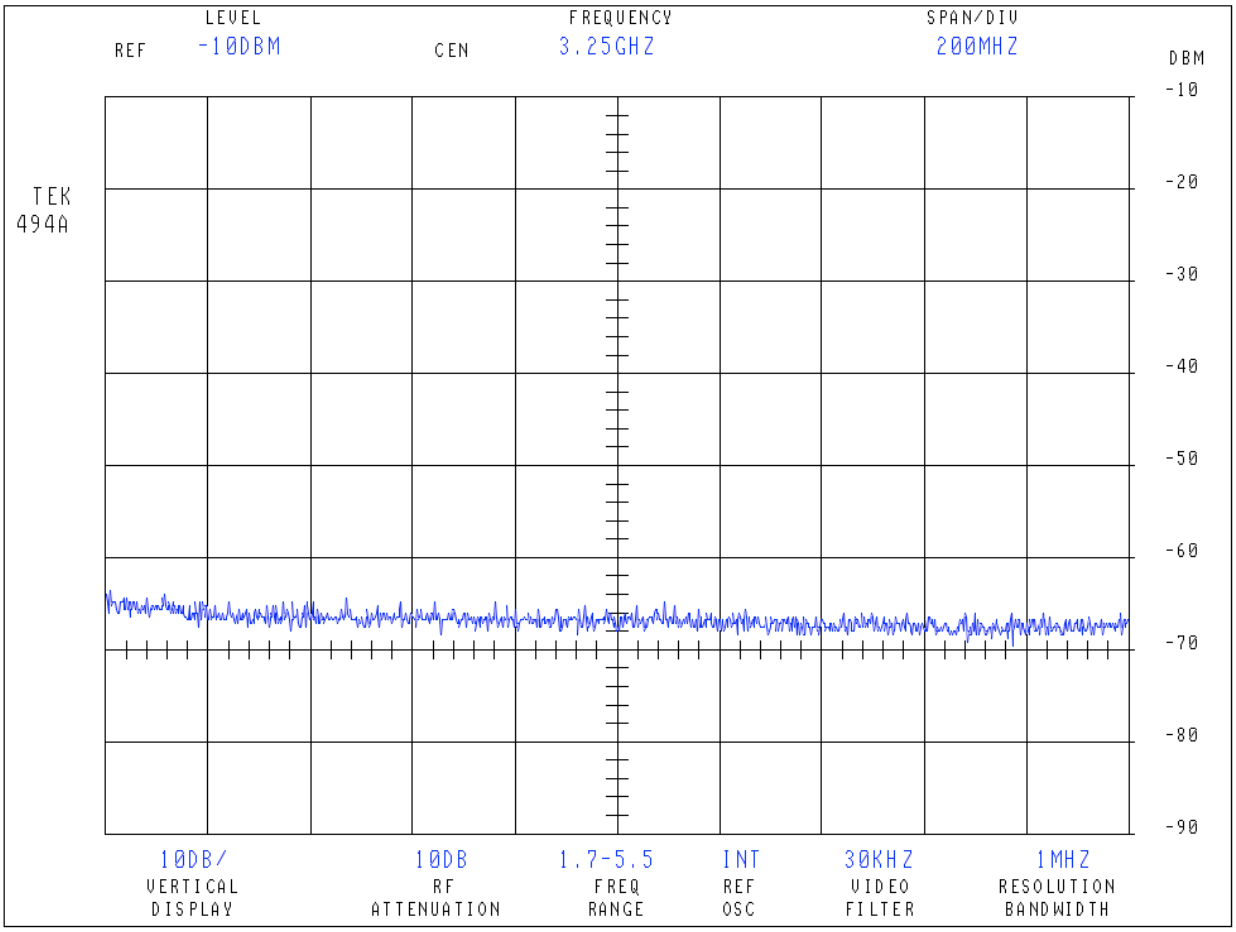

Figure 5. PPC-10G - Spurious Emissions High Band

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3.5 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

3.5.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2014. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The emissions were measured using the following resolution bandwidths:

Table 9: Spectrum Analyzer Settings

Frequency Range	**Resolution Bandwidth**	**Video Bandwidth**
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	<30 Hz (Avg.), 1MHz (Peak)

Note: For the transmitter spurious emissions, no emissions were detected. Ambient emissions measurements have been provided.

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Table 10: Radiated Emission Test Data TX on

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
35.80	V	90.00	1.00	32.00	-8.0	15.9	100.0	-16.0
116.37	V	180.00	2.00	32.60	-11.0	12.0	150.0	-22.0
126.86	V	0.00	0.00	32.50	-10.5	12.6	150.0	-21.5
145.49	V	0.00	0.00	47.60	-12.1	59.8	150.0	-8.0
317.00	V	90.00	1.00	38.00	-9.0	28.2	200.0	-17.0
400.00	V	0.00	0.00	46.60	-6.6	99.4	200.0	-6.1
500.00	V	180.00	1.00	39.50	-3.8	61.2	200.0	-10.3
35.80	H	0.00	0.00	34.00	-8.0	20.0	100.0	-14.0
116.37	H	0.00	0.00	32.20	-11.0	11.4	150.0	-22.4
126.86	H	0.00	0.00	31.50	-10.5	11.3	150.0	-22.5
145.49	H	0.00	0.00	39.50	-12.1	23.5	150.0	-16.1
317.00	H	0.00	0.00	36.30	-9.0	23.2	200.0	-18.7
400.00	H	0.00	0.00	49.50	-6.6	138.9	200.0	-3.2
500.00	H	0.00	0.00	42.00	-3.8	81.6	200.0	-7.8

Table 11: Radiated Emission Test Data TX on Spurious

Above 1 GHz, the measurements were performed with the transmitter link active. Off-axis spurious emissions were measured to a frequency of 200 GHz.

Freq (MHZ)	POL	Raw analyzer dBuv/m Reading	CL added by analyzer	Actual CL	AF	Corrected dBuV/m	EIRP (dBm)	Limit (dBm)	Margin	
95530.00	H	13.60	20	35	47.2	75.8	-31.19	-13	-18.19	Amb
96359.00	H	12.00	20	35	47.4	74.4	-32.59	-13	-19.59	Amb
111509.00	H	12.70	20	50	23.2	65.9	-41.09	-12	-29.09	Amb
168000.00	H	12.40	20	55	23.5	70.9	-36.09	-13	-23.09	Amb
180000.00	H	12.80	20	55	23.5	71.3	-35.69	-13	-22.69	Amb
200000.00	H	14.00	20	62	23.5	79.5	-27.49	-12	-15.49	Amb

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