Test Center

# Test Report

Conformance tests for ODU-24 UBT-1 LM,
to be operated in the Broadband Radio Access System AXR-24

## ODU-24 UBT-1 LM

Marconi Communications GmbH
Gerberstrasse 33
D-71522 Backnang
Germany

Edition 07.2005

# Conformance Test Report

**Technical Support – Test Center**

# ODU-24 UBT-1 LM


Testing Laboratory:

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Technical Support - Test Center

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Client information:

Mr. Khaled Fazel
Marconi Communications GmbH
D-71522 Backnang / Germany
Radio System Engineering

Receipt of item: 08th July2005
Testing period: 08th July to 15th July 2005

Equipment under Test:

ODU-24 UBT-1 LM for AXR-24
Access Radio System Point-to-Point,
operating in the 24 GHz band

Description no.: ODU-24 UBT-1 LM
05HAA00105ABL
FCC-ID: THB-05HAA00105ABL
IC: 100K-00105ABL
Serial no.: 05 1006335
Manufacturer: Marconi Communications GmbH

Test Standards:

**47 CFR 101 Subpart C (USA, 2004-10)**
**RSS-191 (Canada, 2002-08)**

Test Summary:

**The EUT is compliant with the requirements**.

| | | | |
|---|---|---|---|
| Tested by: | Werner Schlecht | Approved by: | Eberhard Marx |
| Date: | 12th August 2005 | Date: | 12th August 2005 |

Signature

Signature

The test results relate only to the tested sample. Each modification at the test item may expire this test report.

## Contents

# 1 Summary of Compliance Status

**All measurements are traceable to national standards.**

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 101, Subpart C., and RSS-191 (Industry Canada).

| Tested Parameter | Test Requirement | | Compliance Status |
|---|---|---|---|
| Transmitter Power Limitations | 47 CFR 101.113 | RSS-191 chap. 6.4 | Compliant |
| Microwave Modulation | 47 CFR 101.141 | RSS-191 chap. 6.2 | Compliant Note 2 |
| Occupied Bandwidth | 47 CFR 101.111 | RSS-191 chap. 6.5 | Compliant |
| Spurious Emissions at Antenna Port | 47 CFR 101.111 | RSS-191 chap. 6.5 | Compliant Note 1 |
| Receiver Spurious Emissions | -- | RSS-191 chap. 6.6 | Compliant Note 1 |
| Radiated Spurious Emissions | 47 CFR 101.111 | RSS-191 chap. 6.5 | Compliant Note 1 |
| Frequency Stability | 47 CFR 101.107 | RSS-191 chap. 6.3 | Compliant |

Explanatory notes:

| | |
|---|---|
| Compliant | When tested to the indicated specification the EUT was found wholly compliant |
| Note 1 | Reference to Test Report No.: 2-5029-01-02/05 of CETECOM ICT Services. |
| Note 2 | Possible modulation schemes are QPSK 2/3, QPSL 1/1, 16QAM, and 64QAM, configurable in static and adaptive mode. Due to the fact, that modulation format QPSK 2/3 will only be used in adaptive modulation and the typical probability for occurrence of QPSK 2/3 is less than 10 minutes per year, the test result was stated as compliant. |

# 2 General Information

## 2.1 Device under Test (ODU-24 UBT-1 LM)

| | | | | |
|---|---|---|---|---|
| Manufacturer | | Marconi Communications GmbH | | |
| Model Name | | ODU-24 UBT-1 LM | | |
| Model Number | | 05HAA00105ABL | | |
| Serial Number | | 05 1006335 | | |
| Frequency Range | transmit<br>receive | 25 066 MHz to 25 234 MHz<br>24 266 MHz to 24 434 MHz | | for center frequencies |
| Frequency setting stepsize | | 2 MHz | | |
| Channel spacing | | 28 MHz | | Bandwidth |
| Modulation | | QPSK<br>16QAM<br>64QAM | | preconfigurable or adaptive per link |
| Internal/External data source | | external | | IDU-AXR |
| Emission Designator | | 28M0G7W<br>28M0D7W | | QPSK modulated carrier<br>16QAM and 64QAM modulated carrier |
| Output power | modulation | static | adaptive | |
| | maximum | 19 dBm | 16 dBm | QPSK |
| | | 17 dBm | 16 dBm | 16QAM |
| | | 16 dBm | 16 dBm | 64QAM |
| | minimum | 1 dBm | 1 dBm | all modulations, via static RTPC |
| Dynamic setting range of output power | | 15 dB | | via ATPC, in addition to RTPC.<br>ATPC and adaptive modulation controlled via receive power level at opposite station |
| Receive noise figure | | 6 dB (typ.) | | |
| Antenna port | | waveguide R260 | | |
| Supply voltage | nominal<br>tolerance | -48 Vdc<br>-36 V to -72 V | | |

ODU-24 LBT-1 LM and ODU-24 UBT-1 LM are identical in mechanical and electrical design. Therefore the performance versus temperature as obtained for the ODU-24 LBT-1 LM are applicable also for the ODU-24 UBT-1 LM.

## 2.2 System block diagram / test configuration

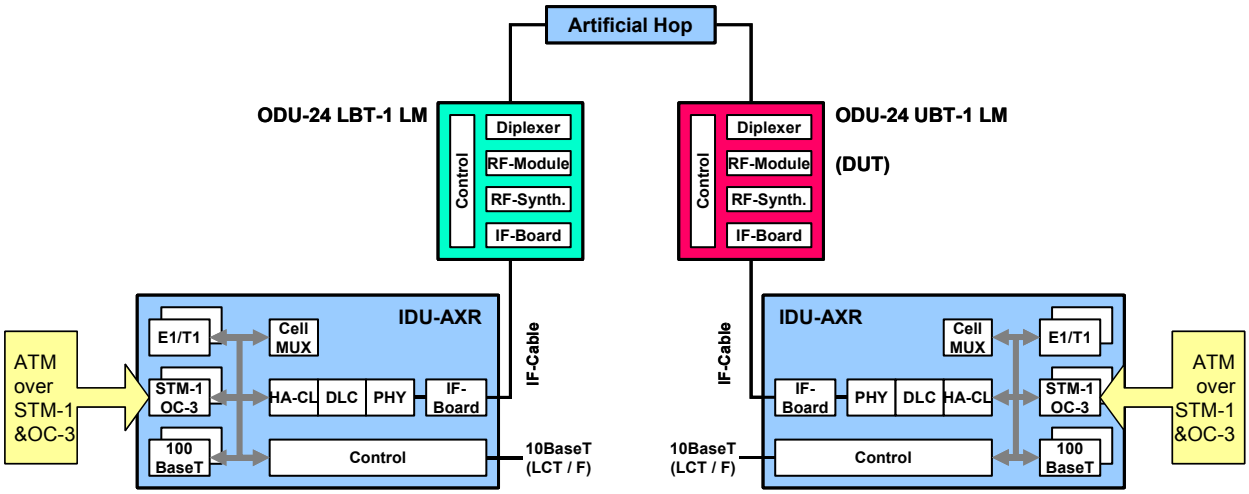



**Figure 1 Test configuration**

Channel configuration:

| | |
|---|---|
| Measured frequencies pairs : | 25 066 MHz / 24 266 MHz<br>25 150 MHz / 24 350 MHz<br>25 234 MHz / 24 434 MHz |
| TX/RX Separation: | 800 MHz |
| Center gap: | 600 MHz |

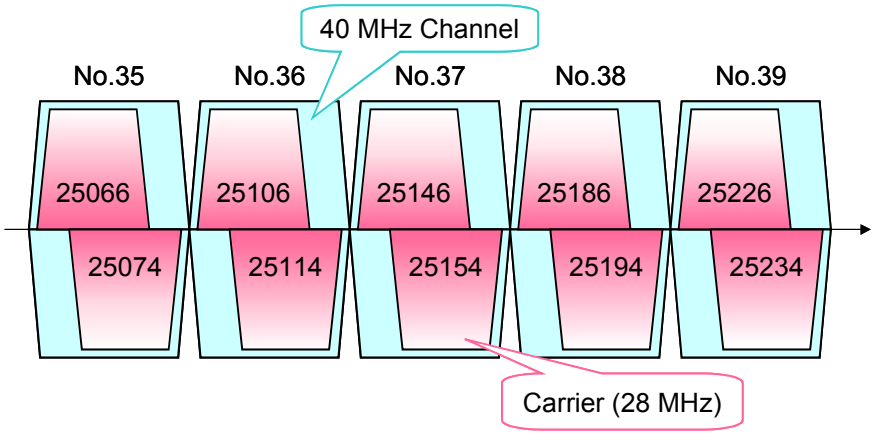



**Figure 2 Individual channel carrier arrangement for upper sub band**

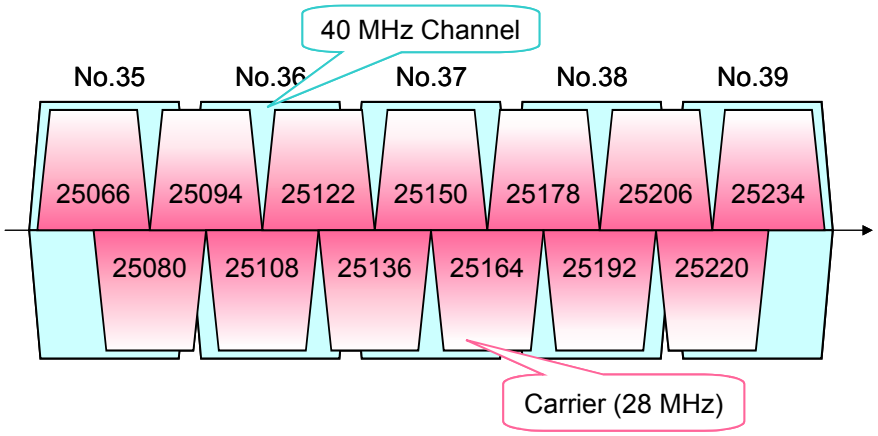



**Figure 3 Contiguous channel carrier arrangement for upper sub band**

## 2.3 Equipment list

| Designation | Description- No | Serial number | IUT |
|---|---|---|---|
| **Upper band system** | | | |
| **Outdoor Radio Unit** | | | |
| ODU 24 UBT-1 LM | 05HAA00105ABL | 05 1006335 | **DUT** |
| **Modem-Unit** | | | |
| IDU-AXR | 05HAN00174AAR | 05 1122162 | |
| **Lower band system (tested under climatic conditions)** | | | |
| **Outdoor Radio Unit** | | | |
| ODU 24 LBT-1 LM | 05HAA00105AAT | 05 1006340 | |
| **Modem-Unit** | | | |
| IDU-AXR | 05HAN00174AAR | 05 1122159 | |

Software: 0.9.1

## 2.4 Definitions and abbreviations

| | |
|---|---|
| AS | Access Station |
| DLC | Data Link Control |
| DRS | Digital Radio System |
| DUT | Device under test |
| HA-CL | Hiper Access Convergence Layer |
| IDU | Indoor Unit |
| IF | Intermediate frequency |
| LCT | Local Craft Terminal |
| ODU | Outdoor Unit |
| PHY | Physical layer |
| RX | Receive Direction |
| SW | Software |
| TX | Transmit Direction |

## 2.5 Test equipment

| No | Type | Manufacturer | Marconi Id | Serial No.. |
|---|---|---|---|---|
| 1 | Spectrum Analyzer FSEK 30 | R & S | 40/63436 | 826939/009 |
| 2 | Signal Generator SMP04 | R & S | 40/63468 | 826933/003 |
| 3 | Frequency Counter MF 2414a | Anritsu | 40/63462 | MT07271 |
| 4 | Power Meter ML 2438A | Anritsu | 40/63459 | 97400024 |
| 5 | Power Sensor MA 2424A | Anritsu | 40/63461 | 971394 |
| 6 | Power Sensor MA 2444A | Anritsu | 40/65618 | 002278 |
| 7 | GPS PRC SASE 5548 | OSA | 40/59431 | - |
| 8 | Precision Rotary Attenuator 21611 | Flann | 40/63423 | 21 |
| 9 | Precision Rotary Attenuator 21110 | Flann | 40/63418 | 54 |
| 10 | SDH Tester ANT-20 | W & G | 40/59753 | AS-0051 |
| 11 | Attenuator 54-20 | Weinschel | - | D9316 |
| 12 | Ext. Mixer M19HW 40...60 GHz | R & S | - | U90519-4 |
| 13 | Coupler 4227-16 | Narda | 40/65174 | 02856 |
| 14 | Frequency doubler MUD-15-L-10F0 | Millitech | -- | 10559 |

Accredited laboratories responsible for calibration: Acterna & Agilent.

## 2.6 Environmental test conditions

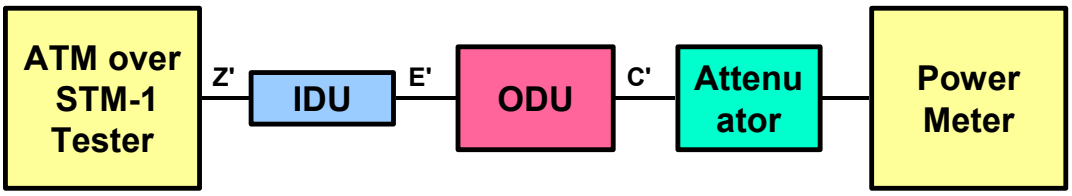
| | | |
|---|---|---|
| Normal ambient temperature: | | +23°C |
| Relative humidity: | | 33 % |
| Extreme temperature: | Outdoor Unit | -45°C and +55°C |
| | Indoor Unit | -5 °C and +45°C |

# 3 Test cases

## 3.1 Transmitter Power Limitations

Method of measurement: 47 CFR 2.1046

Test configuration:




Requirement:

RSS-191 chapter 6.4

Maximum carrier power of +10 dBW (+40 dBm) into the antenna.
The output power shall be within +/-1 dB of the rated power.

47 CFR 101.113 and 47 CFR 101.513

Maximum EIRP of +55 dBW for the band 24 250 to 25 250 MHz,
corresponding to +85 dBm (Note 1)
Footnote 5: Maximum power level per 250-kHz-slot of the occupied bandwidth:
0,5 W per nodal transmitter and 0,04 W per user transmitter.

Note 1
Largest antenna to be used with the DUT: 1.2 m diameter, 46.8 dBi on-axis gain. In order to comply with the limit of +85 dBm for EIRP, the transmit power into the antenna must not be higher than +38.2 dBm.

Test Result:

| | |
|---|---|
| Maximum transmit power capability of the DUT | +19 dBm +/- 1 dB |
| Maximum transmit power density per 250 kHz-slot | 0.002 W |

The tests were performed

- for maximum and minimum transmit power at the antenna port of the DUT
- at the lowest, the medium, and the highest foreseen carrier frequencies (see fig. 2 & 3)
- at all potential modulation schemes (QPSK / 16QAM / 64QAM)
- at ambient temperature, representative measurement results are obtained for the ODU-24 LBT-1 LM
- at low, nominal, and high supply voltage

### 3.1.1 Maximum RF Output Power

| Specification for maximum power at C‘ | |
|---|---|
| QPSK | +19 dBm ± 1 dB |
| 16QAM | +17 dBm ± 1 dB |
| 64QAM | +16 dBm ± 1 dB |

Measurement Data:

ATPC enabled, nominal and max power set to max. output power values as specified.

| Test conditions | | | | | Maximum transmitter power level at C’ | | |
|---|---|---|---|---|---|---|---|
| Temp. IDU | Temp. ODU | Bitrate | Modulation | Power supply | 25066 MHz | 25150 MHz | 25234 MHz |
| [°C] | [°C] | Mbit/s | | [V] | [dBm] | [dBm] | [dBm] |
| -5 | -45 | 38 | QPSK | 36/48/72 | Performance versus temperature verified at ODU-24 LBT-1 LM | | |
| -5 | -45 | 77 | 16QAM | 36/48/72 | | | |
| -5 | -45 | 116 | 64QAM | 36/48/72 | | | |
| +23 | +23 | 38 | QPSK | 36/48/72 | +19.0 | +19.0 | +18.9 |
| +23 | +23 | 77 | 16QAM | 36/48/72 | +17.0 | +16.9 | +16.9 |
| +23 | +23 | 116 | 64QAM | 36/48/72 | +16.2 | +16.1 | +16.1 |
| +45 | +55 | 38 | QPSK | 36/48/72 | Performance versus temperature verified at ODU-24 LBT-1 LM | | |
| +45 | +55 | 77 | 16QAM | 36/48/72 | | | |
| +45 | +55 | 116 | 64QAM | 36/48/72 | | | |

| Measurement uncertainty | ±0.3 dB |
|---|---|
| Test equipment used (item no) | 4, 5, |

### 3.1.2 Minimum RF Output Power

Marconi Specification:

| Specification for minimum power at C‘ | |
|---|---|
| QPSK | +1 dBm |
| 16QAM | +1 dBm |
| 64QAM | +1 dBm |

Test Results:

ATPC enabled, nominal and max. power set to min. output power values as specified.

| Test conditions | | | | | Minimum transmitter power level at C’ | | |
|---|---|---|---|---|---|---|---|
| Temp IDU | Temp ODU | Bitrate | Modulation | Power supply | 25066 MHz | 25150 MHz | 25234 MHz |
| [°C] | [°C] | Mbit/s | | [V] | [dBm] | [dBm] | [dBm] |
| -5 | -45 | 38 | QPSK | 36/48/72 | Performance versus temperature verified at ODU-24 LBT-1 LM | | |
| -5 | -45 | 77 | 16QAM | 36/48/72 | | | |
| -5 | -45 | 116 | 64QAM | 36/48/72 | | | |
| +23 | +23 | 38 | QPSK | 36/48/72 | +0.7 | +0.7 | +0.6 |
| +23 | +23 | 77 | 16QAM | 36/48/72 | +08 | +07 | +0.7 |
| +23 | +23 | 116 | 64QAM | 36/48/72 | +1. | +1.0 | +0.9 |
| +45 | +55 | 38 | QPSK | 36/48/72 | Performance versus temperature verified at ODU-24 LBT-1 LM | | |
| +45 | +55 | 77 | 16QAM | 36/48/72 | | | |
| +45 | +55 | 116 | 64QAM | 36/48/72 | | | |

| Measurement uncertainty | ±0.3 dB |
|---|---|
| Test equipment used (item no) | 4, 5 |

## 3.2 Microwave Modulation

Method of measurement: 47 CFR 2.1046

Requirement:

47 CFR 101.141 (DUT with digital modulation techniques)

For the 24 GHz-service, subparagraph (a)(1) is applicable, requiring a modulation efficiency of at least 1 bit/s/Hz. For customers having received licenses of more than a single 40-MHz-channel, the allocated channels can be used in a contiguous manner as stated in 47 CFR 101.109 footnote 7. This approach is applied in Figure 3.

Test Result:

Correlation between modulation format and efficiency:

| modulation | occupied bandwidth | user data rate per carrier | single channel (40 MHz) | | continuous channels | |
|---|---|---|---|---|---|---|
| | | | user data rate | efficiency | user data rate | efficiency |
| QPSK 2/3 | 28 MHz | 25 Mbps | 25 Mbps | 0,625 bps/Hz | 175 Mbps | 0,875 bps/Hz |
| QPSK 1/1 | 28 MHz | 38 Mbps | 38 Mbps | 0,95 bps/Hz | 266 Mbps | 1,33 bps/Hz |
| 16QAM 1/1 | 28 MHz | 77 Mbps | 77 Mbps | 1,925 bps/Hz | 539 Mbps | 2,695 bps/Hz |
| 64QAM 1/1 | 28 MHz | 116 Mbps | 116 Mbps | 2,9 bps/Hz | 812 Mbps | 4,06 bps/Hz |

The user data rate shown in this table is fully available for user traffic, overheads are not included. Thus the modulation efficiency relates to the radio interface capacity, and not to the gross bit rate (which would lead to higher figures)

## 3.3 Occupied Bandwidth

Method of measurement: 47 CFR 2.1049

Requirement:

RSS-191 chapter 6.5

47 CFR 101.111 (a)(2)(ii) & (iv) Spectrum mask 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 an including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

$$A = 11 + 0.4 \cdot (P - 50) + 10 \cdot \log(B)$$

with P = percent removed from center frequency
B = allocated channel (40-MHz-channels)

Attenuation greater than 56 decibels or to an absolute power of less than -13 dBm/1MHz is not required.

The maximum authorized bandwidth is 40 MHz according to 47 CFR 101.109. Unwanted emissions must be suppressed at the aggregate channel block edges based on the same roll-off rate as specified for a single channel block in 47 CFR 101.111 (a) (2) (ii), (iii) and (iv).

The formula including the power density limit of -13 dBm/MHz, which is referred to the transmit power capability of the ODU-24 LBT-1 LM and the occupied bandwidth of the carrier, is outlined in Figure 4. I.e., the blue line shows the requirement according to 47 CFR 101.111. The figure includes also the internal specification for the transmit spectrum mask of the ODU, for the worst case where the carrier is shifted by 4 MHz to the edge of the 40-MHz-channel. The suppliers ODU specification is significantly more stringent than required by 47 CFR 101.111.

The RSS-191 contains the same approach and the same limits as 47 CFR 101.111(a)(2).

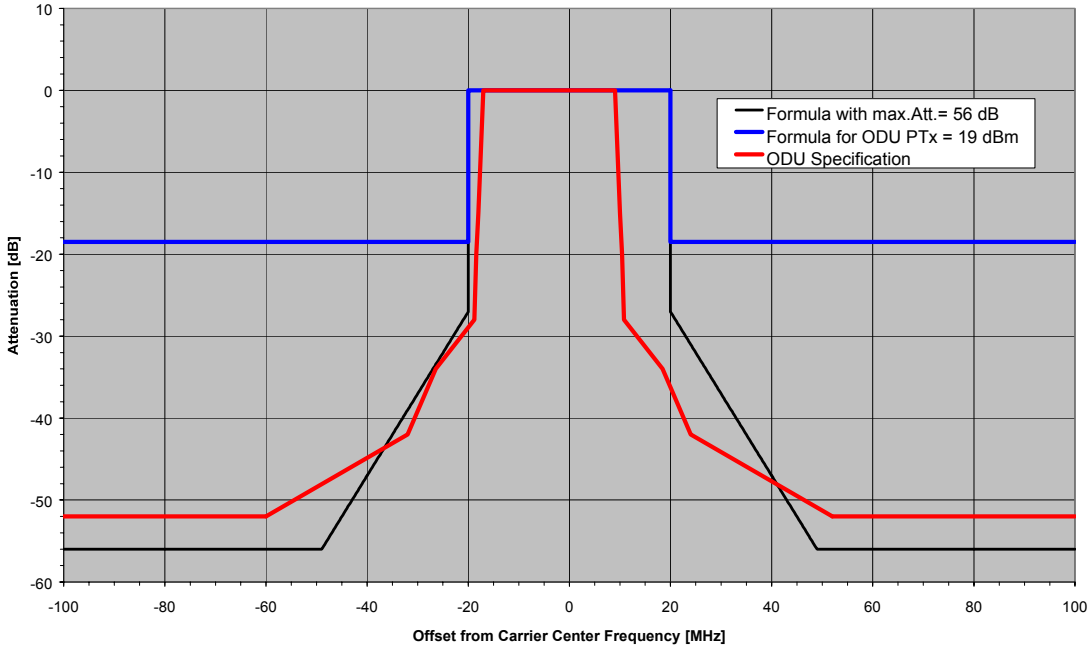
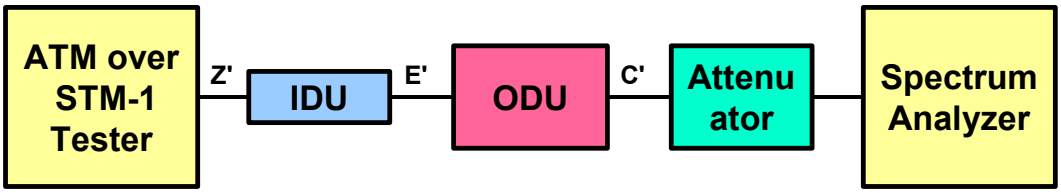



**Figure 4 Spectrum Mask acc. to 47 CFR 101.111, with ODU specification for carrier shifted by 4 MHz from channel center**

Test configuration:




| Parameter | Setting |
|---|---|
| IF-Bandwidth | 100 kHz |
| Total sweep width | 160 MHz |
| Total scan time | automatic |

Test Results:

The graphs for the occupied bandwidth signals are shown in the Annex. The ODU is set to the maximum transmitter power depending on the modulation scheme. ´

The test were performed for

- the potential modulation schemes (QPSK / 16QAM / 64QAM)
- low, ambient, and high operational temperatures
- low, nominal, and high supply voltage

| Test conditions | | | | | RF Spectrum at C' at max. Power | | |
|---|---|---|---|---|---|---|---|
| Temp IDU | Temp ODU | Bitrate | Modulation | Power supply | 25066 MHz | 25150 MHz | 25234 MHz |
| [°C] | [°C] | Mbit/s | | [V] | Plot | Plot | Plot |
| -5 | -45 | 38 | QPSK | 36/48/72 | Performance versus temperature verified at ODU-24 LBT-1 LM | | |
| -5 | -45 | 77 | 16 QAM | 36/48/72 | | | |
| -5 | -45 | 116 | 64 QAM | 36/48/72 | | | |
| +23 | +23 | 38 | QPSK | 36/48/72 | Plot No. 1 | Plot No. 2 | Plot No. 3 |
| +23 | +23 | 77 | 16 QAM | 36/48/72 | Plot No. 4 | Plot No. 5 | Plot No. 6 |
| +23 | +23 | 116 | 64 QAM | 36/48/72 | Plot No. 7 | Plot No. 8 | Plot No. 9 |
| +45 | +55 | 38 | QPSK | 36/48/72 | Performance versus temperature verified at ODU-24 LBT-1 LM | | |
| +45 | +55 | 77 | 16 QAM | 36/48/72 | | | |
| +45 | +55 | 116 | 64 QAM | 36/48/72 | | | |

| | |
|---|---|
| Measurement uncertainty (linearity) [dB] | <0.5 |
| Measurement uncertainty (frequency) df/f | <3E-12 |
| Test equipment used (item no) | 1, 4, 6 |

## 3.4 Conducted Spurious Emissions at Antenna Terminals

This test and the results are covered in the test report:

CETECOM ICT Services GmbH: Test Report No.: 2-5029-01-02/05

## 3.5 Receiver Spurious Emissions

Since transmitter and receiver are operated at the same waveguide port to the antenna, therefore the "Receiver Spurious Emissions" are also covered by the test report:

CETECOM ICT Services GmbH: Test Report No.: 2-5029-01-02/05

## 3.6 Field Strength of Spurious Radiation

This test and the results are covered in the test report:

CETECOM ICT Services GmbH: Test Report No.: 2-5029-01-02/05

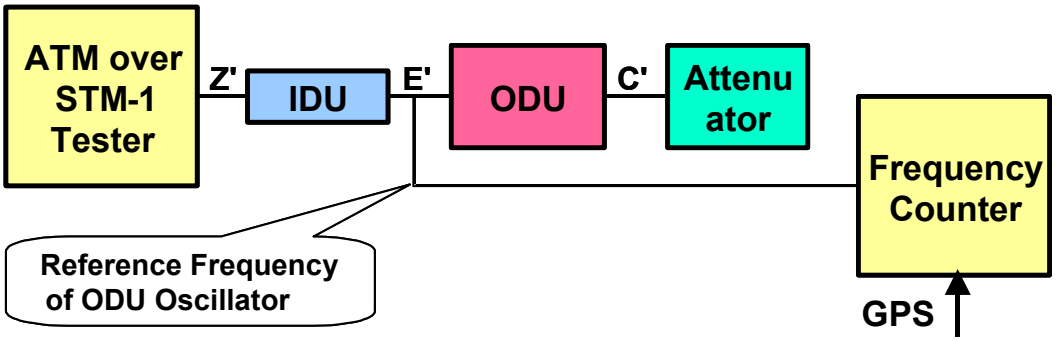
## 3.7 Frequency Stability

Method of measurement: 47 CFR 2.1055

Requirement:

| | |
|---|---|
| 47 CFR 101.107 | 0.001% (= 10 ppm) |
| 47 CFR 101.507 | 0.001% for Nodal Station<br>0.003% for User Station |
| RSS-191 chapter6.3 | +/- 10 ppm |

Test configuration:

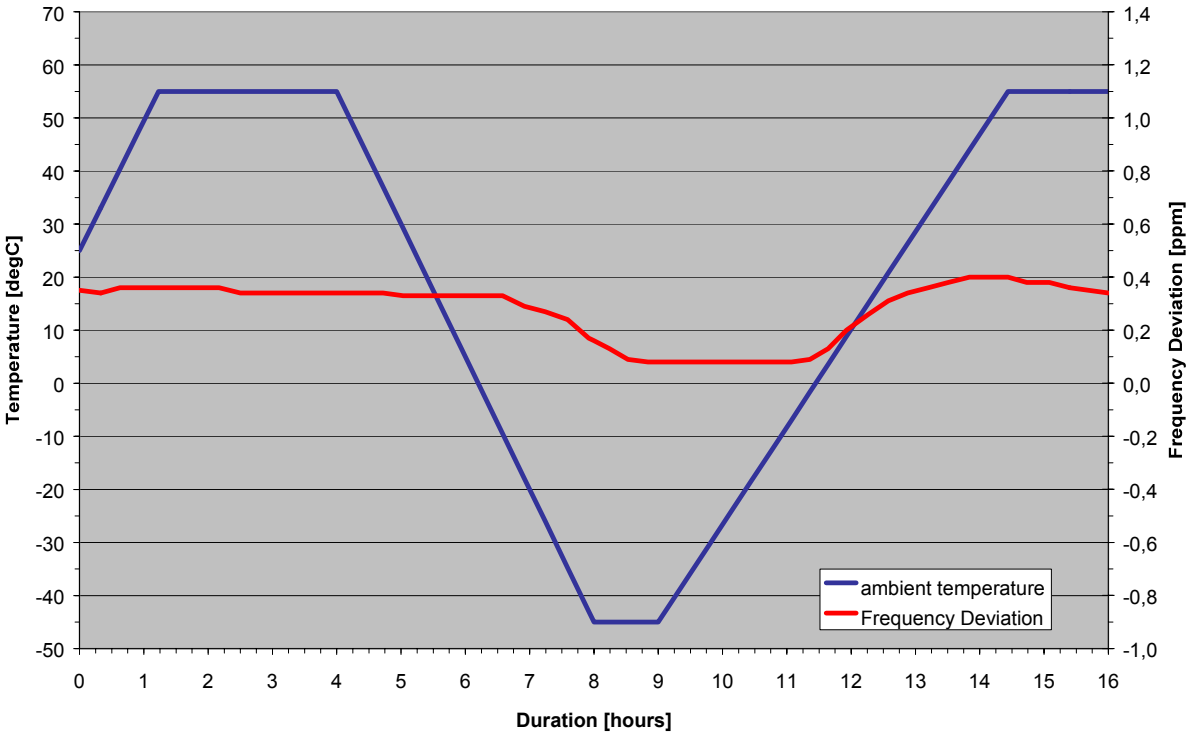



The DUT provides a reference signal at 55 MHz. This signal is directly correlated with all conversion frequencies of the ODU. Therefore measurement of this signal indicates the frequency stability of the unit.

Test Results:

The test was performed under climatic conditions.

Max. measured frequency deviation: + 0.4ppm




| | |
|---|---|
| Measurement uncertainty df/f | <3E-12 |
| Test equipment used (item no) | 3, 8 |

The test was performed for the range of supply voltage at ambient temperature.

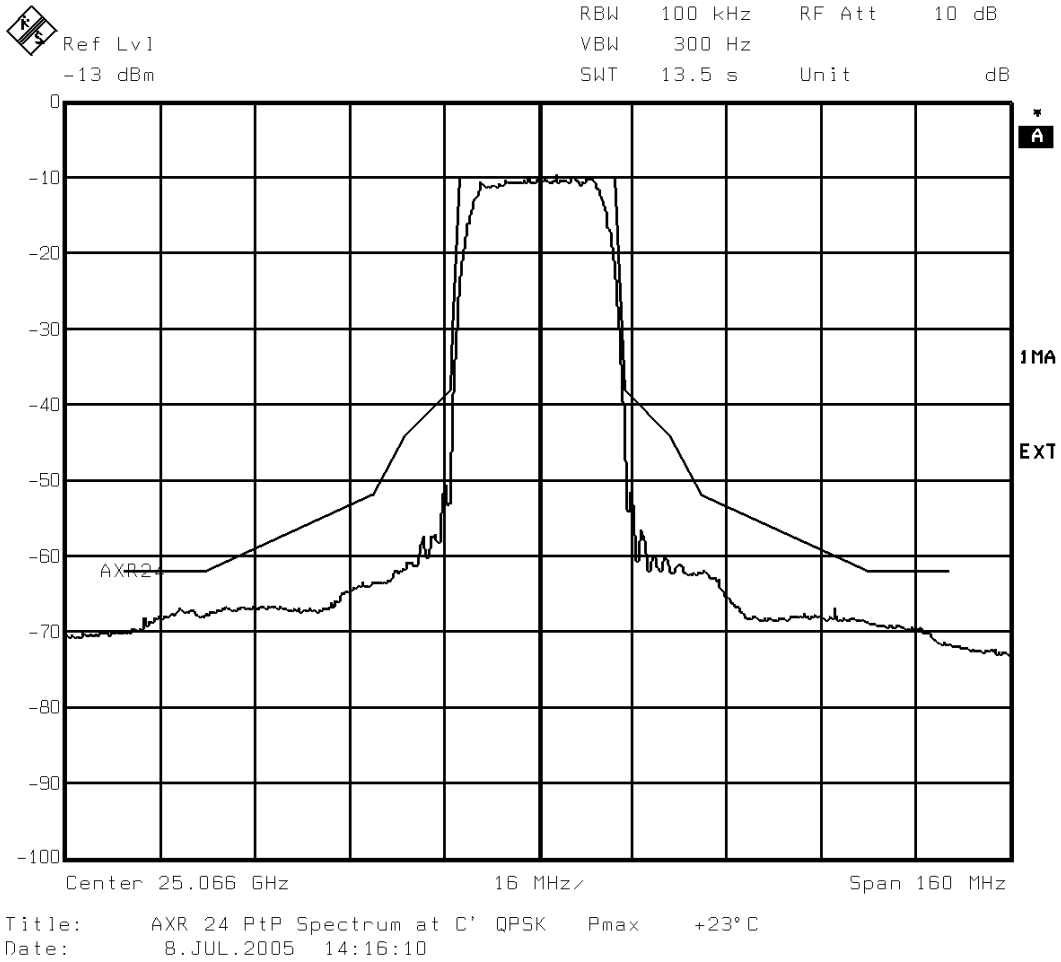
| Min. Voltage | -48 V range (85% to 115%) | -60 V range (85% to 115%) | Max. Voltage | Deviation |
|---|---|---|---|---|
| -36.0 V | | | | variation less than 0.02 ppm |
| | -40.8 V | | | |
| | -48.0 V | | | |
| | | -51.0 V | | |
| | -55.2 V | | | |
| | | -60.0 V | | |
| | | -69.0 V | | |
| | | | -72.0 V | |

# Annex Plots

## Plot No. 1

**RF-Spectrum upper band**
**28 MHz Bandwidth QPSK**
**25 066 MHz**

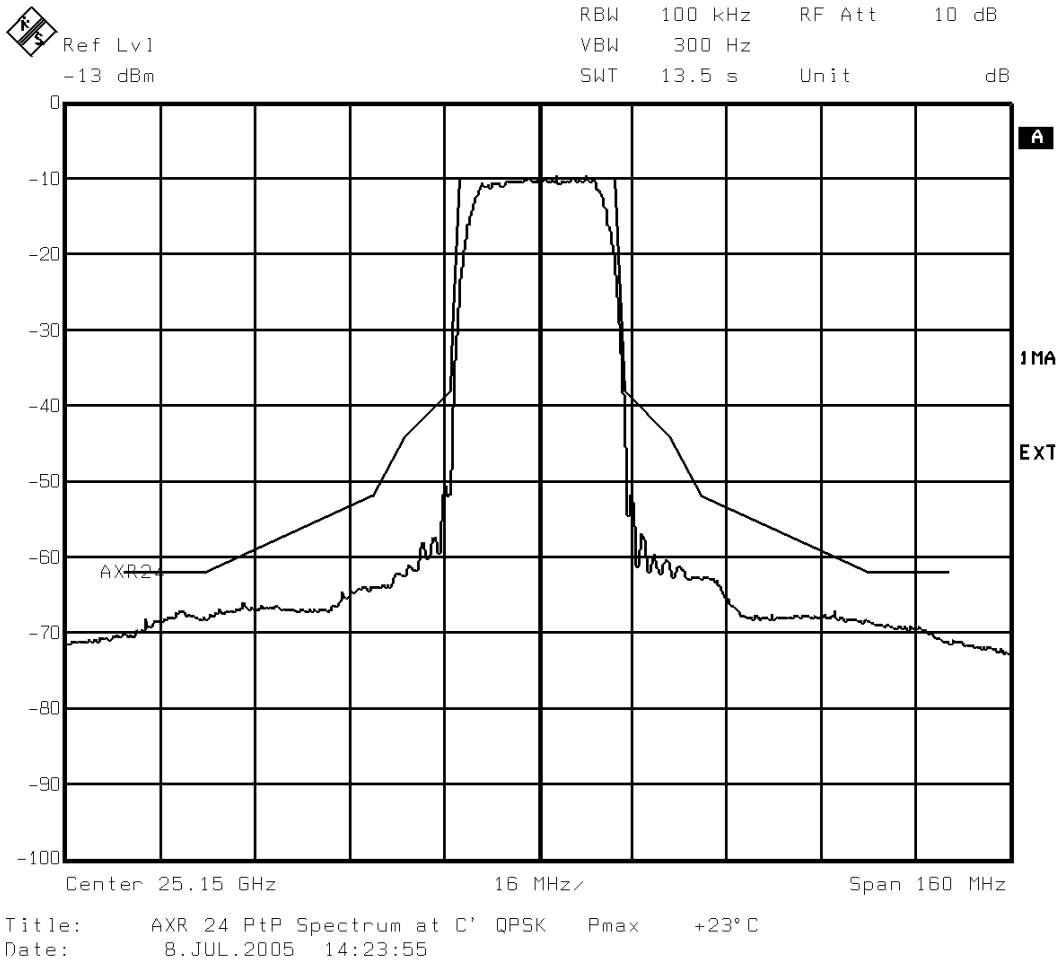
**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 2

**RF-Spectrum upper band**
**28 MHz Bandwidth QPSK**
**25 150 MHz**

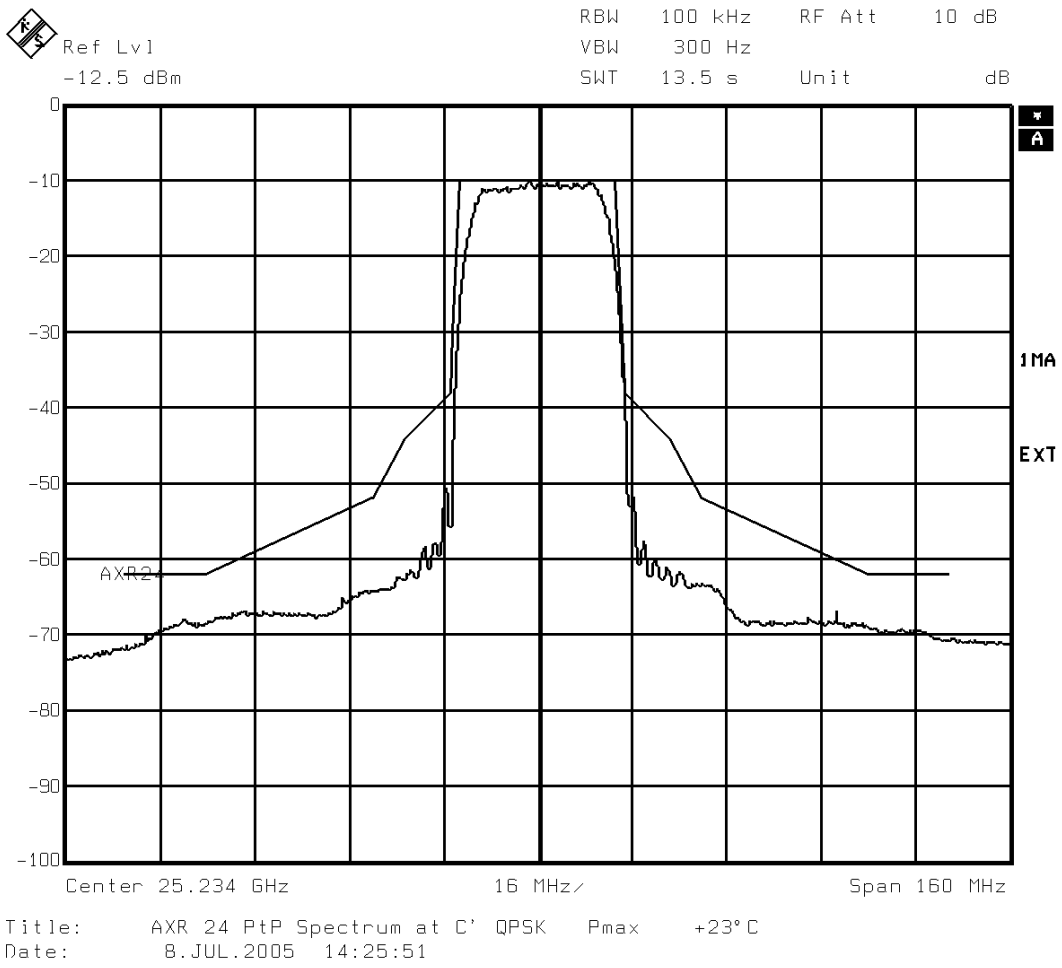
**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 3

**RF-Spectrum upper band**
**28 MHz Bandwidth QPSK**
**25 234 MHz**

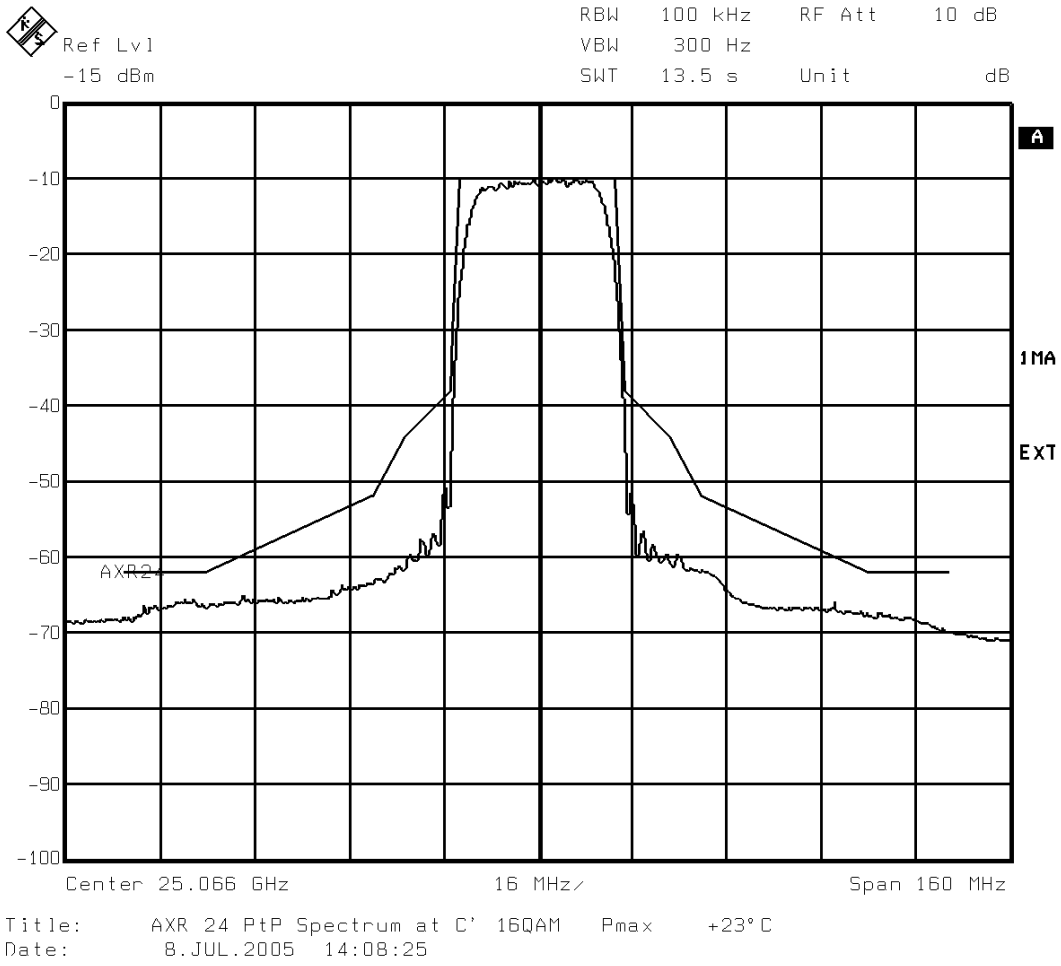
**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 4

**RF-Spectrum upper band**
**28 MHz Bandwidth 16QAM**
**25 066 MHz**

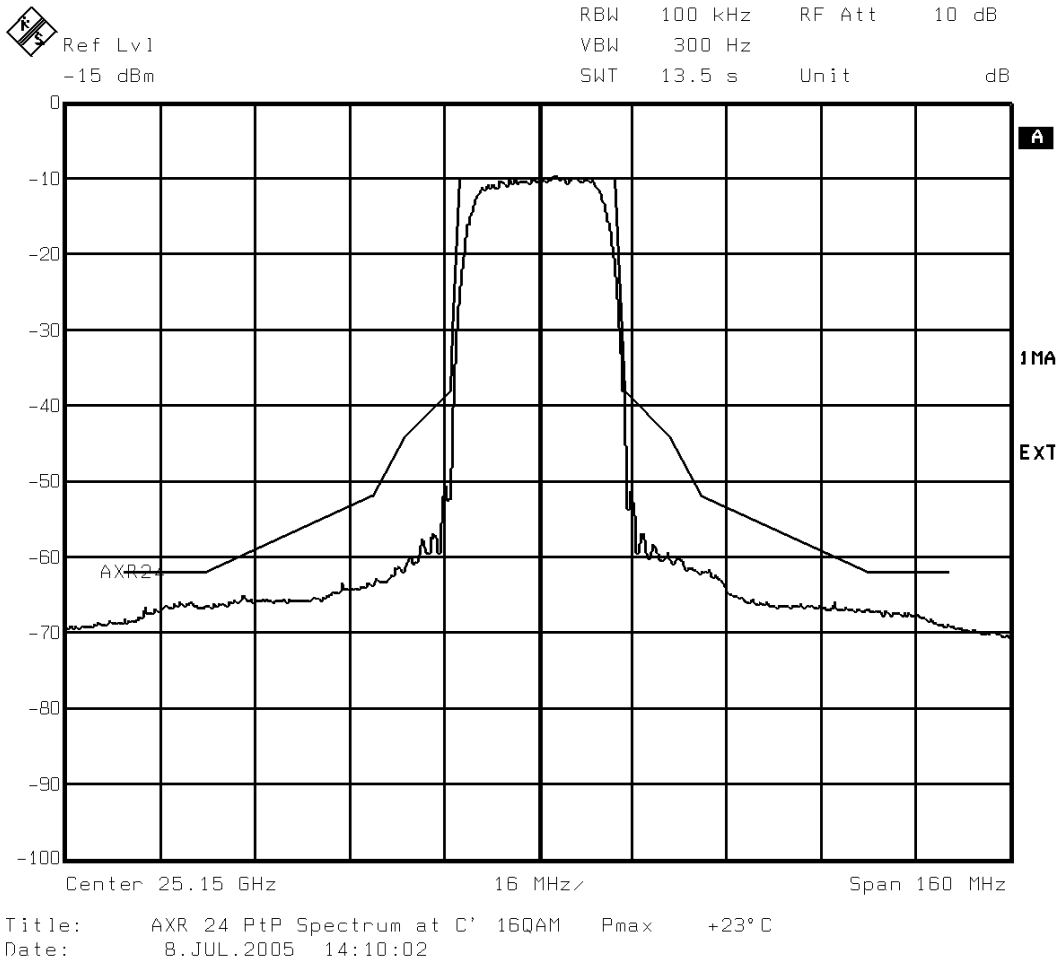
**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 5

**RF-Spectrum upper band**
**28 MHz Bandwidth 16QAM**
**25 150 MHz**

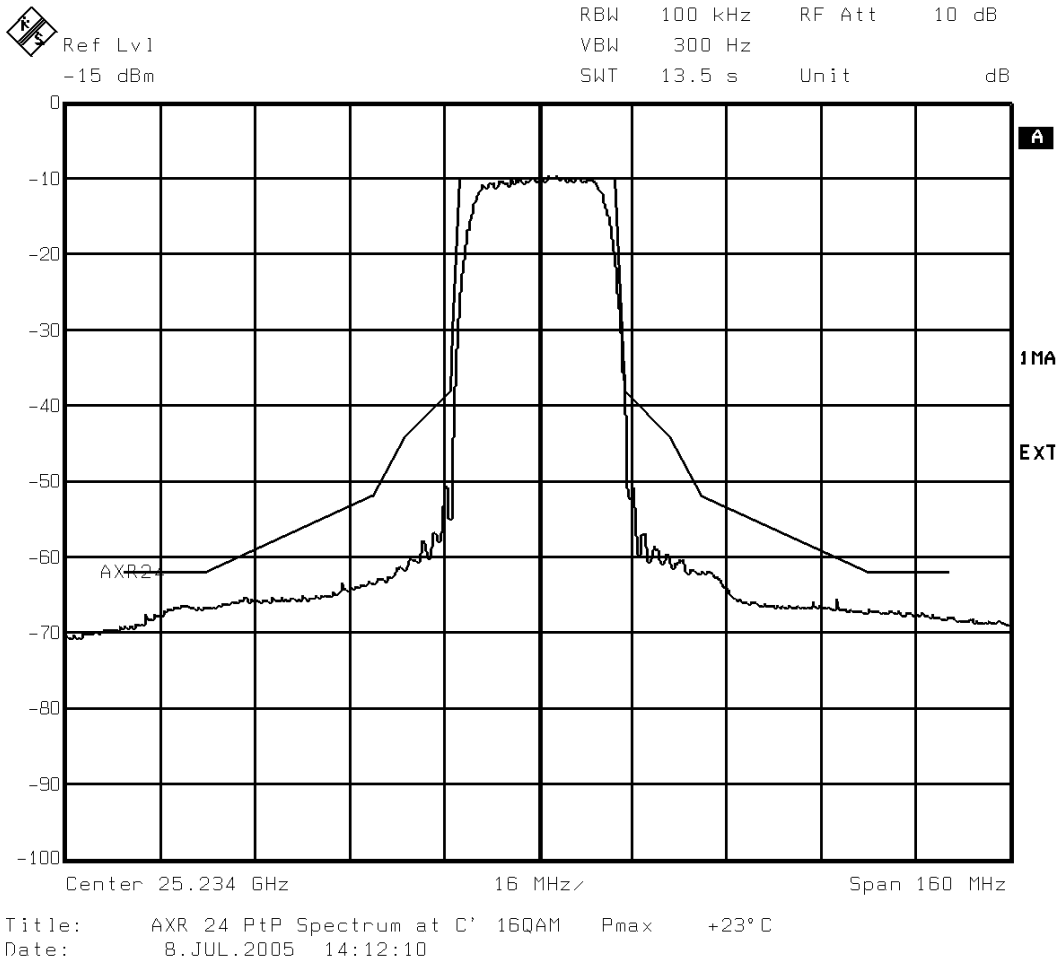
**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 6

**RF-Spectrum upper band**
**28 MHz Bandwidth 16QAM**
**25 234 MHz**

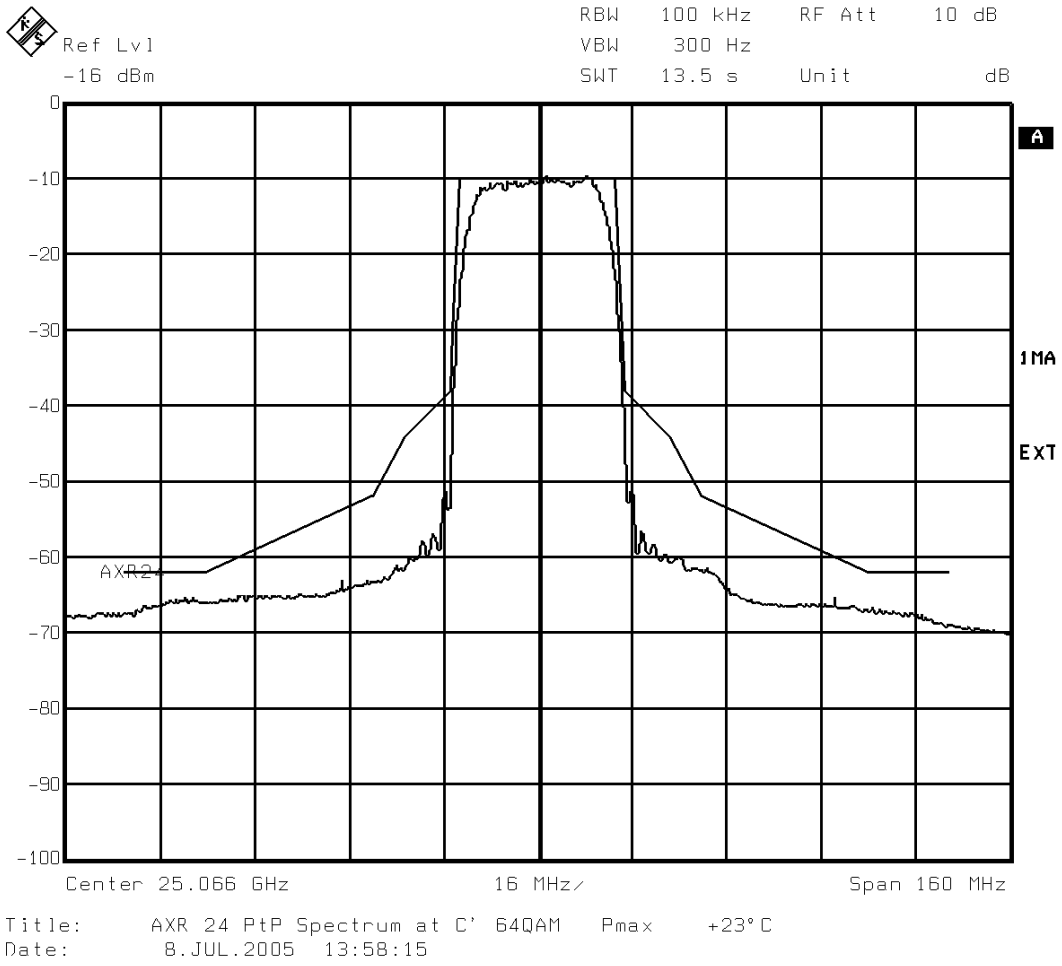
**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 7

**RF-Spectrum upper band**
**28 MHz Bandwidth 64 QAM**
**25 066 MHz**

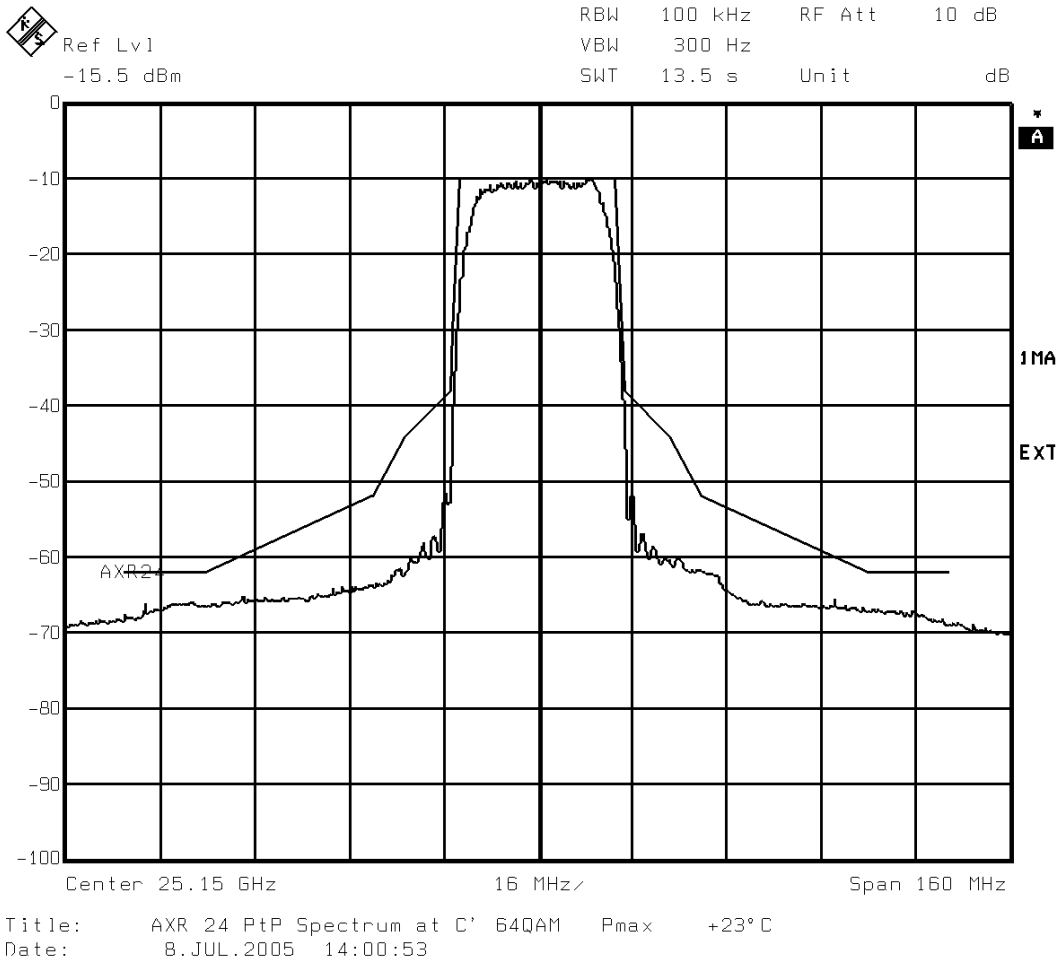
**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 8

**RF-Spectrum upper band**
**28 MHz Bandwidth 64 QAM**
**25 150 MHz**

**Temperature IDU +23°C**
**Temperature ODU +23 °C**



## Plot No. 9

**RF-Spectrum upper band**
**28 MHz Bandwidth 64 QAM**
**25 234 MHz**

**Temperature IDU +23°C**
**Temperature ODU +23 °C**