# Nortel BWA Type Acceptance Radio Transceiver Test Report

| | |
|---|---|
| **Product Description:** | 24 GHz Base Station (BTR) and Customer Premise (CTR) Radio Transceivers |
| **Model**: | BTR2400 and CTR 2400 |
| **Nortel BWA File #** | 00001-R01 |

**CHARLIE BISHOP PI ENGINEER** **DATE**

**ROMAN WROCZYNSKI PI MANAGER** **DATE**

WINNIPEG,

**DECLARATION BY Nortel Networks BWA**

The tests were performed from Oct 2 through Oct 21 at the Nortel Networks BWA's EMC Laboratory in Winnipeg.

The following personnel collaborated to this project:

Mitch Hebert, Tech.
Charlie Bishop, PI Engineer

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: | Date |
| Supervised by: | Date |



Total number of pages: xx including x pages in appendices.

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 9001:1998, certificate no. xxx-xxxx-xx.**

# TABLE OF CONTENTS

## 1. INTRODUCTION

### Object

This test report presents emissions profile of Nortel Networks BWA radios that are to operate in the 24 GHz DEMS band for the Type Acceptance of Nortel Networks BWA radios. Nortel Networks BWA radios cannot comply to the specifications referenced in the results section below, as our radios have been designed to provide mulit-carrier point-to-multipoint communication services. The present rules for 24 GHz DEMS do not regulate the emissions characteristics of mulit-carrier, pt-to-mpt radios. Our present customer has a license/waiver to commercially deploy services within this band, therefore it is Nortel Networks BWA intention to have our radio be blanketed under our customers waiver until such a time that the FCC formally performs a rule making for the 24GHz DEMS band. Nortel Networks BWA has identified our customer in our cover letter that has been supplied for this type acceptance filing, and furnished copies of their of number license/waiver for various installations sites in the United States.

### Equipment Under Test Description

The Nortel Networks BWA 24 GHz radio product is of wide band design. The power amplifiers and the LNA are designed to provide gain over the entire 24.25 to 25.25 GHz band. The BTR and CTR are of a single conversion design. A single DRO serve both the transmit and receive path. The BTR and CTR provide a maximum power output of 1 and 0.5 watt respectively for a single unmodulated tone. Thus the power limitation requirement of FCC part 101 section 101.113 is satisfied. Photographs of the EUT are included in the appendix E of this report. The following table identifies the EUT:

| Model # | Description | Manufacturer | Part # |
|---|---|---|---|
| BTR2400 | Base Transceiver | Nortel BWA | NTVG11AA 03 |
| CTR2400 | Customer Transceiver | Nortel BWA | P0883603 |

### Application and Exceptions

## General

Tests were performed on a production sample(s) of the BTR and 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.

## Deviations

The following deviations from, additions to, or exclusions from the test specifications have been made: None

## Results

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

| Standard | Test Description | Para. No. | Results |
|---|---|---|---|
| FCC part 2, section 2.997; FCC part 101 section 101.111 (a) (4) | Conducted Emissions | 2 | Non compliant to part 101 |
| FCC part 2, Section 2.997, FCC part 101 section 101.111 (a) (4) | Radiated Emissions | 3 | Non compliant to part 101 |
| FCC part 2, Section 2.995 (a) (1), (b) and FCC part 101 section 101.107 | Frequency Stability Over Temperature | 4 | Complies |

## Test Facilities Description

The Nortel Network BWA EMC facility is a faraday cage with wire mesh screening, the room measures 12-ft (w) by 24 ft (l) by 11 ft (h). The room is provided with input voltage of 120 and 240 V ac, which is filtered through Corcom filters before entry. The wire mesh is of ¼ inch size, provides adequate shielding attenuating almost all ambient emissions. The wire mesh is installed in an overlapping fashion (at least 1-foot) and fastened to the metal construction studs.

### 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 | 09/99 |
| Synthesized Sig. Gen. | Anritsu | 69369A | 981807 | 06/99 |
| Power Meter | Anritsu | ML2438A | 97400074 | 06/99 |
| Power Sensor | Anritsu | MA2475A | | 06/99 |
| Mixer Assembly 40 to 60 GHz | Millitech/Nortel BWA | MHB-19-RD3A0 | MS-118086 | 7/99 |

| 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 | 7/99 |
| Mixer Assembly 90 to 140 GHz | Millitech/Nortel BWA | MHB-08-RD3A0 | MS-118090 | 7/99 |
| Frequency Counter | XL microwave | 3460 | 980338143 | 03/98 |
| Antenna Bilog 30 to 1000 MHz | Shaffner-Chase | CBL6111B | 2261 | 08/98 |
| Horn Antenna 1 to 18 GHz | EMCO | 3115 | 9711-5345 | 11/98 |
| Horn Antenna 14 to 40 GHz | Shaffner-Chase | BBHA 9170 | 9046 | 3/99 |

## 2. CONDUCTED EMISSIONS

Tested by: Charlie Bishop and Mitch Hebert

Date: Oct 2 through Oct 5,1998

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

### Test Conditions

Temperature 22 to 25C,
Primary Voltage BTR - 48 V and for CTR –18 V dc

### Minimum Specifications

Specification specified in FCC part 101, section 101.111 for DEMS devices operating in the 24.25 to 25.25GHz band.

### Test Results

The EUT does not comply with the specification referenced in the previous paragraph. The radios do comply with either of the proposed emissions profile in the Nortel Networks BWA request for waiver.

### Measurement Data

See on Appendix A for test results and setup photographs.

## Test Method

Nortel processing equipment stimulated the EUT (BTR and CTR) with digitally modulated 64 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the BTR and/or 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 64 QAM modulated carriers, occupied bandwidth of 40MHz for the BTR and two for the CTR occupying 20MHz. The measured reference is used to determine the out of band emissions, by measuring the relative differences between the reference and the measured emission.

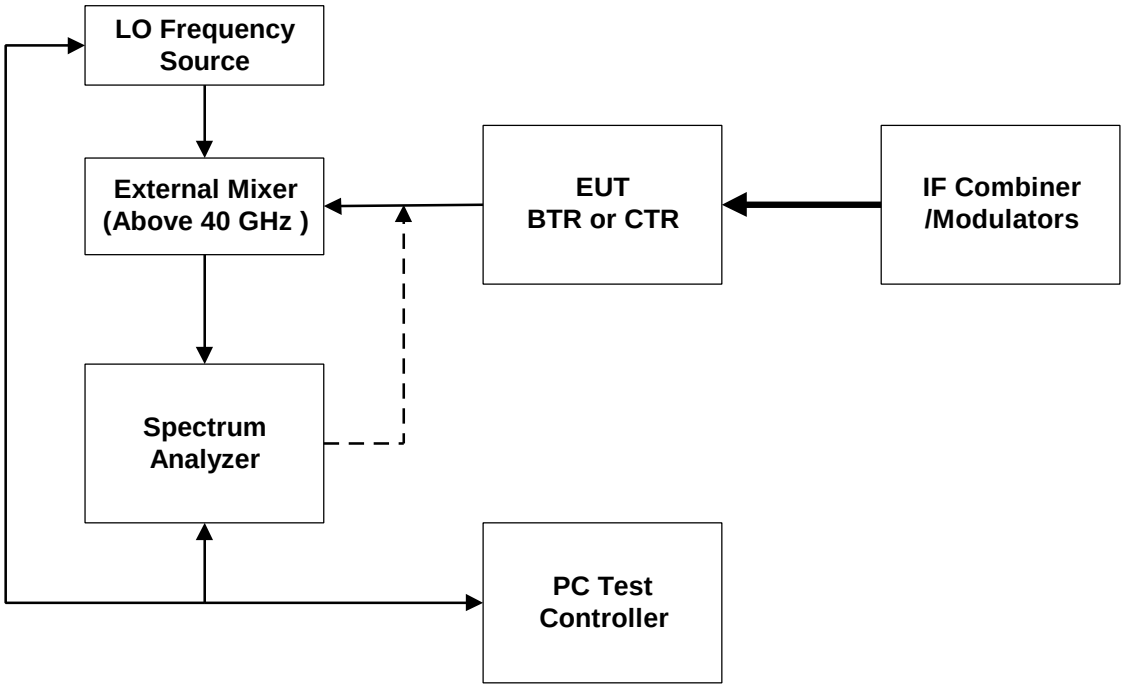



**Figure 1.0: Test Setup Configuration for Conducted Emissions**

## 3. RADIATED EMISSIONS

| | |
|---|---|
| Tested by: | Charlie Bishop and Mitch Hebert |
| Date: | Oct 6 through 9, 1998 |

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 | BTR -48 V dc and for CTR –18 Vdc |

### Specifications

Specification specified in FCC part 2, section 2.997, and FCC part 101, section 101.111 for DEMS devices operating in the 24.25 to 25.25GHz band.

### Test Results

The EUT does not comply with the specification referenced in the previous paragraph. The radios do comply with either of the proposed emissions profile in the Nortel Networks BWA request for waiver.

### Measurement Data

See on Appendix B for test results and setup photographs.

### Test Method

Nortel processing equipment stimulated the EUT (BTR and CTR) with digitally modulated 64 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the BTR and/or 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 and 90 to 140GHz. Below 40 GHz, the antennae is positioned 1m from the EUT; the input to the spectrum analyzer was connected to various antenna 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 110 GHz. The measured reference is used to determine the out of band emissions, by measuring the relative differences between it and the measured emission.

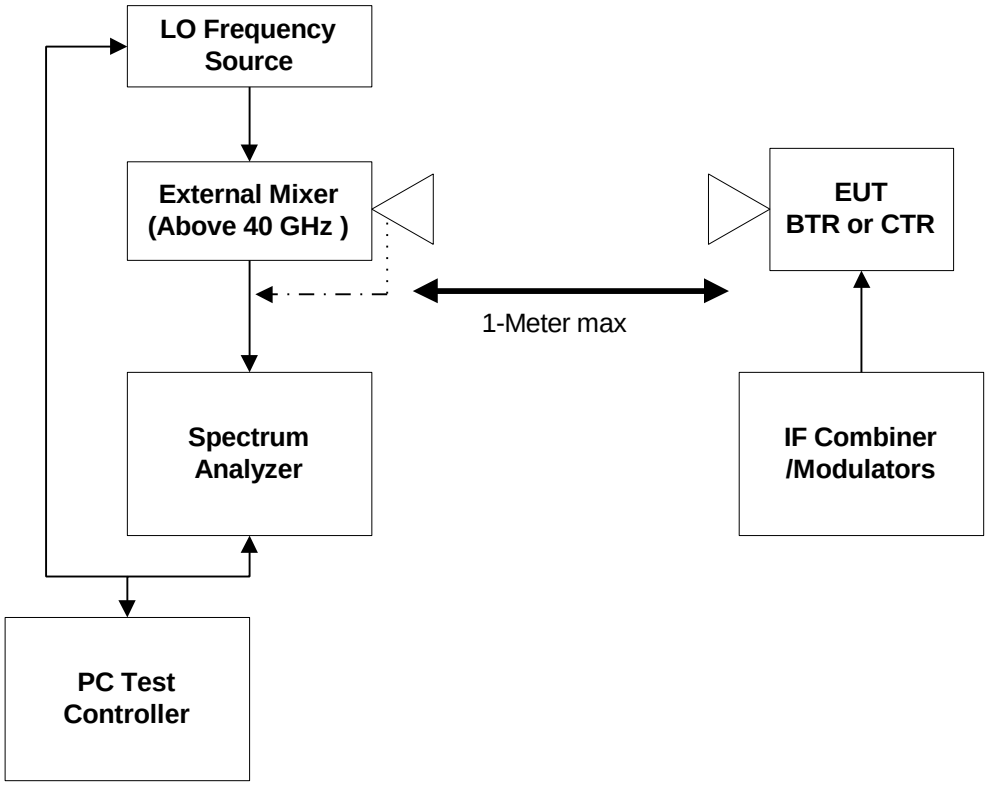



**Figure 2.0: Test Setup Configuration for Radiated Emissions**

## 4. TEMPERATURE STABILITY TESTS

| | |
|---|---|
| Tested by: | Charlie Bishop and Mitch Hebert |
| Date: | Oct 20 to 22, 1998 |

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

### Test Conditions

| | |
|---|---|
| Temperature | -30C to +50C, |
| Primary Voltage | BTR -48 V dc and for CTR –18 Vdc |

### Specifications

Requirement specified in FCC part 101, section 101.107, frequency tolerance of ±0.03%

### Test Results

The BTR and CTR complies with the specifications stated in specification paragraph

### Measurement Data

See on Appendix C for test setup and photographs.

### Test Method

Tests were performed on a BTR and 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 .(30min) 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. The temperature of the DRO is also recorded, plotted and stored to disk.

## 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 –30°C to +50°C.

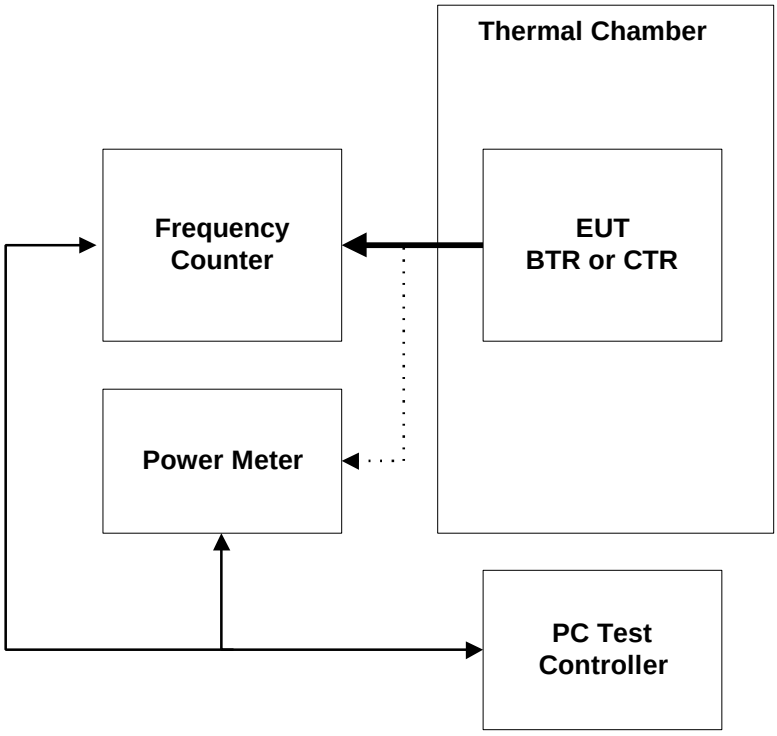
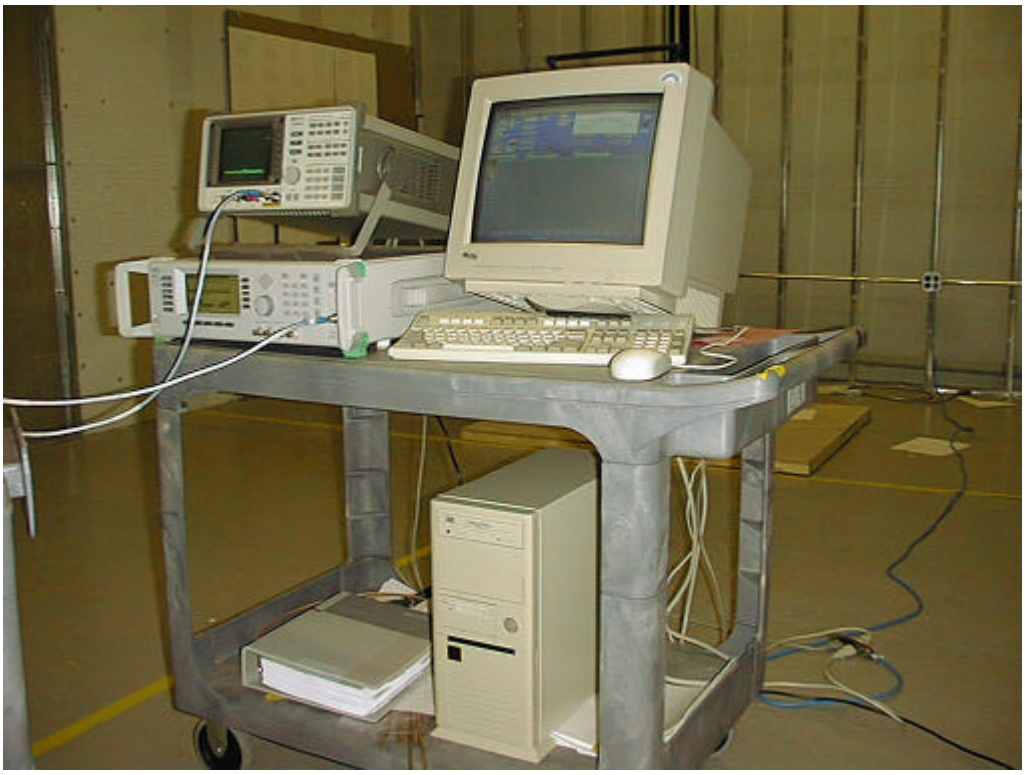


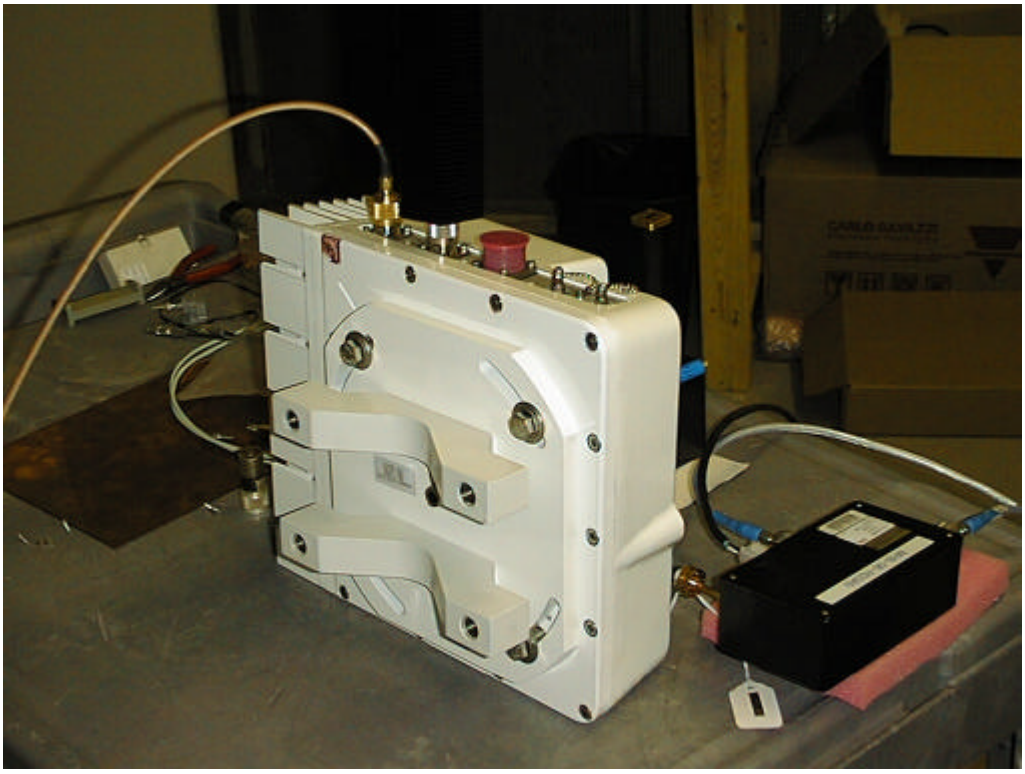

**Figure 3.0: Test Setup Configuration for Temperature Stability Tests**

# APPENDIX A1
# BTR
## Conducted Emissions Measurement Results

Computer setup and instrumentation in the PI laboratory

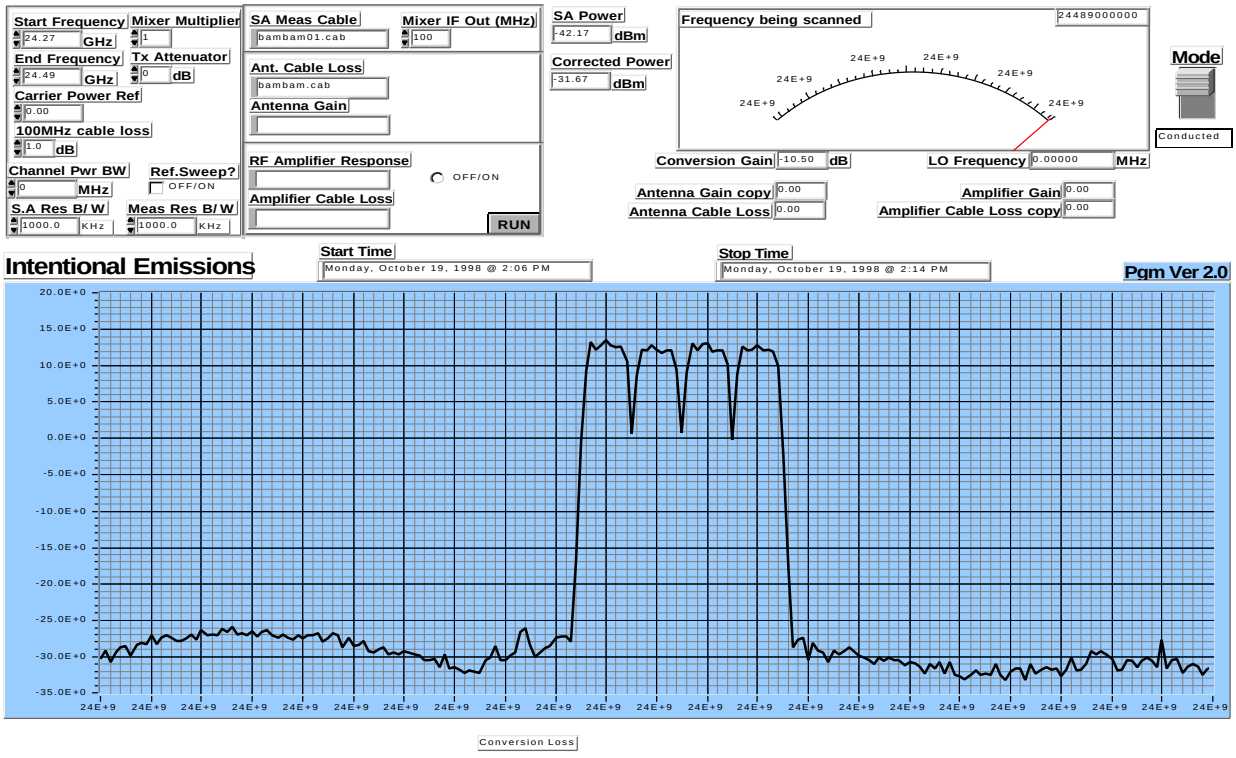


Connection to the EUT using the wave-guide connection

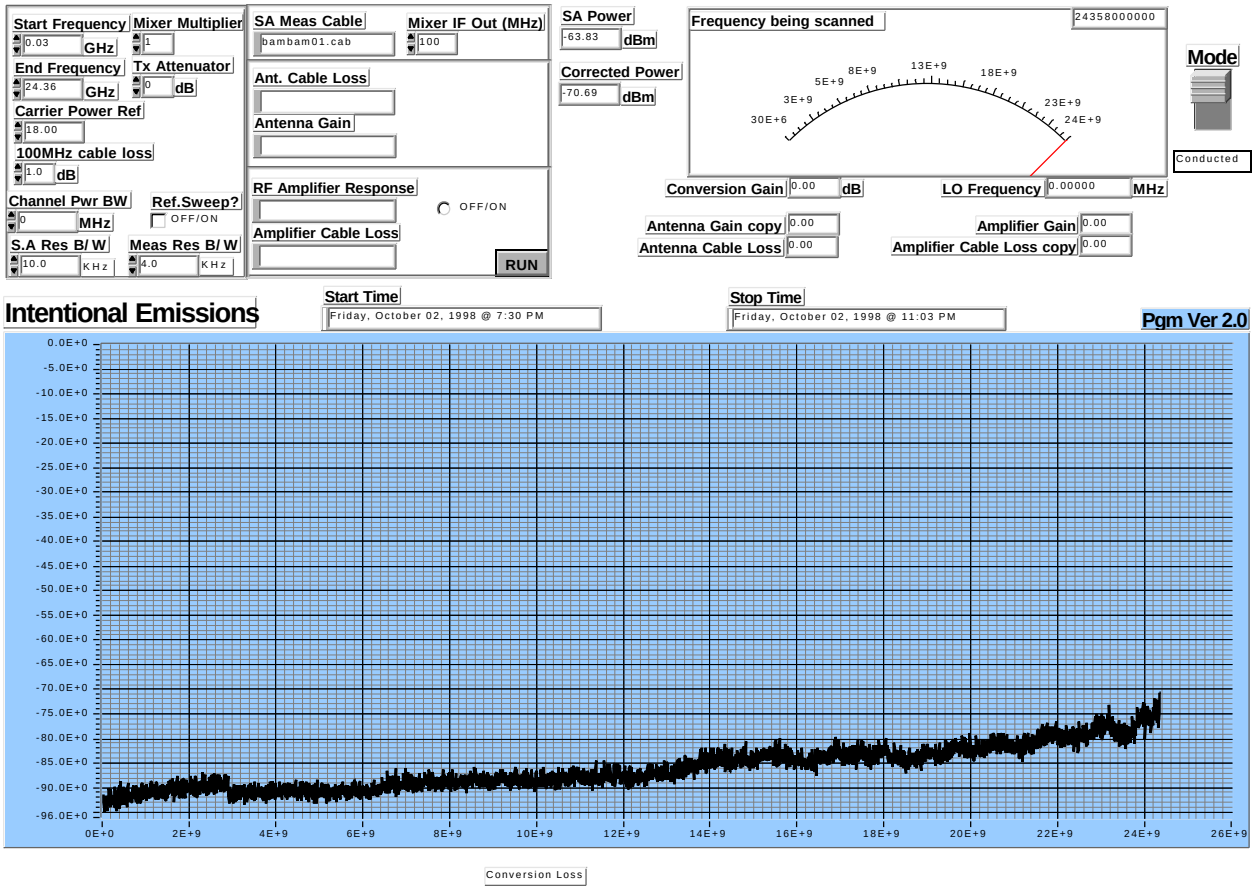


Production BTR 2400, 4 carrier QAM 64 modulated - In-band carriers

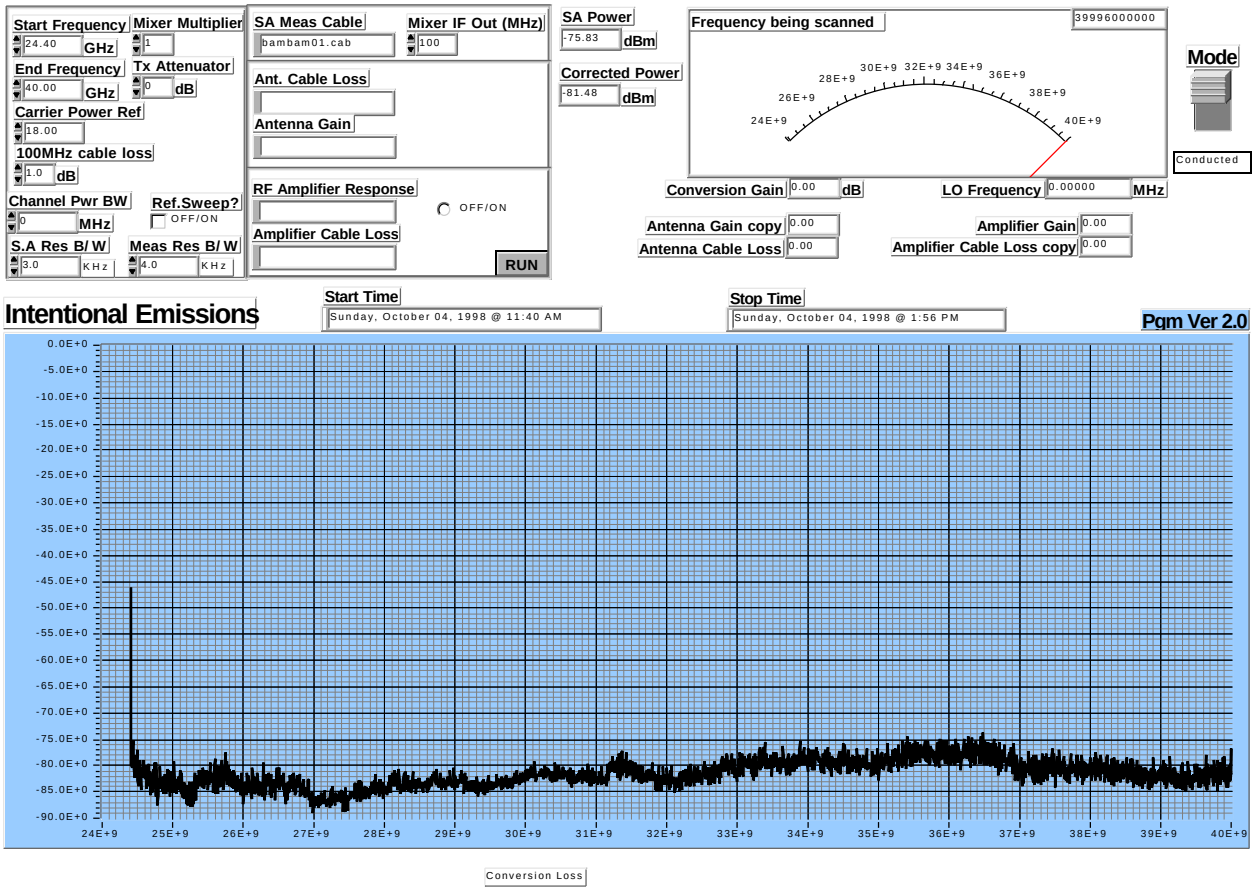
The emission showing amplitude and angle-modulated (D) with two or more channels (7) which could contain data or telephony (W). The signal has a maximum occupied bandwidth of 40MHz. (40M0). Equipment Type 40M0D7W



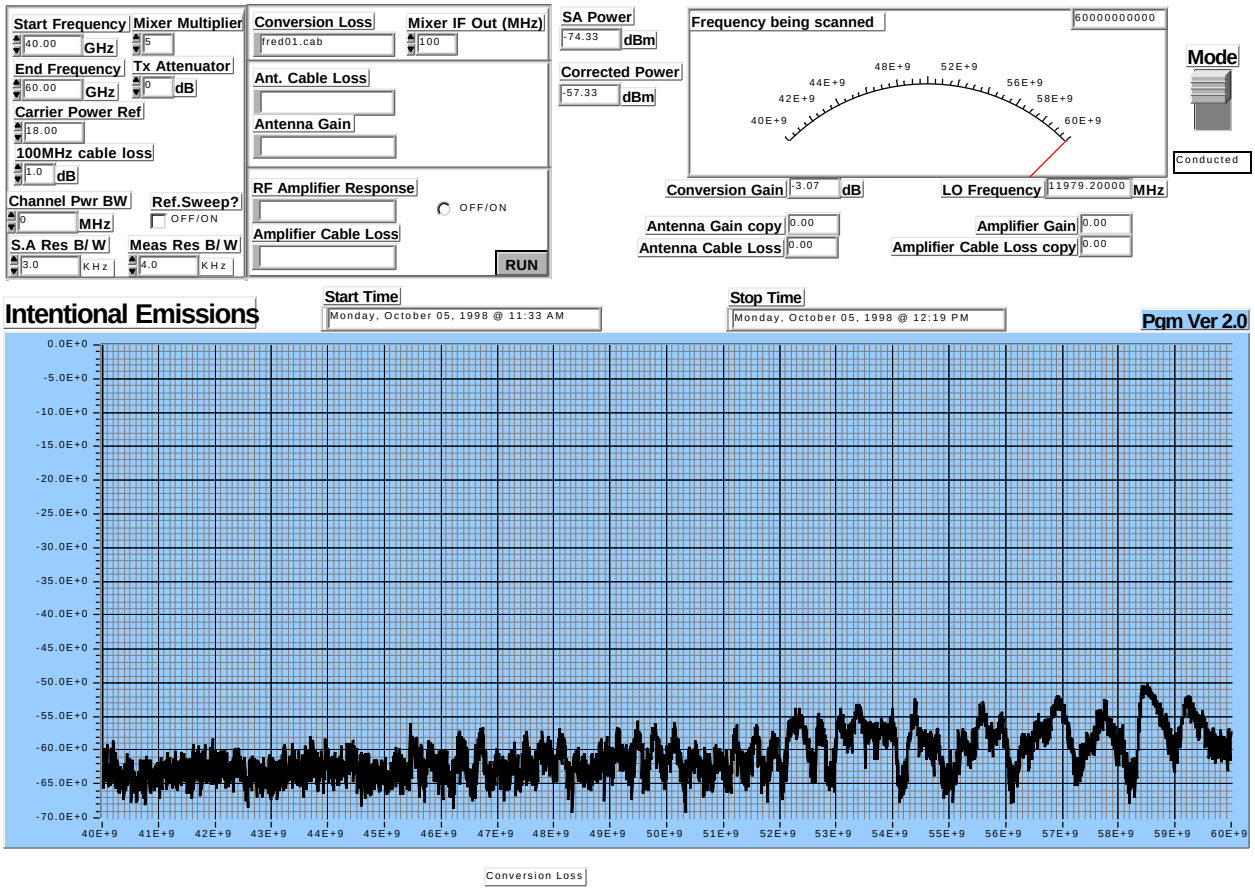
Production BTR 2400, 4 carrier QAM 64 modulated. – 30MHz to edge of carriers



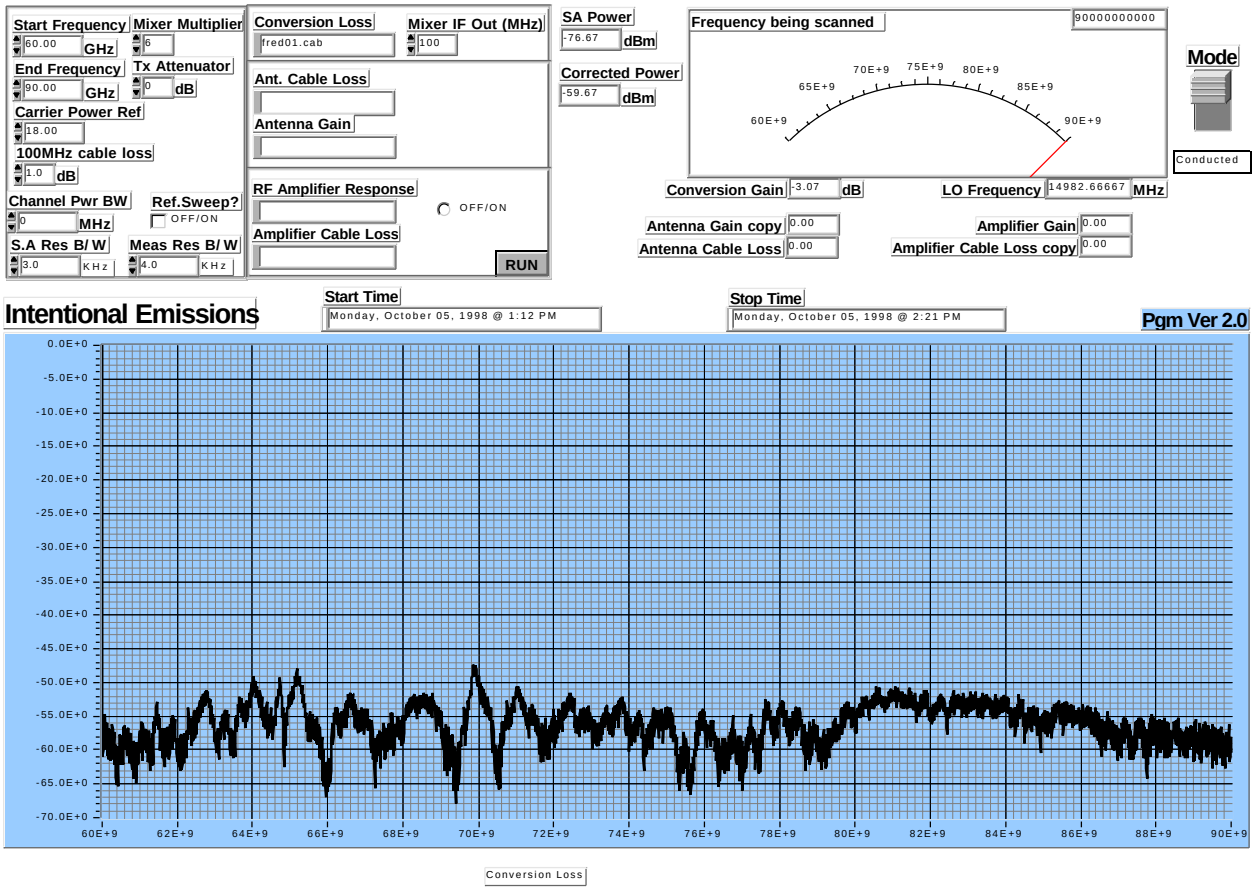
Production BTR 2400, 4 carrier QAM 64 modulated. – edge of carriers to 40GHz



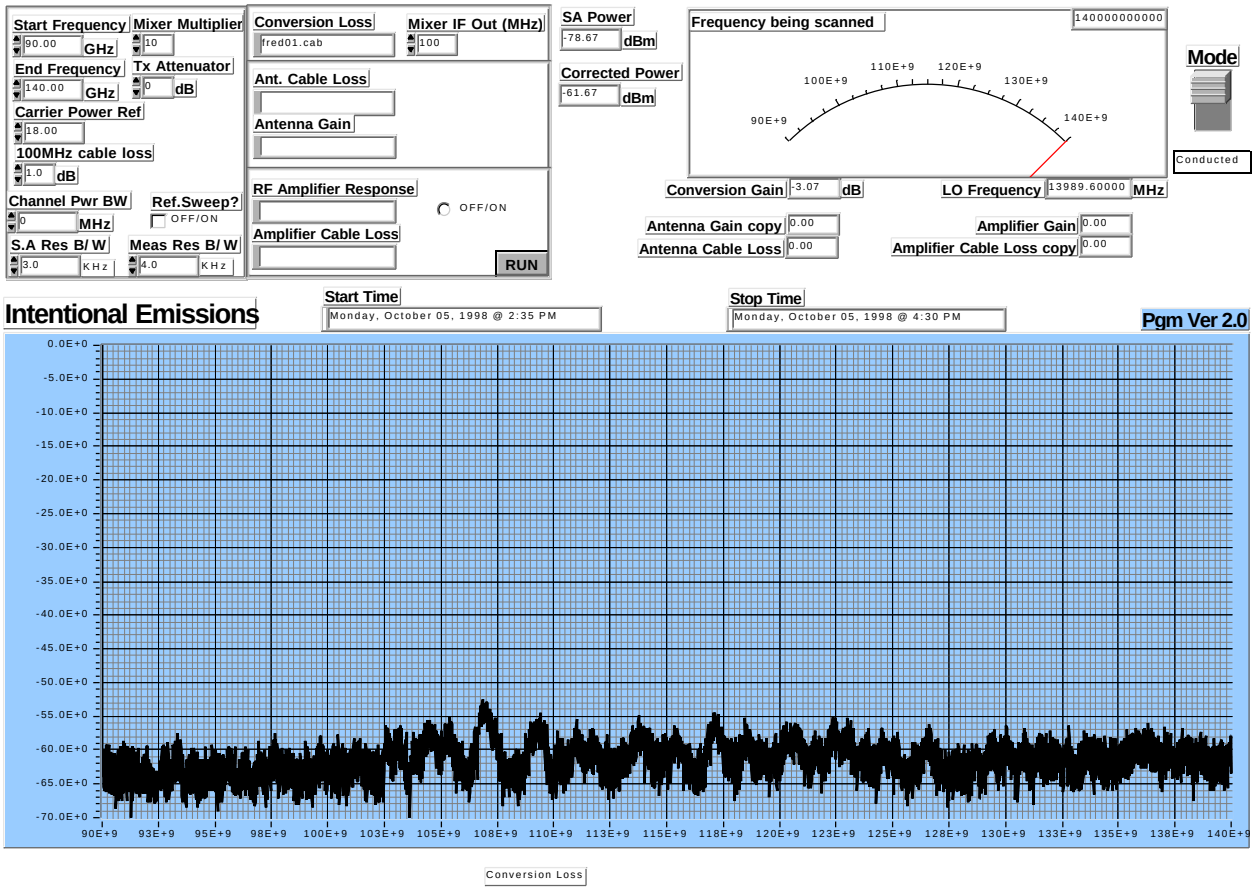
Production BTR 2400, 4 carrier QAM 64 modulated. – 40 to 60GHz



Production BTR 2400, 4 carrier QAM 64 modulated. – 60 to 90GHz

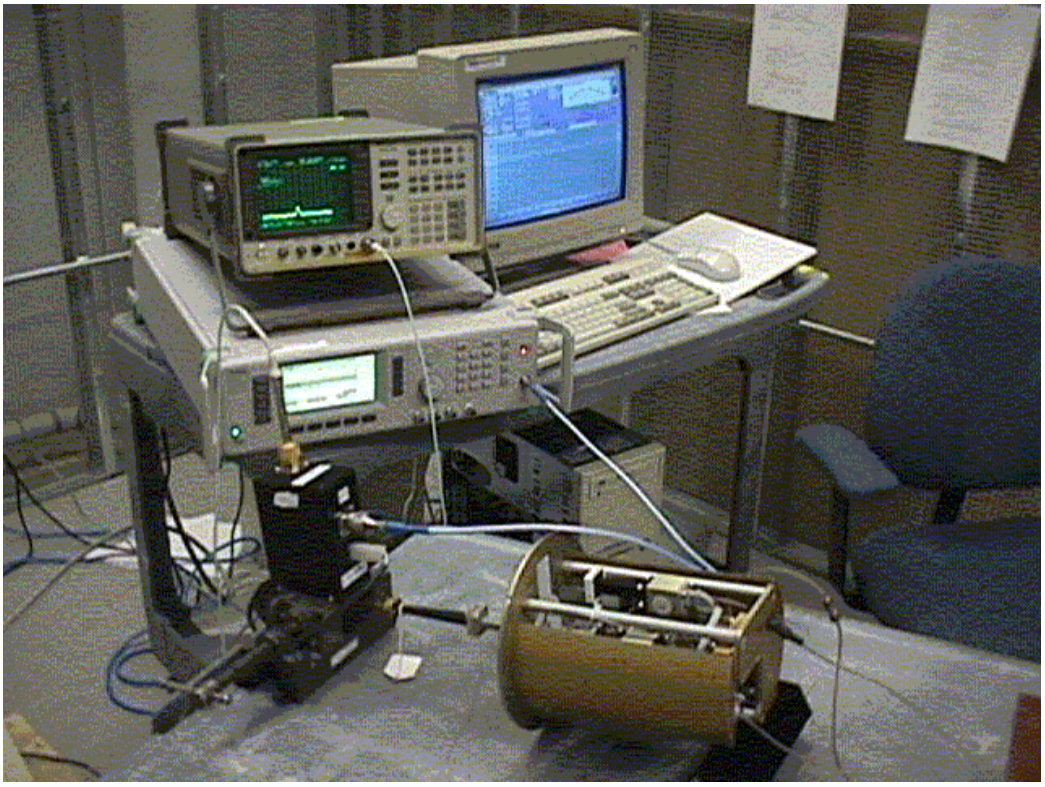


Production BTR 2400, 4 carrier QAM 64 modulated. – 90 to 110GHz

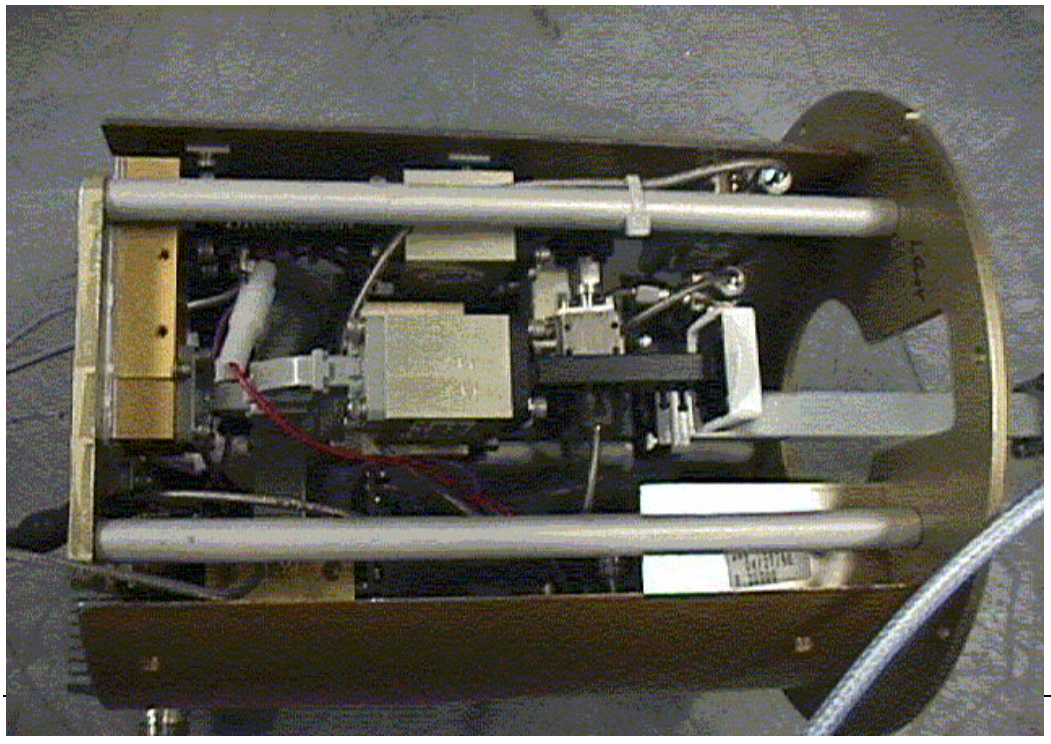


# APPENDIX A2
# CTR
## Conducted Emissions Measurement Results

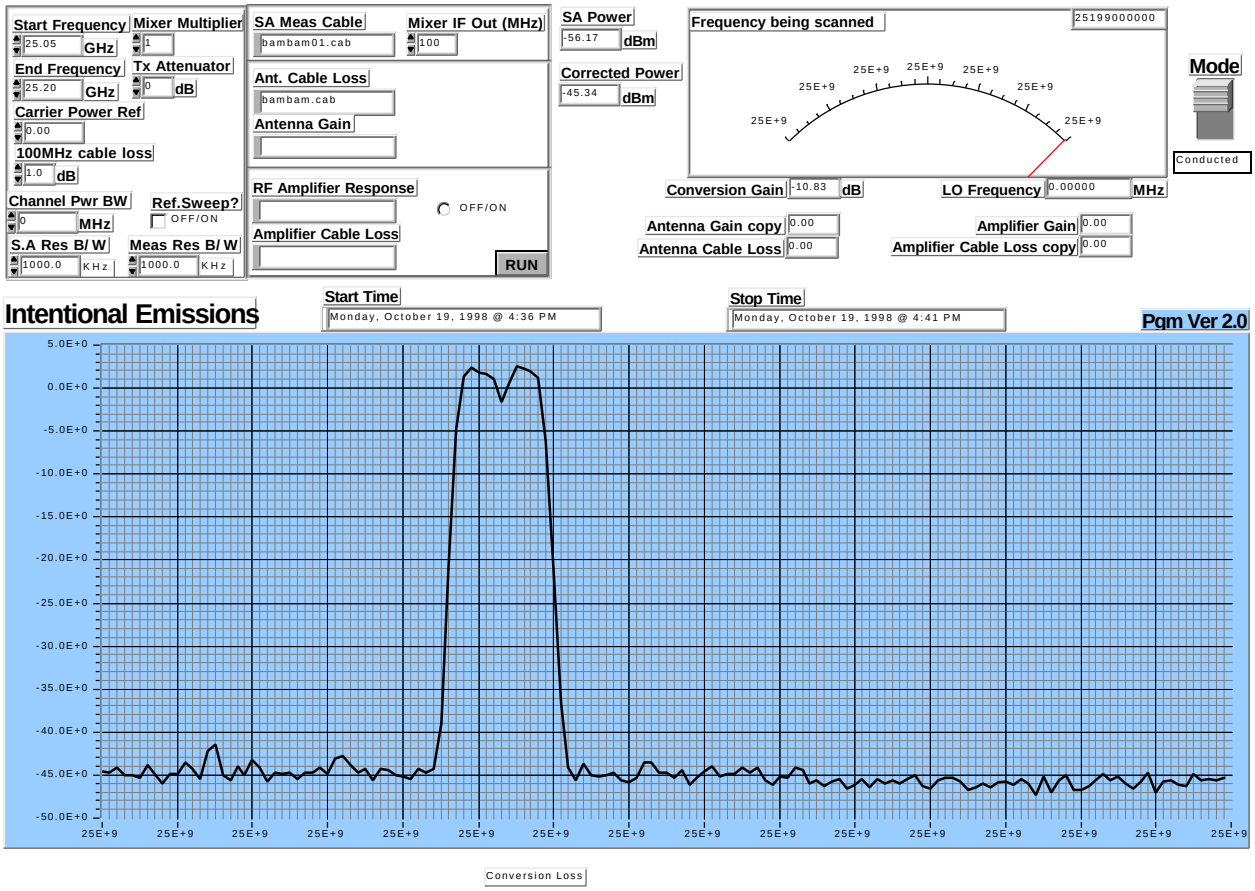
CTR connected in the laboratory for conducted measurements



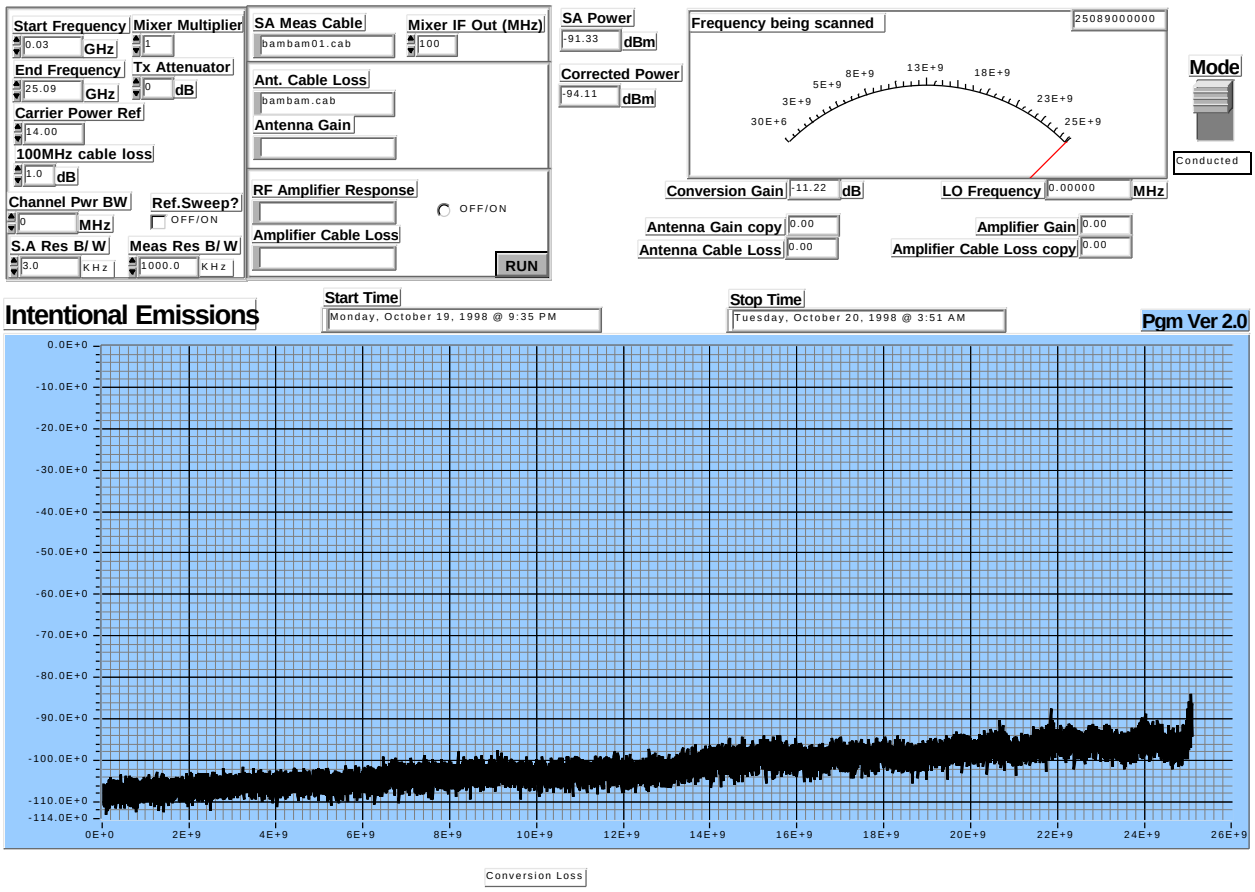
CTR with the case removed



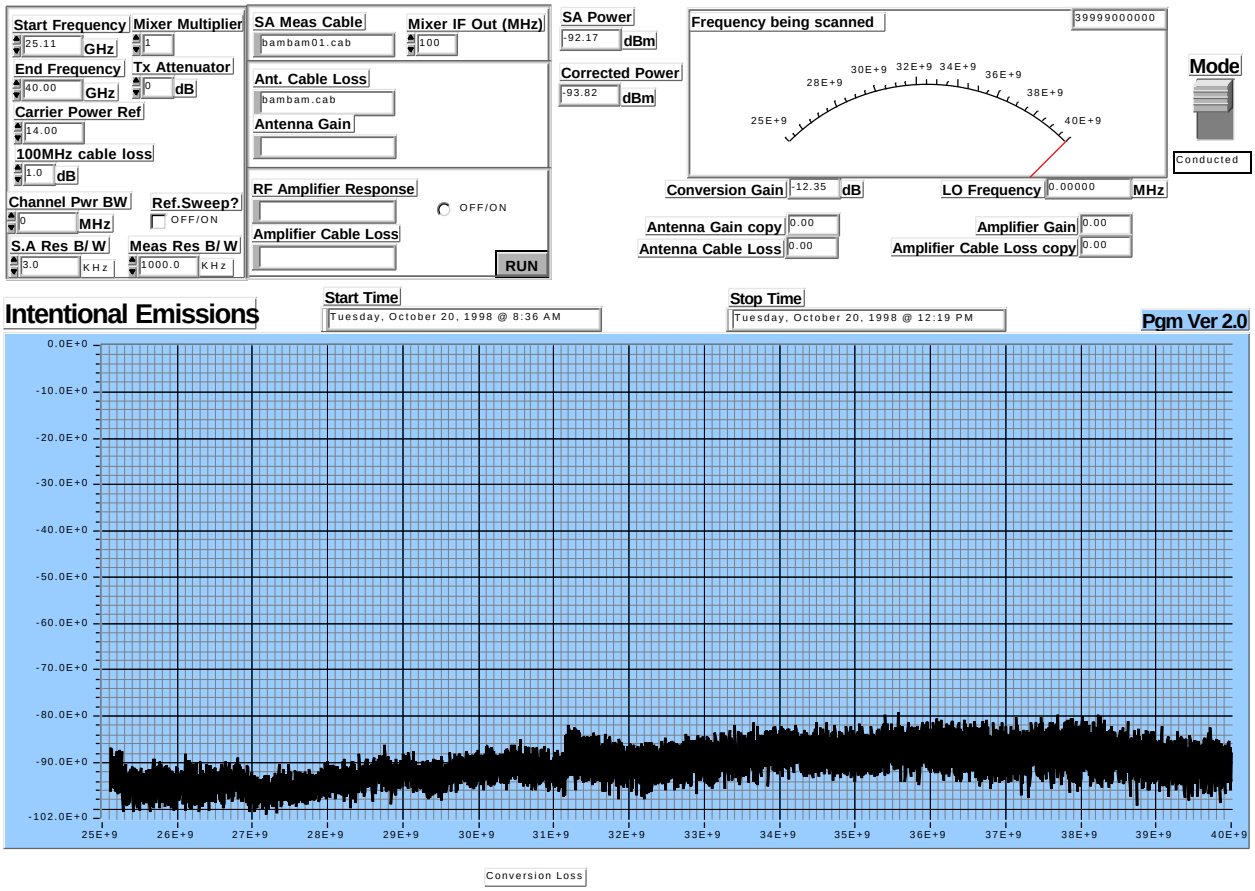
Production CTR 2400, carriers



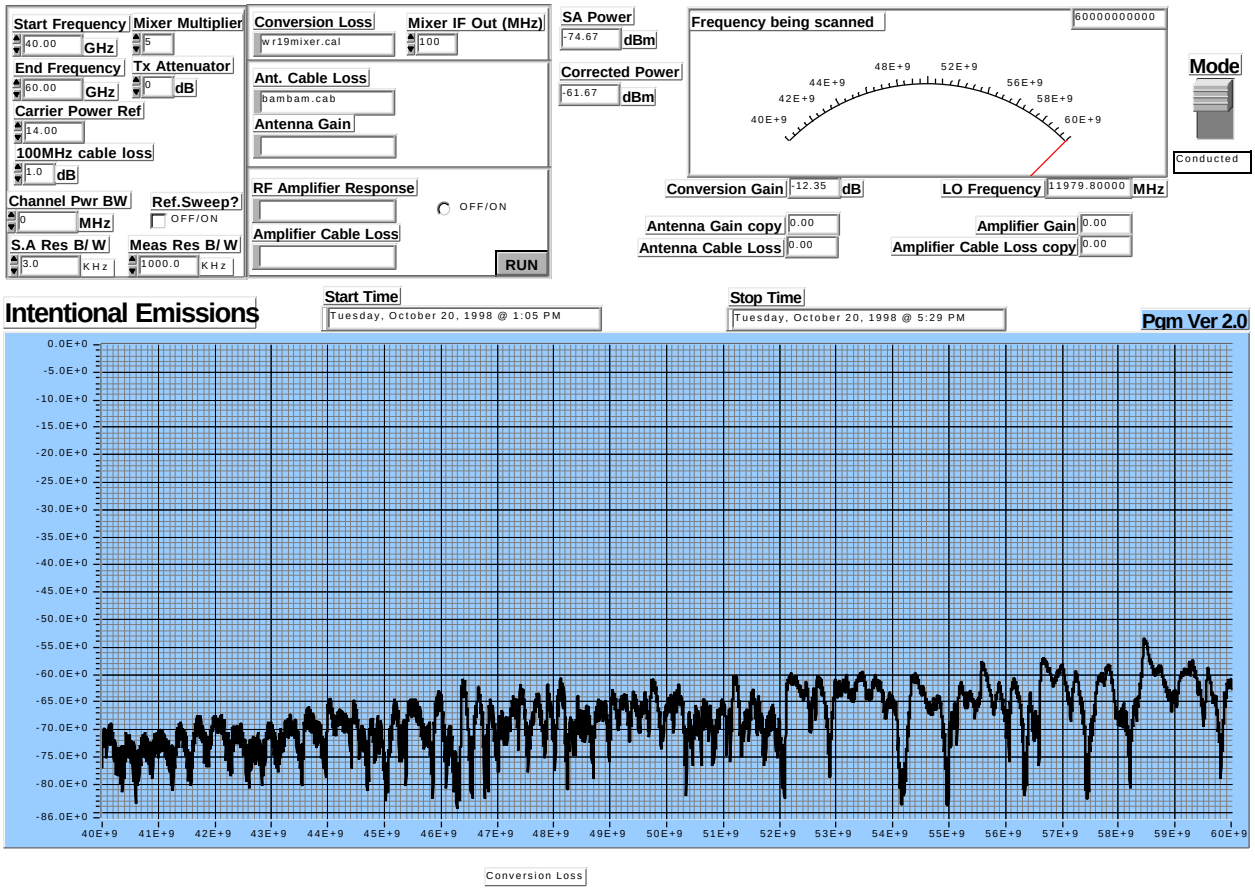
Production CTR 2400, 2 carrier QAM 64 modulated. – 30MHz to edge of carriers



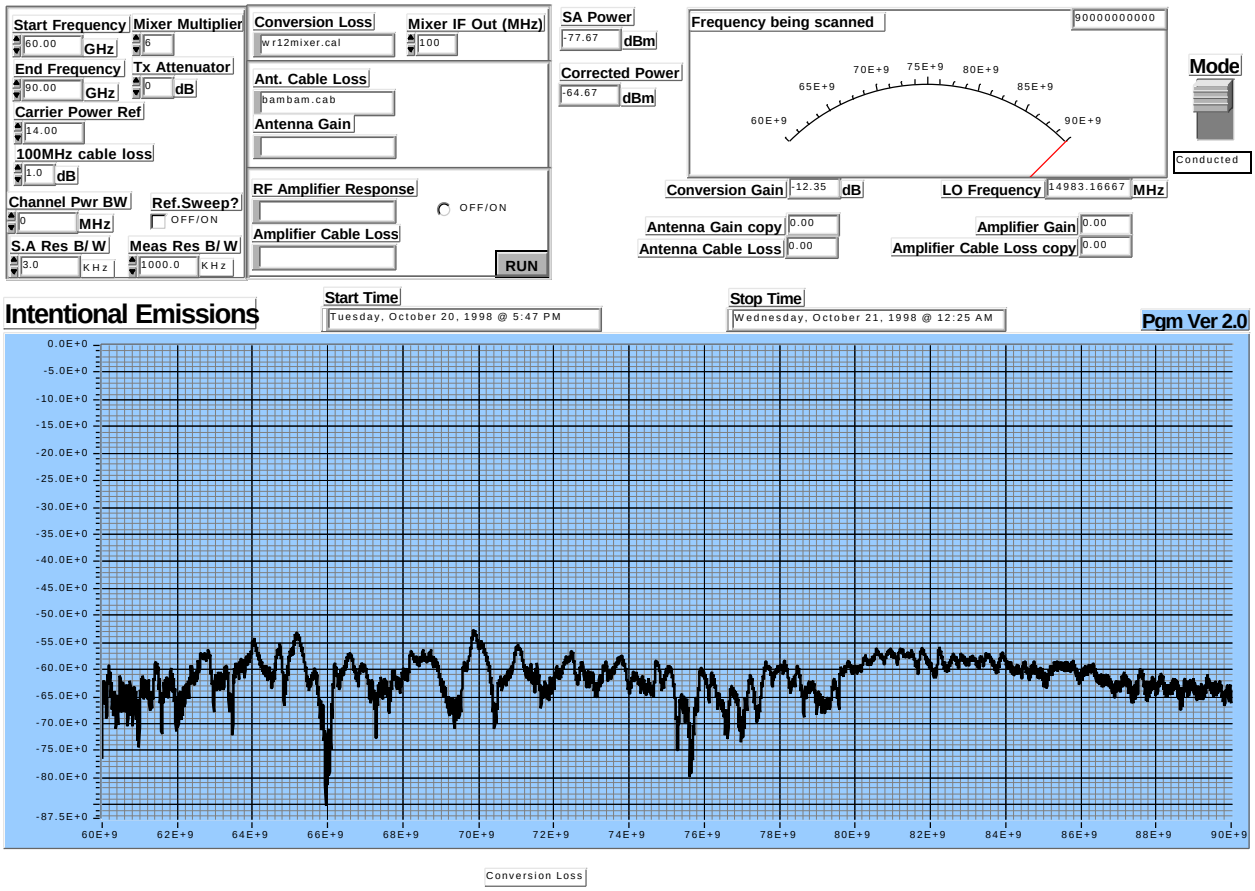
Production CTR 2400, 2 carrier QAM 64 modulated. – edge of carriers to 40GHz



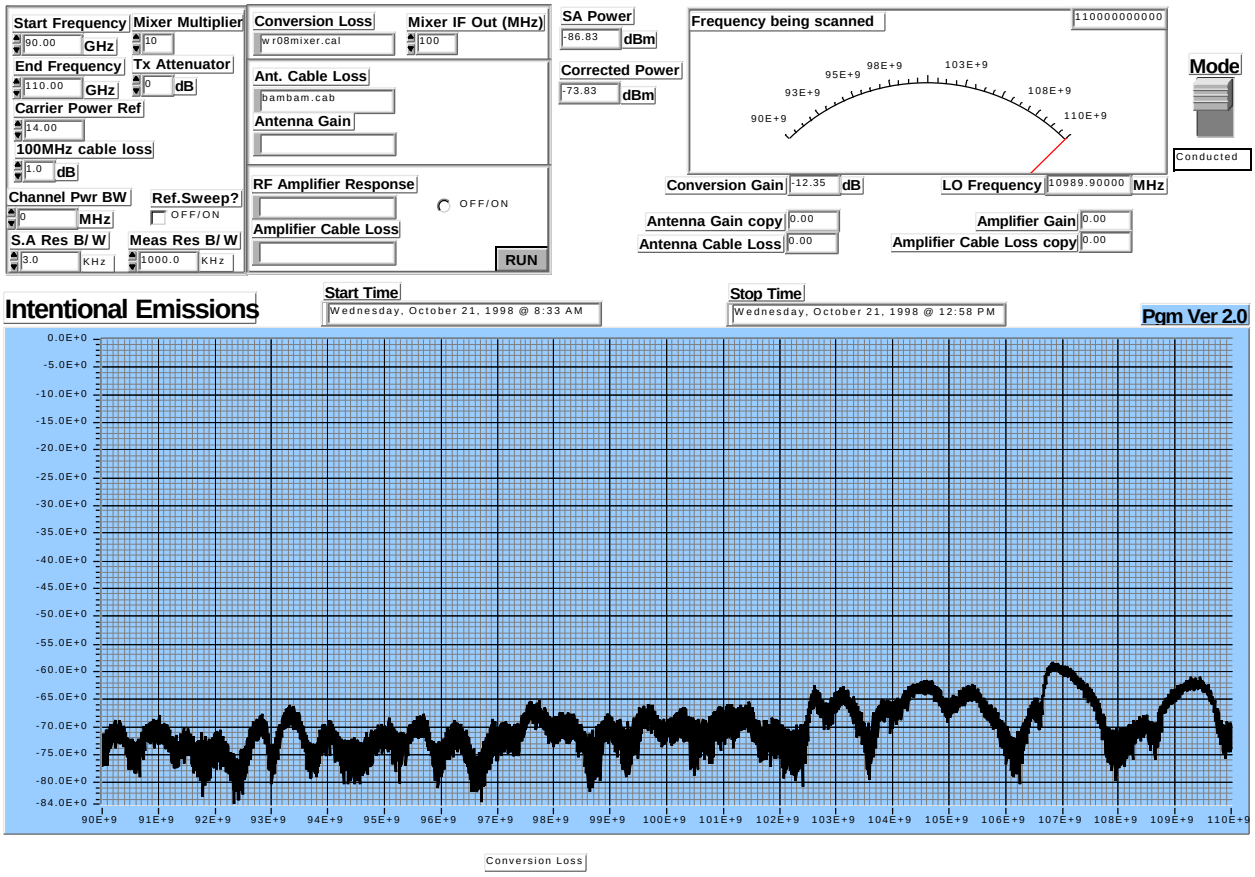
Production CTR 2400, 2 carrier QAM 64 modulated. – 40-60GHz



Production CTR 2400, 2 carrier QAM 64 modulated. –60-90GHz



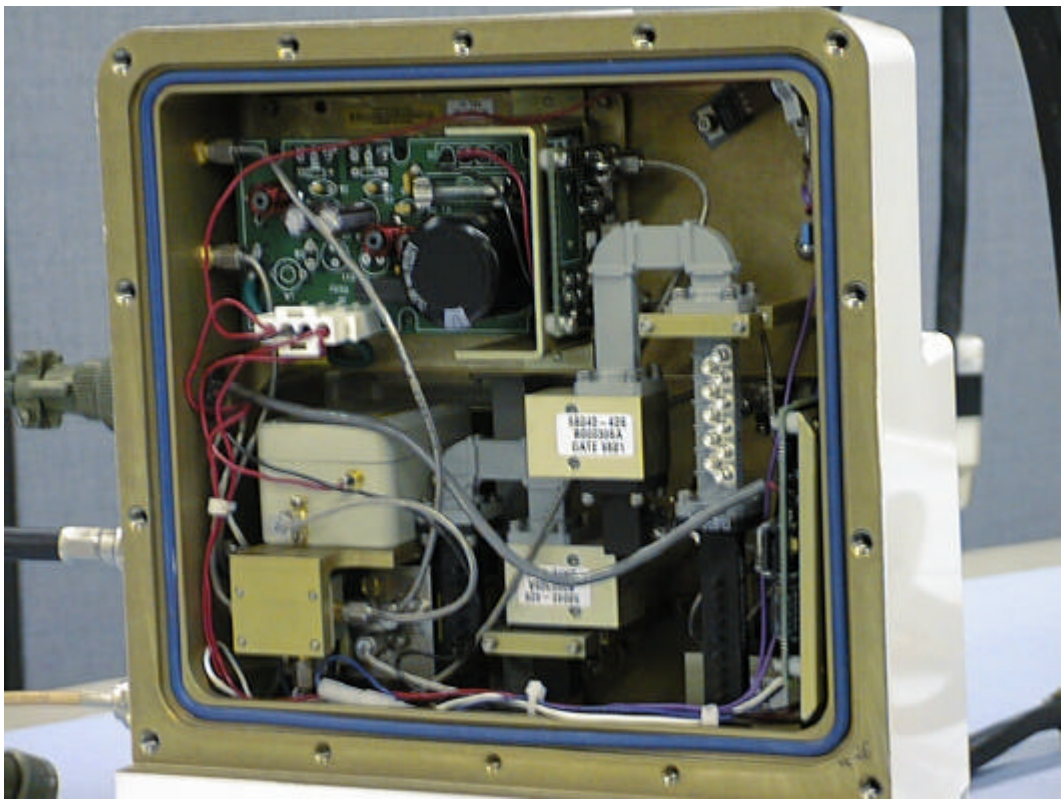
Production CTR 2400, 2 carrier QAM 64 modulated. –90-110GHz



# APPENDIX B

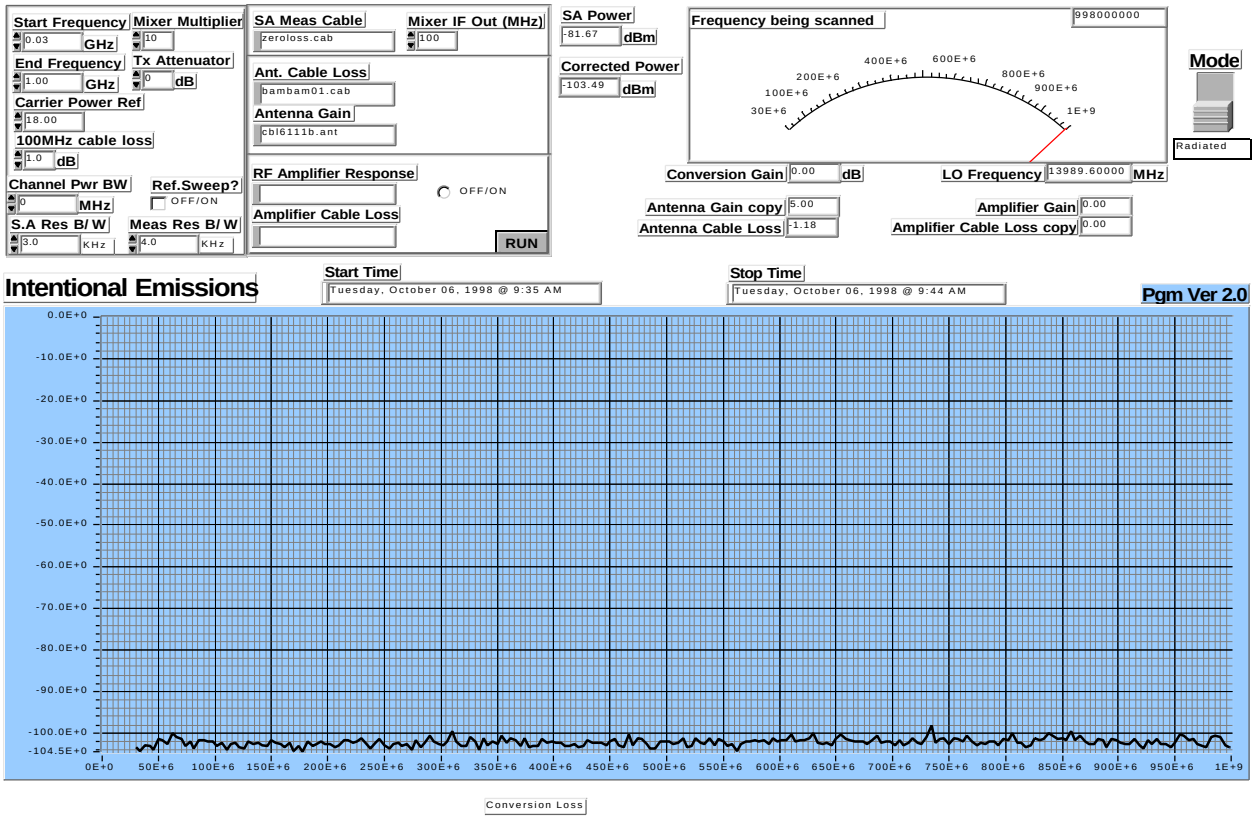
## Radiated Emissions Measurement Results

Radiated test using the 40-60GHz horn.

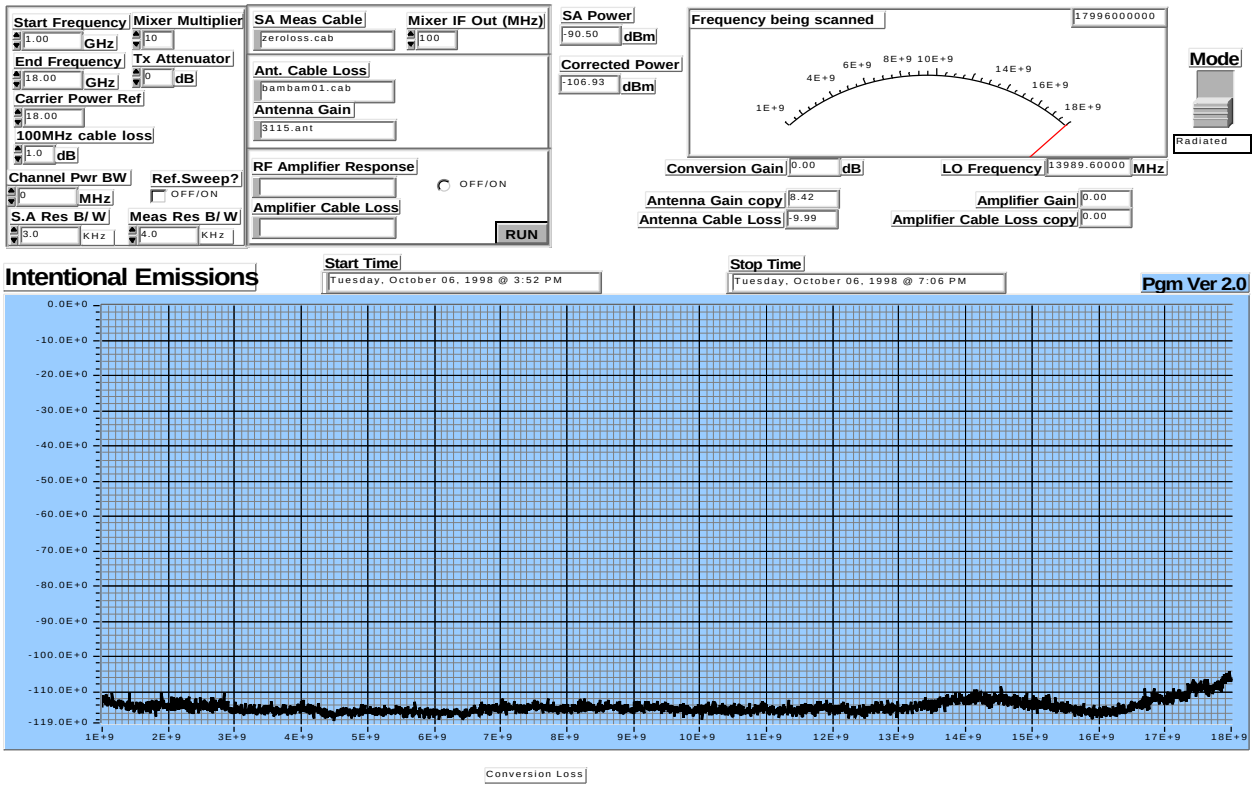


**BTR with the back cover removed**

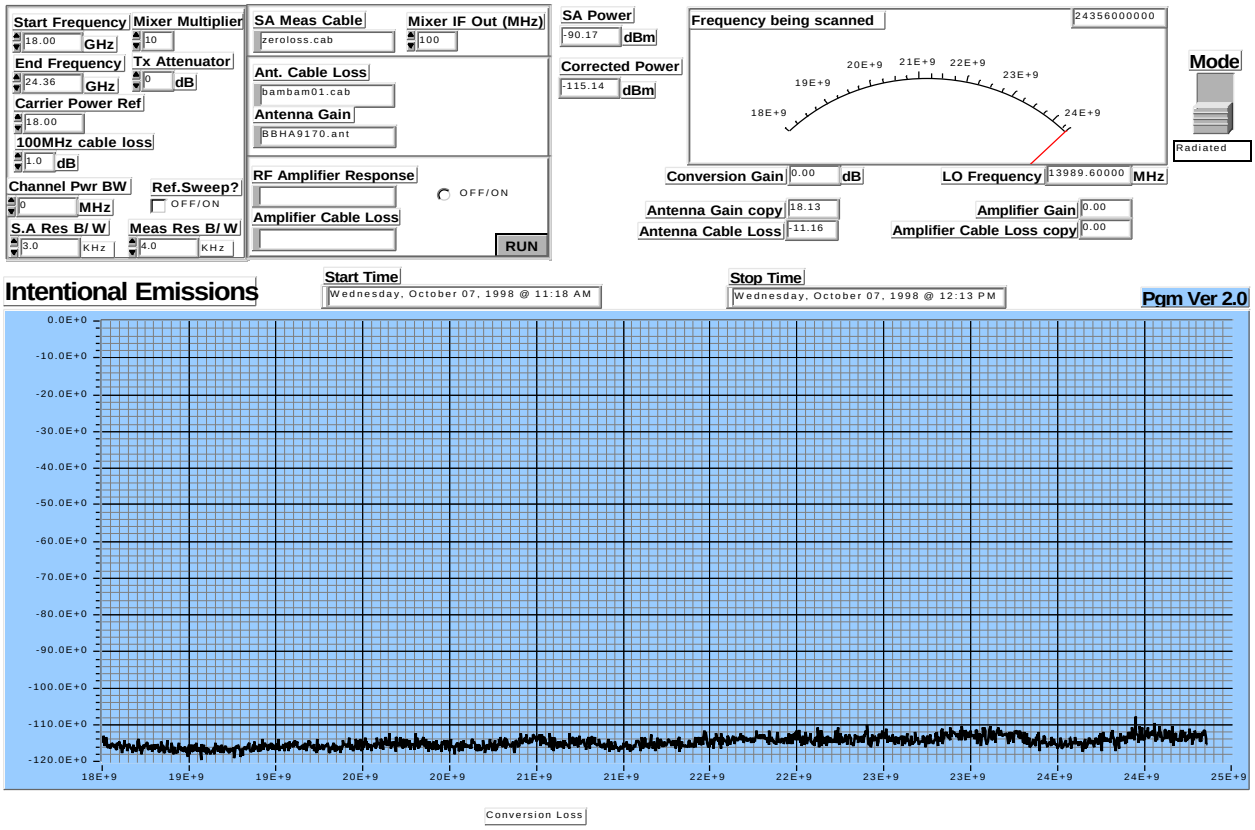
Production BTR 2400, 4 carrier QAM 64 modulated. – 30MHz to 1GHz



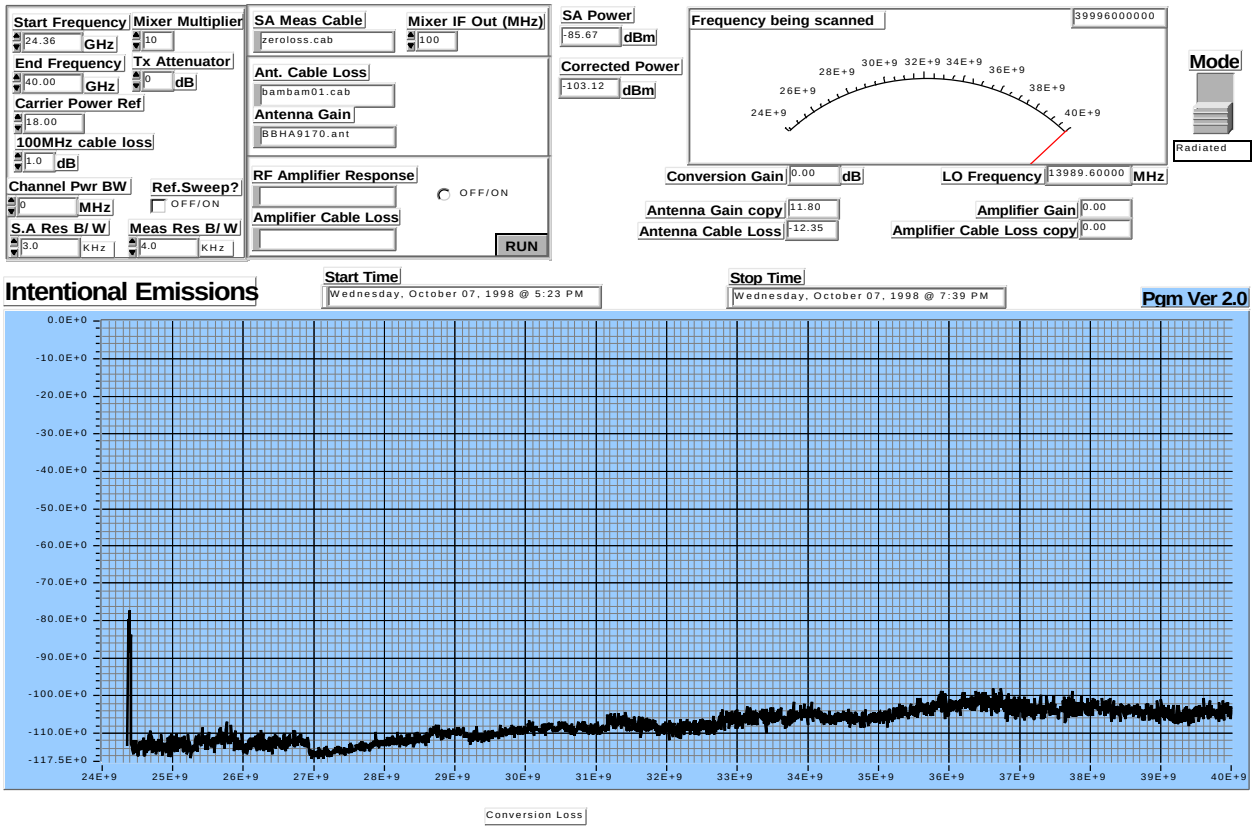
Production BTR 2400, 4 carrier QAM 64 modulated. – 1 to 18 GHz



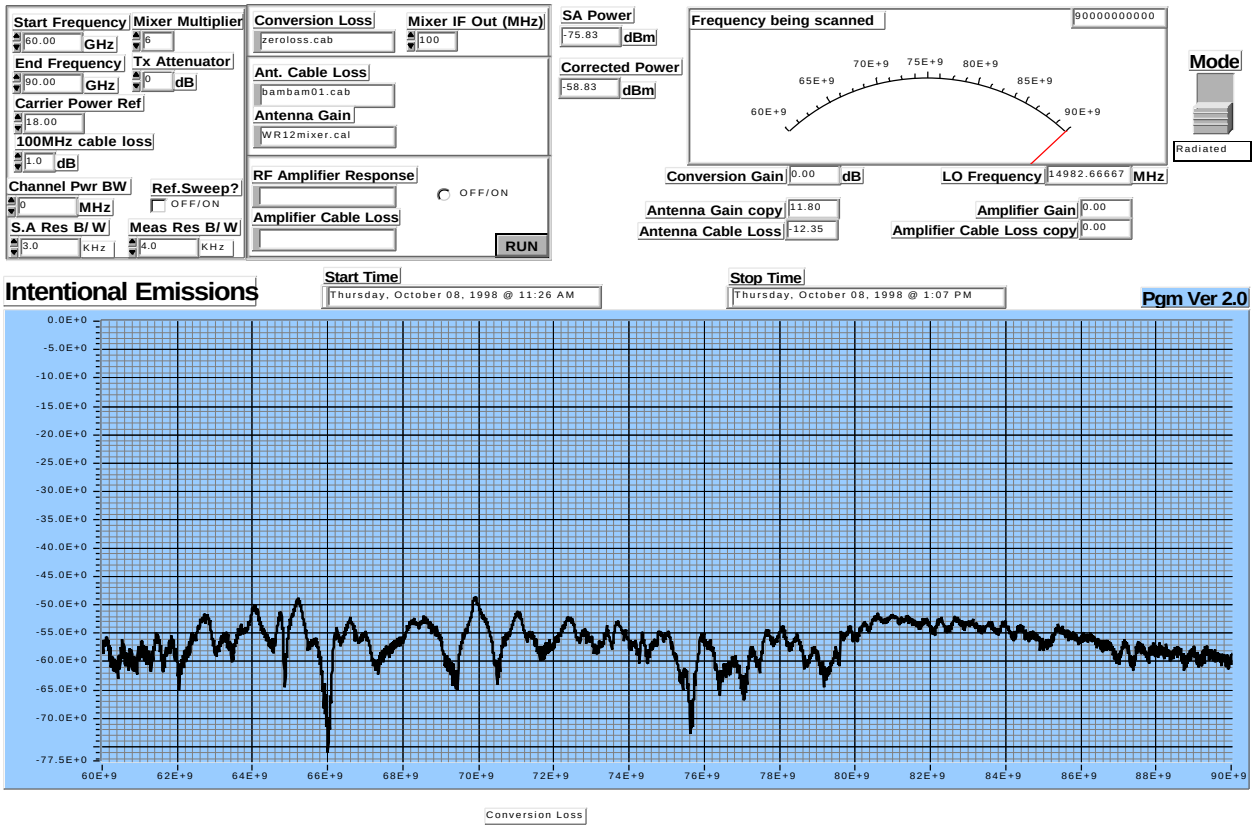
Production BTR 2400, 4 carrier QAM 64 modulated. – 18GHz to edge of carriers



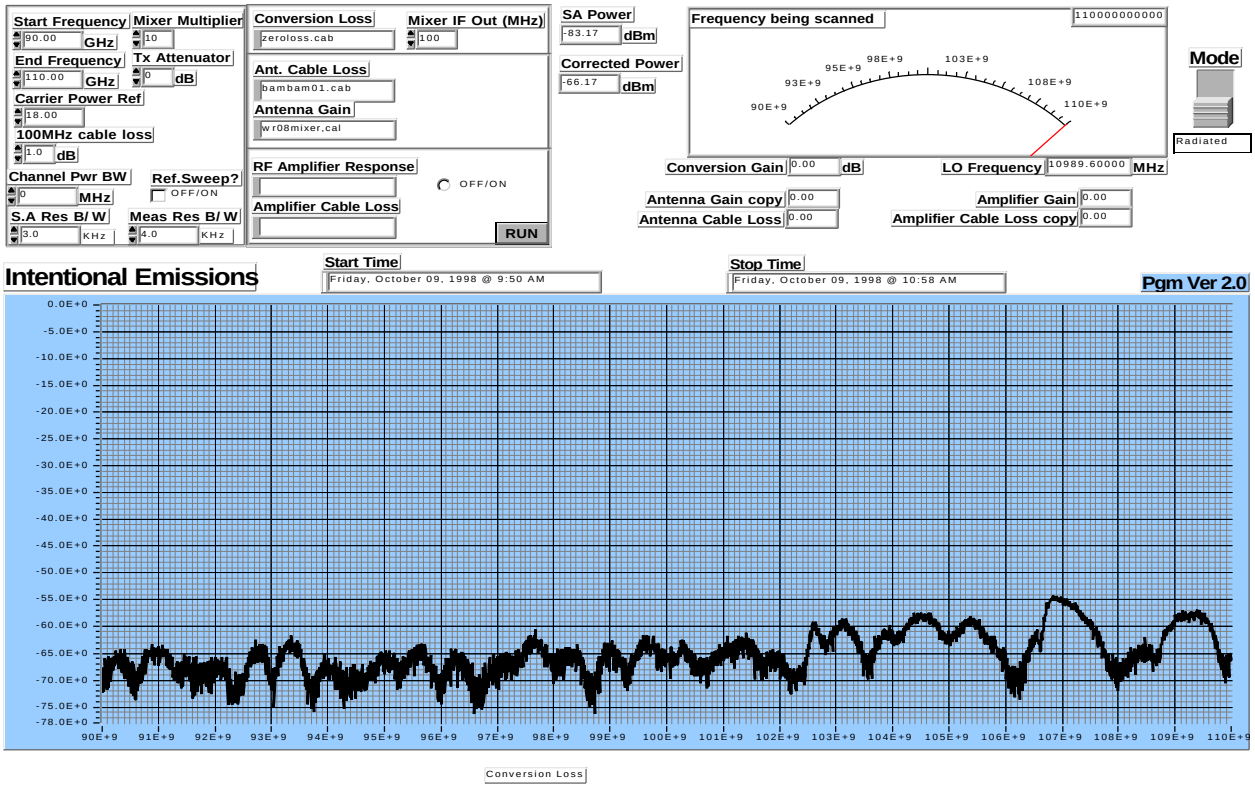
Production BTR 2400, 4 carrier QAM 64 modulated. – edge of carriers to 40GHz



Production BTR 2400, 4 carrier QAM 64 modulated. – 60-90GHz

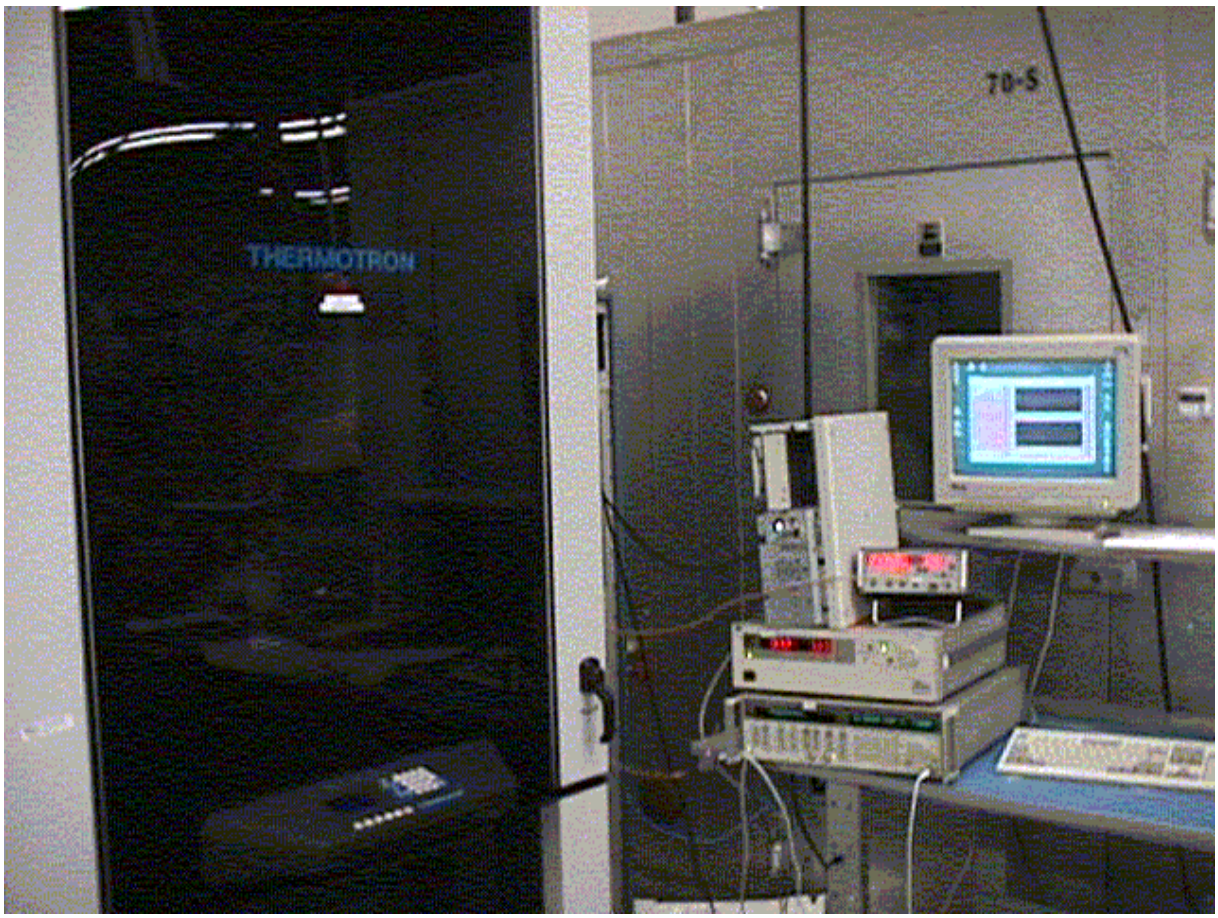


Production BTR 2400, 4 carrier QAM 64 modulated. - 90-110GHz

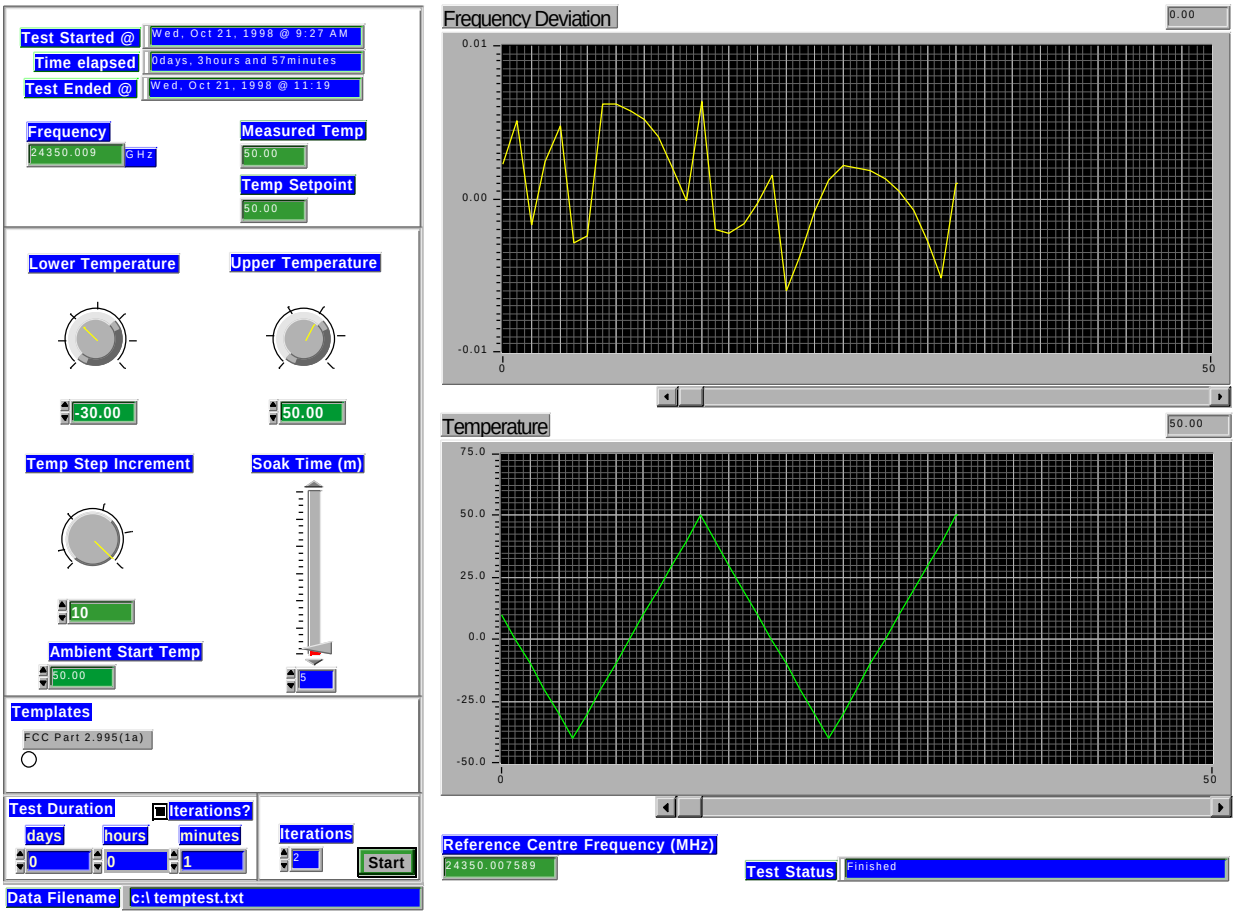


# APPENDIX C

## Temperature Stability Measurements Results




Test Setup


Test Started @
Wed, Oct 21, 1998 @ 9:27 AM
Time elapsed
0days, 3hours and 57minutes
Test Ended @
Wed, Oct 21, 1998 @ 11:19
Frequency
24350.009
GHz
Measured Temp
50.00
Temp Setpoint
50.00
Lower Temperature
Upper Temperature
-30.00
50.00
Temp Step Increment
Soak Time (m)
10
Ambient Start Temp
50.00
5
Templates
FCC Part 2.995(1a)
Test Duration
Iterations?
days
hours
minutes
0
0
1
Iterations
2
Start
Data Filename
c:\ temptest.txt
Frequency Deviation
0.00
0.01
0.00
-0.01
0
50
Temperature
50.00
75.0
50.0
25.0
0.0
-25.0
-50.0
0
50
Reference Centre Frequency (MHz)
24350.007589
Test Status
Finished

Test Plot

Test Results

| Microwave | Temp(C) | Deviation | DRO Temp | Error (%) |
|---|---|---|---|---|
| 24350.00349 | | | | |
| 24350.00577 | 10 | 0.002281 | 23.2 | 9.36756E-06 |
| 24350.00857 | 0 | 0.005076 | 17 | 2.0846E-05 |
| 24350.00177 | -10 | -0.001721 | 8.4 | -7.06776E-06 |
| 24350.00594 | -20 | 0.002446 | -1.1 | 1.00452E-05 |
| 24350.00824 | -30 | 0.004744 | -10.9 | 1.94825E-05 |
| 24350.00059 | -40 | -0.002898 | -21.1 | -1.19014E-05 |
| 24350.00108 | -30 | -0.002407 | -17.3 | -9.88501E-06 |
| 24350.00969 | -20 | 0.006198 | -9.2 | 2.54538E-05 |
| 24350.00969 | -10 | 0.006198 | -0.1 | 2.54538E-05 |
| 24350.00926 | 0 | 0.005767 | 9.3 | 2.36838E-05 |
| 24350.00871 | 10 | 0.00522 | 18.9 | 2.14374E-05 |
| 24350.00755 | 20 | 0.004056 | 28.4 | 1.66571E-05 |
| 24350.00545 | 30 | 0.001955 | 37.9 | 8.02875E-06 |
| 24350.00338 | 40 | -0.000115 | 47.3 | -4.72279E-07 |
| 24350.00987 | 50 | 0.006383 | 56.8 | 2.62135E-05 |
| 24350.00556 | 40 | -0.002034 | 54.7 | -8.35318E-06 |
| 24350.00535 | 30 | -0.002236 | 46.7 | -9.18275E-06 |
| 24350.00591 | 20 | -0.001683 | 37.6 | -6.9117E-06 |
| 24350.00728 | 10 | -0.000312 | 28 | -1.28131E-06 |
| 24350.00919 | 0 | 0.001599 | 18.5 | 6.56673E-06 |
| 24350.00156 | -10 | -0.006027 | 8.7 | -2.47515E-05 |
| 24350.00378 | -20 | -0.003814 | -1.1 | -1.56632E-05 |
| 24350.00672 | -30 | -0.000868 | -11 | -3.56468E-06 |
| 24350.0088 | -40 | 0.001211 | -20.8 | 4.97331E-06 |
| 24350.00973 | -30 | 0.002145 | -17.3 | 8.80903E-06 |
| 24350.0096 | -20 | 0.002006 | -9.3 | 8.23819E-06 |
| 24350.00938 | -10 | 0.00179 | -0.1 | 7.35113E-06 |
| 24350.00887 | 0 | 0.001277 | 9.3 | 5.24435E-06 |
| 24350.00808 | 10 | 0.000493 | 18.8 | 2.02464E-06 |
| 24350.00682 | 20 | -0.000766 | 28.3 | -3.14579E-06 |
| 24350.00483 | 30 | -0.002763 | 37.8 | -1.1347E-05 |
| 24350.00241 | 40 | -0.00518 | 47.3 | -2.12731E-05 |
| 24350.00864 | 50 | 0.001051 | 56.9 | 4.31622E-06 |