Nortel BWA Type Acceptance Radio Transceiver Test Report

Product Description:	31 GHz Customer Premise (CTR) Radio Transceivers
Model:	CTR 3101
Nortel BWA File #	AB6CTR3101P

MITCH HEBERT PI SPECIALIST

DATE NOVEMBER 30, 1999

WINNIPEG,

DECLARATION BY Nortel Networks BWA

The tests were performed from Sep 11 through Sep 30,1999 at the Nortel Networks BWA's EMC Laboratory in Winnipeg.

The following personnel collaborated to this project:

Mitch Hebert, PI Specialist
Eduardo Atanacio, PI Tech

Testing was performed and supervised by the undersigned. The test supervisor attests to the accuracy of the test data recorded in this report.

Performed by: Eduardo Atanacio	Date September 30, 1999
Supervised by: Mitch Hebert	Date September 30, 1999

Total number of pages: 47.

The results presented in this report refer only to the product(s) described in section 1.

All equipment and instrumentation used during this test have been verified and/or calibrated. All calibration certificates are traceable to the National Research Council of Canada (CNRC) and/or to the American National Institute of Standards and Technology (NIST) standards and can be provided on request.

Nortel BWA is registered ISO 9002:1998, certificate # 766.2.

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1. INTRODUCTION

Object

This test report is being submitted for type acceptance of the Nortel Networks BWA Reunion Radios operating in the LMDS Band 31.225 to 31.300 GHz. The ReUnion radios are designed to provide wide-band multi-carrier point-to-multi-point subscriber services in an efficient and cost effective manner. The adherence to the rules for LMDS radios in these bands is demonstrated in the following pages. Nortel Networks BWA is currently seeking type approval on this product.

Equipment Under Test Description

The Nortel Networks BWA 31 GHz radio product is of wide band design. The power amplifiers and the LNA are designed to provide gain over the entire 31.000 to 31.300 GHz band. The CTR is a single conversion design. A single DRO serves both the transmit and receive path. The CTR provides a maximum power output of 0.5 watt for a single un-modulated tone. Thus the power limitation requirement of FCC part 101 section 101.113 is satisfied. The following tables identify the EUT:

Model #	Description	Manufacturer	Part #
CTR3101P	Customer Transceiver	Nortel BWA	NTVG22AA

Model #	Order Code	uW Tx (GHz)	uW Rx (GHz)	RF Tx (MHz)	RF Rx (MHz)	BW	Separation
CTR3101P	NTVG22AA	31.225-31.3	31.0-31.075	450-525	225-300	75	700

Antennae

The antenna used by the CTR is the follows.

Nortel Part Number	System	Spread (degrees)	Isotropic Gain (dBi)
A0773887	Customer	2.0	36.5 min

General

Tests were performed on a production sample of the CTR, according to standards and directives indicated on the table in paragraph 1.1. All measurements were performed in accordance to the measurement procedures outlined in these standards or detailed in this report. The CTR is intended to transmit in the 31225 to 31300 MHz range of the Part 101.109 table and will be documented under NTVG22AA and FCC ID AB6CTR3101P. The complimenting BTR transmits in the 31000 to 31075 MHz section of the Part 101.109 table and will be documented under NTVG21AA and FCC ID AB6BTR3101P

Results

The following table summarizes the EUT test results of the testing described in this report:

Standard	Test Description	Para. No.	Results
FCC part 101 section 101.111 (a) (4)	Spectral Mask		Compliant
FCC part 2, section 2.997;	Conducted Emissions except mask region	2	Compliant
FCC part 2, Section 2.997,	Radiated Emissions except mask region	3	Compliant
TSB10F – June 1994	Adjacent Channel Interference	4.2.1	Compliant
TSB10F – June 1994	Co-Channel Interference	ANNEX B	Compliant
FCC part 2, Section 2.995 (a) (1), (b) and FCC part 101 section 101.107	Frequency Stability Over Temperature	4	Compliant

Test Facilities Description

The Nortel Network BWA EMC facility is a shielded 3m room. The room is provided with input voltage of 120 and 240 V ac, which is filtered through Corcom filters before entry. Due to lab construction, the radiated measurements were performed in an open lab environment. A reference sweep was taken to demonstrate the ambient conditions.

Test Equipment

The following is a list of test equipment used to perform all tests described in this report.

Equipment	Manufacturer	Model	Serial or Asset #	Cal due (Y/M/D)
Spectrum Analyzer	Hewlett Packard	HP 8665E	02940	10/00
Spectrum Analyzer	Hewlett Packard	HP 8663E	3611A05001	09/00
Synthesized Sig. Gen.	Anritsu	69369A	981807	04/00
Power Meter	Anritsu	ML2438A	97400074	07/00
Power Sensor	Anritsu	MA2475A		07/00
Mixer Assembly 40 to 60 GHz	Millitech/Nortel BWA	MHB-19-RD3A0	MS-118086	08/00

Equipment	Manufacturer	Model	Serial or Asset #	Cal due (Y/M/D)
Mixer Assembly 60 to 90 GHz	Millitech/Nortel BWA	MHB-12-RD3A0	MS-118101	08/00
Mixer Assembly 90 to 140 GHz	Millitech/Nortel BWA	MHB-08-RD3A0	MS-118090	08/00
Mixer assembly 140-170 GHz	Millitech/Nortel BWA	CDA-06-DC0253	017-8943	03/00
Power Supply	Hewlett Packard	6544A	US36390168	-----
Power Supply	Hewlett Packard	6554A	US36340233	-----
Frequency Counter	XL microwave	3460	980338143	04/00
Antenna Bilog 30 to 1000 MHz	Shaffner-Chase	CBL6112B	2261	06/00
Horn Antenna 1 to 18 GHz	EMCO	3115	9711-5345	06/00
Horn Antenna 14 to 40 GHz	Shaffner-Chase	BBHA 9170	9046	06/00

2. CONDUCTED EMISSIONS

Tested by: Mitch Hebert and Eduardo Atanacio

Test was performed to validate the requirements specified in FCC part 101 Section 101.111 (a)(2)(iii)

Test Conditions

Temperature	22 to 25C,
Primary Voltage	CTR +18 V dc

Test Results

The EUT does comply with the specification referenced in the Part 101.111 requirement.

Measurement Data

See on Appendix A for test results and setup photographs.

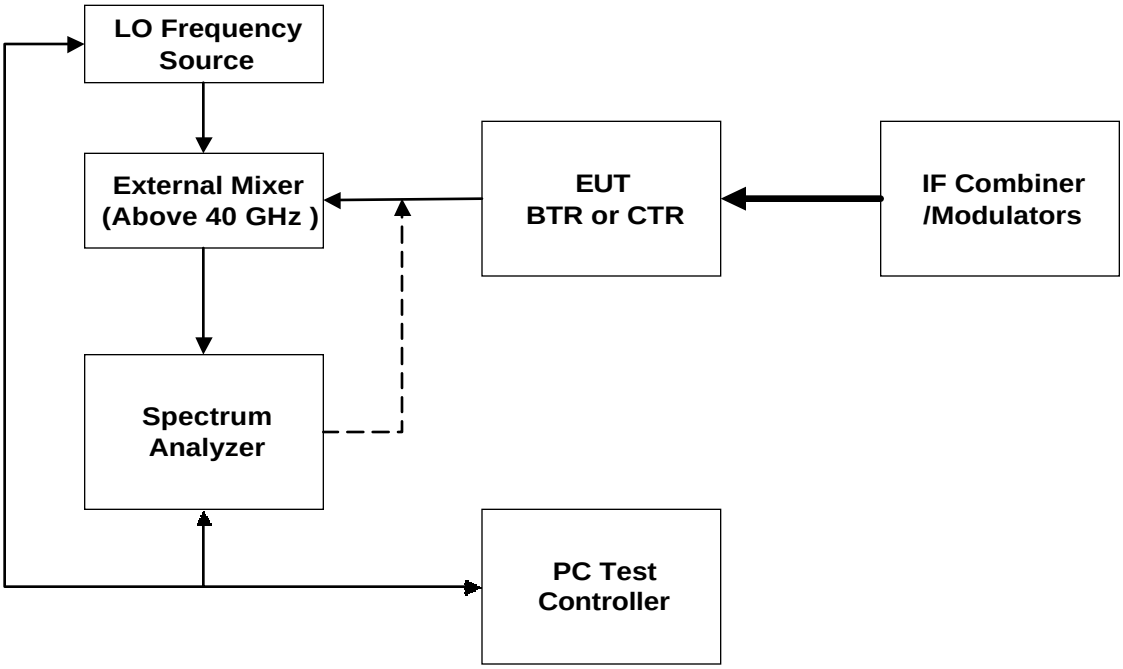
Test Method

Nortel processing equipment stimulated the EUT (CTR) with digitally modulated 16 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the CTR. The output is examined directly by a spectrum analyzer for up to frequencies of 40GHz. External mixers are used for frequencies greater than 40GHz. A synthesized frequency generator stimulates the external mixer's local oscillator input. The spectrum analyzer, synthesized generator and all calculations are administered by a Labview software application on a PC.

Test System Test Configuration

Figure 1.0 presents a simplified block diagram of the conducted emissions test set-up. For measurements above 40GHz, a PC controlled a synthesized generator programming the LO frequency input to the external mixer, so that the difference frequency between what is measured and the LO frequency is 100MHz. Below 40GHz, the output of the EUT was directly connected to the input of the spectrum analyzer.

A reference passband response is recorded, of four 16 QAM modulated carriers, occupied bandwidth of 20MHz for the CTR .he measured reference is used to determine the out of band emissions, by measuring the relative differences between the reference and the measured emission.


LO Frequency Source
External Mixer (Above 40 GHz)
EUT BTR or CTR
IF Combiner /Modulators
Spectrum Analyzer
PC Test Controller

3. RADIATED EMISSIONS

Tested by: Mitch Hebert and Eduardo Atanacio

Test was performed to validate the requirements specified in FCC part 2, section 2.997; and FCC part 101 Section 101.111.

Test Conditions

Temperature	20-25C,
Primary Voltage	CTR +18 V dc

Test Results

The EUT does comply with the specification referenced in the Part 101.111 requirement.

Measurement Data

See on Appendix B for test results and setup photographs.

Test Method

Nortel processing equipment stimulated the EUT (CTR) with digitally modulated 16 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the CTR. The output is examined directly by a spectrum analyzer for up to frequencies of 40GHz. External mixers are used for frequencies greater than 40GHz. A synthesized frequency generator stimulates the external mixer's local oscillator input. The spectrum analyzer, synthesized generator and all calculations are administered by a Labview software application on a PC.

Test System Configuration

Figure 2.0 presents a simplified block diagram of the radiated emissions test set-up. For measurements above 40GHz, the antennae is positioned 30cm from the EUT; a PC controlled a synthesized generator programming the LO frequency input to the external mixer, so that the difference frequency between what is measured and the LO frequency is 100 MHz. External mixers are connected to Millitech horn antennae, covering the band 40 to 60GHz, 60 to 90GHz, 90 to 140GHz and 140 to 170 GHz. Below 40 GHz, the antenna is positioned 1m from the EUT; the input to the spectrum analyzer was connected to various antennas a Chase 30 to 1000MHz bilog, EMCO 1 to 18GHz horn, and Chase 14 to 40GHz horn.

A reference passband response is recorded, of four 64 QAM modulated carriers, occupied bandwidth of 40 MHz for the BTR and two for the CTR occupying 20 MHz. The test antennae and the EUT antenna are positioned at a given distance, to produce a maximum amplitude response of the passband. The antennae are held in this position during the entire testing of up to 170 GHz. The measured reference is used to determine the out of band emissions, by measuring the relative differences between it and the measured emission.

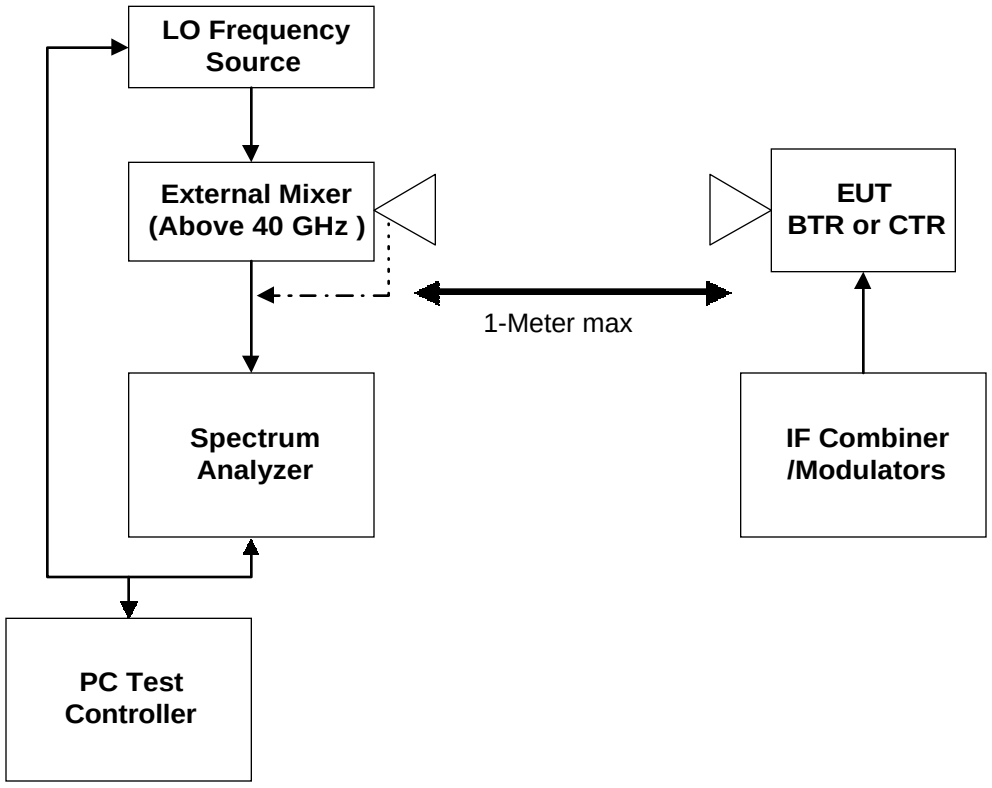


Figure 2.0: Test Setup Configuration for Radiated Emissions

4. TEMPERATURE STABILITY TESTS

Tested by: Mitch Hebert and Eduardo Atanacio

Test was performed to the validate the requirement of part 101, section

Test Conditions

Temperature	-40C to +50C,
Primary Voltage	CTR +18 V dc

Specifications

Requirement specified in FCC part 101, section 101.107, and frequency tolerance of ±0.01%

Test Results

The CTR complies with the frequency tolerance stated in the specification paragraph

Measurement Data

See on Appendix C for test setup and photographs.

Test Method

Tests were performed on a CTR, these units were placed into a temperature chamber, and the temperature profile used for temperature is referenced in FCC part 2, section. A base line frequency measurement is made at first ambient temperature. With the power not applied to the EUT, the temperature is then decreased by the programmed interval (10C) and allowed to "soak" for a period time specified by the user.(20min). This time allows the internal component temperature to stabilize. Once the plateau has been achieved, the power is applied to the EUT and the frequency is measured to 6 significant digits.

Test System Configuration

Figure 3.0 presents a simplified block diagram of the temperature stability test set-up. The PC controls the temperature profile of the temperature chamber. The specified temperature profile is –40°C to +50°C.

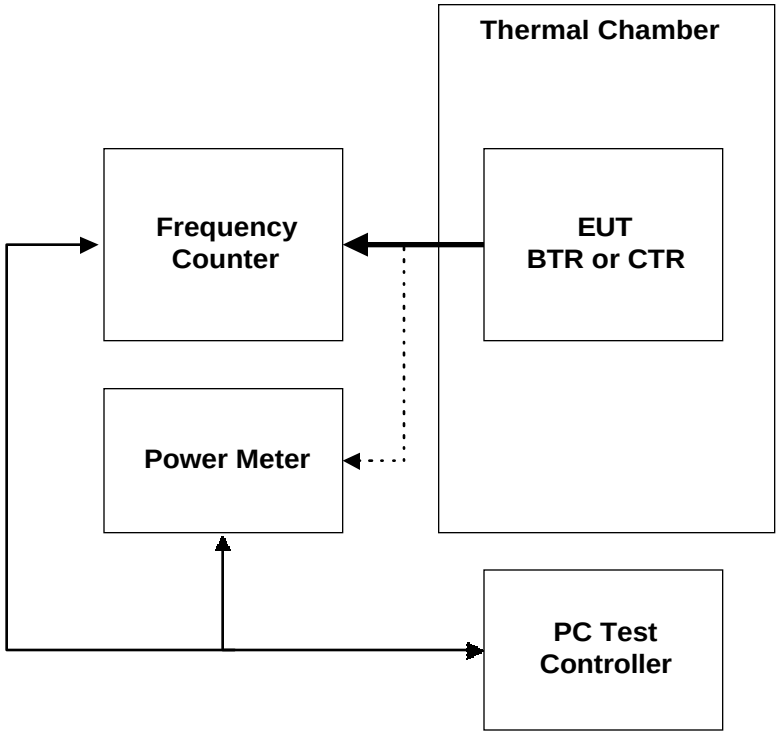


Figure 3.0: Test Setup Configuration for Temperature Stability Tests

5. CO/ADJACENT CHANNEL TEST

Tested by: Mitch Hebert

Test Conditions

Temperature	25C,
Primary Voltage	BTR -48 V and for CTR +18 V dc

Minimum Specifications

As specified in Part 101.105(c)(6), the protection criteria shall be at least 0dB for adjacent channel and as found in TIA Bulletin TSB-10 Table B-1, the limits for 4, 16 and 64 QAM are 19.5, 26.9 and 33.1 dB respectively for co-channel.

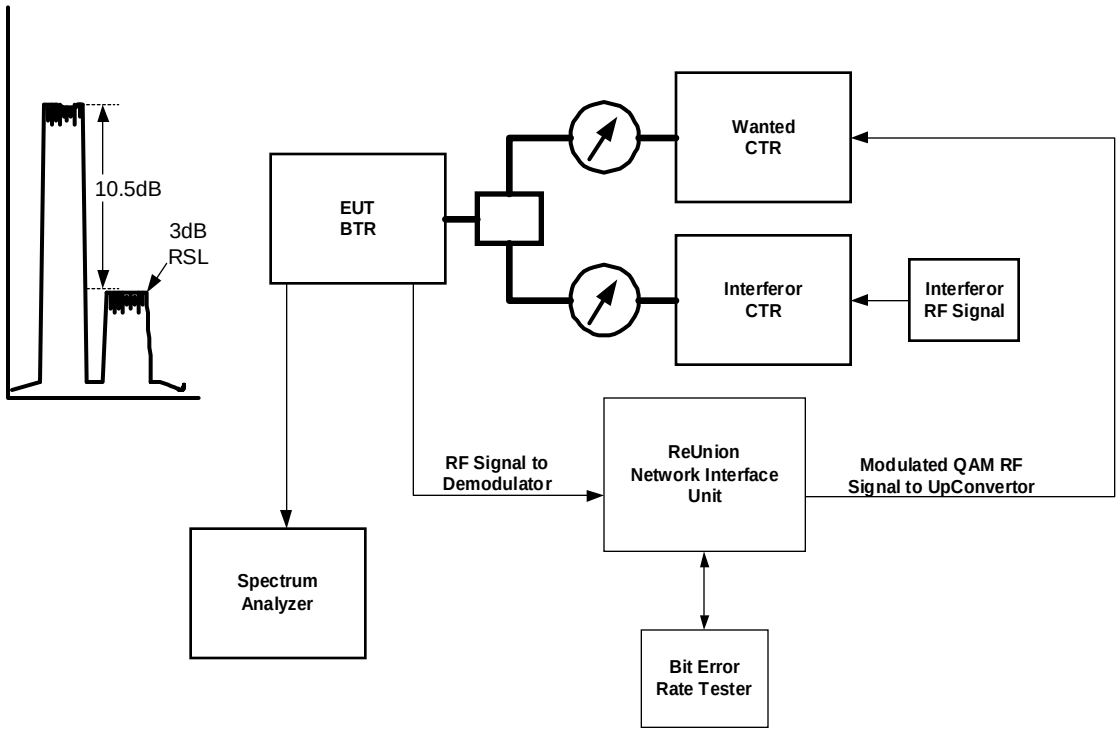
Adjacent Channel Test Method

Nortel translation equipment (CTR) is stimulated with digitally modulated 16 QAM RF signals. The two signals (wanted and interferor) are combined, up-converted and fed into the microwave receive of the EUT (BTR). The wanted CTR output is adjusted such that a quality QAM signal is present. An inline vane attenuator is adjusted until a payload BER of 10^{-6} is achieved. The level is then increased by 3dB. The interfering signal is applied and adjusted such that the BER of 10^{-6} is achieved. The power density of the wanted and interfering carrier are recorded. It should be noted that the vane attenuation reading is noted and it is removed so that accurate measurements are easily made at the microwave flange of the receiver.

Co-Channel Test Method

Nortel translation equipment (CTR) is stimulated with digitally modulated 16 QAM signals. The two signals (wanted and interferor) are combined and fed into the microwave receiver of the EUT (BTR). The wanted CTR output is adjusted such that a quality QAM signal is present. An inline vane attenuator is adjusted until a payload BER of 10^{-6} is achieved. The wanted output is then increased by 3dB and the level is recorded. The interfering signal is then applied at maximum in-line attenuation. The interfering signal is adjusted until the payload BER reaches $10^{-6.}$ The interfering signal is removed. The power density of the wanted carrier is measured and recorded. The wanted carrier is then removed and the interfering signal is measured and recorded. The two measurements should be at least 20.9 dB. It should be noted that the vane attenuation reading is noted and it is removed so that accurate measurements are easily made at the microwave flange of the receiver.

Test System Test Configuration



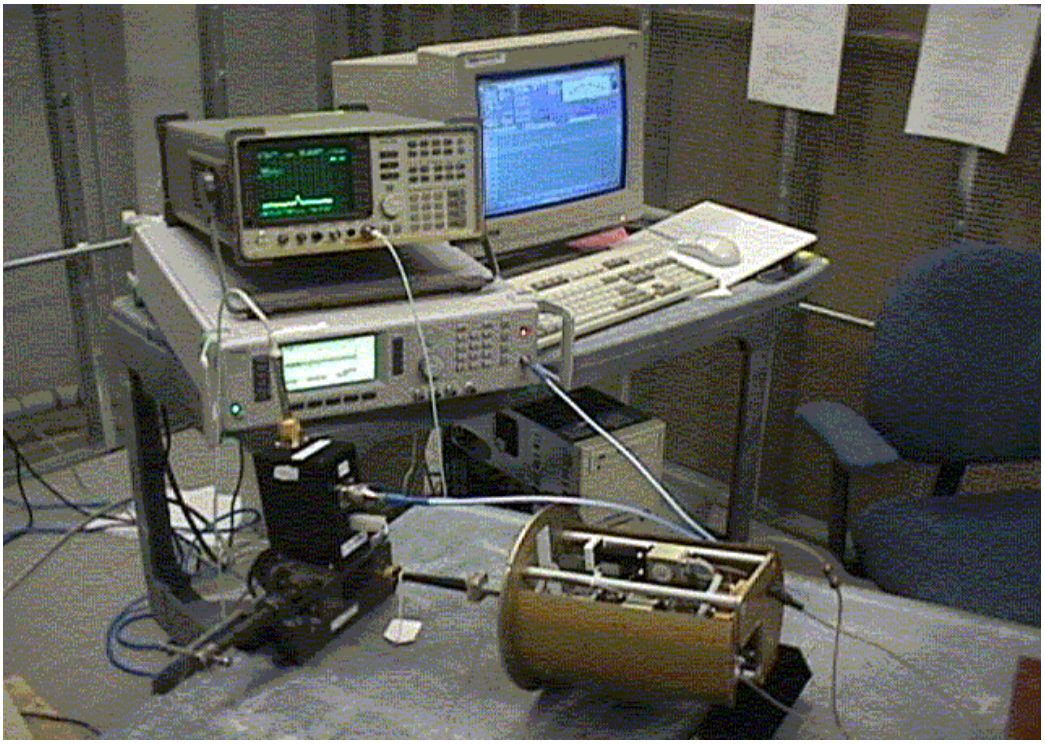
The figure below represents a simplified block diagram of the adjacent and co-channel interference test set-up. 8.0Msps carriers were used giving a bandwidth of 10MHz. Measurements at 4, 16 and 64 QAM were performed using a BER trigger metric of 3dB RSL. For ease of measurement, the relative levels were measured at the RF output of the receiver.

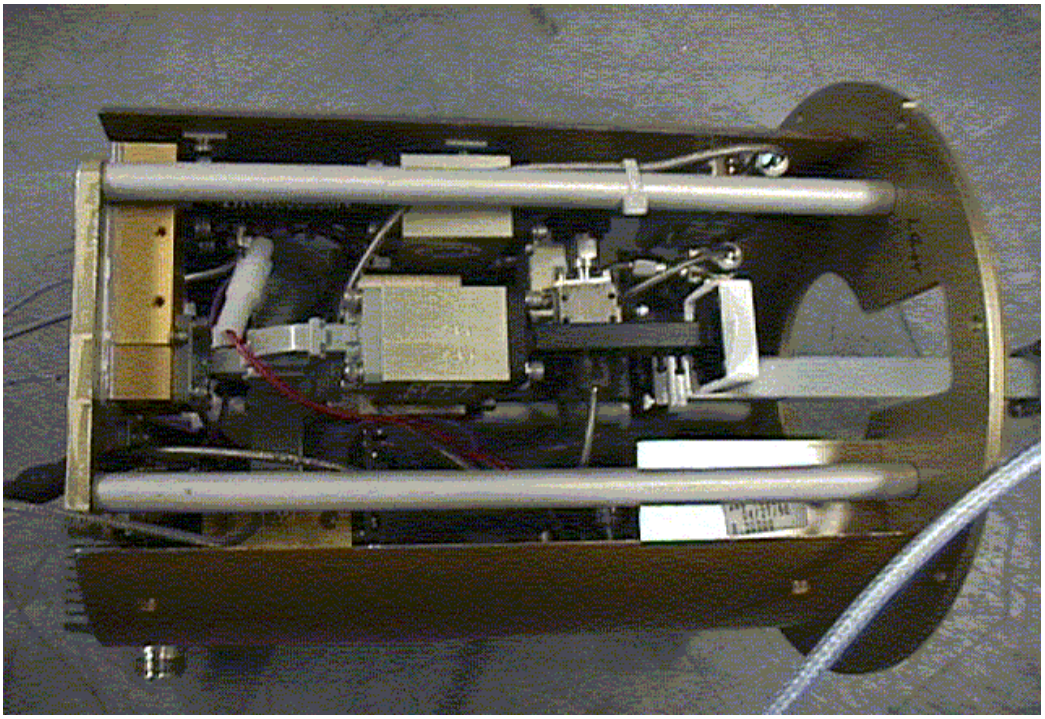
APPENDIX A

Conducted Emissions Measurement Results

6. CONDUCTED EMISSIONS MEASUREMENT RESULTS

Computer setup and instrumentation in the PI laboratory
CTR connected in the laboratory for conducted measurements





CTR with the case removed

The following pictures show 2 – 10MHz carriers across the minimum, maximum of the 75MHz band at a channel power of 11dBm

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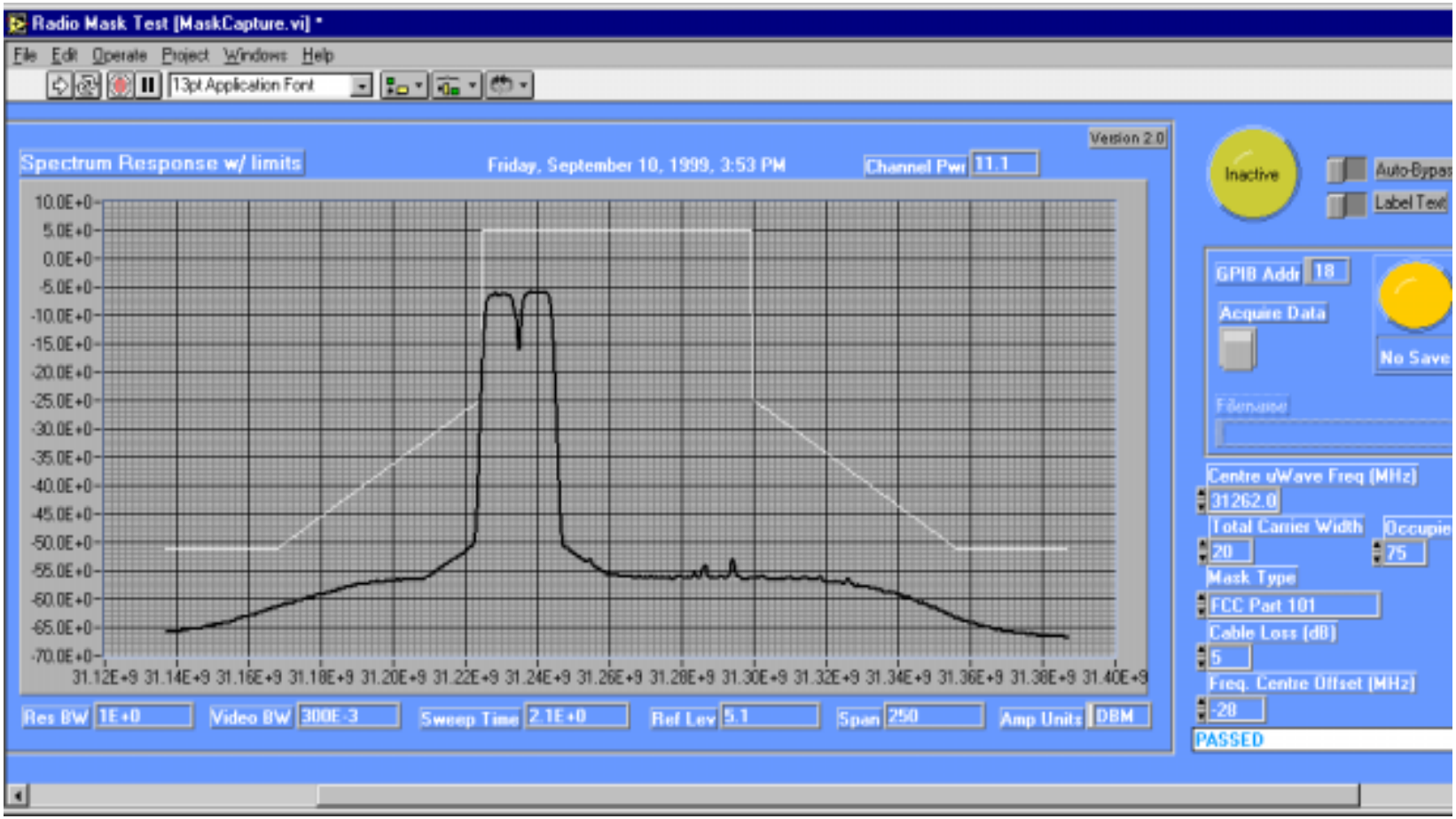
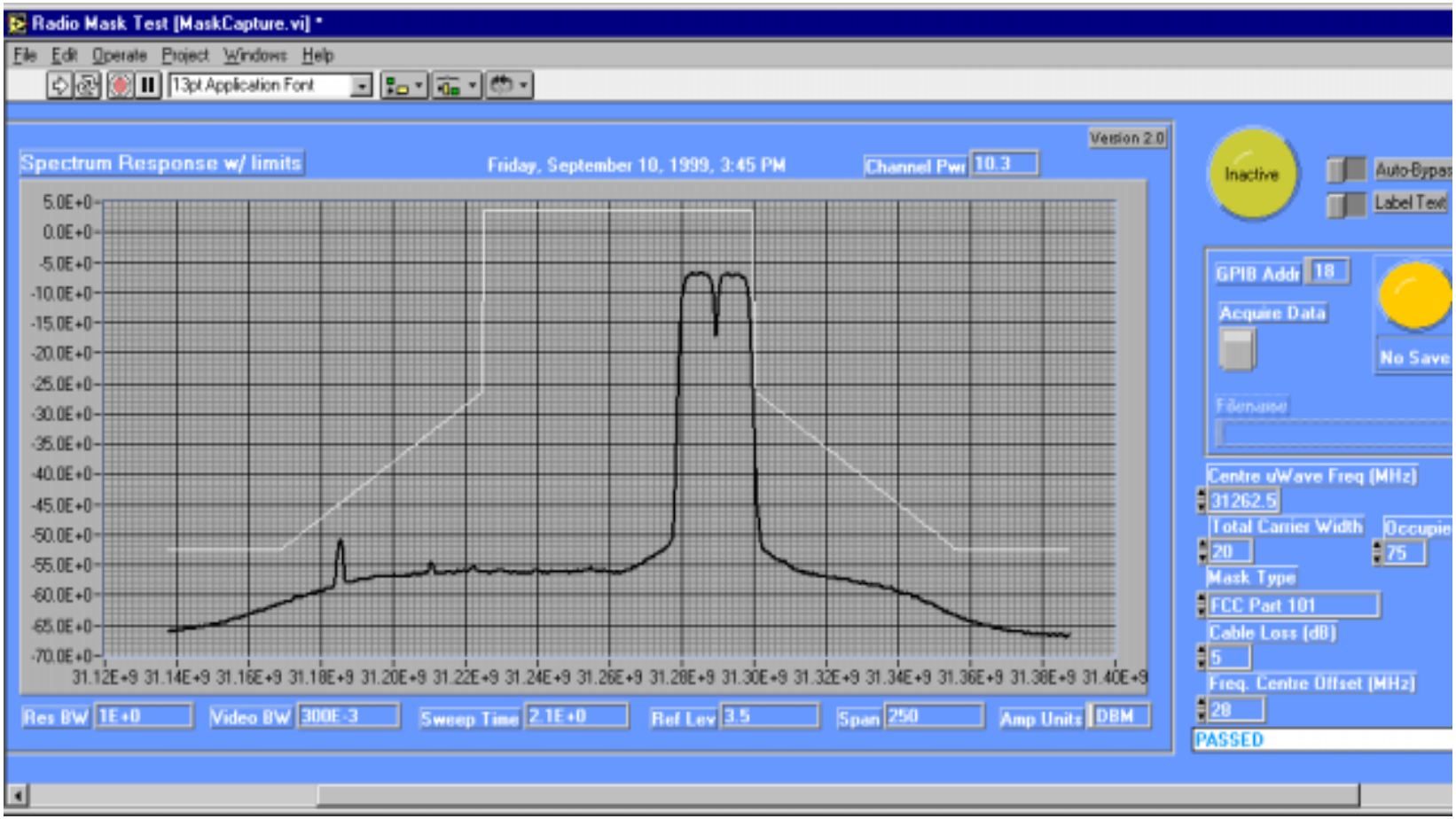
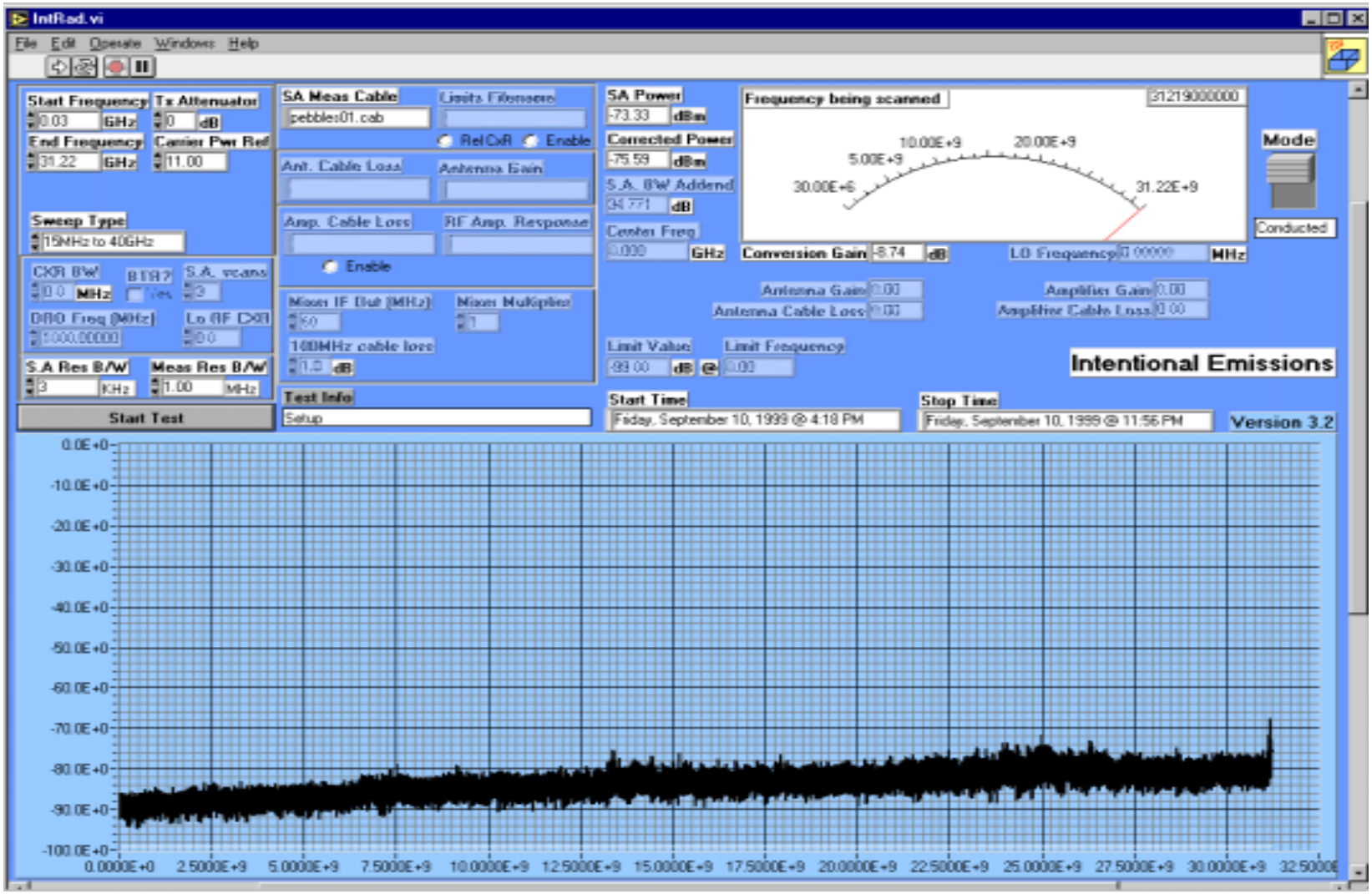
CTR 31-01P 2-10 MHz Carriers, 16 QAM (Low Side)



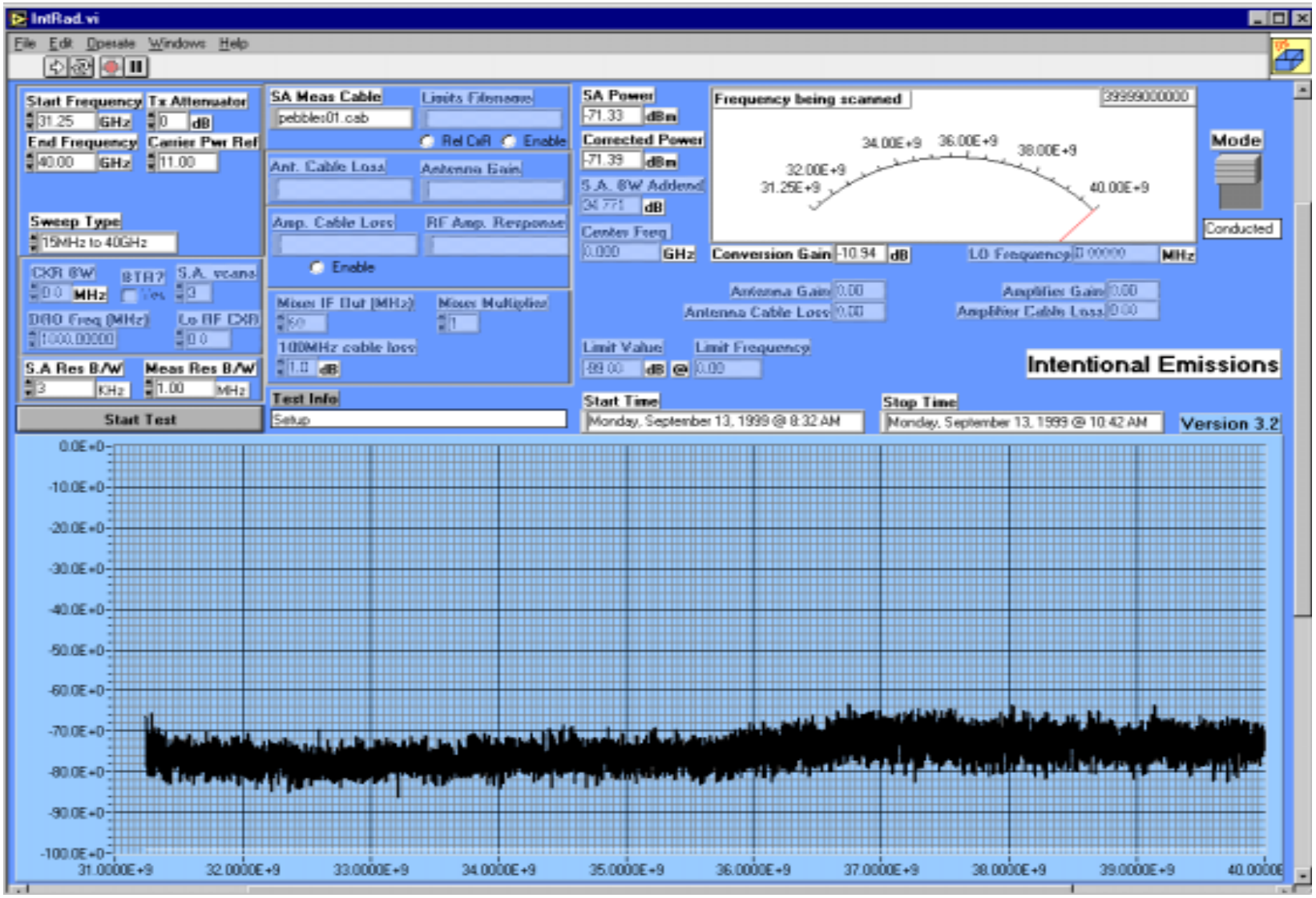
CTR 31-01P 2-10 MHz Carriers, 16 QAM (High Side)



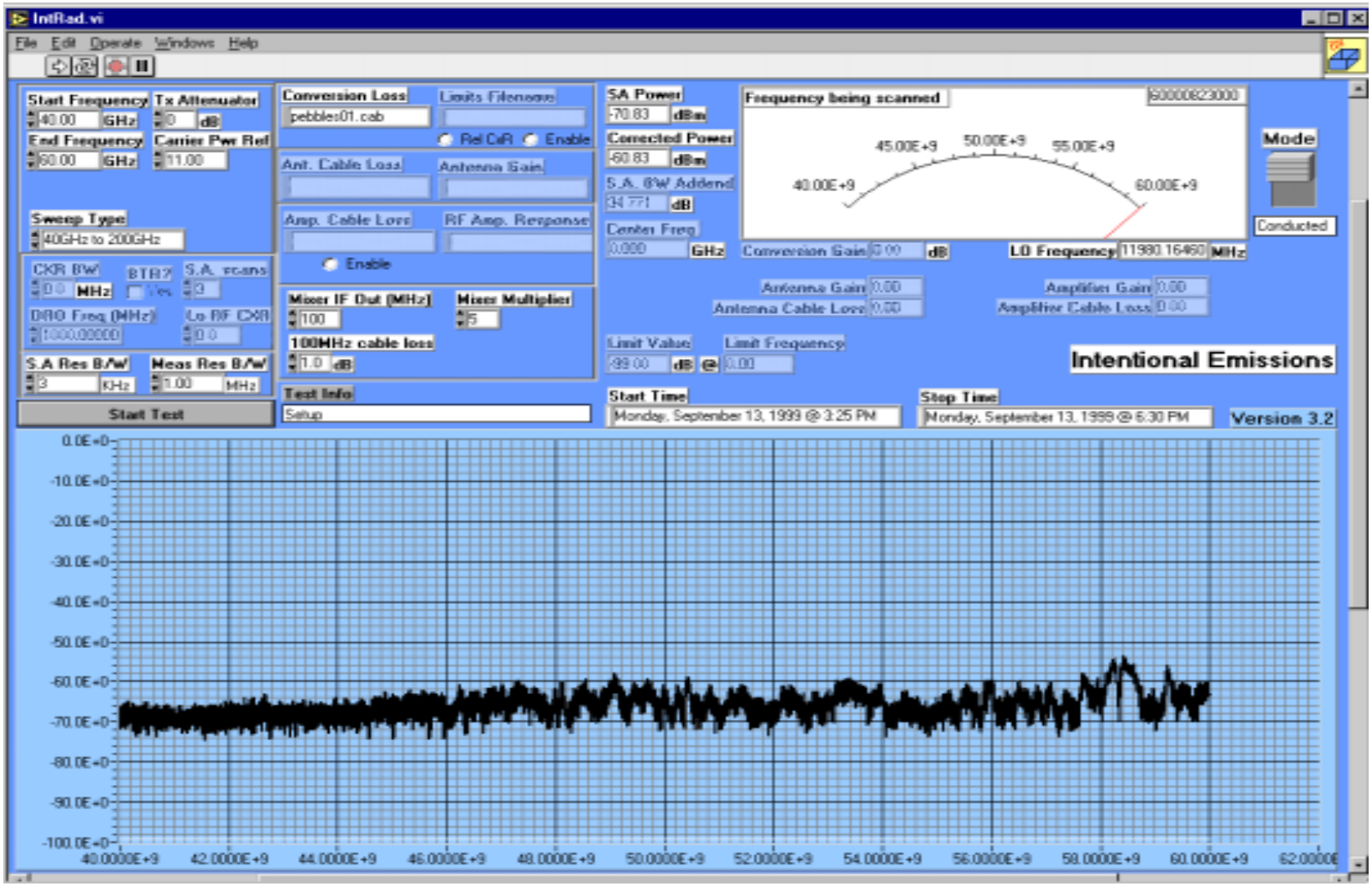
CTR 31-01P Conducted Emissions Test – 30MHz to edge of carriers



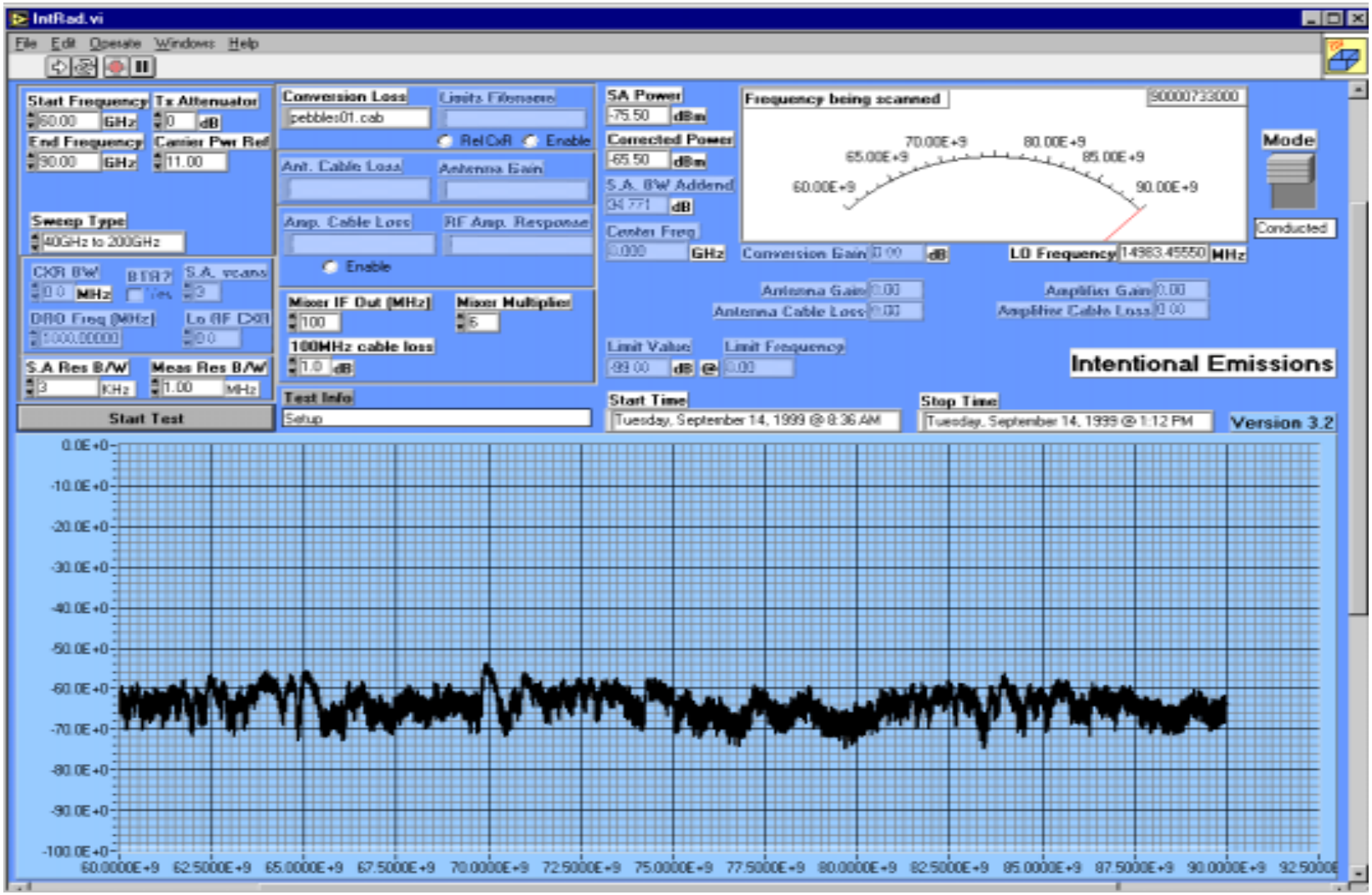
CTR 31-01P Conducted Emissions Test – edge of carriers to 40GHz



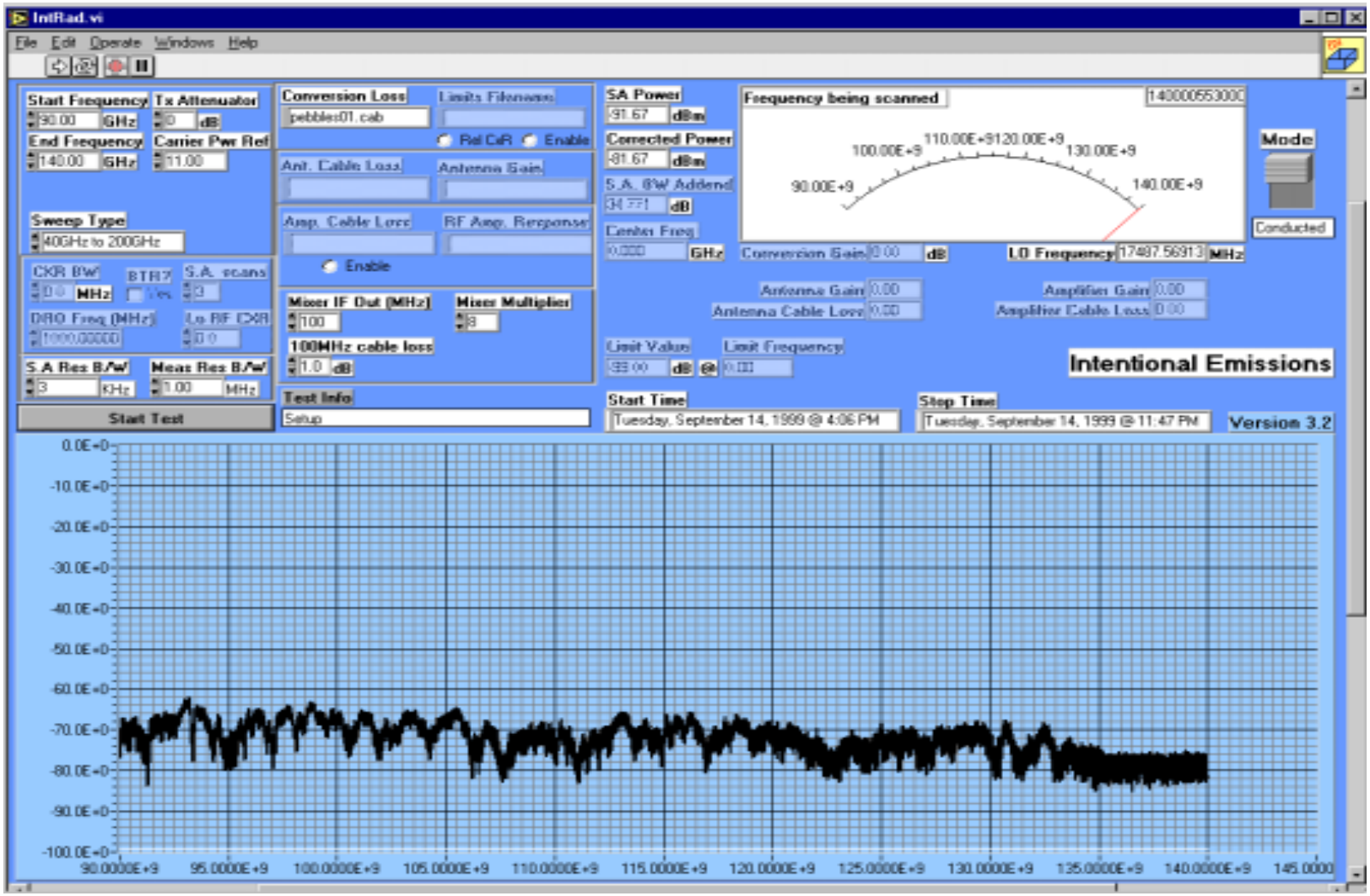
CTR 31-01P Conducted Emissions Test (40-60GHz)



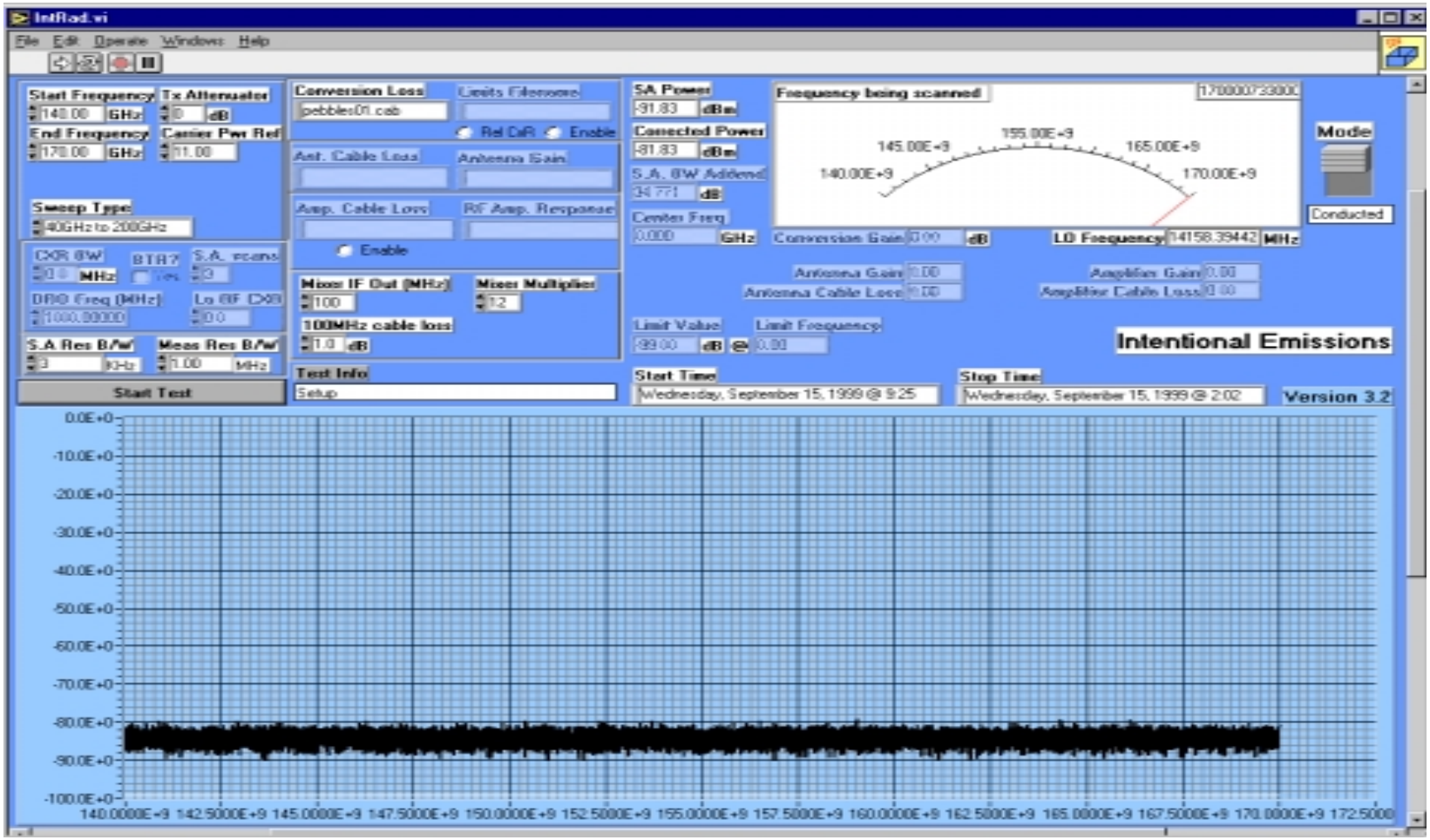
CTR 31-01P, Conducted Emissions Test. (60 - 90GHz)



CTR 31-01P Conducted Emissions Test (90 -140GHz)



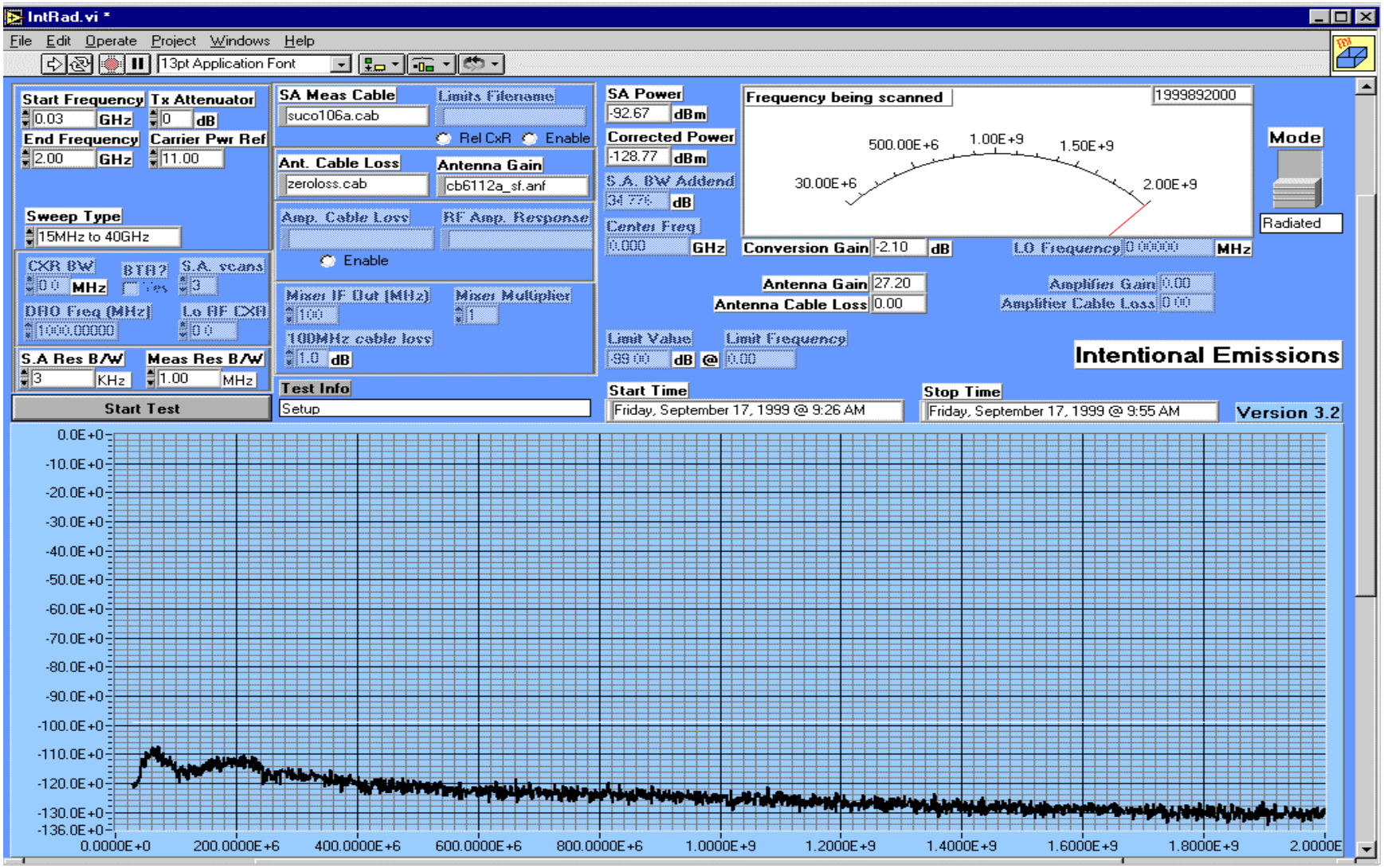
CTR 31-01P Conducted Emissions Test (140-170GHz)



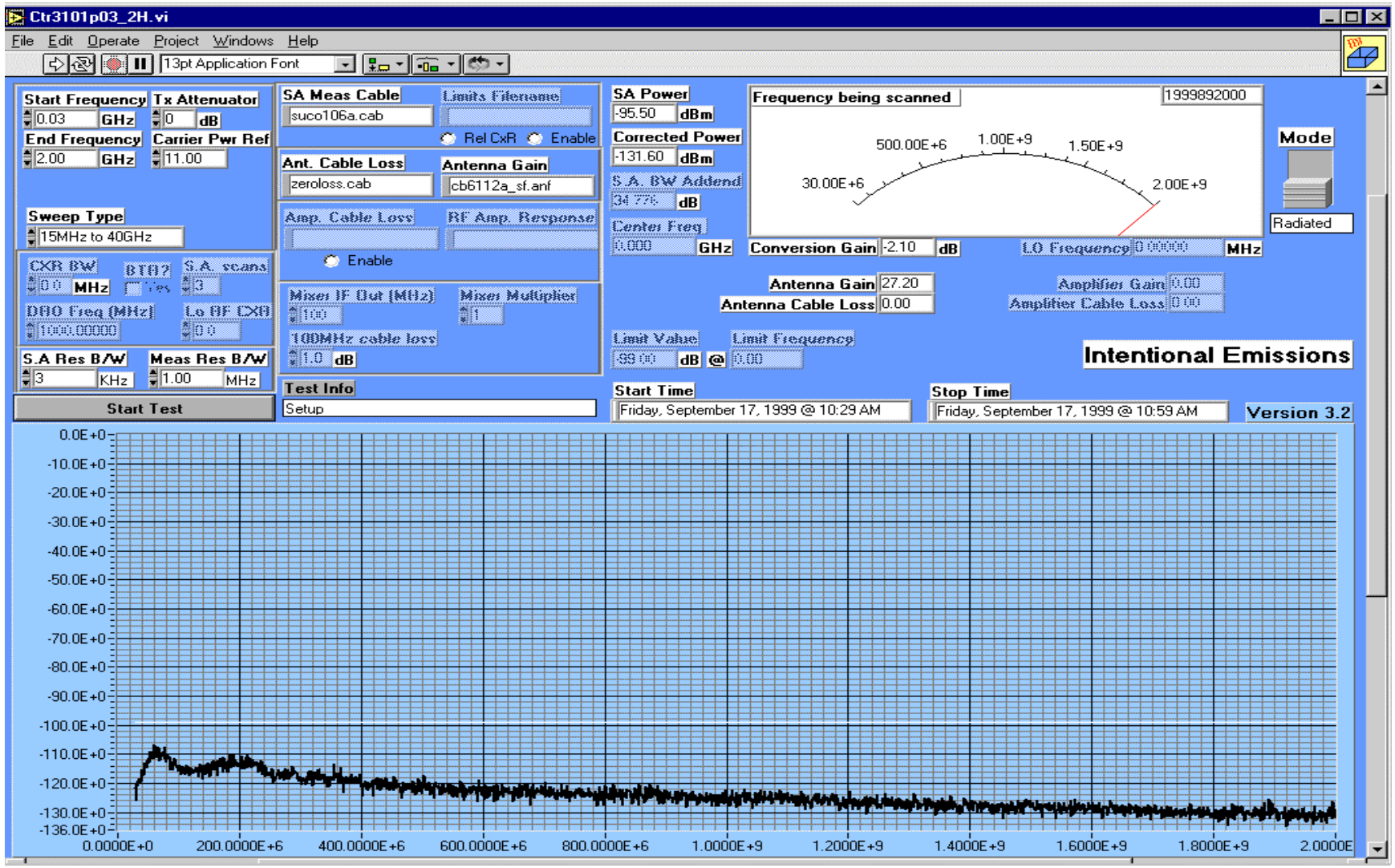
APPENDIX B

Radiated Emissions Measurement Results

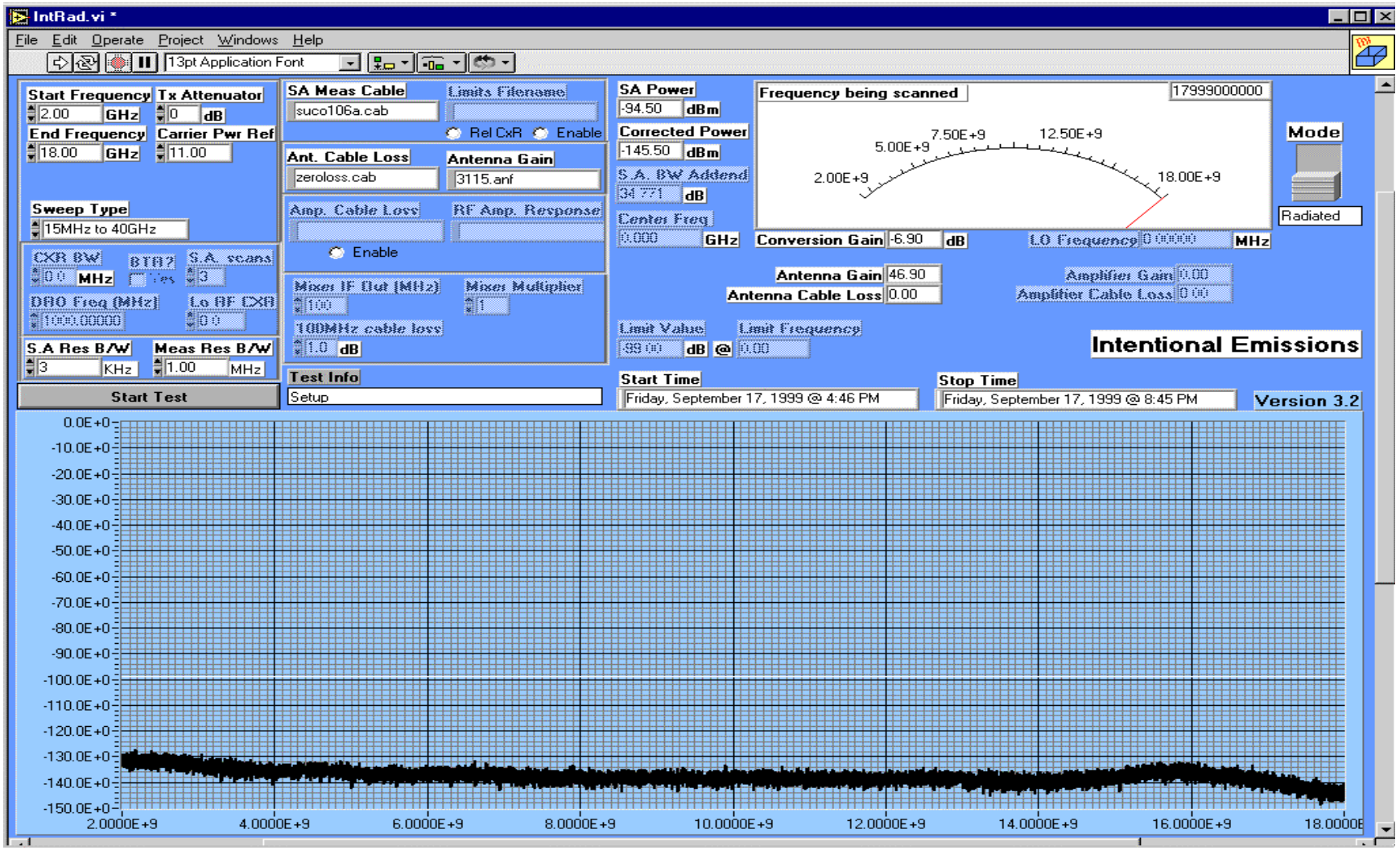
CTR 31-01P, 2 carrier QAM 64 modulated. – 30MHz to 2GHz – Horizontal



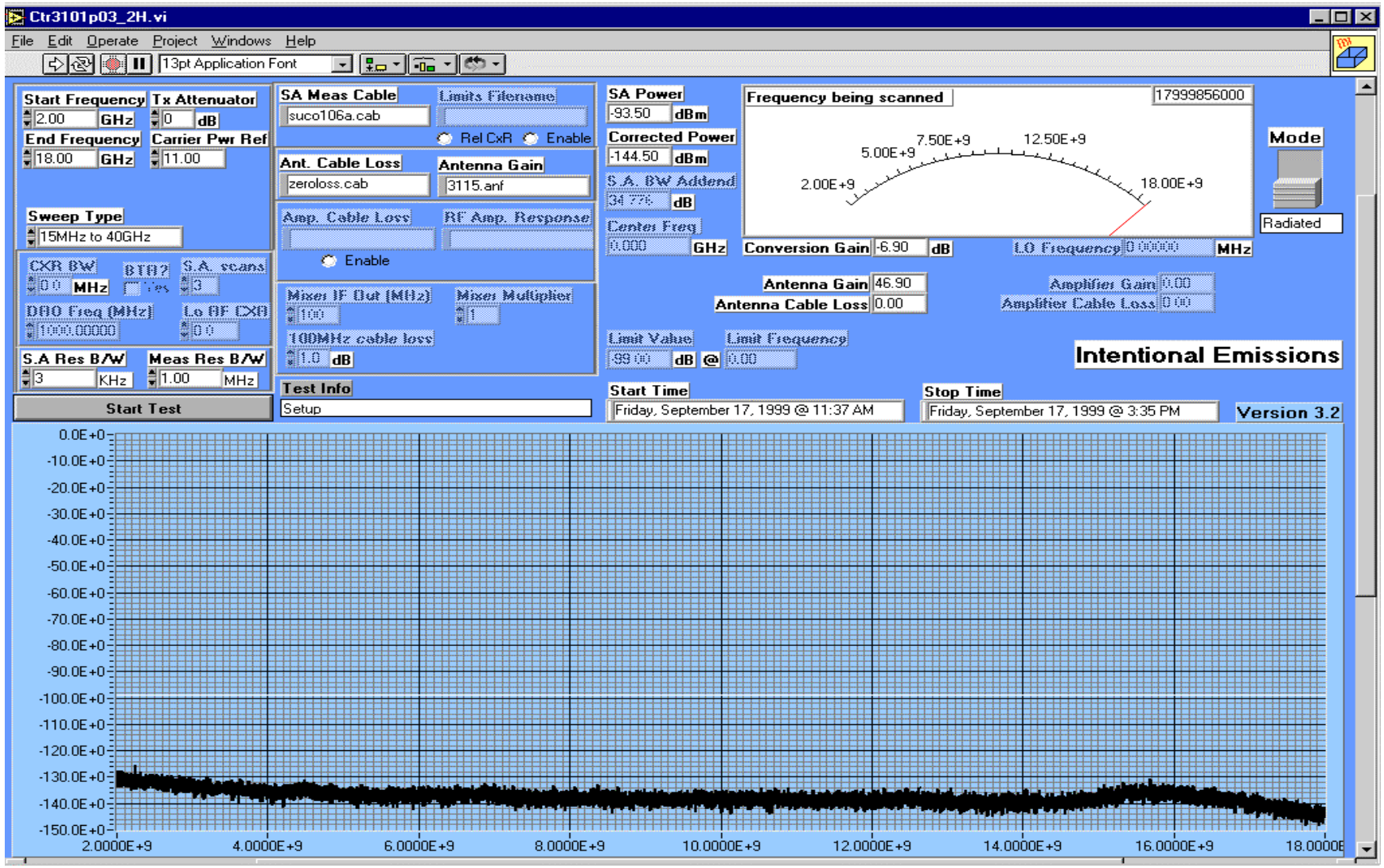
CTR 31-01P, 2 carrier QAM 64 modulated. – 30MHz to 2GHz – Vertical



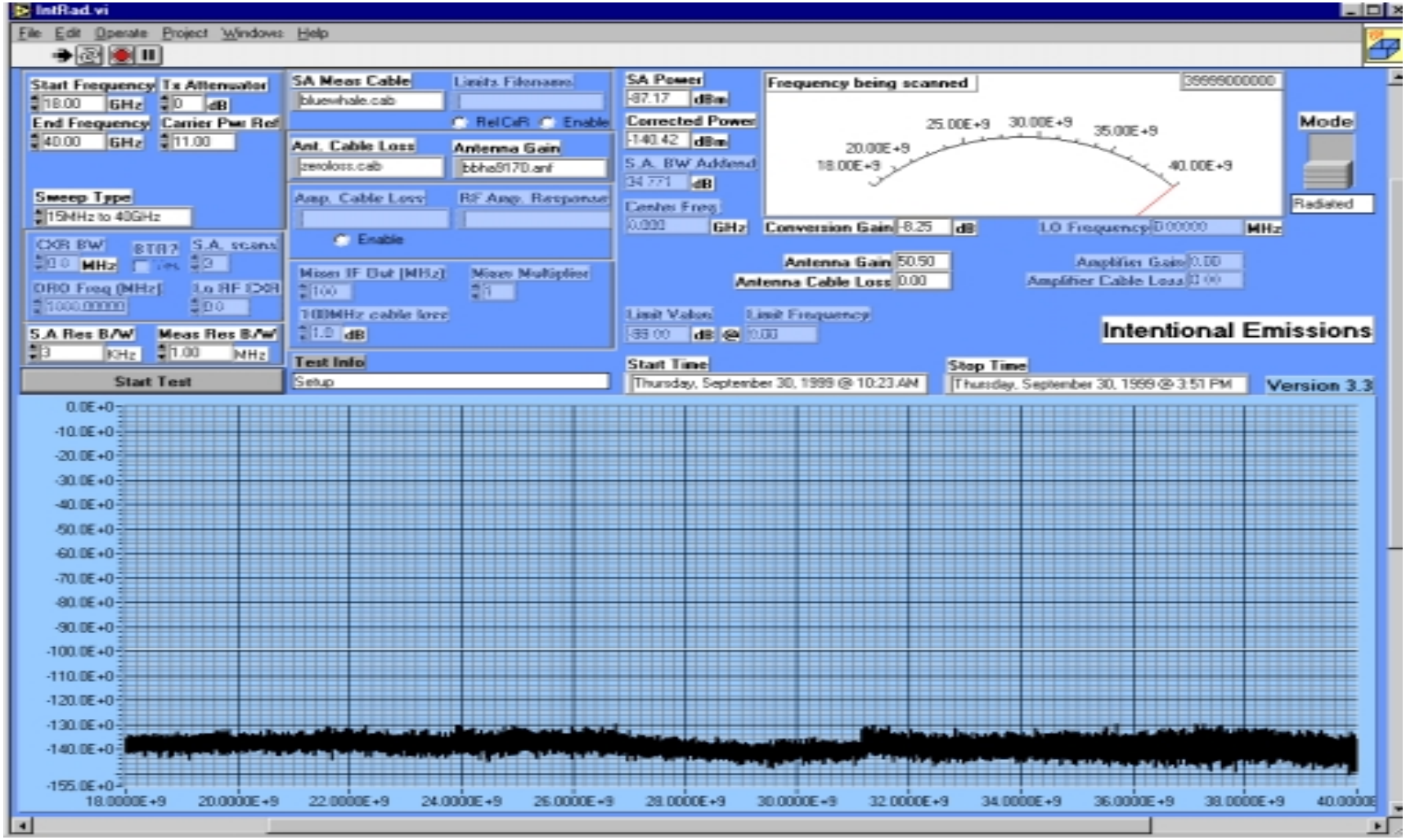
CTR 31-01P, 2 carrier QAM 64 modulated. – 2GHz to 18GHz - Horizontal



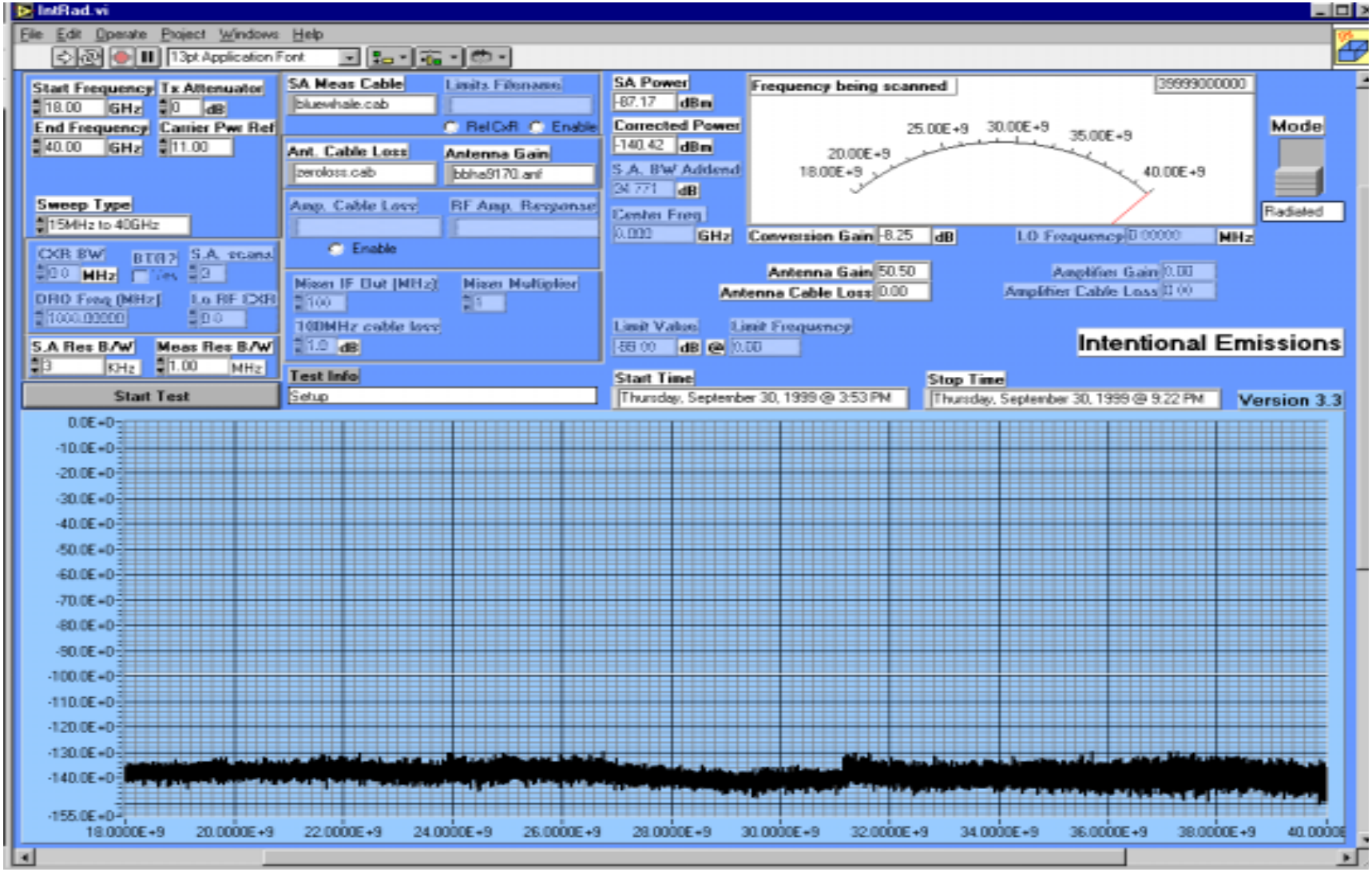
CTR 31-01P, 2 carrier QAM 64 modulated. – 2GHz to 18GHz - Vertical



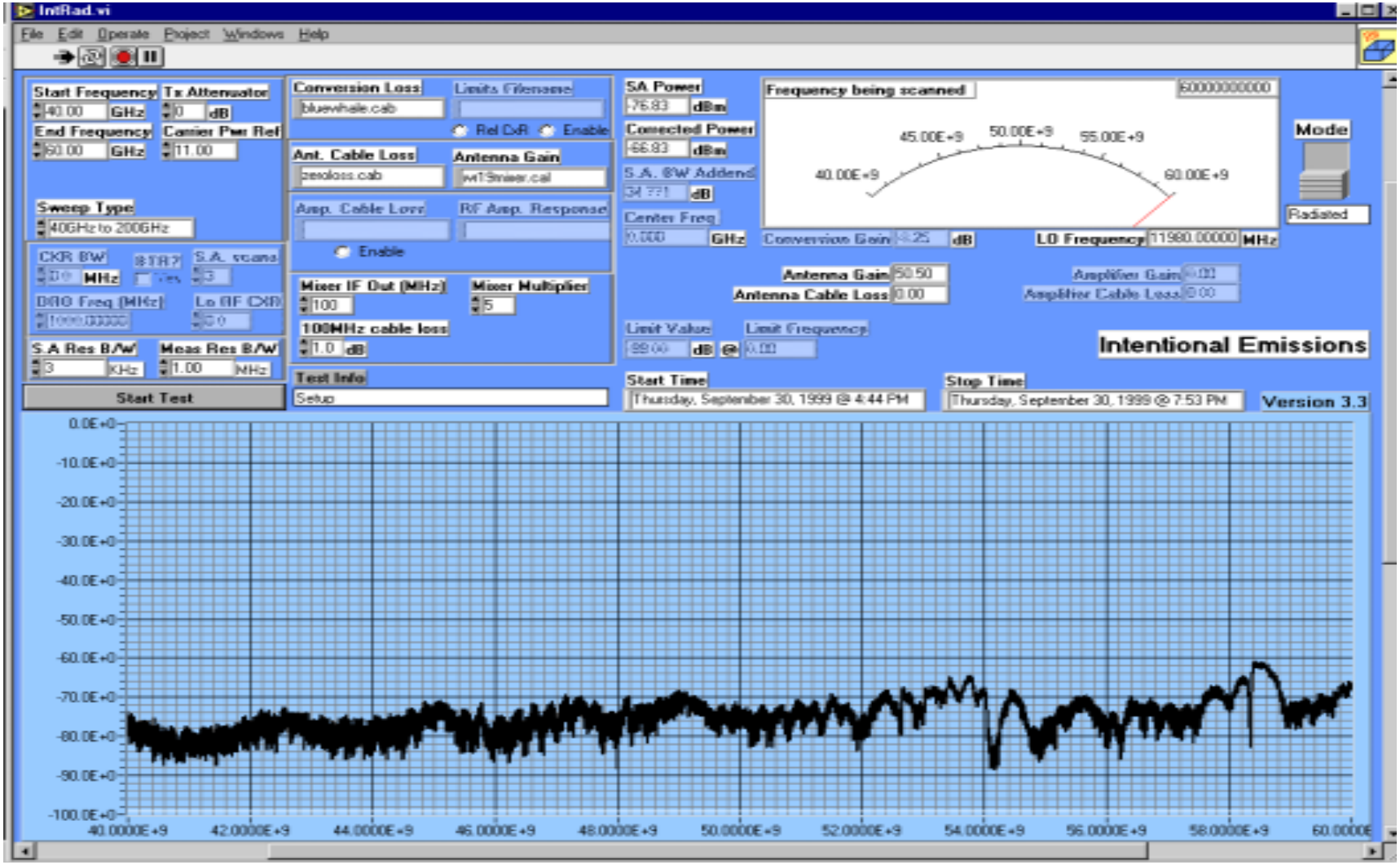
CTR 31-01P, 2 carrier QAM 64 modulated. –18GHz to 40GHz - Horizontal



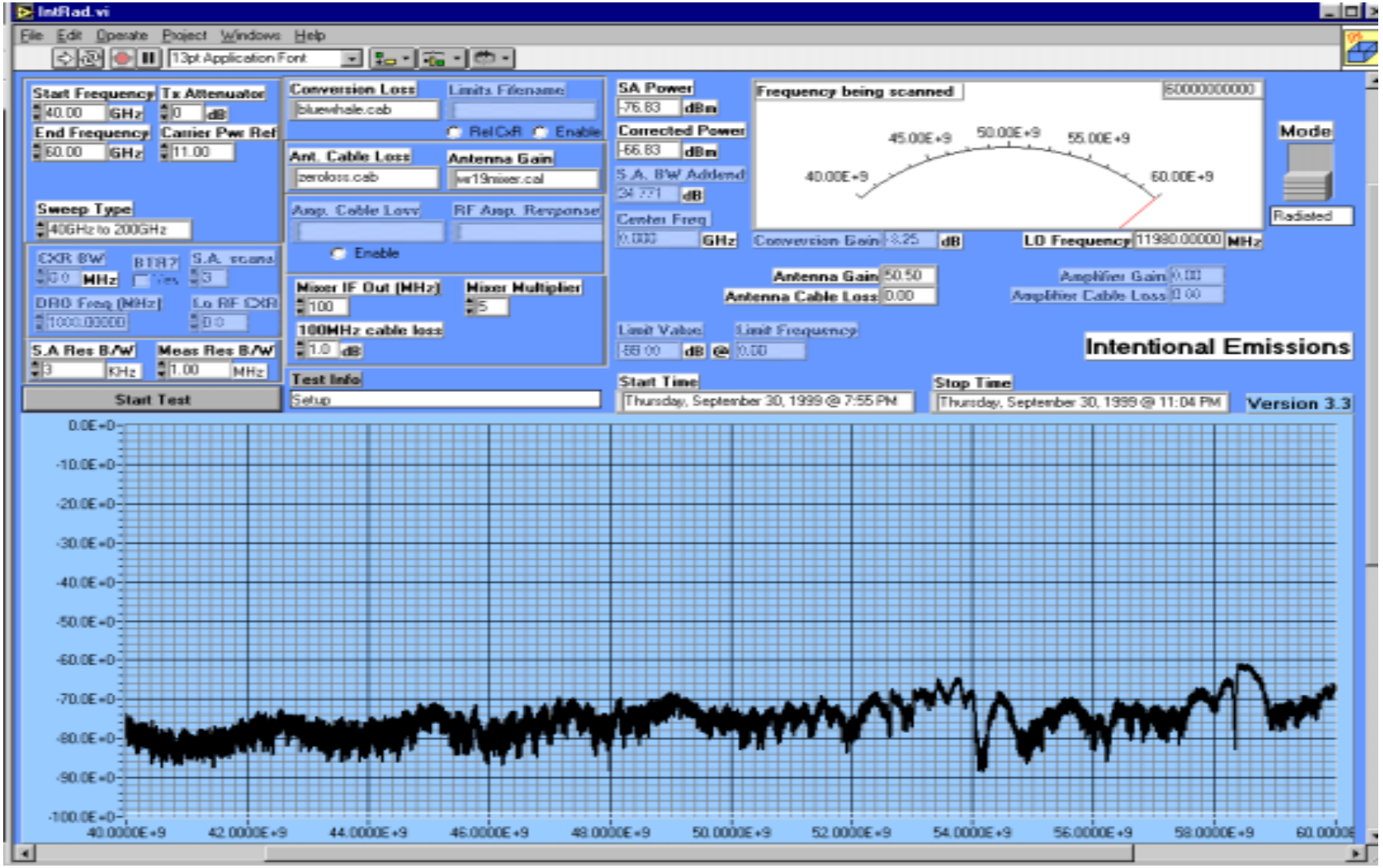
CTR 31-01P, 2 carrier QAM 64 modulated. –18GHz to 40GHz - Vertical



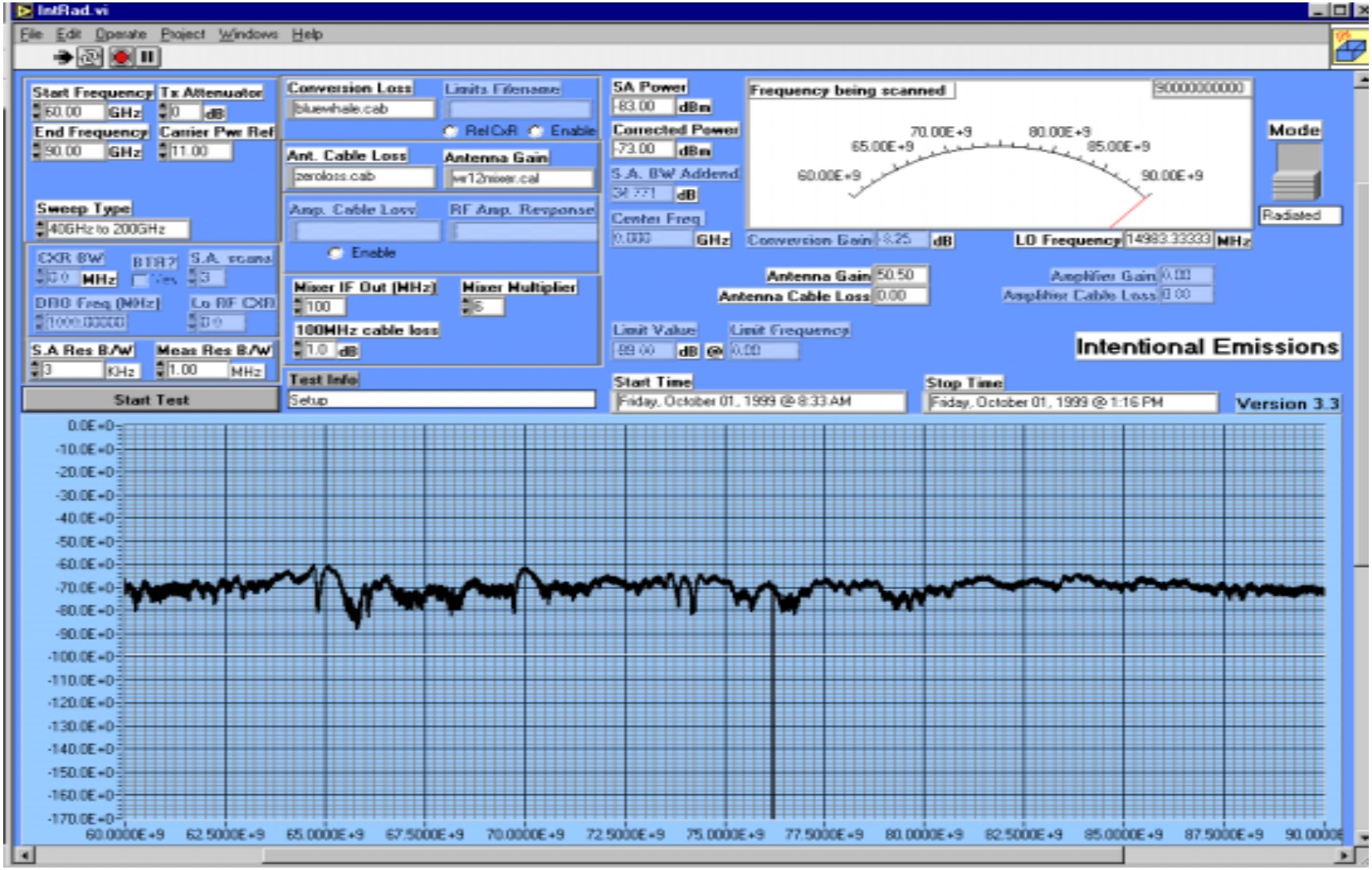
CTR 31-01P, 2 carrier QAM 64 modulated. –40GHz to 60GHz - Horizontal



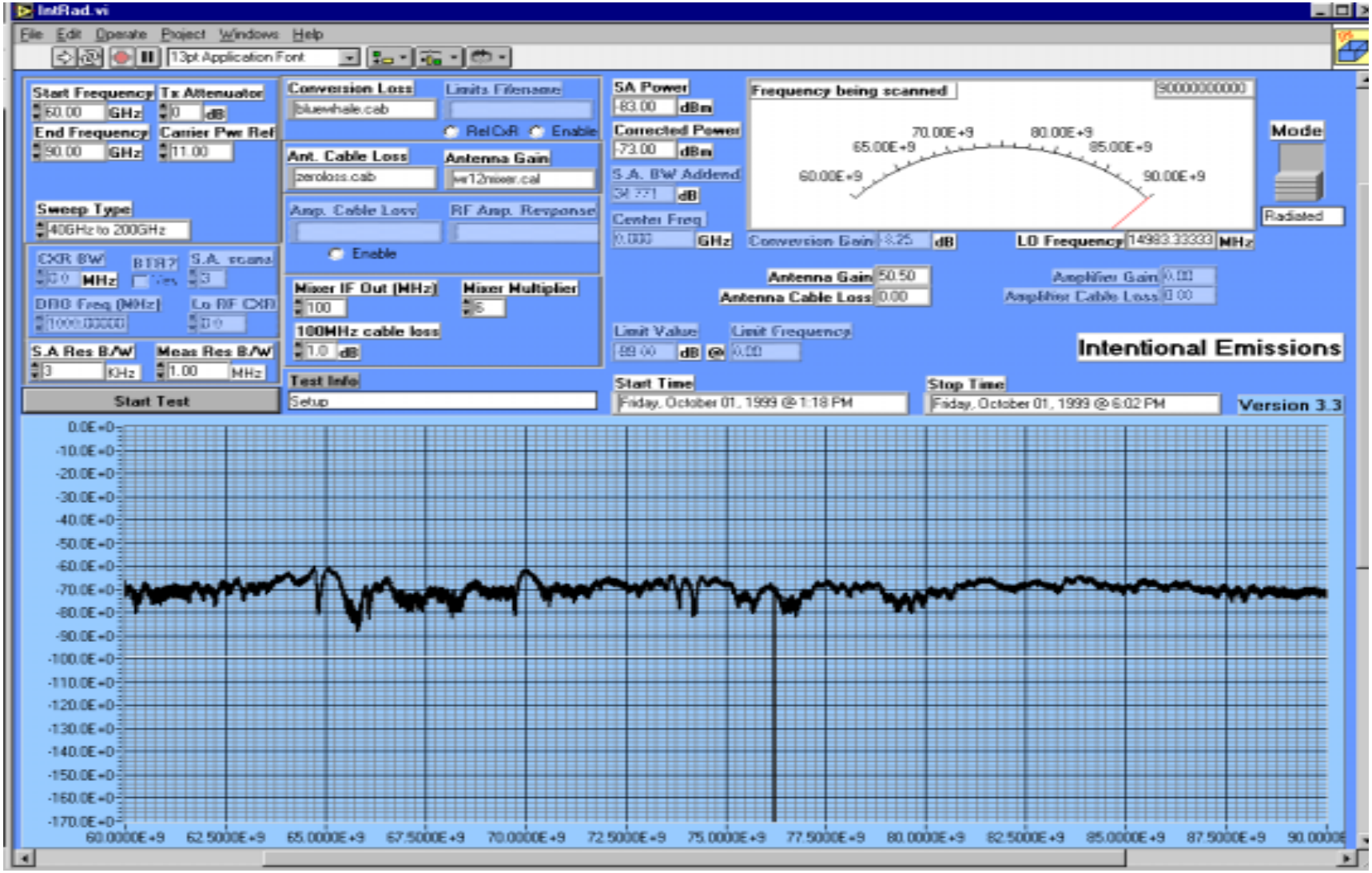
CTR 31-01P, 2 carrier QAM 64 modulated. –40GHz to 60GHz - Vertical



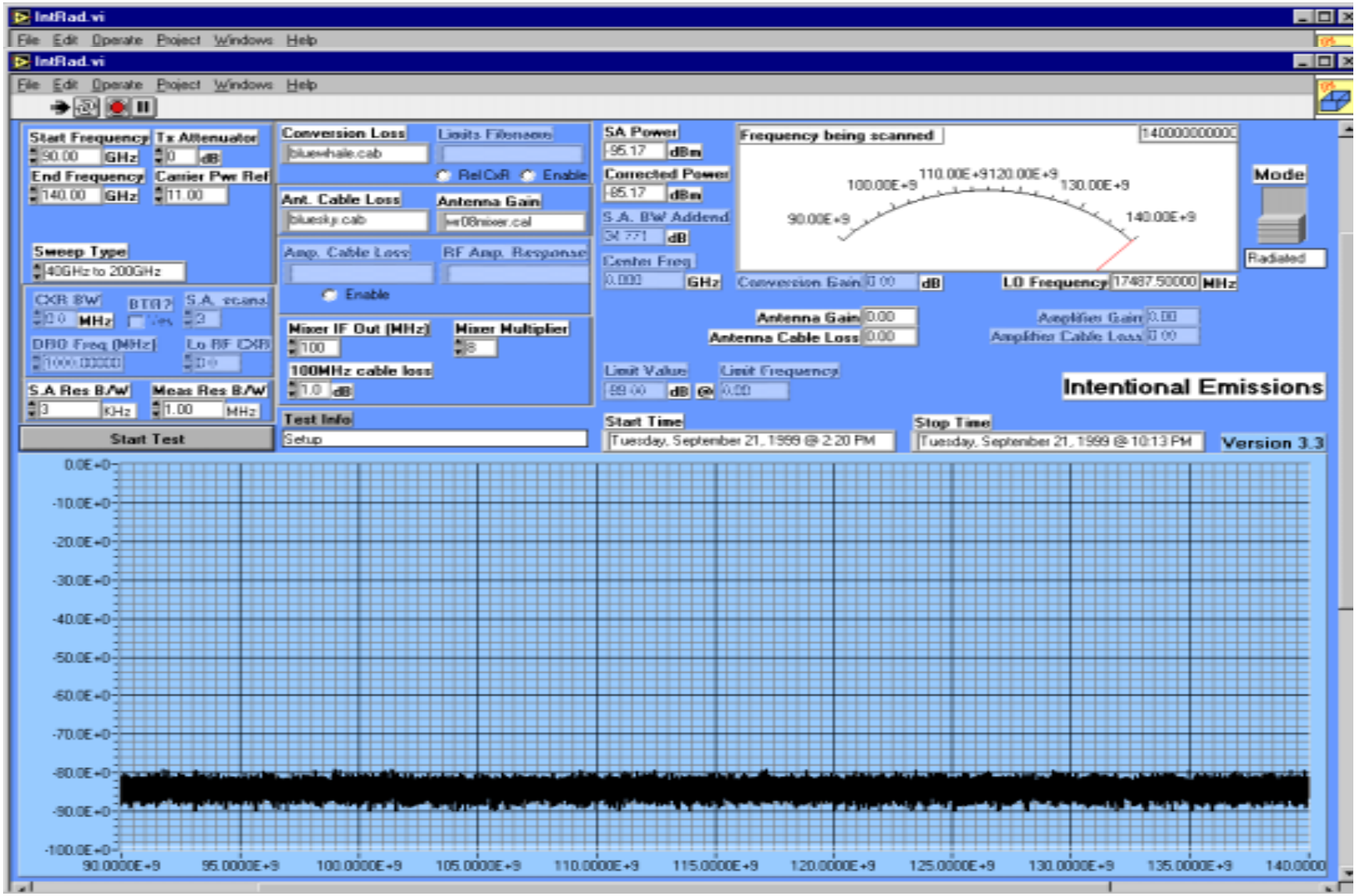
CTR 31-01P, 2 carrier QAM 64 modulated. –60GHz to 90GHz - Horizontal



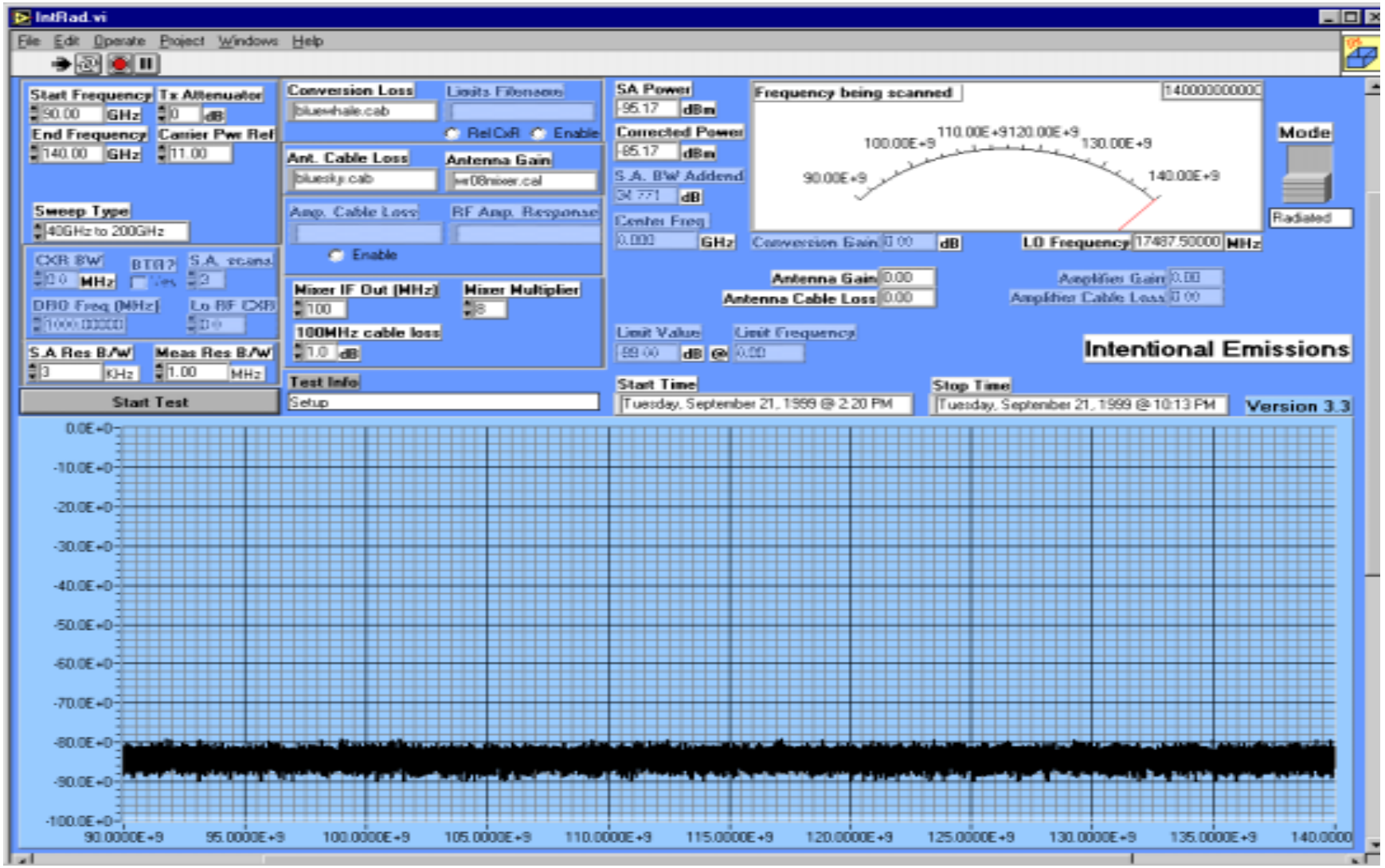
CTR 31-01P, 2 carrier QAM 64 modulated. –60GHz to 90GHz - Vertical



CTR 31-01P, 2 carrier QAM 64 modulated. –90GHz to 140GHz - Horizontal



CTR 31-01P, 2 carrier QAM 64 modulated. –90GHz to 140GHz - Vertical

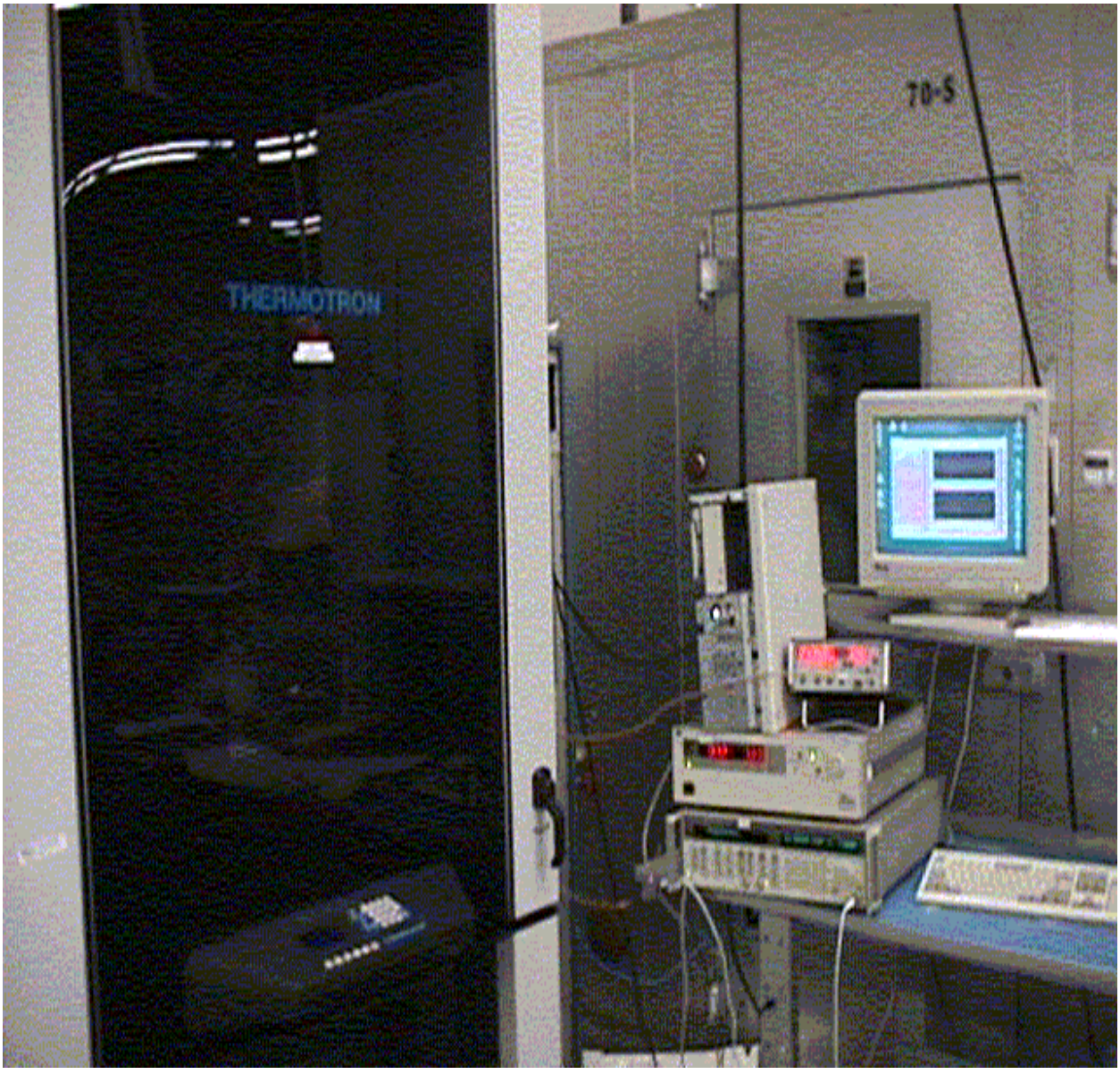


APPENDIX C

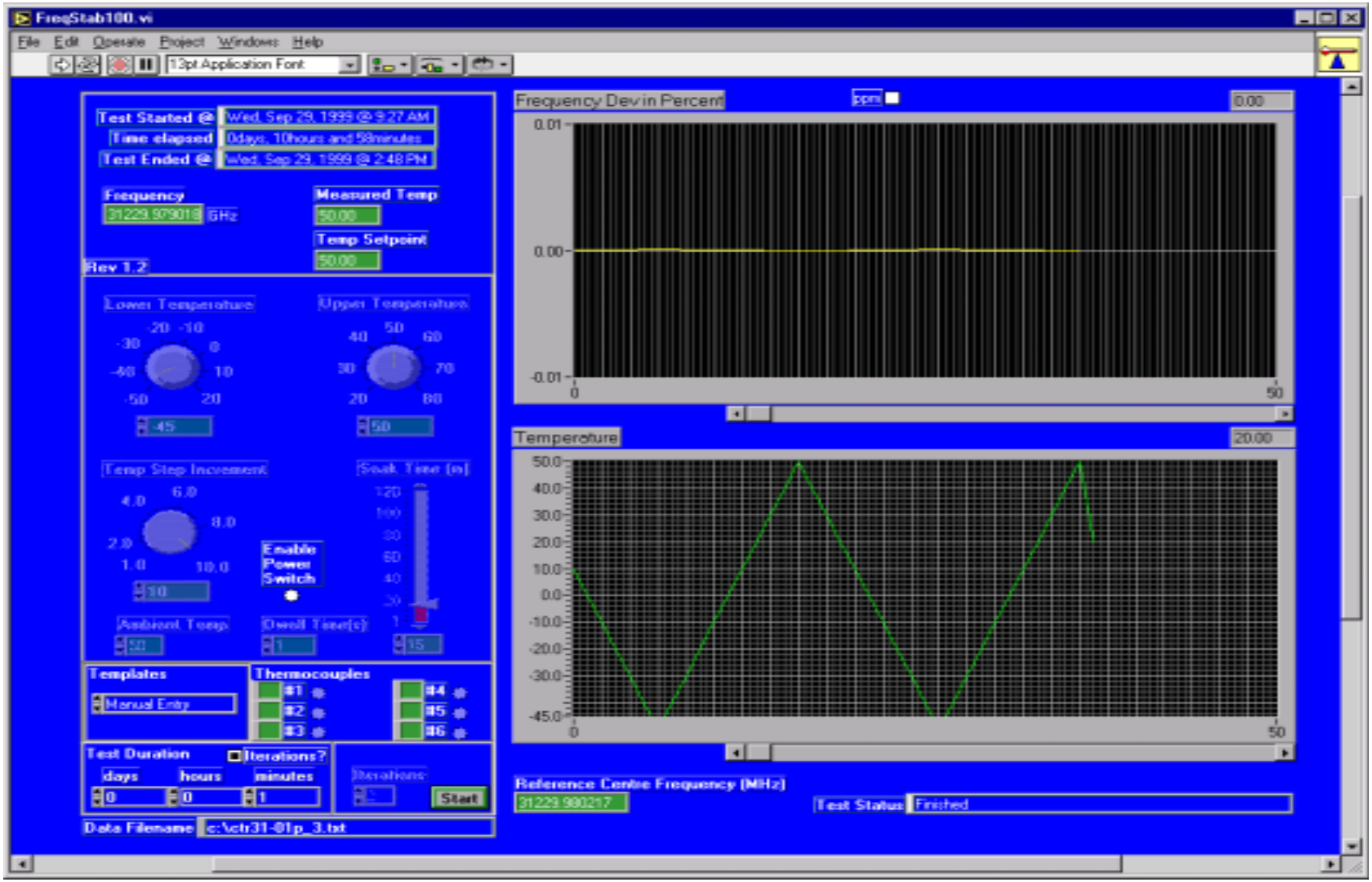
Temperature Stability Measurements Results

7. TEMPERATURE STABILITY MEASUREMENTS RESULTS

Frequency Stability Test Setup



CTR Frequency Stability



Test Date	Frequency (GHz)	Temp (C)	% Deviation
	31229.981134	20.0	--------
Wed Sep 29 1999 @ 9:51 AM	31229.981137	10.0	0.000003
Wed Sep 29 1999 @ 10:09 AM	31229.983224	0.0	0.000010
Wed Sep 29 1999 @ 10:25 AM	31229.986778	-10.0	0.000021
Wed Sep 29 1999 @ 10:43 AM	31229.991971	-20.0	0.000038
Wed Sep 29 1999 @ 11:00 AM	31229.999796	-30.0	0.000063
Wed Sep 29 1999 @ 11:19 AM	31230.010549	-40.0	0.000097
Wed Sep 29 1999 @ 11:37 AM	31230.022675	-50.0	0.000136
Wed Sep 29 1999 @ 11:56 AM	31230.014526	-40.0	0.000110
Wed Sep 29 1999 @ 12:13 PM	31230.004514	-30.0	0.000078
Wed Sep 29 1999 @ 12:31 PM	31229.996095	-20.0	0.000051
Wed Sep 29 1999 @ 12:49 PM	31229.990194	-10.0	0.000032
Wed Sep 29 1999 @ 1:06 PM	31229.985686	0.0	0.000018
Wed Sep 29 1999 @ 1:23 PM	31229.982651	10.0	0.000008
Wed Sep 29 1999 @ 1:40 PM	31229.980962	20.0	0.000002
Wed Sep 29 1999 @ 1:57 PM	31229.979999	30.0	-0.000001
Wed Sep 29 1999 @ 2:14 PM	31229.979297	40.0	-0.000003
Wed Sep 29 1999 @ 2:31 PM	31229.979333	50.0	-0.000003
Wed Sep 29 1999 @ 2:48 PM	31229.979265	40.0	-0.000003
Wed Sep 29 1999 @ 3:05 PM	31229.979310	30.0	-0.000003
Wed Sep 29 1999 @ 3:23 PM	31229.979684	20.0	-0.000002
Wed Sep 29 1999 @ 3:40 PM	31229.980642	10.0	0.000001
Wed Sep 29 1999 @ 3:57 PM	31229.982935	0.0	0.000009
Wed Sep 29 1999 @ 4:16 PM	31229.986902	-10.0	0.000021
Wed Sep 29 1999 @ 4:35 PM	31229.992413	-20.0	0.000039
Wed Sep 29 1999 @ 4:55 PM	31230.000170	-30.0	0.000064
Wed Sep 29 1999 @ 5:14 PM	31230.010794	-40.0	0.000098
Wed Sep 29 1999 @ 5:33 PM	31230.022691	-50.0	0.000136
Wed Sep 29 1999 @ 5:51 PM	31230.014522	-40.0	0.000110
Wed Sep 29 1999 @ 6:09 PM	31230.004668	-30.0	0.000078
Wed Sep 29 1999 @ 6:26 PM	31229.996306	-20.0	0.000052
Wed Sep 29 1999 @ 6:43 PM	31229.990152	-10.0	0.000032
Wed Sep 29 1999 @ 7:00 PM	31229.985501	0.0	0.000017
Wed Sep 29 1999 @ 7:17 PM	31229.982361	10.0	0.000007
Wed Sep 29 1999 @ 7:34 PM	31229.980613	20.0	0.000001
Wed Sep 29 1999 @ 7:51 PM	31229.979619	30.0	-0.000002
Wed Sep 29 1999 @ 8:09 PM	31229.979133	40.0	-0.000003
Wed Sep 29 1999 @ 8:26 PM	31229.979018	50.0	-0.000004

APPENDIX D

CHANNEL INTERFERENCE TESTS

8. CHANNEL INTERFERENCE TESTS

Adjacent Channel Test Results

4 QAM	Wanted	Hi-Side Interferor	Low-Side Interferor
	475MHz	485MHz	465MHz
Channel Power	-.41.3	-15	-18.4
Limit (0dB)	----	> -41.3	> -41.3
Pass Margin	----	26.3	22.9

16 QAM	Wanted	Hi-Side Interferor	Low-Side Interferor
	475 MHz	485MHz	465MHz
Channel Power	--34.5	-14.5	-17
Limit (0dB)	----	> -34.5	> -34.5
Pass Margin	----	20	17.5

64 QAM	Wanted	Hi-Side Interferor	Low-Side Interferor
	475 MHz	485MHz	465MHz
Channel Power	-28.9	-14.5	-17.4
Limit (0dB)	----	> -28.9	> -28.9
Pass Margin	----	14.4	11.5

Co-Channel Test Results

Frequency 475 MHz @ 4 QAM	Wanted	Interferor
Channel Power	-43.5	-54.5
Limit (19.5dB)	----	> -63
Pass Margin	----	8.5

Frequency 475 MHz @ 16 QAM	Wanted	Interferor
Channel Power	-45	-60.5
Limit (26.9dB)	----	> -71.9
Pass Margin	----	11.4

Frequency 475 MHz @ 64 QAM	Wanted	Interferor
Channel Power	-47.5	-65.5
Limit (33.1dB)	----	> -80.6
Pass Margin	----	15.1

APPENDIX E

SPECTRAL Mask Limit Calculations

9. SPECTRAL MASK LIMIT CALCULATIONS

CTR Mask

% Removed	FCC Spec	Delta BW, Form passband edge	Lower Band	Upper Band
0	0	0	31262.5	31262.5
50	0	37.5	31225	31300
50.5	-29.9506126	37.875	31224.625	31300.375
51	-30.1506126	38.25	31224.25	31300.75
55	-31.7506126	41.25	31221.25	31303.75
60	-33.7506126	45	31217.5	31307.5
75	-39.7506126	56.25	31206.25	31318.75
100	-49.7506126	75	31187.5	31337.5
101	-50.1506126	75.75	31186.75	31338.25
102	-50.5506126	76.5	31186	31339
105	-51.7506126	78.75	31183.75	31341.25
106	-52.1506126	79.5	31183	31342
107	-52.5506126	80.25	31182.25	31342.75
107.45	-52.7306126	80.5875	31181.913	31343.0875
115	-55.7506126	86.25	31176.25	31348.75
120	-57.7506126	90	31172.5	31352.5
125	-56	93.75	31168.75	31356.25
150	-56	112.5	31150	31375
175	-56	131.25	31131.25	31393.75
200	-56	150	31112.5	31412.5
250	-56	187.5	31075	31450
250.1	-43	187.575	31074.925	31450.075
300	-43	225	31037.5	31487.5
500	-43	375	30887.5	31637.5
1000	-43	750	30512.5	32012.5
1100	-43	440	30822.5	31702.5
1200	-43	937.5	30325	32200
1250	-43	937.5	30325	32200
1300	-43	975	30287.5	32237.5
1500	-43	1125	30137.5	32387.5