# Nortel BWA Type Acceptance Radio Transceiver Test Report

| | |
|---|---|
| **Product Description:** | 28 GHz Base Station (BTR) Radio Transceiver |
| **Model**: | BTR2800 |
| **Nortel BWA File #** | OHOBTR2807NT |

**CHARLIE BISHOP PI ENGINEER**

**DATE MAY 11, 1999**

WINNIPEG,

**DECLARATION BY Nortel Networks BWA**

The tests were performed from Feb 5 through Mar 26,1999 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: Mitch Hebert | Date March 26, 1999 |
| Supervised by: Charlie Bishop | Date March 26, 1999 |



Total number of pages: 69.

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.**

NORTEL NETWORKS

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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 Bands 29.1 to 29.25GHz. 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 are demonstrated in the following pages. Nortel Networks BWA is currently seeking type approval on this product.

### Equipment Under Test Description

The Nortel Networks BWA 28GHz radio product is of wide band design. The power amplifiers and the LNA are designed to provide gain over the entire 27.5 to 29.25 GHz band. The BTR is of a single conversion design and a single DRO serve both the transmit and receive path. The BTR provide a maximum power output of 1 watt respectively 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 EUTs:

| Model # | Description | Manufacturer | Part # |
|---|---|---|---|
| BTR2800 | Base Transceiver | Nortel BWA | NTVG14AG |

| Model # | Order Code | uW Tx (GHz) | uW Rx (GHz) | RF Rx (MHz) | RF Tx (MHz) | BW | Separation |
|---|---|---|---|---|---|---|---|
| BTR2800 | NTVG14AG | 29.1-29.25 | 28.2-28.35 | 250-400 | 500-650 | 150 | 900 |

### Antennae

The antenna used by the Base Station transceiver can be identified by the marking 2800-07 on the side of the wave-guide housing. Please note that the below table indicates the horizontal/vertical polarization by the part numbers.

| Nortel Part Number | Spread (degrees) | Isotropic Gain (dBi) |
|---|---|---|
| NTVG13AB/ED | 90 +/- 9 | 15 min |
| NTVG13AD/EF | 45 +/- 4.5 | 18 min |
| NTVG13EG/EH | 15 +/- 1.5 | 23 min |

## General

Tests were performed on a production sample(s) of the BTR, 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 BTR is intended to fall under the 29100 to 29250MHz section of the Part 101.109 table. The complimenting customer transceiver (CTR) is intended to fall under the 27500 to 28350MHz section and will be documented under CTVG16AG and FCC ID OHOCTR2807NT.

## Results

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

| Standard | Test Description | Para. No. | Results |
|---|---|---|---|
| FCC part 101.111(a) | Spectral Mask | (2)(ii) | Compliant |
| FCC part 101.111(a) | Conducted Emissions except mask region | (2)(iii) | Compliant |
| FCC part 101.111(a) | Radiated Emissions except mask region | (2)(iii) | Compliant |
| FCC part 101, sec 101.113 | Transmit Power Limitation | C2 | Compliant |
| FCC part 101, sec 101.113 | Antenna azimuth limitation | C3 | 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 | 09/99 |
| Spectrum Analyzer | Hewlett Packard | HP 8663E | 3611A05001 | 08/99 |
| 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 |
| Power Supply | Hewlett Packard | 6544A | US36390168 | ----- |
| Power Supply | Hewlett Packard | 6554A | US36340233 | ----- |
| Frequency Counter | XL microwave | 3460 | 980338143 | 03/99 |
| Antenna Bilog 30 to 1000 MHz | Shaffner-Chase | CBL6111B | 2261 | 08/99 |
| Horn Antenna 1 to 18 GHz | EMCO | 3115 | 9711-5345 | 11/99 |
| Horn Antenna 14 to 40 GHz | Shaffner-Chase | BBHA 9170 | 9046 | 3/99 |

## 2. CONDUCTED EMISSIONS

| | |
|---|---|
| Tested by: | Charlie Bishop and Mitch Hebert |
| Date: | Mar 9 through Mar 15,1998 |

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

### Test Conditions

| | |
|---|---|
| Temperature | 22 to 25C, |
| Primary Voltage | BTR -48 Vdc |

### 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.

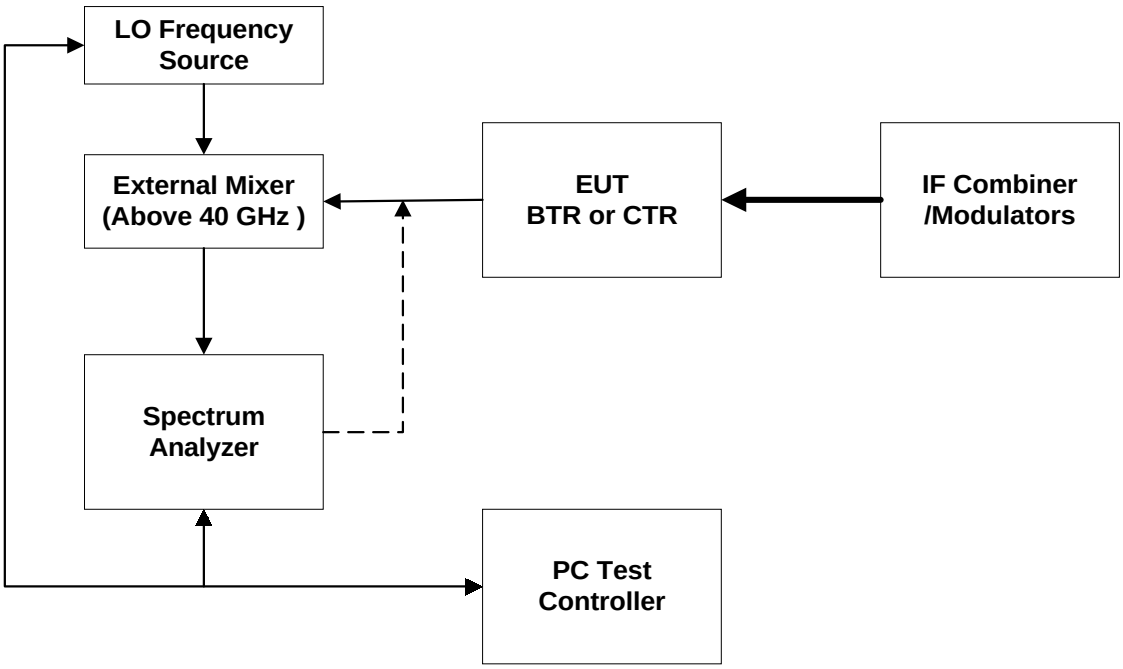
### Test Method

Nortel processing equipment stimulated the BTR with digitally modulated 16 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the BTR. 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 40MHz for the BTR. The 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 )
Spectrum Analyzer
EUT BTR or CTR
IF Combiner /Modulators
PC Test Controller

## 3. RADIATED EMISSIONS

| | |
|---|---|
| Tested by: | Charlie Bishop and Mitch Hebert |
| Date: | Mar 9 through Mar 15, 1998 |

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

### Test Conditions

| | |
|---|---|
| Temperature | 20-25C, |
| Primary Voltage | BTR -48 Vdc |

### 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 BTR with digitally modulated 16 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the BTR. 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. 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.

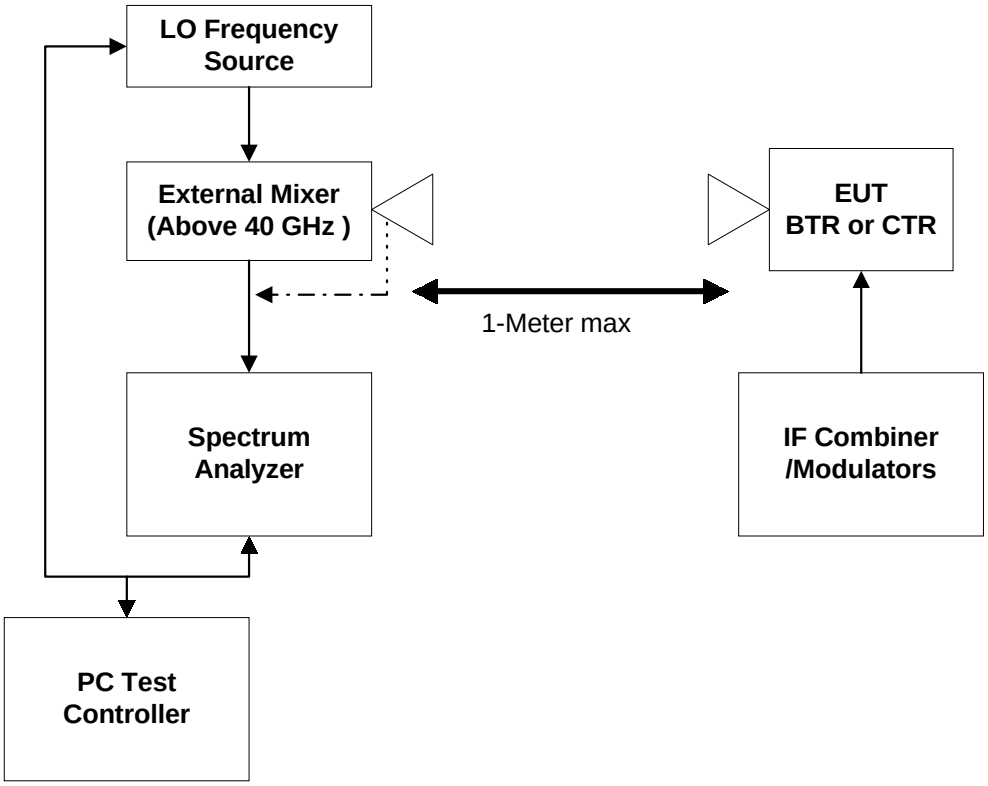



**Figure 2.0: Test Setup Configuration for Radiated Emissions**

## 4. TEMPERATURE STABILITY TESTS

| | |
|---|---|
| Tested by: | Charlie Bishop and Mitch Hebert |
| Date: | Mar 8, 1998 |

Test was performed to the validate the requirement of part 101.

### Test Conditions

| | |
|---|---|
| Temperature | -40C to +50C, |
| Primary Voltage | BTR -48 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, 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.

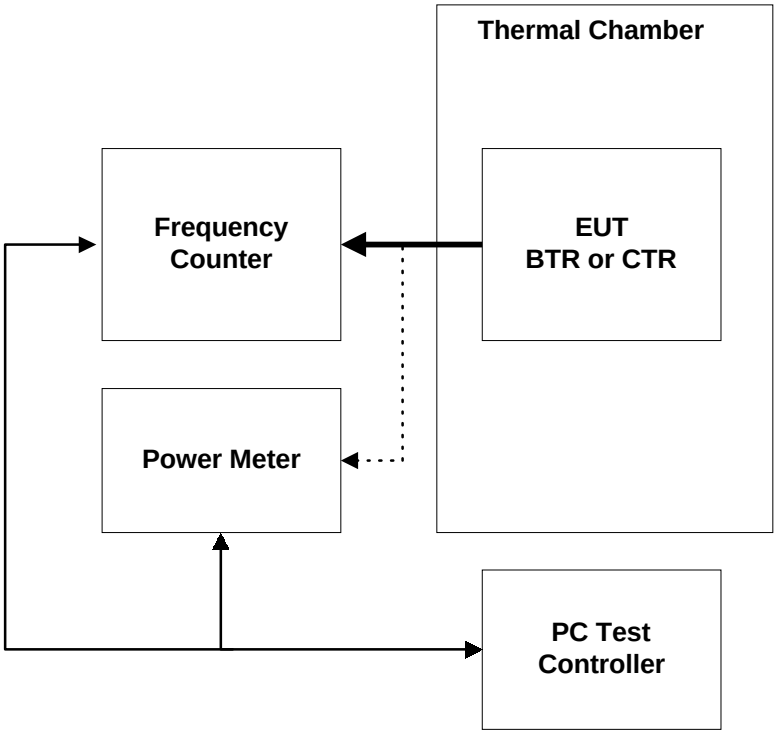



**Figure 3.0: Test Setup Configuration for Temperature Stability Tests**

## 5. CO/ADJACENT CHANNEL TEST

| | |
|---|---|
| Tested by: | Charlie Bishop and Mitch Hebert |
| Date: | Apr 13,1999 |

### Test Conditions

| | |
|---|---|
| Temperature | 25C, |
| Primary Voltage | BTR -48 Vdc |

### 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.

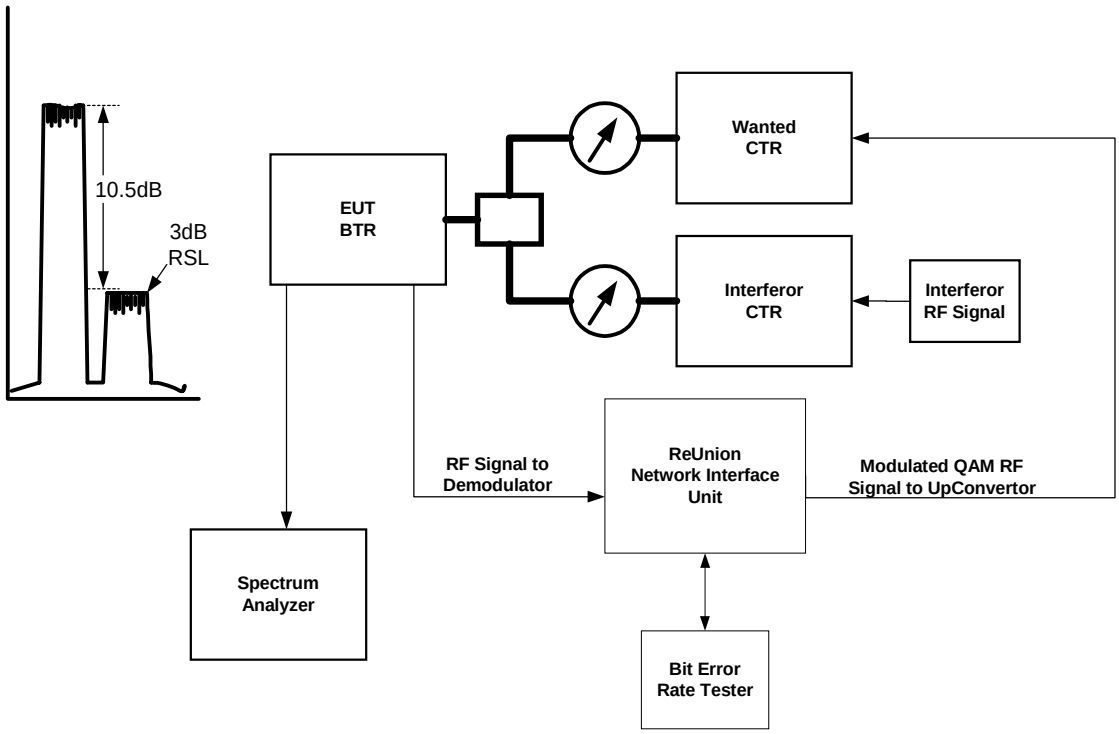
### Adjacent Channel Test Method

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.

**Adjacent Channel Test Results**

| 4 QAM | Wanted | Hi-Side Interferor | Low-Side Interferor |
|---|---|---|---|
| | 550 MHz | 560MHz | 540MHz |
| 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 |
|---|---|---|---|
| | 550 MHz | 560MHz | 540MHz |
| 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 |
|---|---|---|---|
| | 550 MHz | 560MHz | 540MHz |
| 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 550MHz @ 4 QAM | Wanted | Interferor |
|---|---|---|
| Channel Power | -43.5 | -54.5 |
| Limit (19.5dB) | ---- | > -63 |
| Pass Margin | ---- | 8.5 |

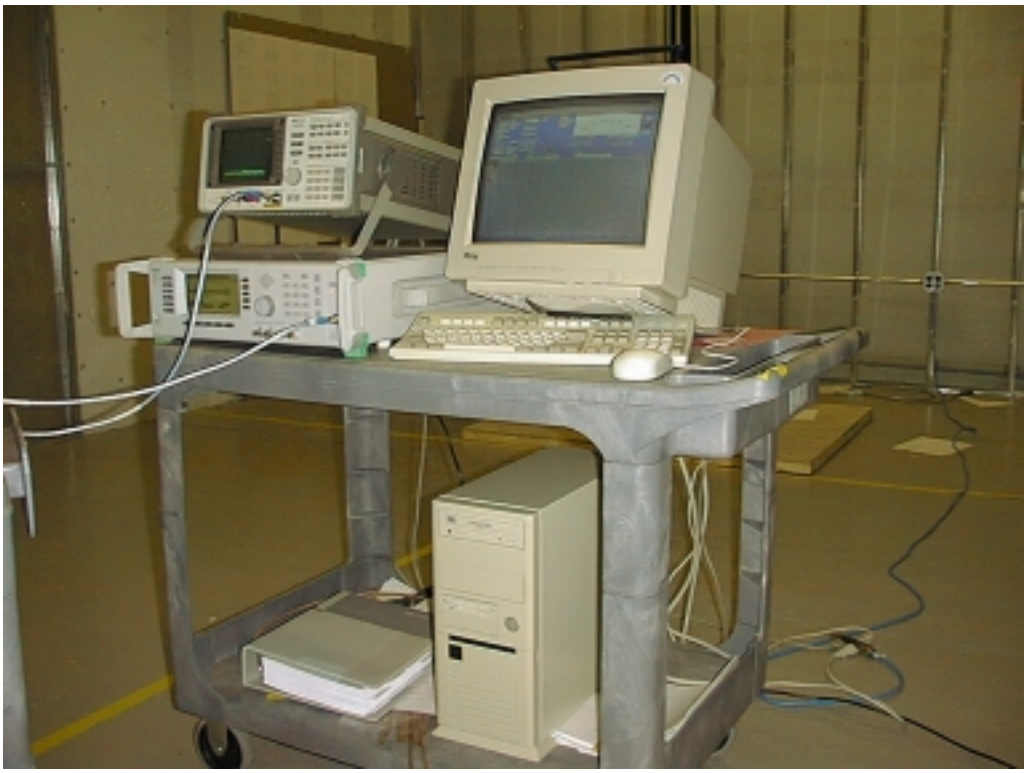
| Frequency 550MHz @ 16 QAM | Wanted | Interferor |
|---|---|---|
| Channel Power | -45 | -60.5 |
| Limit (26.9dB) | ---- | > -71.9 |
| Pass Margin | ---- | 11.4 |

| Frequency 550MHz @ 64 QAM | Wanted | Interferor |
|---|---|---|
| Channel Power | -47.5 | -65.5 |
| Limit (33.1dB) | ---- | > -80.6 |
| Pass Margin | ---- | 15.1 |

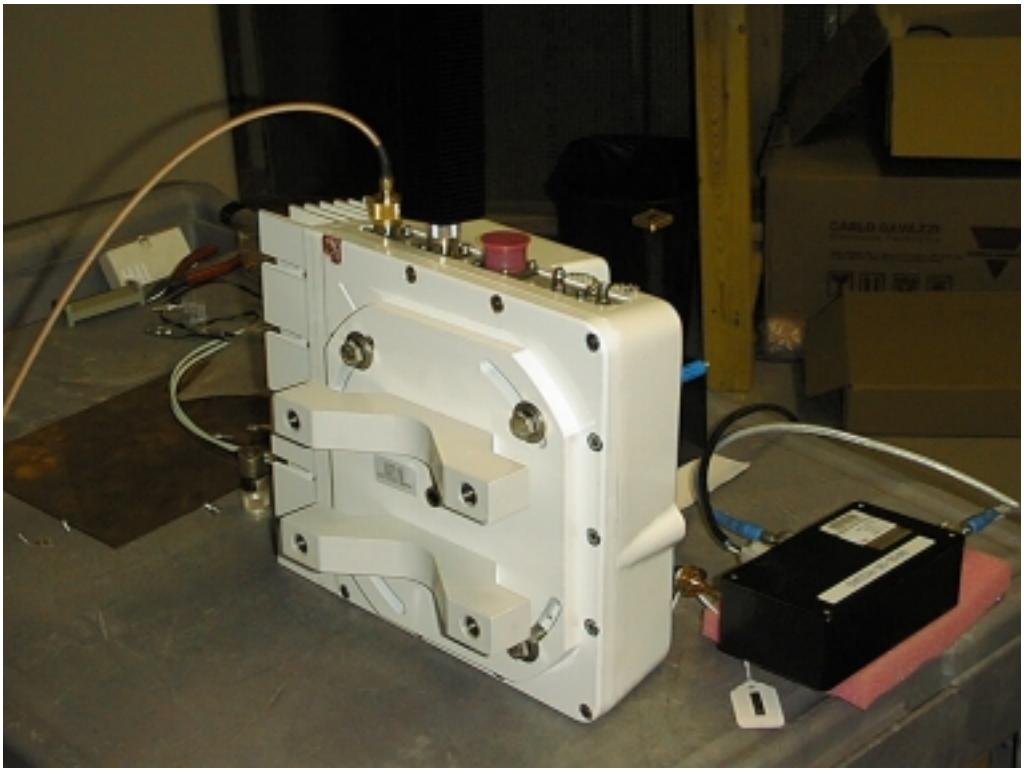
# APPENDIX A

## Conducted Emissions Measurement Results

## 6. CONDUCTED EMISSIONS MEASUREMENT RESULTS



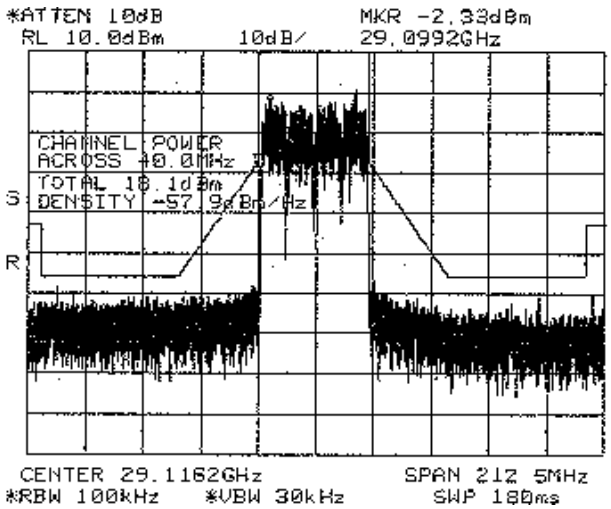
Computer setup and instrumentation in the PI laboratory

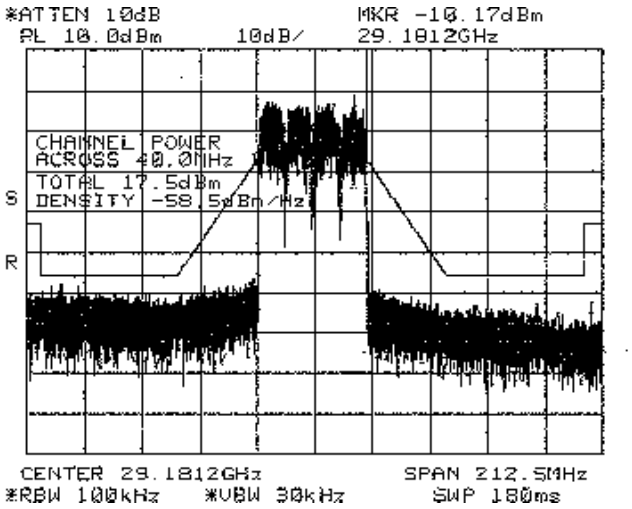


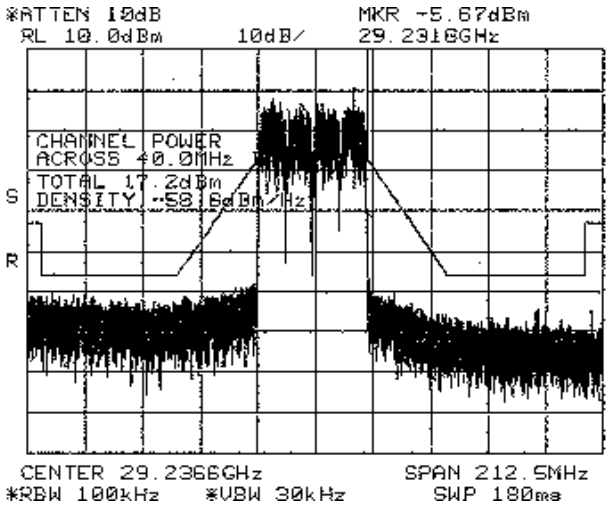
Connection to the BTR using the wave-guide connection

BTR 2800, 4 carrier QAM 64 modulated - In-band carriers

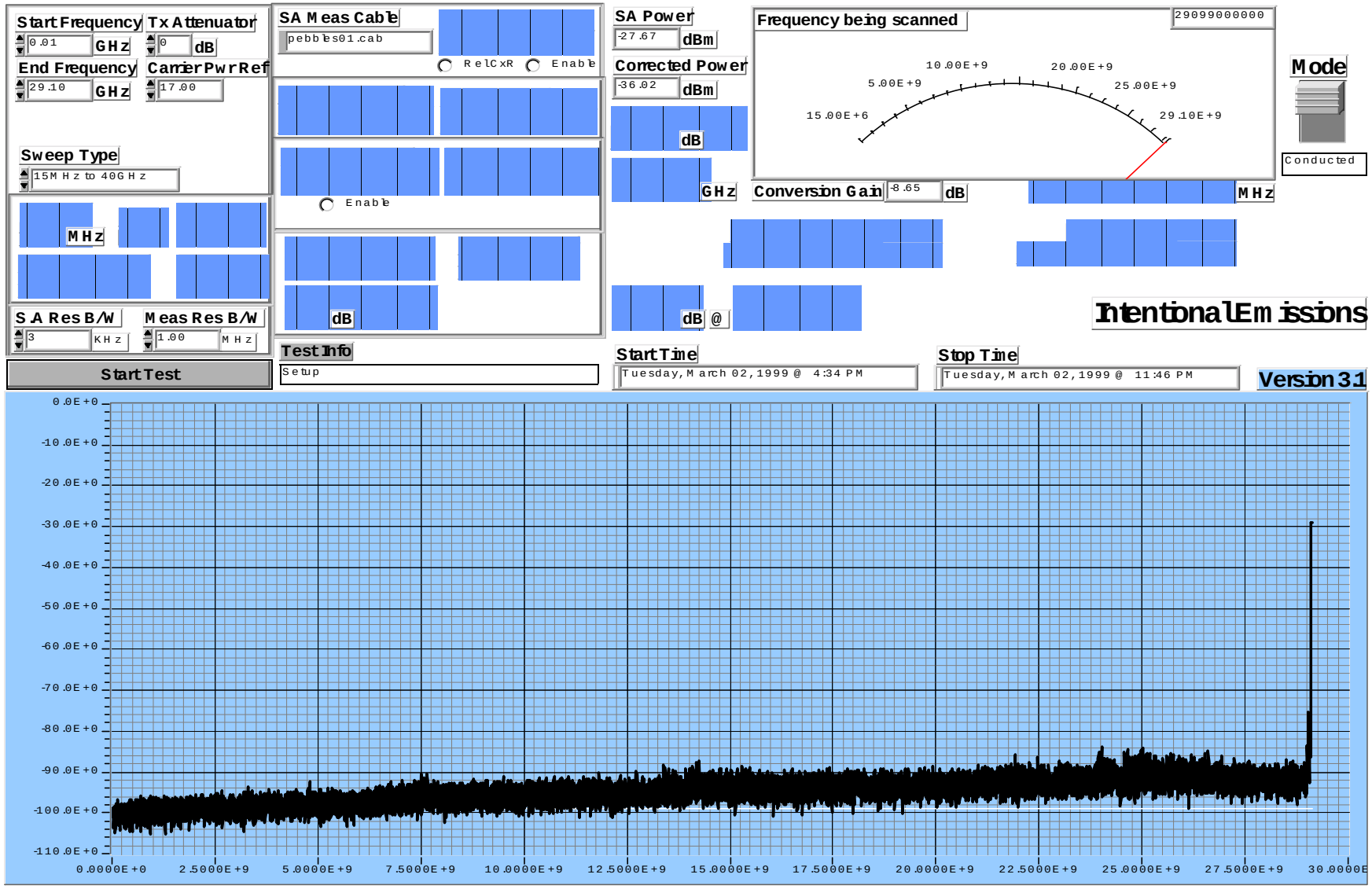
The emission showing amplitude and angle-modulated (D) with two or more channels (7) which could contain data or telephony (W). The signal has a maximum occupied bandwidth of 40MHz. (40M0). Equipment Type 40M0D7W The following pictures show 4 – 10MHz carriers across the minimum, maximum and middle of the 150MHz band at a channel power of 20dBm Limit calculations can be found in Appendix D.



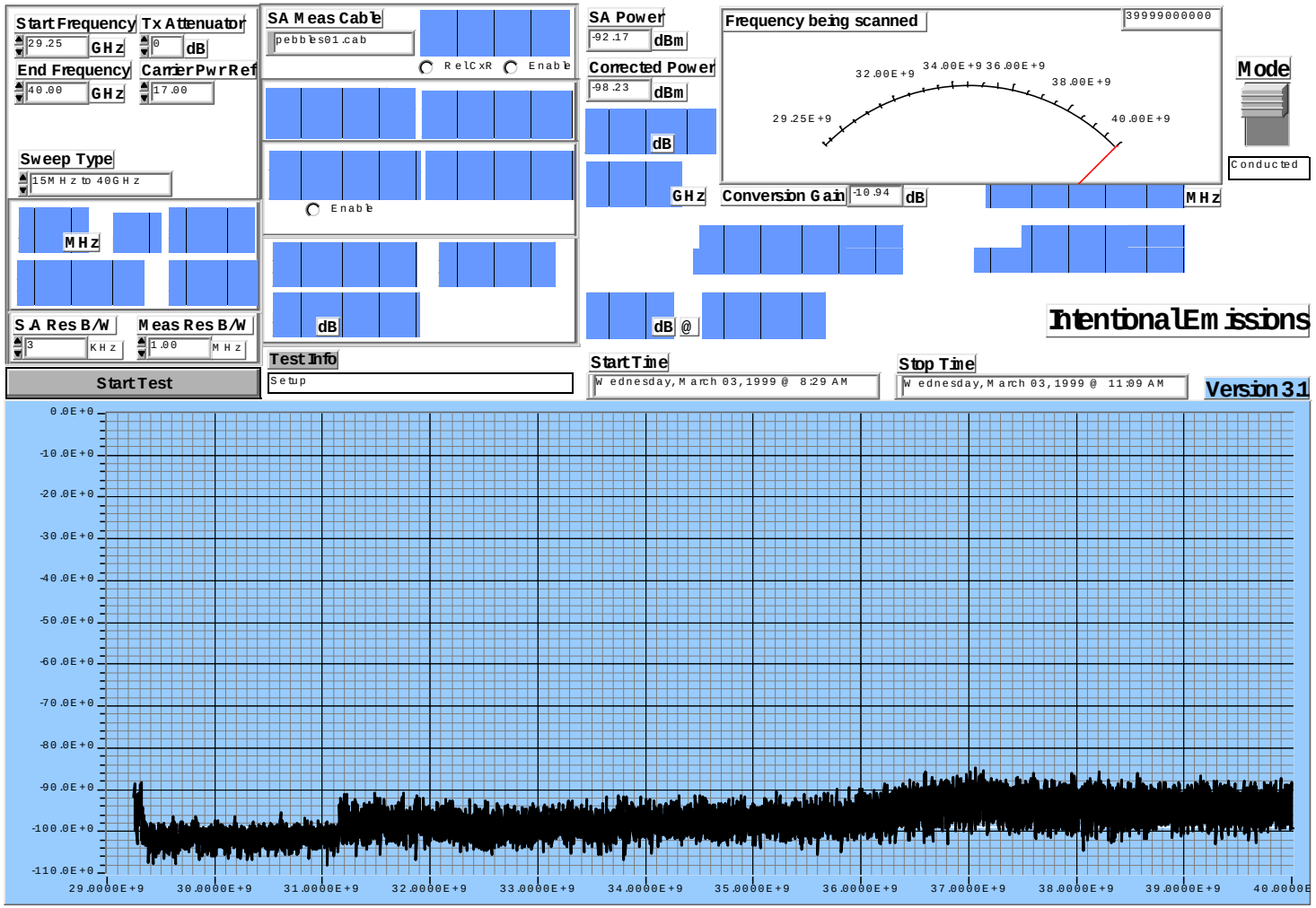



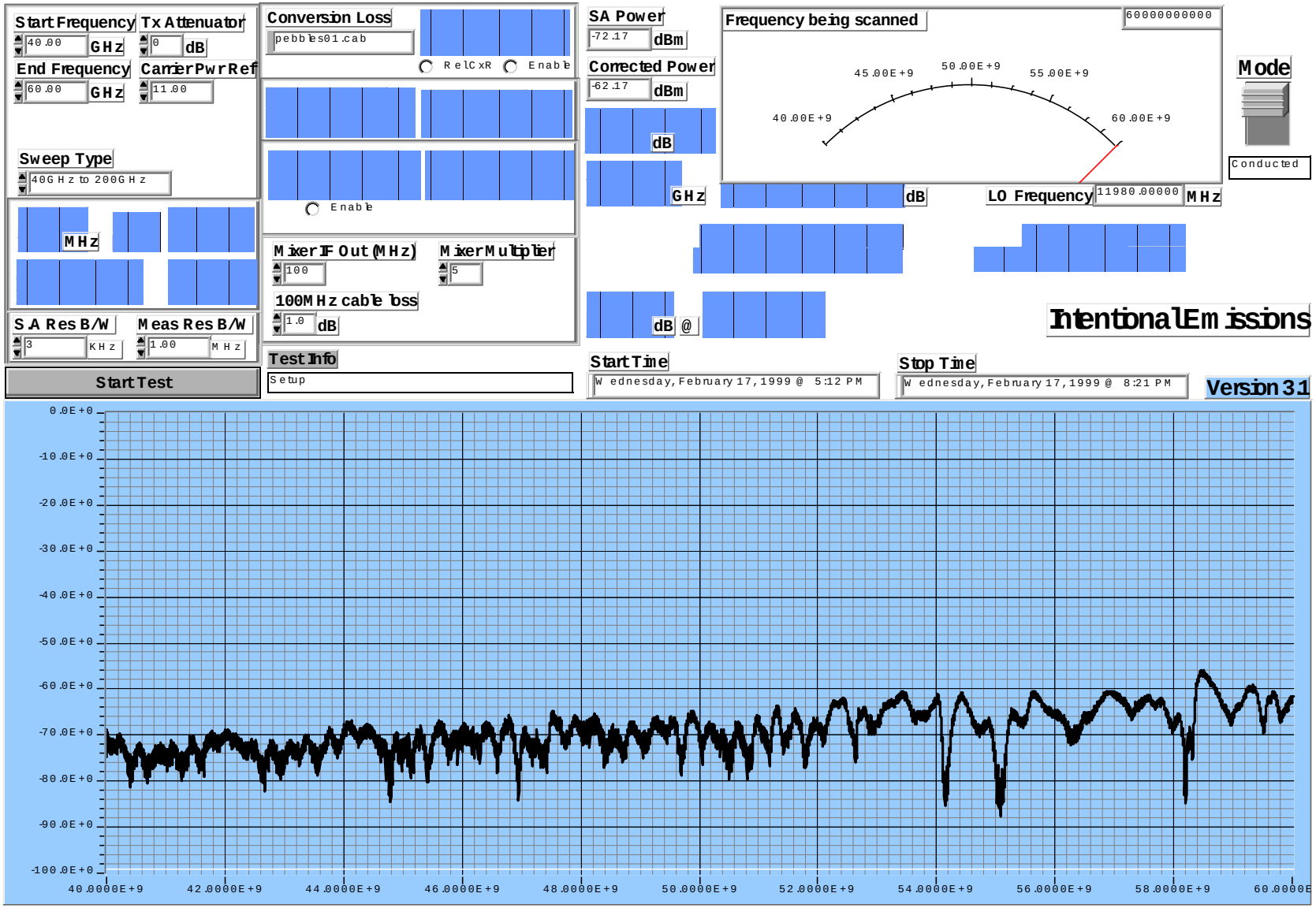
BTR 2800, 4 carrier QAM 64 modulated. – 30MHz to edge of carriers



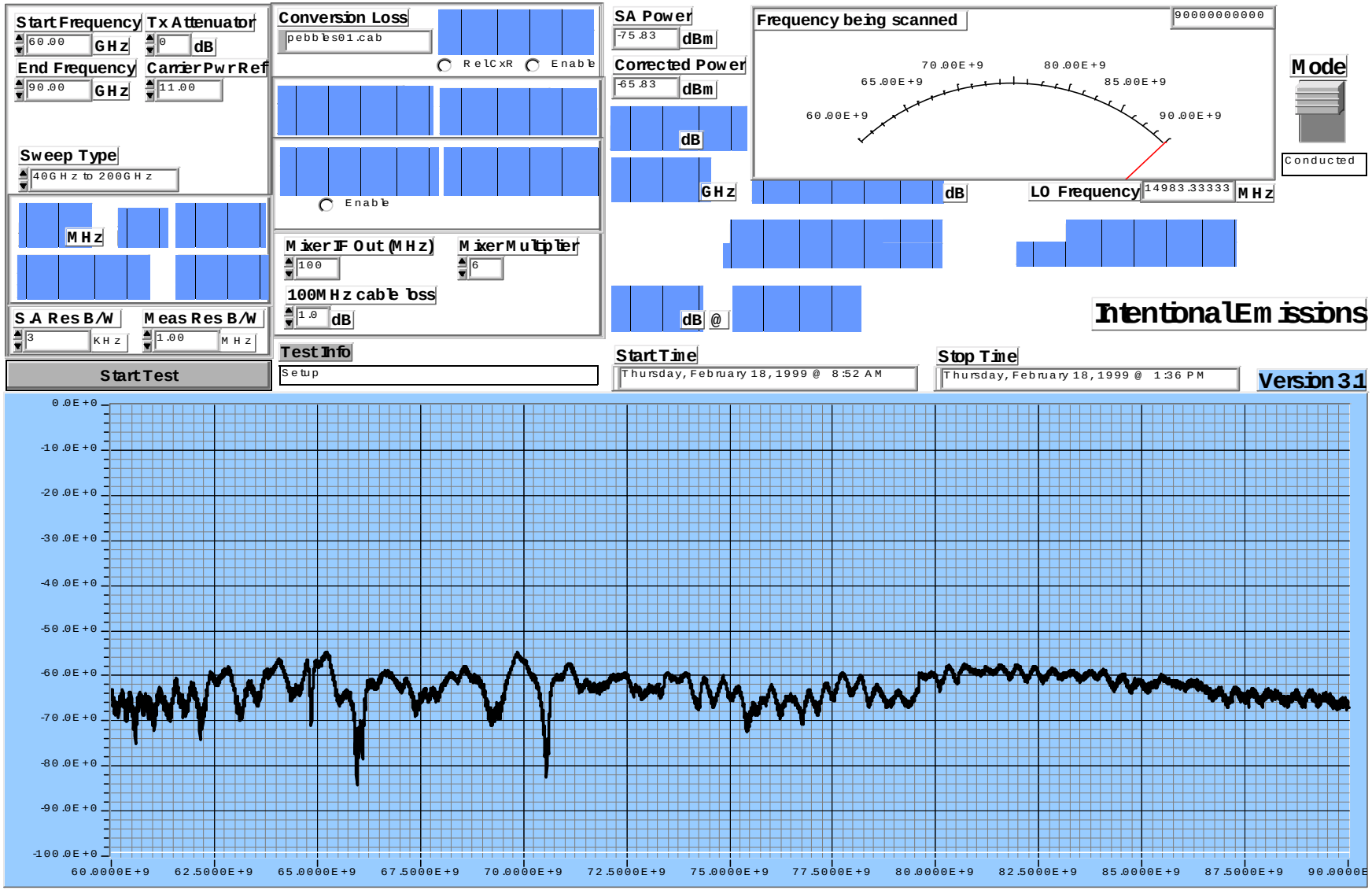
BTR 2800, 4 carrier QAM 64 modulated. – edge of carriers to 40GHz



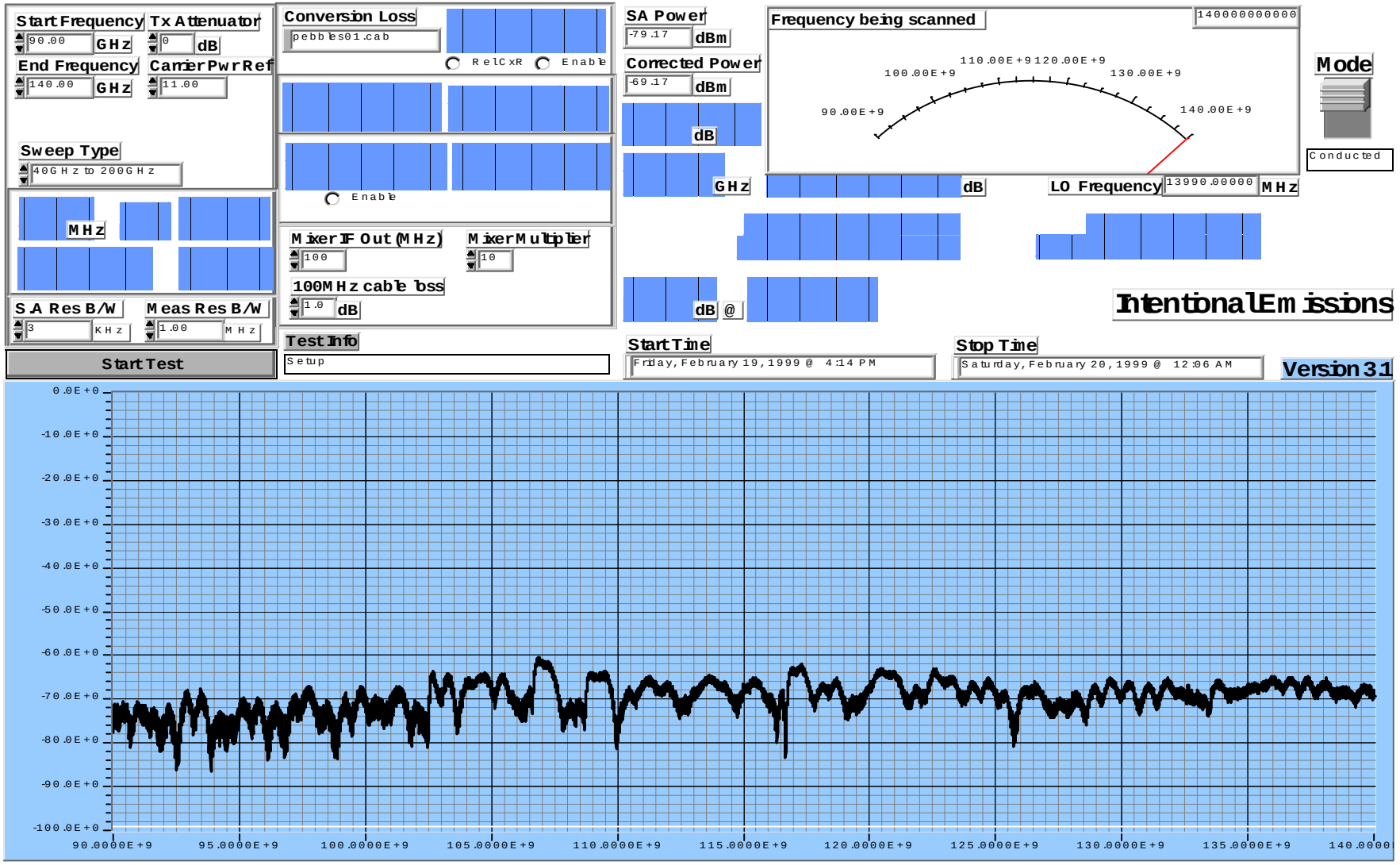
BTR 2800, 4 carrier QAM 64 modulated. – 40 to 60GHz



BTR 2800, 4 carrier QAM 64 modulated. – 60 to 90GHz



BTR 2800, 4 carrier QAM 64 modulated. – 90 to 140GHz

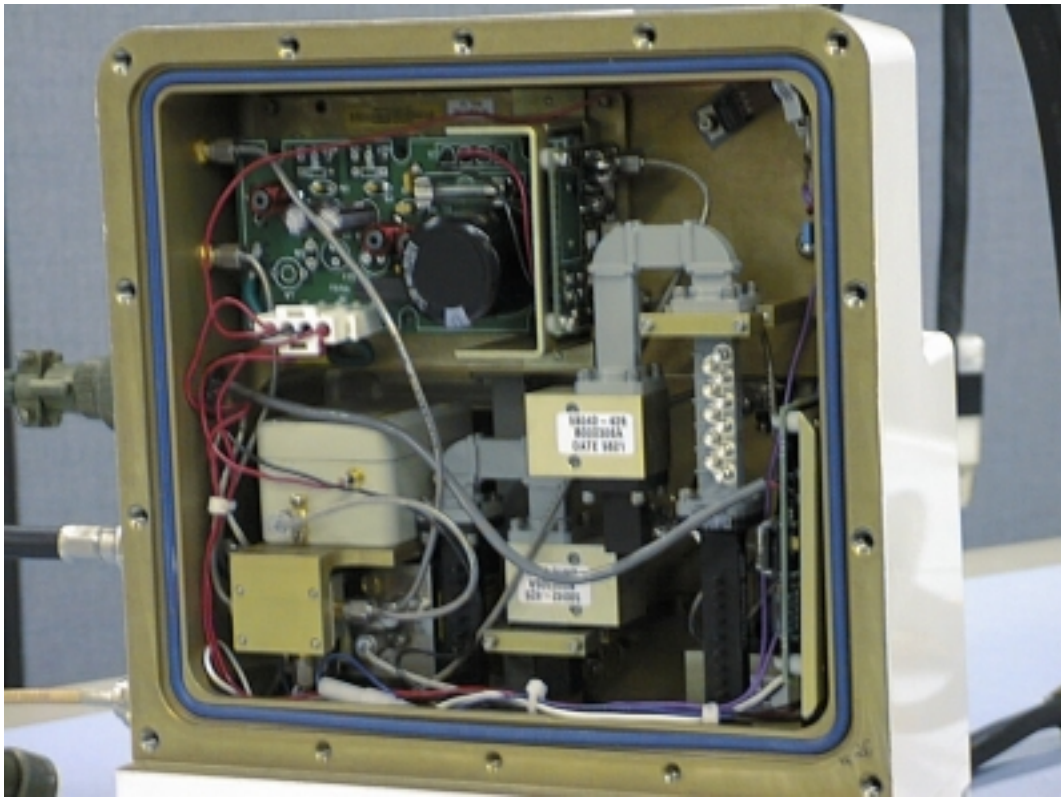


# APPENDIX B

## Radiated Emissions Measurement Results

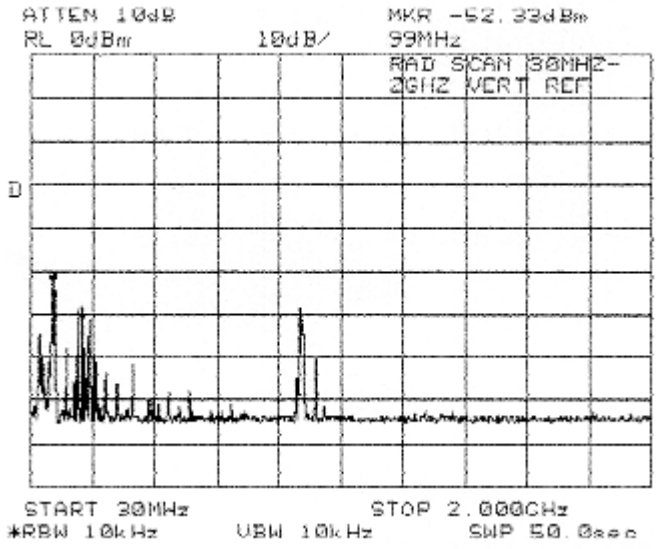
## 7. RADIATED EMISSIONS MEASUREMENT RESULTS

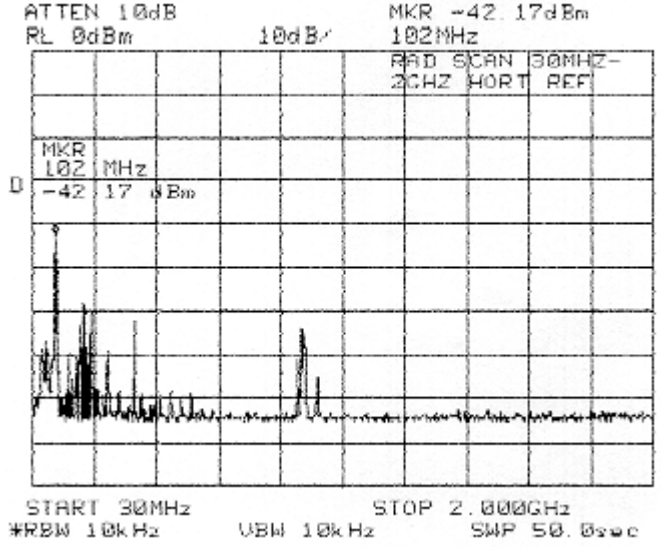
Radiated test using the 40-60GHz horn**.**



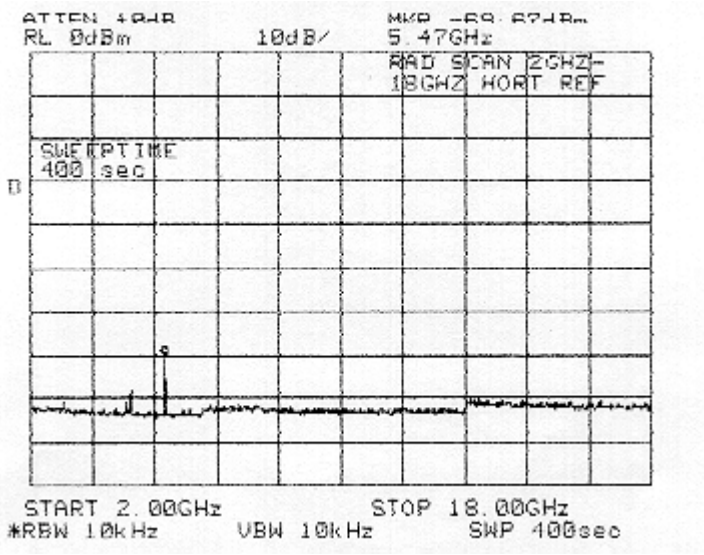
BTR with the back cover removed

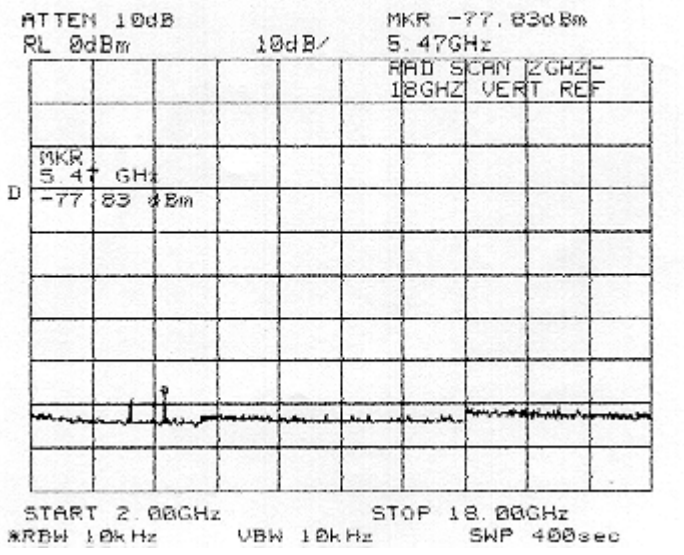
BTR 2800, 4 carrier QAM 64 modulated. – 30MHz to 2GHz



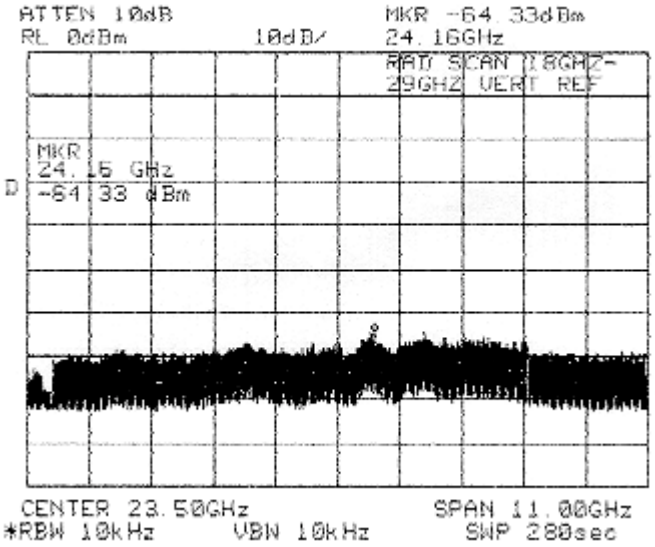



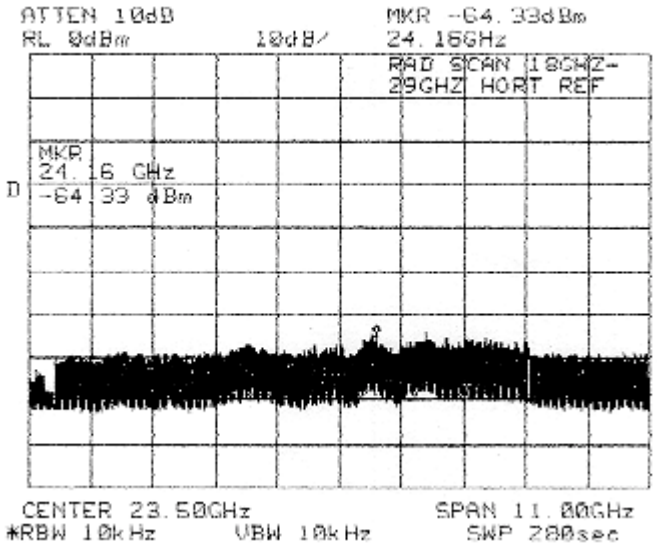
BTR 2800, 4 carrier QAM 64 modulated. – 2GHz to 18GHz



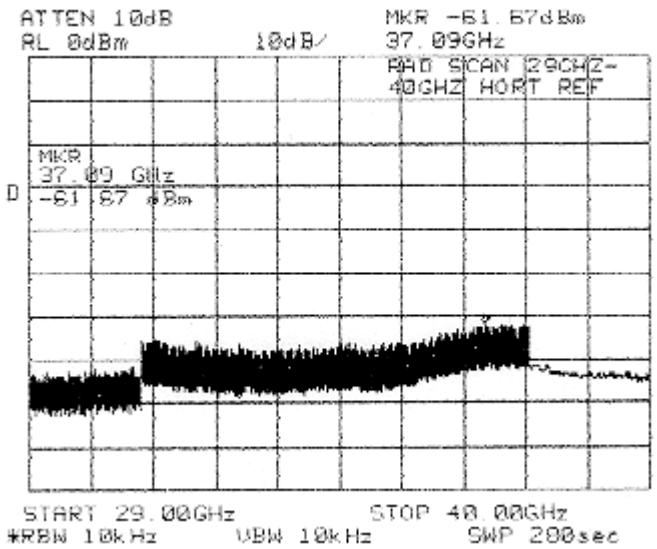



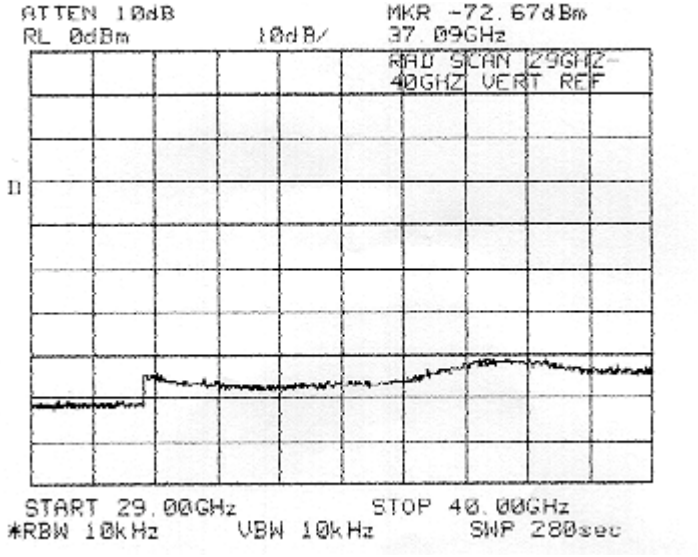
BTR 2800, 4 carrier QAM 64 modulated. – 18 to 29 GHz



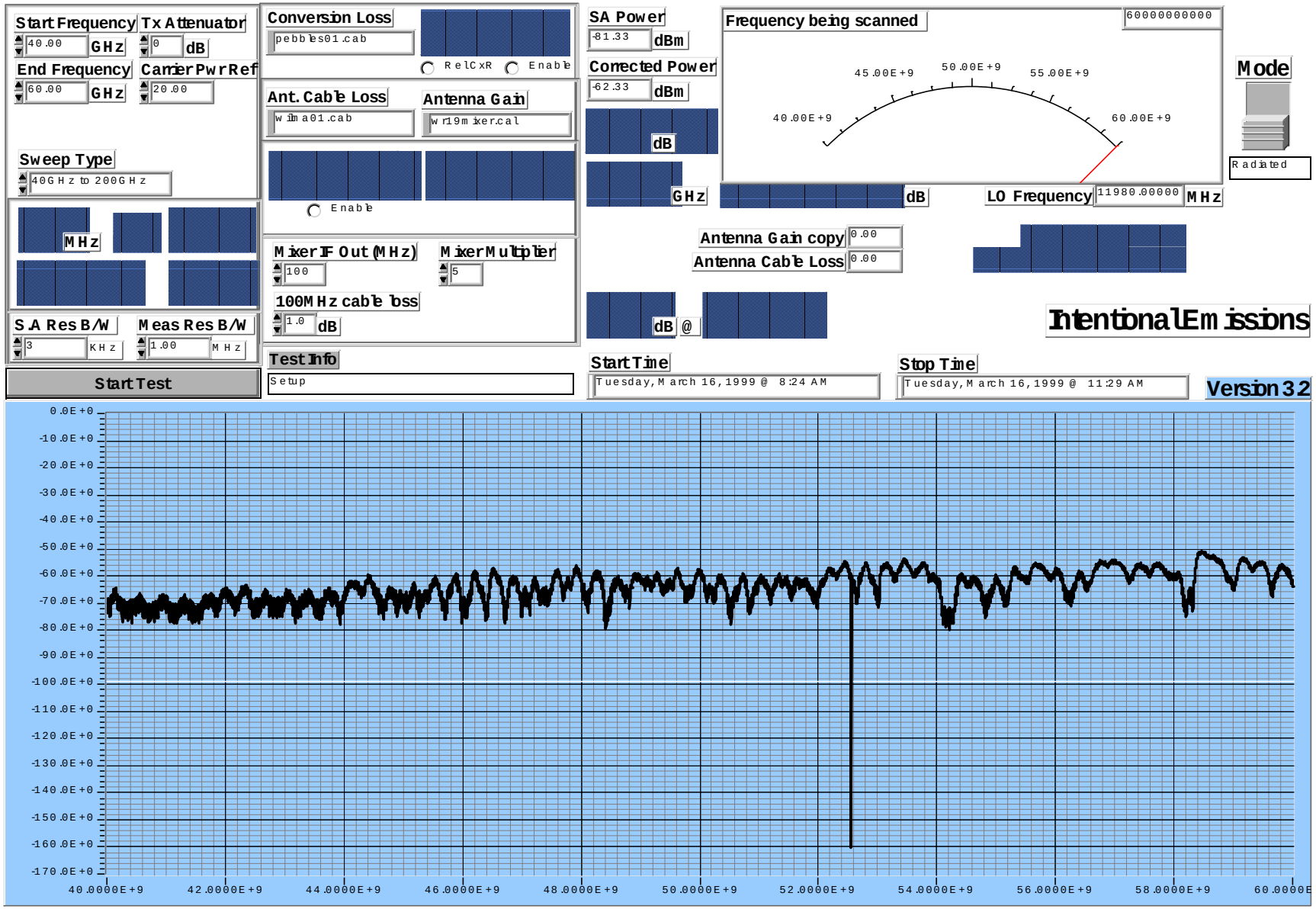



BTR 2800, 4 carrier QAM 64 modulated. – 29.5GHz to 40GHz

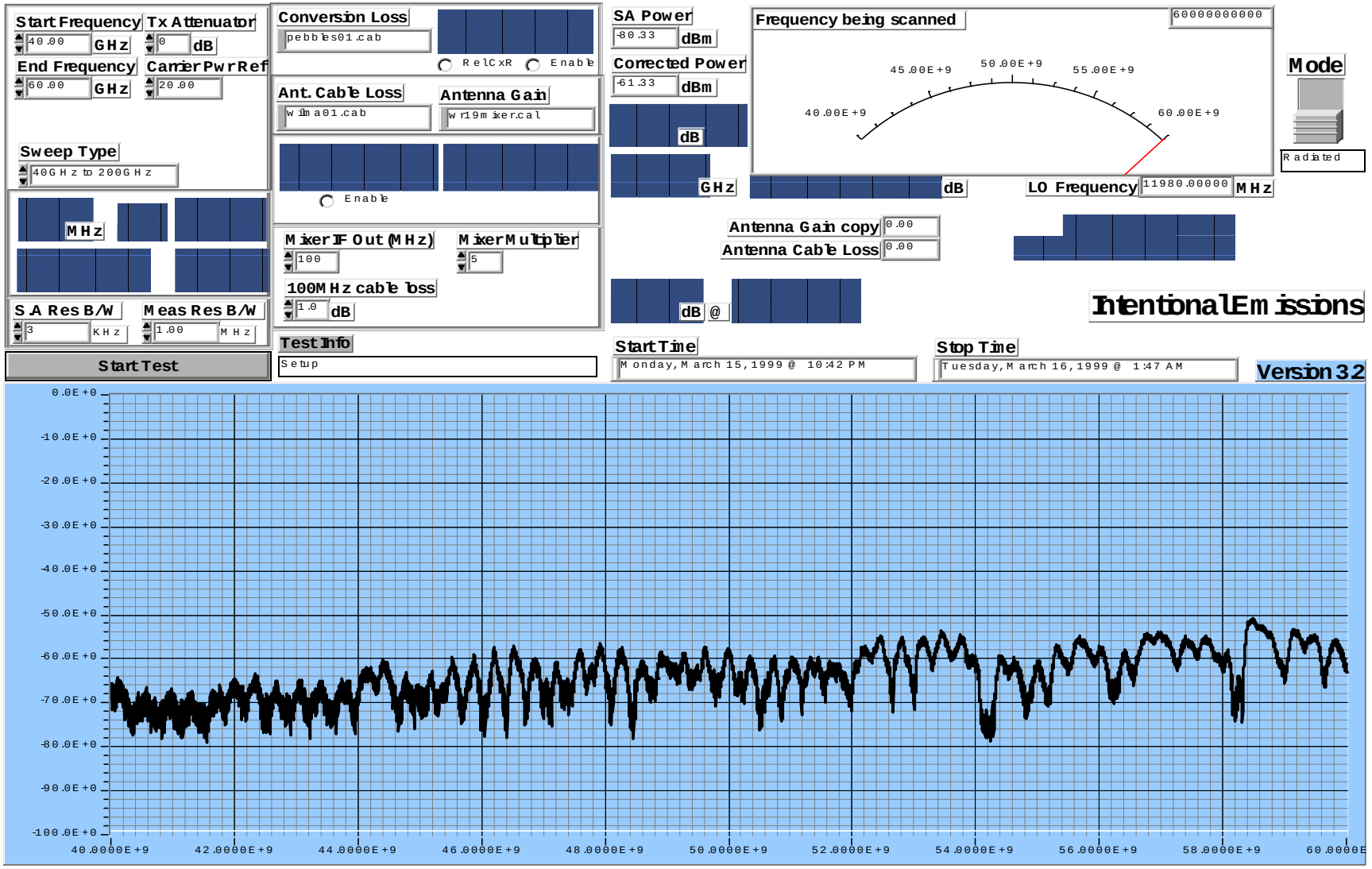


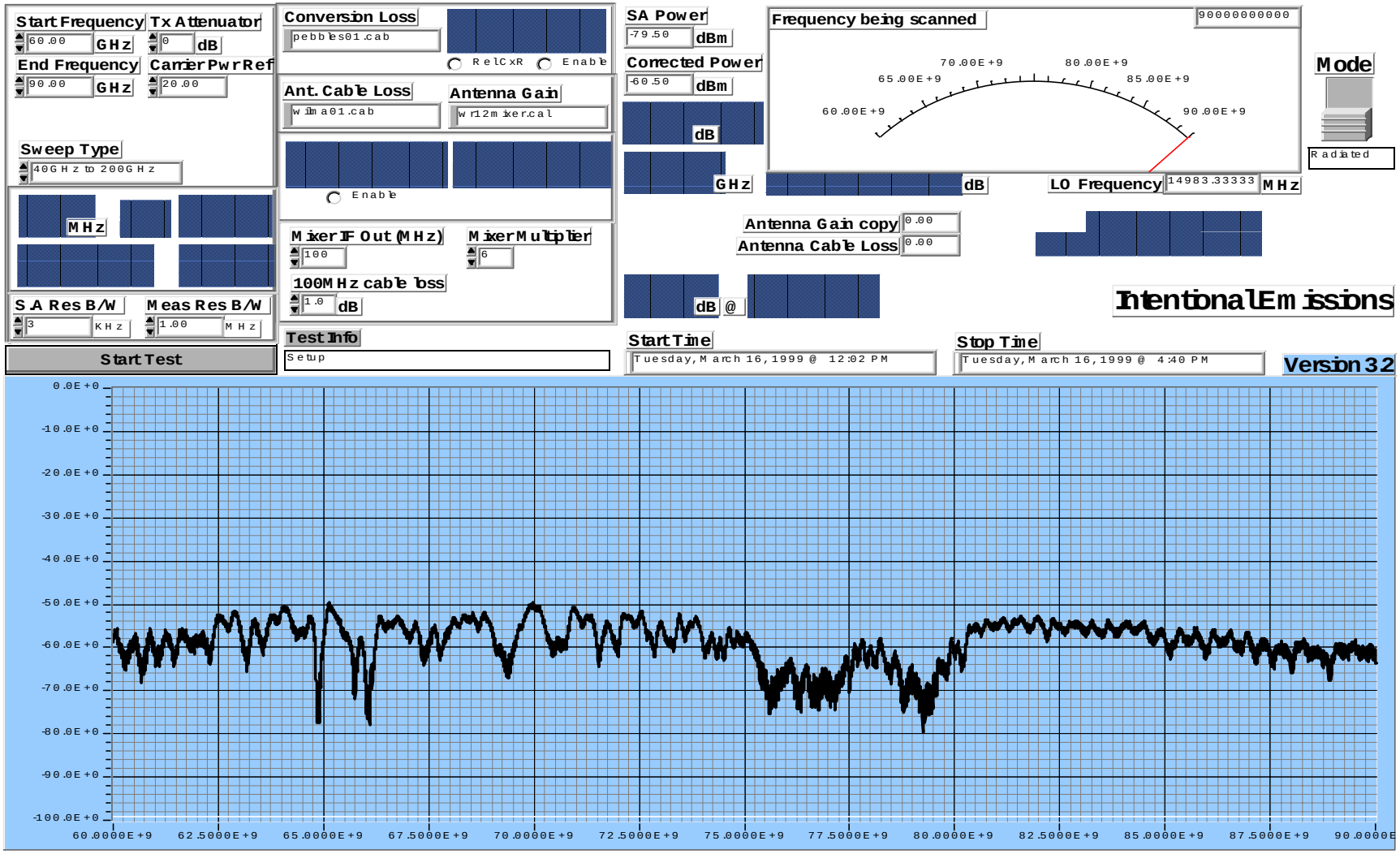
BTR 2800, 4 carrier QAM 64 modulated. –40GHz-60GHz - Horizontal



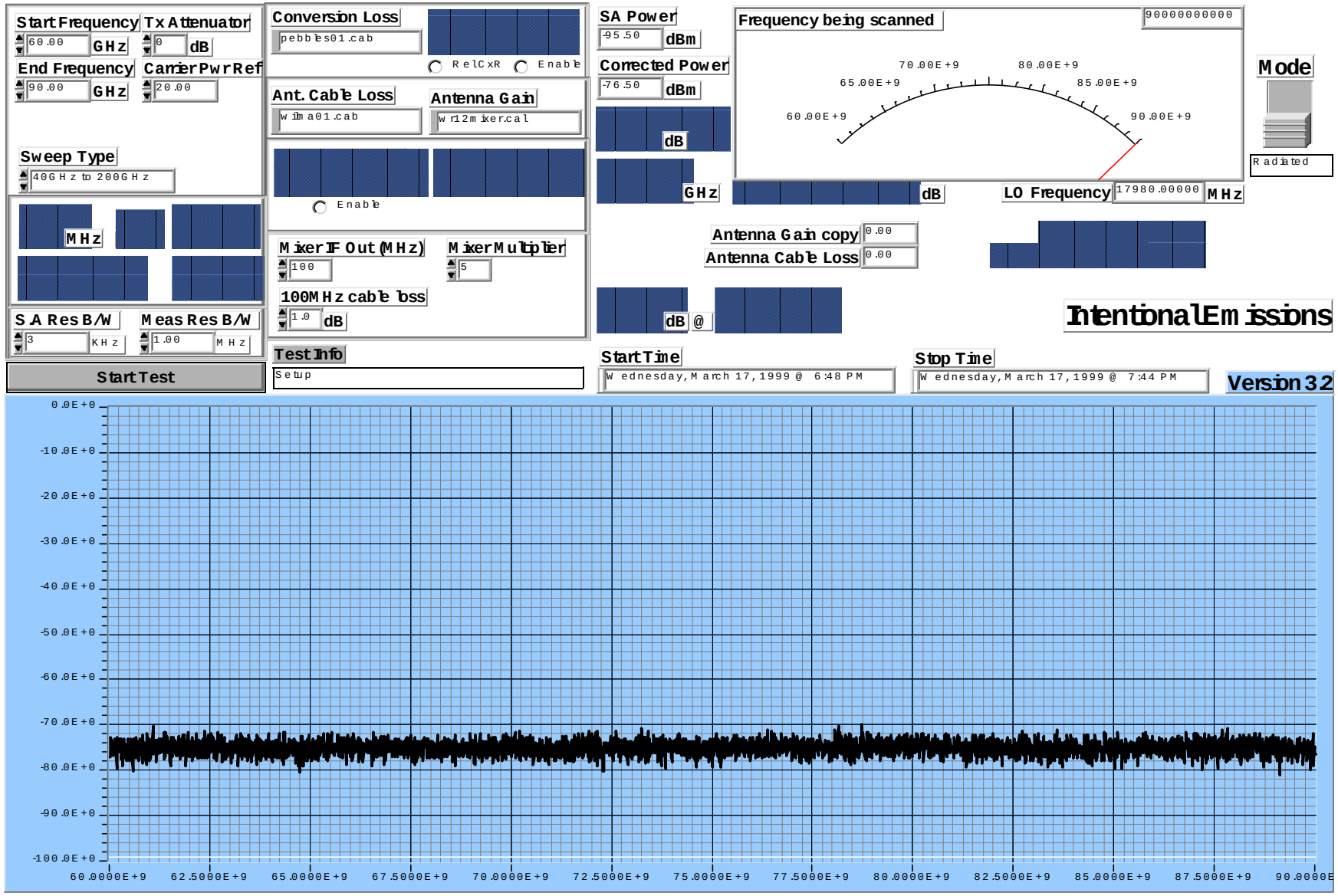
BTR 2800, 4 carrier QAM 64 modulated. –40GHz-60GHz - Vertical



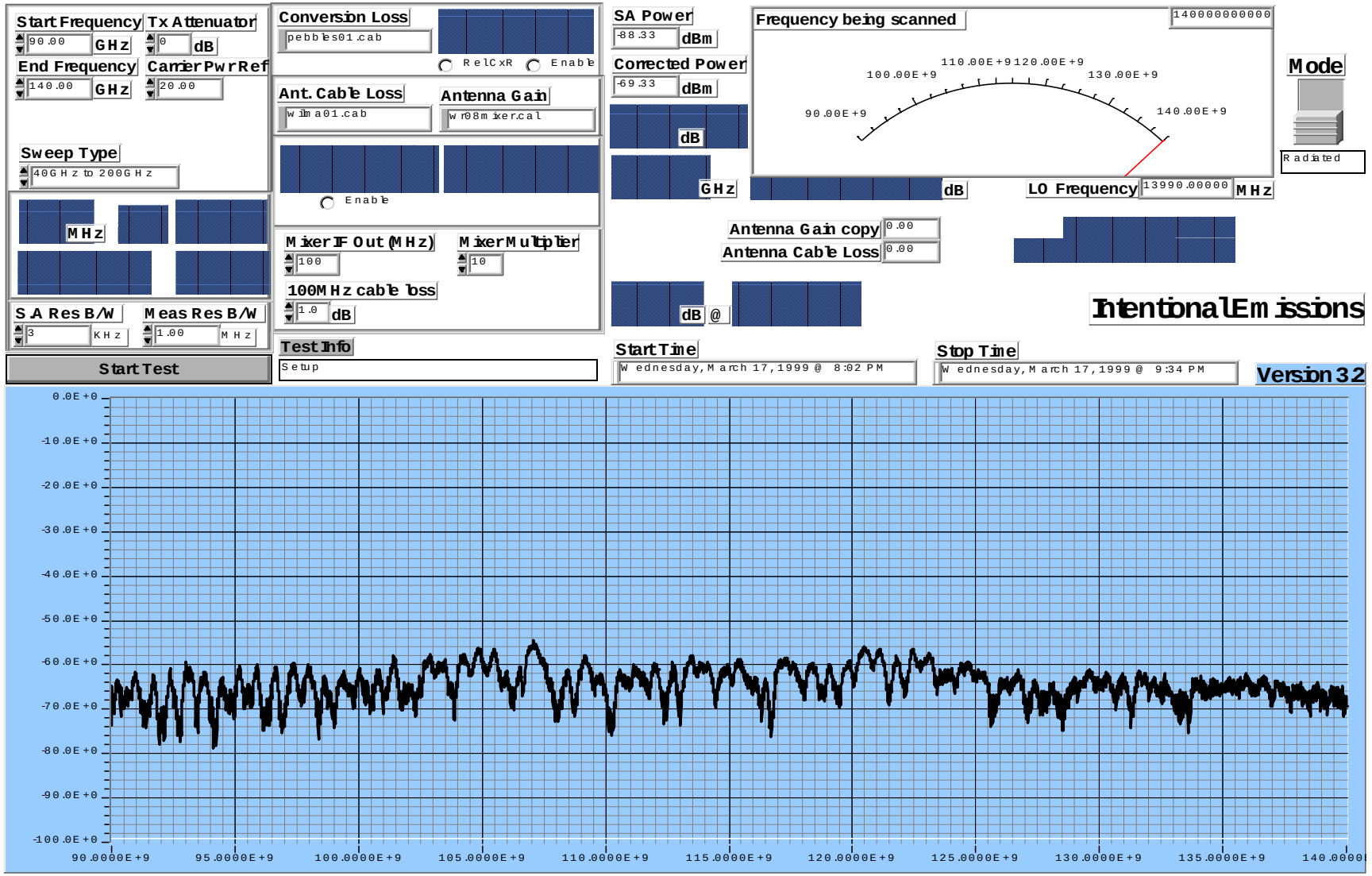
BTR 2800, 4 carrier QAM 64 modulated. –60GHz-90GHz - Horizontal



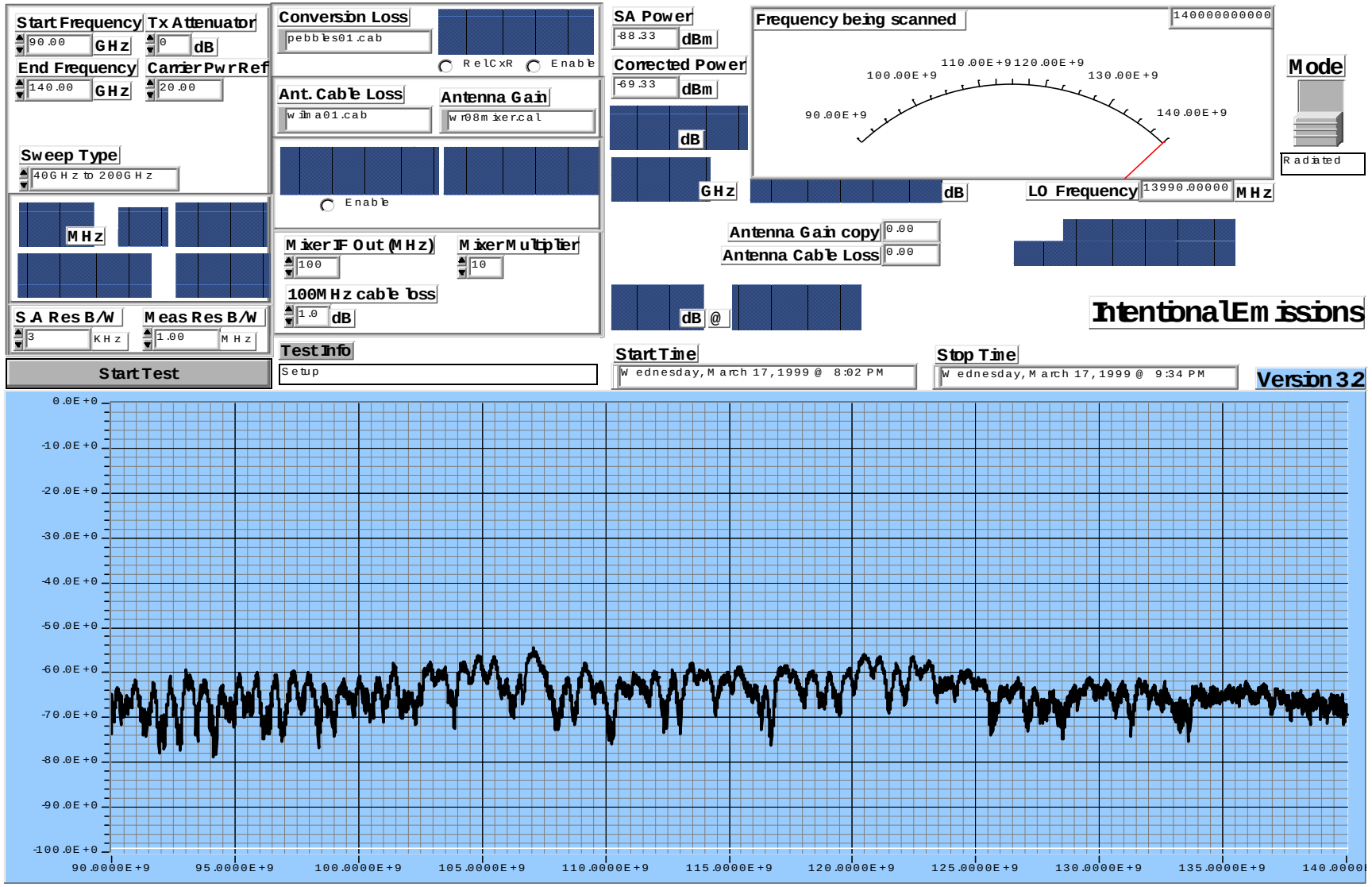
BTR 2800, 4 carrier QAM 64 modulated. –60GHz-90GHz – Vertical



BTR 2800, 4 carrier QAM 64 modulated. –90GHz-140GHz – Horizontal



BTR 2800, 4 carrier QAM 64 modulated. –90GHz-140GHz – Vertical

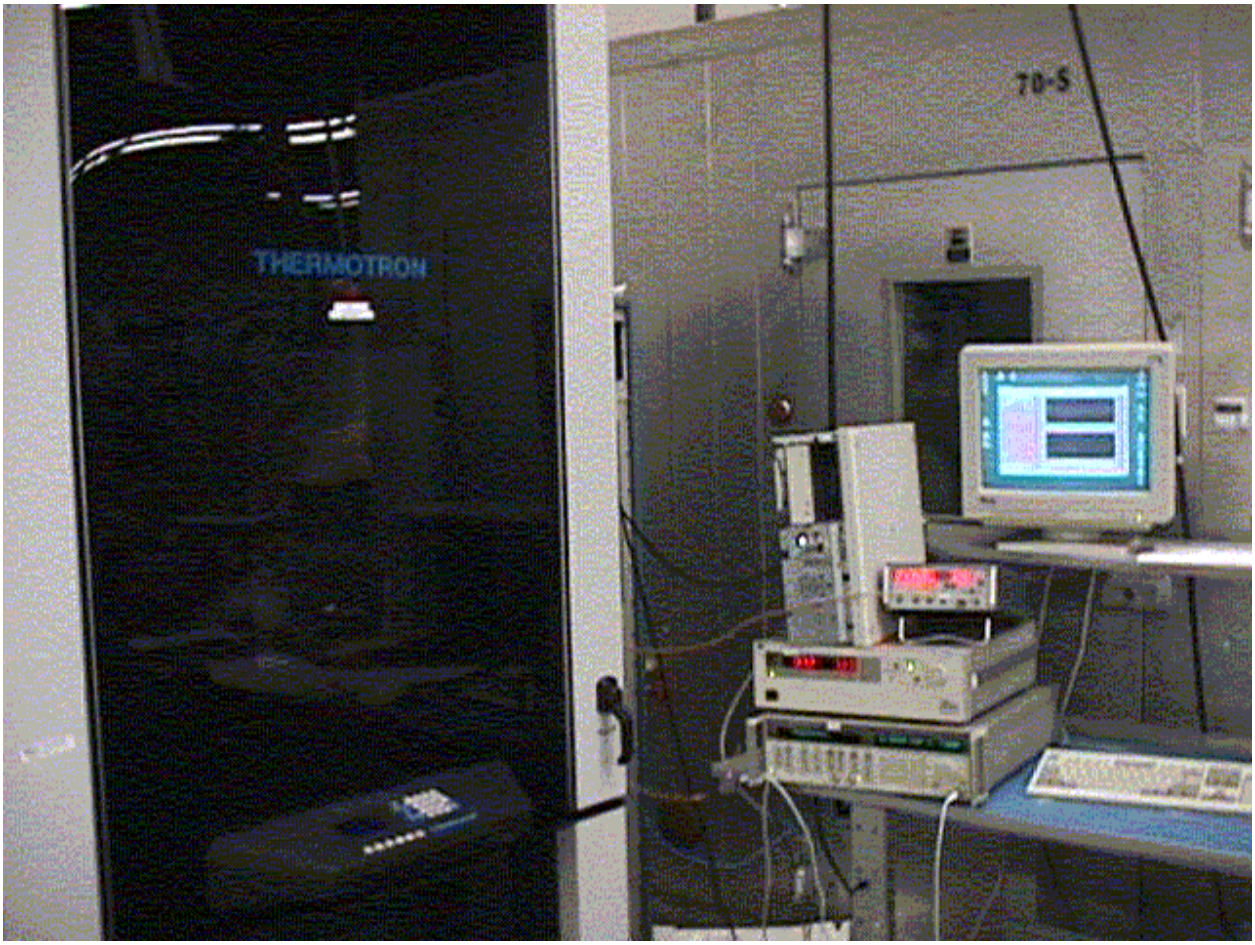


# APPENDIX C

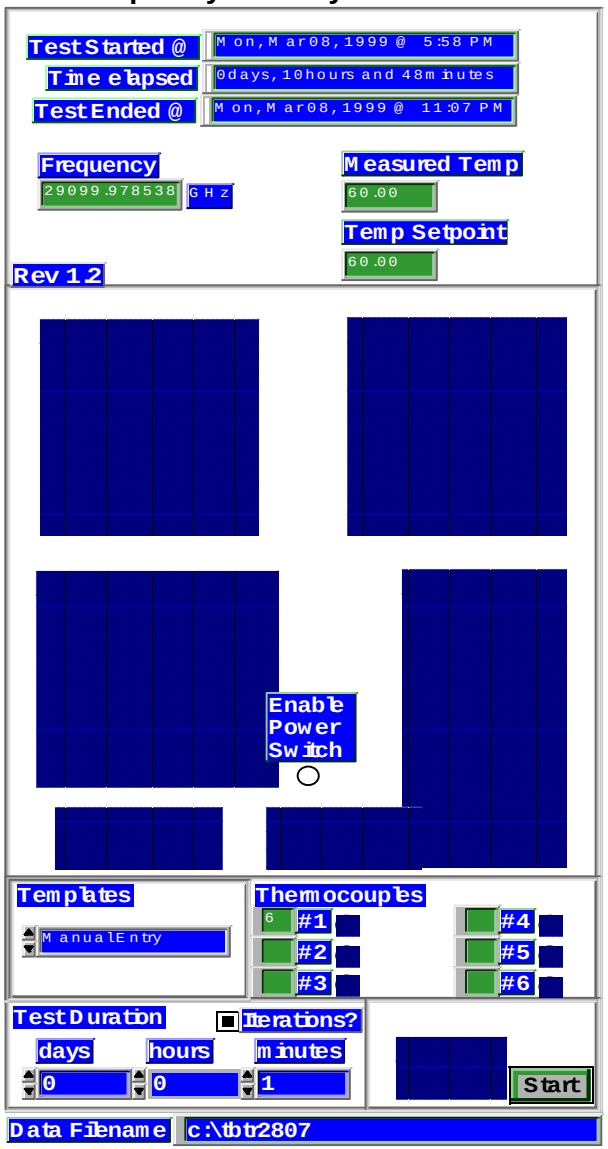
## Temperature Stability Measurements Results

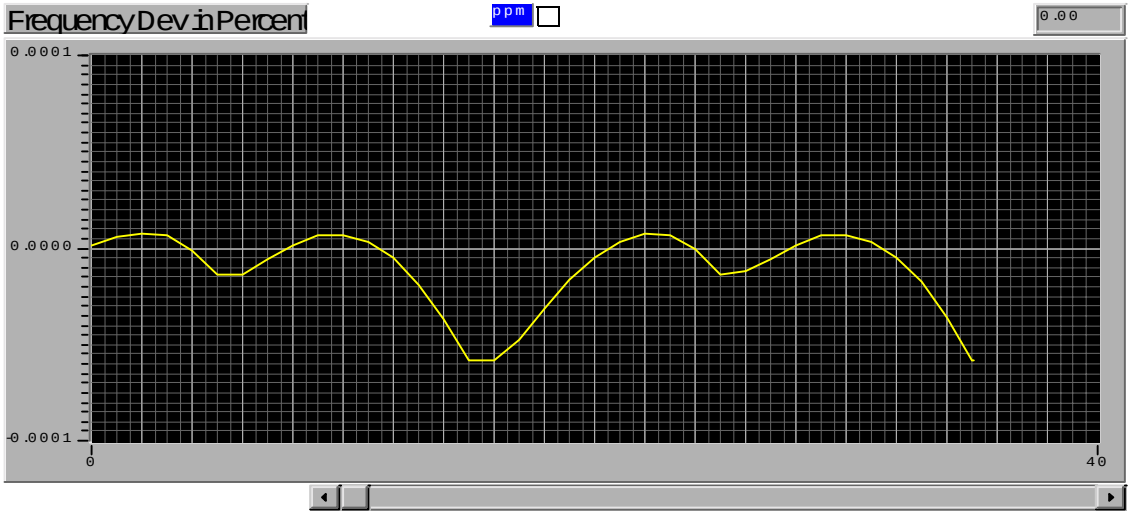
## 8. TEMPERATURE STABILITY MEASUREMENTS RESULTS

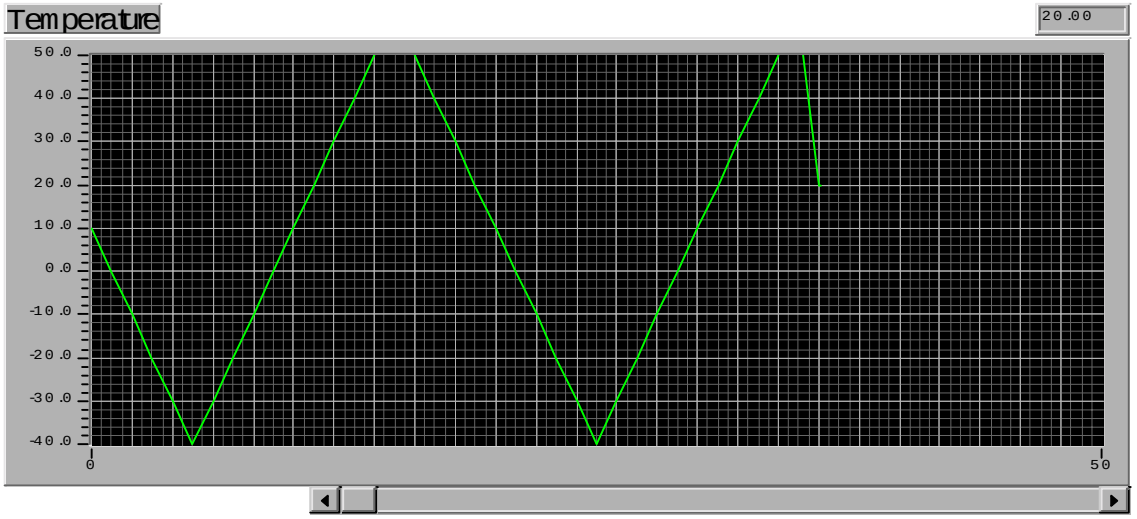
Frequency Stability Test Setup



## BTR Frequency Stability





| Date and Time | | | Frequency | Temp | Deviation |
|---|---|---|---|---|---|
| Mon | Mar08 | 1999 @ 6:16PM | 29099.995747 | 10.0 | 0.000001 |
| Mon | Mar08 | 1999 @ 6:36PM | 29099.997153 | 0.0 | 0.000006 |
| Mon | Mar08 | 1999 @ 6:54PM | 29099.997590 | -10.0 | 0.000007 |
| Mon | Mar08 | 1999 @ 7:13PM | 29099.997346 | -20.0 | 0.000006 |
| Mon | Mar08 | 1999 @ 7:32PM | 29099.995199 | -30.0 | -0.000001 |
| Mon | Mar08 | 1999 @ 7:51PM | 29099.991453 | -40.0 | -0.000014 |
| Mon | Mar08 | 1999 @ 8:10PM | 29099.991398 | -30.0 | -0.000014 |
| Mon | Mar08 | 1999 @ 8:27PM | 29099.993856 | -20.0 | -0.000006 |
| Mon | Mar08 | 1999 @ 8:44PM | 29099.995924 | -10.0 | 0.000002 |
| Mon | Mar08 | 1999 @ 9:00PM | 29099.997276 | 0.0 | 0.000006 |
| Mon | Mar08 | 1999 @ 9:17PM | 29099.997357 | 10.0 | 0.000007 |
| Mon | Mar08 | 1999 @ 9:34PM | 29099.996241 | 20.0 | 0.000003 |
| Mon | Mar08 | 1999 @ 9:51PM | 29099.993925 | 30.0 | -0.000005 |
| Mon | Mar08 | 1999 @ 10:09PM | 29099.989839 | 40.0 | -0.000019 |
| Mon | Mar08 | 1999 @ 10:28PM | 29099.984737 | 50.0 | -0.000037 |
| Mon | Mar08 | 1999 @ 10:48PM | 29099.978462 | 60.0 | -0.000058 |
| Mon | Mar08 | 1999 @ 11:07PM | 29099.978409 | 50.0 | -0.000059 |
| Mon | Mar08 | 1999 @ 11:24PM | 29099.981585 | 40.0 | -0.000048 |
| Mon | Mar08 | 1999 @ 11:41PM | 29099.986225 | 30.0 | -0.000032 |
| Tue | Mar09 | 1999 @ 12:00AM | 29099.990573 | 20.0 | -0.000017 |
| Tue | Mar09 | 1999 @ 12:19AM | 29099.993987 | 10.0 | -0.000005 |
| Tue | Mar09 | 1999 @ 12:38AM | 29099.996469 | 0.0 | 0.000003 |
| Tue | Mar09 | 1999 @ 12:55AM | 29099.997603 | -10.0 | 0.000007 |
| Tue | Mar09 | 1999 @ 1:16AM | 29099.997368 | -20.0 | 0.000007 |
| Tue | Mar09 | 1999 @ 1:34AM | 29099.995438 | -30.0 | 0.000000 |
| Tue | Mar09 | 1999 @ 1:53AM | 29099.991581 | -40.0 | -0.000013 |
| Tue | Mar09 | 1999 @ 2:11AM | 29099.992010 | -30.0 | -0.000012 |
| Tue | Mar09 | 1999 @ 2:28AM | 29099.993853 | -20.0 | -0.000006 |
| Tue | Mar09 | 1999 @ 2:45AM | 29099.995944 | -10.0 | 0.000002 |
| Tue | Mar09 | 1999 @ 3:01AM | 29099.997295 | 0.0 | 0.000006 |
| Tue | Mar09 | 1999 @ 3:18AM | 29099.997420 | 10.0 | 0.000007 |
| Tue | Mar09 | 1999 @ 3:35AM | 29099.996299 | 20.0 | 0.000003 |
| Tue | Mar09 | 1999 @ 3:52AM | 29099.994005 | 30.0 | -0.000005 |
| Tue | Mar09 | 1999 @ 4:10AM | 29099.990394 | 40.0 | -0.000017 |
| Tue | Mar09 | 1999 @ 4:27AM | 29099.985010 | 50.0 | -0.000036 |
| Tue | Mar09 | 1999 @ 4:46AM | 29099.978538 | 60.0 | -0.000058 |

# APPENDIX D

# SPECTRAL MASK LIMIT CALCULATIONS

## 9. SPECTRAL MASK LIMIT CALCULATIONS

| Symbol rate (Msps) | 8 | Center Freq. (MHz) | 29116.2 | BTR - low side mask |
|---|---|---|---|---|
| Authorized BW (MHz) | 40 | | | |
| O/P Channel Power (dBm) | 20 | 0.1 | Watts | |

| % Removed | FCC Spec | Delta BW | Lwr Band | Upr Band |
|---|---|---|---|---|
| **0** | **0** | **0** | **29116.2** | **29116.2** |
| **50** | **0** | **20** | **29096.2** | **29136.2** |
| **50.5** | **-27.2205999** | **20.2** | **29096** | **29136.4** |
| 51 | -27.4205999 | 20.4 | 29095.8 | 29136.6 |
| 55 | -29.0205999 | 22 | 29094.2 | 29138.2 |
| 60 | -31.0205999 | 24 | 29092.2 | 29140.2 |
| 75 | -37.0205999 | 30 | 29086.2 | 29146.2 |
| 100 | -47.0205999 | 40 | 29076.2 | 29156.2 |
| 101 | -47.4205999 | 40.4 | 29075.8 | 29156.6 |
| 102 | -47.8205999 | 40.8 | 29075.4 | 29157 |
| 105 | -49.0205999 | 42 | 29074.2 | 29158.2 |
| 106 | -49.4205999 | 42.4 | 29073.8 | 29158.6 |
| 107 | -49.8205999 | 42.8 | 29073.4 | 29159 |
| 107.45 | -50.0005999 | 42.98 | 29073.22 | 29159.18 |
| 115 | -53.0205999 | 46 | 29070.2 | 29162.2 |
| 120 | -55.0205999 | 48 | 29068.2 | 29164.2 |
| **125** | **-56** | **50** | **29066.2** | **29166.2** |
| 150 | -56 | 60 | 29056.2 | 29176.2 |
| 175 | -56 | 70 | 29046.2 | 29186.2 |
| 200 | -56 | 80 | 29036.2 | 29196.2 |
| **250** | **-56** | **100** | **29016.2** | **29216.2** |
| **250.1** | **-43** | **100.04** | **29016.16** | **29216.24** |
| 300 | -43 | 120 | 28996.2 | 29236.2 |
| 500 | -43 | 200 | 28916.2 | 29316.2 |
| 1000 | -43 | 400 | 28716.2 | 29516.2 |
| 1100 | -43 | 440 | 28676.2 | 29556.2 |
| 1200 | -43 | 500 | 28616.2 | 29616.2 |
| 1250 | -43 | 500 | 28616.2 | 29616.2 |
| 1300 | -43 | 520 | 28596.2 | 29636.2 |
| **1500** | **-43** | **600** | **28516.2** | **29716.2** |

| Number of CXR | 4 | Center Freq (MHz) | 29181.2 | BTR - mid-band mask |
|---|---|---|---|---|

| Symbol rate (Msps) | 8 | | | |
|---|---|---|---|---|
| Authorized BW (MHz) | 40 | | | |
| O/P Channel Power (dBm) | 20 | 0.1 | Watts | |
| % Removed | FCC Spec | Delta BW | Lower Band | Upper Band |
| **0** | **0** | **0** | **29181.2** | **29181.2** |
| **50** | **0** | **20** | **29161.2** | **29201.2** |
| **50.5** | **-27.2205999** | **20.2** | **29161** | **29201.4** |
| 51 | -27.4205999 | 20.4 | 29160.8 | 29201.6 |
| 55 | -29.0205999 | 22 | 29159.2 | 29203.2 |
| 60 | -31.0205999 | 24 | 29157.2 | 29205.2 |
| 75 | -37.0205999 | 30 | 29151.2 | 29211.2 |
| 100 | -47.0205999 | 40 | 29141.2 | 29221.2 |
| 101 | -47.4205999 | 40.4 | 29140.8 | 29221.6 |
| 102 | -47.8205999 | 40.8 | 29140.4 | 29222 |
| 105 | -49.0205999 | 42 | 29139.2 | 29223.2 |
| 106 | -49.4205999 | 42.4 | 29138.8 | 29223.6 |
| 107 | -49.8205999 | 42.8 | 29138.4 | 29224 |
| 107.45 | -50.0005999 | 42.98 | 29138.22 | 29224.18 |
| 115 | -53.0205999 | 46 | 29135.2 | 29227.2 |
| 120 | -55.0205999 | 48 | 29133.2 | 29229.2 |
| **125** | **-56** | **50** | **29131.2** | **29231.2** |
| 150 | -56 | 60 | 29121.2 | 29241.2 |
| 175 | -56 | 70 | 29111.2 | 29251.2 |
| 200 | -56 | 80 | 29101.2 | 29261.2 |
| **250** | **-56** | **100** | **29081.2** | **29281.2** |
| **250.1** | **-43** | **100.04** | **29081.16** | **29281.24** |
| 300 | -43 | 120 | 29061.2 | 29301.2 |
| 500 | -43 | 200 | 28981.2 | 29381.2 |
| 1000 | -43 | 400 | 28781.2 | 29581.2 |
| 1100 | -43 | 440 | 28741.2 | 29621.2 |
| 1200 | -43 | 500 | 28681.2 | 29681.2 |
| 1250 | -43 | 500 | 28681.2 | 29681.2 |
| 1300 | -43 | 520 | 28661.2 | 29701.2 |
| **1500** | **-43** | **600** | **28581.2** | **29781.2** |
| **Number of CXR** | 4 | **Center Freq. (MHz)** | 29236.6 | BTR - high-band mask |
| **Symbol rate (Msps)** | 8 | | | |

| Authorized BW (MHz) | 40 | | | |
|---|---|---|---|---|
| O/P Channel Power (dBm) | 20 | 0.1 | Watts | |
| % Removed | FCC Spec | Delta BW | Lower Band | Upper Band |
| **0** | **0** | **0** | **29236.6** | **29236.6** |
| **50** | **0** | **20** | **29216.6** | **29256.6** |
| **50.5** | **-27.2205999** | **20.2** | **29216.4** | **29256.8** |
| 51 | -27.4205999 | 20.4 | 29216.2 | 29257 |
| 55 | -29.0205999 | 22 | 29214.6 | 29258.6 |
| 60 | -31.0205999 | 24 | 29212.6 | 29260.6 |
| 75 | -37.0205999 | 30 | 29206.6 | 29266.6 |
| 100 | -47.0205999 | 40 | 29196.6 | 29276.6 |
| 101 | -47.4205999 | 40.4 | 29196.2 | 29277 |
| 102 | -47.8205999 | 40.8 | 29195.8 | 29277.4 |
| 105 | -49.0205999 | 42 | 29194.6 | 29278.6 |
| 106 | -49.4205999 | 42.4 | 29194.2 | 29279 |
| 107 | -49.8205999 | 42.8 | 29193.8 | 29279.4 |
| 107.45 | -50.0005999 | 42.98 | 29193.62 | 29279.58 |
| 115 | -53.0205999 | 46 | 29190.6 | 29282.6 |
| 120 | -55.0205999 | 48 | 29188.6 | 29284.6 |
| **125** | **-56** | **50** | **29186.6** | **29286.6** |
| 150 | -56 | 60 | 29176.6 | 29296.6 |
| 175 | -56 | 70 | 29166.6 | 29306.6 |
| 200 | -56 | 80 | 29156.6 | 29316.6 |
| **250** | **-56** | **100** | **29136.6** | **29336.6** |
| **250.1** | **-43** | **100.04** | **29136.56** | **29336.64** |
| 300 | -43 | 120 | 29116.6 | 29356.6 |
| 500 | -43 | 200 | 29036.6 | 29436.6 |
| 1000 | -43 | 400 | 28836.6 | 29636.6 |
| 1100 | -43 | 440 | 28796.6 | 29676.6 |
| 1200 | -43 | 500 | 28736.6 | 29736.6 |
| 1250 | -43 | 500 | 28736.6 | 29736.6 |
| 1300 | -43 | 520 | 28716.6 | 29756.6 |
| **1500** | **-43** | **600** | **28636.6** | **29836.6** |

**FCC ID Label Positioning**