



## Electromagnetic Compatibility Test Report

Tests Performed on an Aclara Technologies, LLC

Series 4000 Meter Transmitting Unit (MTU), Model 4291-065-MBS2W

Radiometrics Document RP-8231A

|                                                                                             |                   |                                                                                                               |                   |
|---------------------------------------------------------------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------|-------------------|
| <i>Product Detail:</i>                                                                      |                   |                                                                                                               |                   |
| FCC ID: LLB2015001<br>Equipment type: 450-470 MHz Transceiver                               |                   |                                                                                                               |                   |
| <i>Test Standards:</i>                                                                      |                   |                                                                                                               |                   |
| US CFR Title 47, Chapter I, FCC Part 2 and 90<br>FCC Parts 2, 15, and 90 CFR Title 47: 2015 |                   |                                                                                                               |                   |
| <i>Tests Performed For:</i>                                                                 |                   | <i>Test Facility:</i>                                                                                         |                   |
| <b>Aclara Technologies, LLC</b><br>30400 Solon Rd<br>Solon, OH 44139                        |                   | <b>Radiometrics Midwest Corporation</b><br>12 East Devonwood<br>Romeoville, IL 60446<br>Phone: (815) 293-0772 |                   |
| <i>Test Date(s): (Month-Day-Year)</i>                                                       |                   |                                                                                                               |                   |
| November 5 thru 18, 2015                                                                    |                   |                                                                                                               |                   |
| Document RP-8231A Revisions:                                                                |                   |                                                                                                               |                   |
| Rev.                                                                                        | Issue Date        | Affected Sections                                                                                             | Revised By        |
| 0                                                                                           | December 1, 2015  |                                                                                                               |                   |
| 1                                                                                           | December 2, 2015  | Cover, 1, 2, 3, 4, 10                                                                                         | Joseph Strzelecki |
| 2                                                                                           | December 10, 2015 | 2, 10.2.1, 10.3.2                                                                                             | Joseph Strzelecki |
|                                                                                             |                   |                                                                                                               |                   |

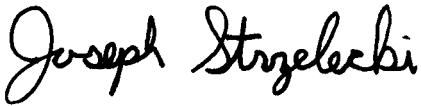
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## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

**1 ADMINISTRATIVE DATA**

|                                                                                                                                                                                                                                                                                   |                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <i>Equipment Under Test:</i><br>An Aclara Technologies LLC. Meter Transmitting Unit (MTU)<br>Model: 4291-065-MBS2W; Serial Numbers: 80010783, 80010757<br>This will be referred to as the EUT in this Report                                                                      |                                                                                                          |
| <i>Date EUT Received at Radiometrics: (Month-Day-Year)</i><br>November 4, 2015                                                                                                                                                                                                    | <i>Test Date(s): (Month-Day-Year)</i><br>November 5 thru 18, 2015                                        |
| <i>Test Report Written By:</i><br>Joseph Strzelecki<br>Senior EMC Engineer                                                                                                                                                                                                        | <i>Test Witnessed By:</i><br>The tests were not witnessed by personnel from Aclara Technologies, LLC     |
| <i>Radiometrics' Personnel Responsible for Test:</i><br><br>12/01/2015<br>Date<br>Joseph Strzelecki<br>Senior EMC Engineer<br>NARTE EMC-000877-NE<br><br>Richard L. Tichgelaar<br>EMC Technician | <i>Test Report Approved By</i><br><br>Chris W. Carlson<br>Director of Engineering<br>NARTE EMC-000921-NE |

**2 TEST SUMMARY AND RESULTS**

The EUT (Equipment Under Test) is a Meter Transmitting Unit (MTU), Model 4291-065-MBS2W, manufactured by Aclara Technologies, LLC. The detailed test results are presented in a separate section. The following is a summary of the test results.

**Transmitter Requirements**

| Environmental Phenomena                  | Frequency Range | FCC Section      | Test Result |
|------------------------------------------|-----------------|------------------|-------------|
| RF Power Output                          | 450-470 MHz     | 2.1046<br>90.205 | Pass        |
| Occupied Bandwidth Test; Emissions Masks | 450-470 MHz     | 2.1049<br>90.209 | Pass        |
| Spurious RF Conducted Emissions          | 1-4700 MHz      | 2.1051<br>90.210 | Pass        |
| Field Strength of Spurious Radiation     | 30-4700 MHz     | 2.1053           | Pass        |
| Frequency Vs. Temperature                | 450-470 MHz     | 2.1055<br>90.213 | Pass        |
| Frequency Vs. Voltage                    | 450-470 MHz     | 2.1055<br>90.213 | Pass        |
| Transient Frequency Behavior             | 450-470 MHz     | 90.214           | Pass        |
| Radiated Emissions Receive Mode          | 30-2000 MHz     | 15               | Pass        |

### 3 EQUIPMENT UNDER TEST (EUT) DETAILS

#### 3.1 EUT Description

The EUT is a Meter Transmitting Unit (MTU), Model 4291-065-MBS2W, manufactured by Aclara Technologies, LLC. The RF communications link is encrypted in both directions. The EUT was in good working condition during the tests, with no known defects.

### 4 TESTED SYSTEM DETAILS

#### 4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations. The Transponder was tested as a stand alone device. The TX/RX Module was used to terminate the receiver ports only. The identification for all equipment used in the tested system, is:

**Tested System Configuration List**

| Item | Description                   | Type* | Manufacturer             | Model Number   | Serial Numbers        |
|------|-------------------------------|-------|--------------------------|----------------|-----------------------|
| 1    | Meter Transmitting Unit (MTU) | E     | Aclara Technologies, LLC | 4291-065-MBS2W | 80010783;<br>80010757 |

\* Type: E = EUT,

#### 4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

#### 4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

### 5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

| Document         | Date | Title                                                                                                                                |
|------------------|------|--------------------------------------------------------------------------------------------------------------------------------------|
| FCC CFR Title 47 | 2015 | Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 & 90 - Radio Frequency Devices           |
| ANSI C63.4-2009  | 2009 | Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| TIA-603-C        | 2004 | Land Mobile FM or PM Communications Equipment – Measurement and Performance Standards                                                |

## 6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2005 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. A copy of the accreditation can be accessed on our web site ([www.radiomet.com](http://www.radiomet.com)). Radiometrics accreditation status can be verified at A2LA's web site ([www.a2la2.org](http://www.a2la2.org)).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber A: Is an anechoic chamber that measures 24' L X 12' W X 12' H. The walls and ceiling are fully lined with ferrite absorber tiles. The floor has a 10' x 10' section of ferrite absorber tiles located in the center. Panashield of Rowayton, Connecticut manufactured the chamber. The enclosure is NAMAS certified.

Chamber B: Is a shielded enclosure that measures 20' L X 12' W X 8' H. Erik A. Lindgren & Associates of Chicago, Illinois manufactured the enclosure.

Chamber C: Is a shielded enclosure that measures 17' L X 10' W X 8' H. Lindgren RF Enclosures Inc. of Addison, Illinois manufactured the enclosure.

Chamber E: Is a custom made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as site number IC3124A-1.

## 7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

## 8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

## 9 TEST EQUIPMENT TABLE

| RMC ID | Manufacturer    | Description       | Model No. | Serial No. | Frequency Range | Cal Period | Cal Date |
|--------|-----------------|-------------------|-----------|------------|-----------------|------------|----------|
| ANT-03 | Tensor          | Biconical Antenna | 4104      | 2231       | 20-250MHz       | 24 Mo.     | 11/26/13 |
| ANT-06 | EMCO            | Log-Periodic Ant. | 3146      | 1248       | 200-1000MHz     | 24 Mo.     | 11/26/13 |
| ANT-13 | EMCO            | Horn Antenna      | 3115      | 2502       | 1.0-18GHz       | 24 Mo.     | 12/01/14 |
| ANT-36 | Ailtech (Eaton) | Horn Antenna      | 96001     | 2013       | 1.0-18GHz       | 24 Mo.     | 10/20/14 |

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

| RMC ID | Manufacturer       | Description         | Model No. | Serial No. | Frequency Range | Cal Period | Cal Date |
|--------|--------------------|---------------------|-----------|------------|-----------------|------------|----------|
| ANT-44 | Impossible Machine | Super Log Antenna   | SL-20M2G  | 1002       | 20-2000MHz      | 24 Mo.     | 12/10/13 |
| ATT-28 | Narda              | Attenuator(20dB)    | 757B-20   | 3131       | DC - 6 GHz      | 24 Mo.     | 09/24/14 |
| CDT-01 | Wiltron            | Crystal RF Detector | 75N50     | CDT-01     | DC-18GHz        | N/A        | NCR      |
| COM-01 | Anaren             | Coupler             | 10023-3   | COM-01     | 250-1000MHz     | N/A        | NCR      |
| DIR-07 | Werlatone          | Directional Coupler | C3908     | 6929       | 80-1000MHz      | 24 Mo.     | 06/10/15 |
| DIR-19 | Narda              | Directional Coupler | 3000-10   | 01174      | 200-500MHz      | N/A        | NCR      |
| DMM-08 | Fluke              | DMM                 | 8840A/AF  | AF4005032  | DC-100kHz       | 24 Mo      | 05/26/14 |
| REC-11 | HP / Agilent       | Spectrum Analyzer   | E7405A    | US39110103 | 9Hz-26.5GHz     | 12 Mo.     | 06/23/15 |
| SCP-02 | Tektronix          | Oscilloscope        | TDS784A   | B040258    | DC-1GHz         | 24 Mo.     | 11/15/14 |
| SIG-30 | Rohde & Schwarz    | Signal Generator    | SMC100A   | 102914     | 9k-3.2GHz       | 24 Mo.     | 10/07/15 |
| THM-02 | Fluke              | Temp/Humid Meter    | 971       | 93490471   | N/A             | 12 Mo.     | 08/03/15 |

Note: All calibrated equipment is subject to periodic checks.

NCR – No Calibration Required. Device monitored by calibrated equipment. N/A: Not Applicable.

## 10 TEST SECTIONS

### 10.1 Peak Output Power

The peak power was measured by connecting the EUT antenna port to the spectrum analyzer via a low loss coaxial cable and an appropriate power attenuator.

|                |                       |               |                 |
|----------------|-----------------------|---------------|-----------------|
| Model          | 4291-065-MBS2W        | Specification | FCC part 90.205 |
| Serial Number  | 80010783              | Test Date     | November , 2015 |
| Test Personnel | Joseph Strzelecki     | Test Location | Chamber B       |
| Test Equipment | EMI Receiver (REC-11) |               |                 |

| TX freq MHz | Reading dBm | Atten & Cable | Total dBm | Peak Power Watts |
|-------------|-------------|---------------|-----------|------------------|
| 450.0250    | 9.5         | 20.2          | 29.7      | 0.933            |
| 460.0000    | 9.5         | 20.3          | 29.8      | 0.955            |
| 469.9875    | 9.5         | 20.3          | 29.8      | 0.955            |

Judgement: Pass

The limit is 33 dBm for this product.

### 10.2 Occupied Bandwidth; Emissions Masks

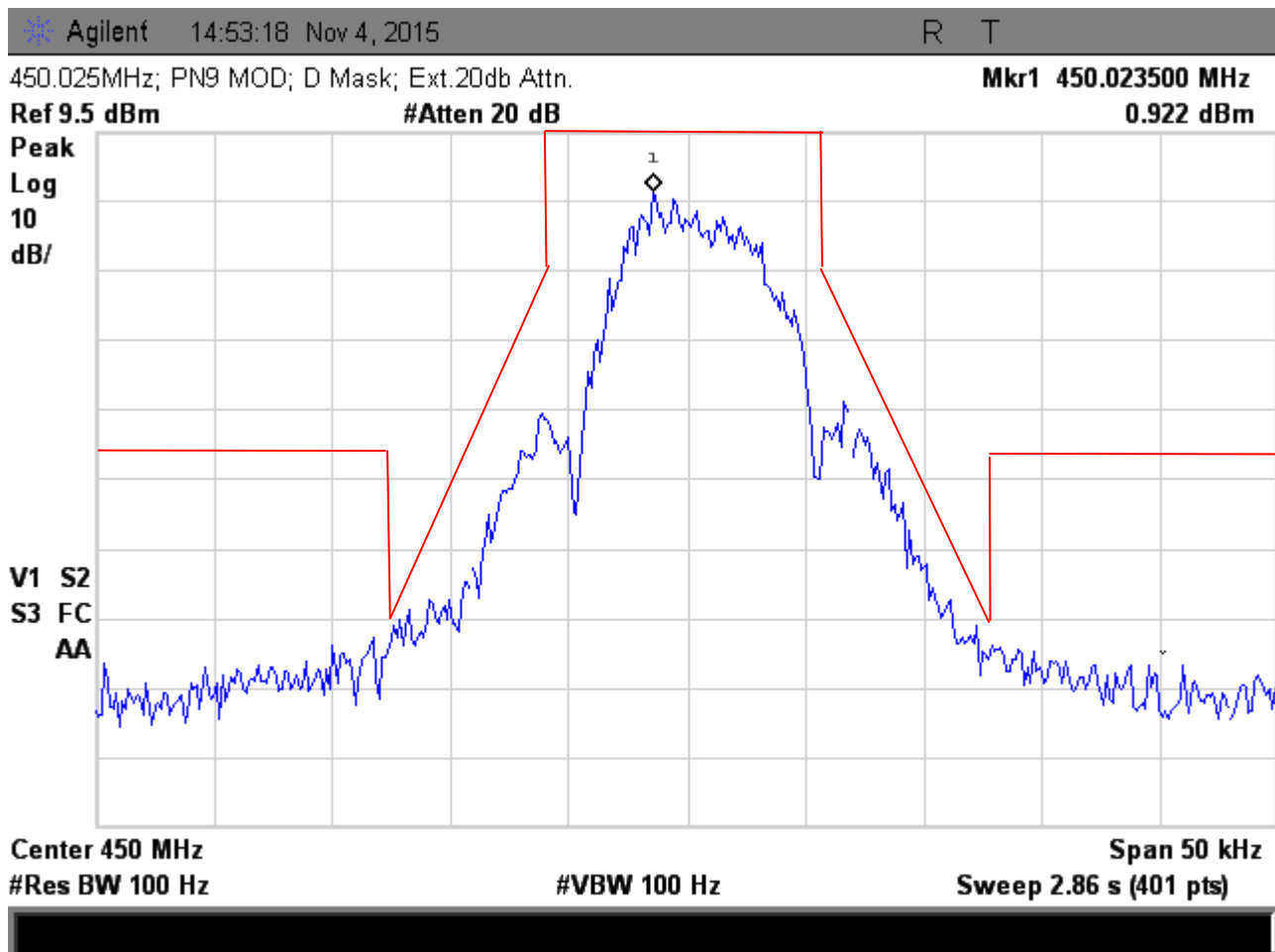
|                |                            |               |                 |
|----------------|----------------------------|---------------|-----------------|
| Model          | 4291-065-MBS2W             | Specification | FCC Part 90.209 |
| Serial Number  | 80010783                   | Test Date     | 08/03/2015      |
| Test Personnel | Richard Tichgelaar         | Test Location | Chamber B       |
| Test Equipment | Spectrum Analyzer (REC-11) |               |                 |

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize. All Channels are 12.5 kHz

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

The emissions Masks D is from FCC part 90.210.

- (1) On any frequency from the center of the authorized bandwidth  $f_0$  to 5.625 kHz removed from  $f_0$ : Zero dB.
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least  $7.27(f_d - 2.88 \text{ kHz})$  dB.
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 12.5 kHz: At least  $50 + 10 \log(P)$  dB.



## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

\* Agilent 14:43:23 Nov 4, 2015

R T

460.000MHz; PN9 MOD; D Mask; Ext.20db Attn.

Mkr1 459.999375 MHz

Ref 9.5 dBm

#Atten 20 dB

-0.41 dBm

Peak  
Log  
10  
dB/V1 S2  
S3 FC  
AA

Center 460 MHz

Span 50 kHz

#Res BW 100 Hz

#VBW 100 Hz

Sweep 2.86 s (401 pts)

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

Agilent 14:18:36 Nov 4, 2015

R T

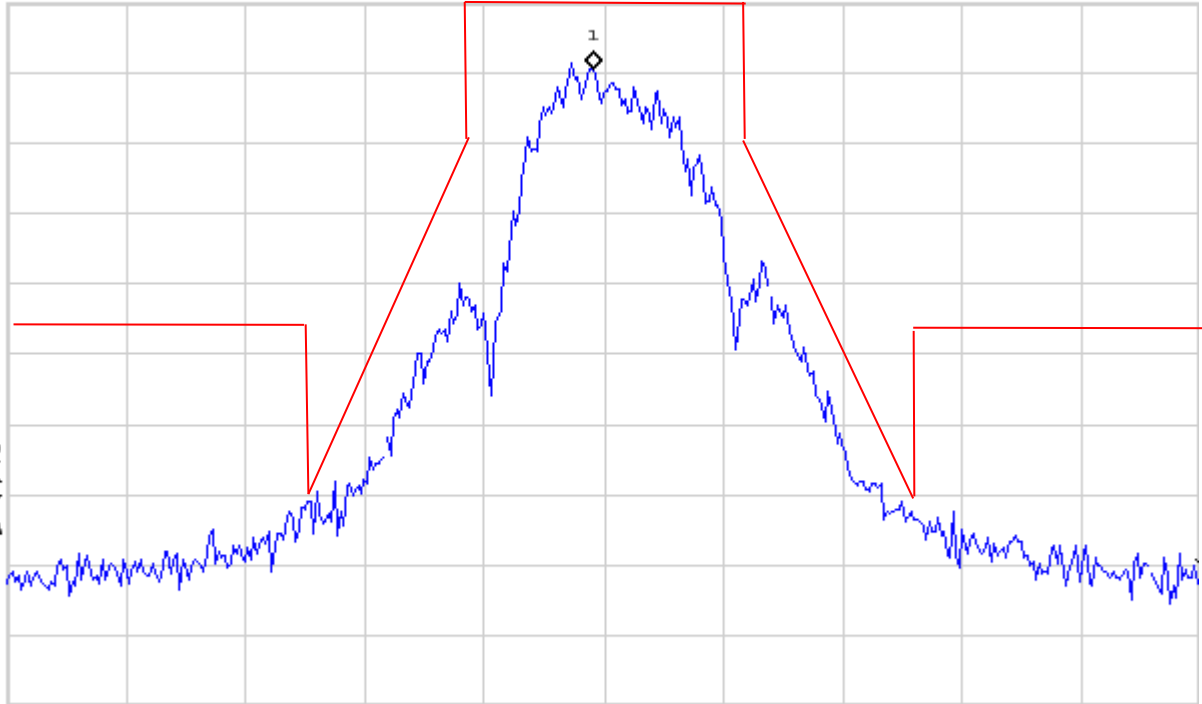
469.9875MHz; PN9 MOD; D Mask w 20db Atten.

Mkr1 469.987000 MHz

Ref 9.5 dBm

#Atten 20 dB

0.121 dBm

Peak  
Log  
10  
dB/V1 S2  
S3 FC  
AA

Center 470 MHz

#Res BW 100 Hz

#VBW 100 Hz

Span 50 kHz  
Sweep 2.86 s (401 pts)

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

\* Agilent 15:19:11 Nov 4, 2015

R T

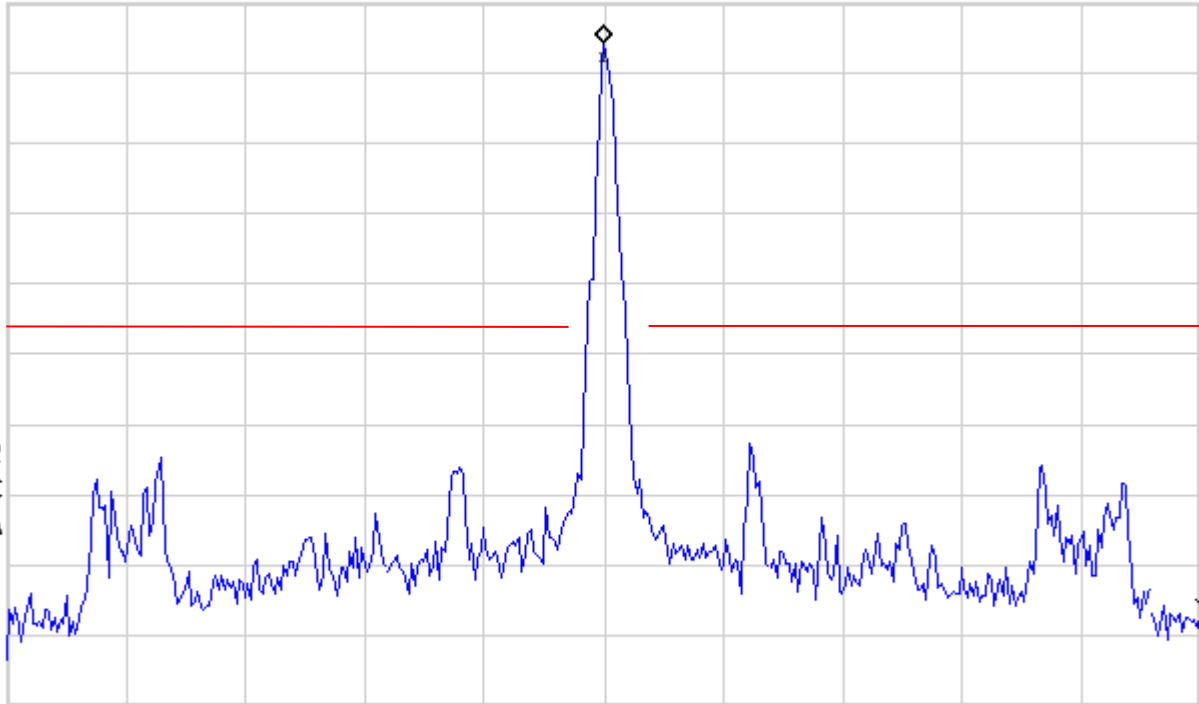
450.025MHz; PN9 MOD; D Mask; Ext.20db Attn.

Mkr1 450.02500 MHz

Ref 9.5 dBm

#Atten 20 dB

3.822 dBm

Peak  
Log  
10  
dB/V1 S2  
S3 FC  
AA

Center 450 MHz

Span 500 kHz

#Res BW 300 Hz

#VBW 1 kHz

Sweep 22.26 s (401 pts)

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

\* Agilent 15:12:39 Nov 4, 2015

R T

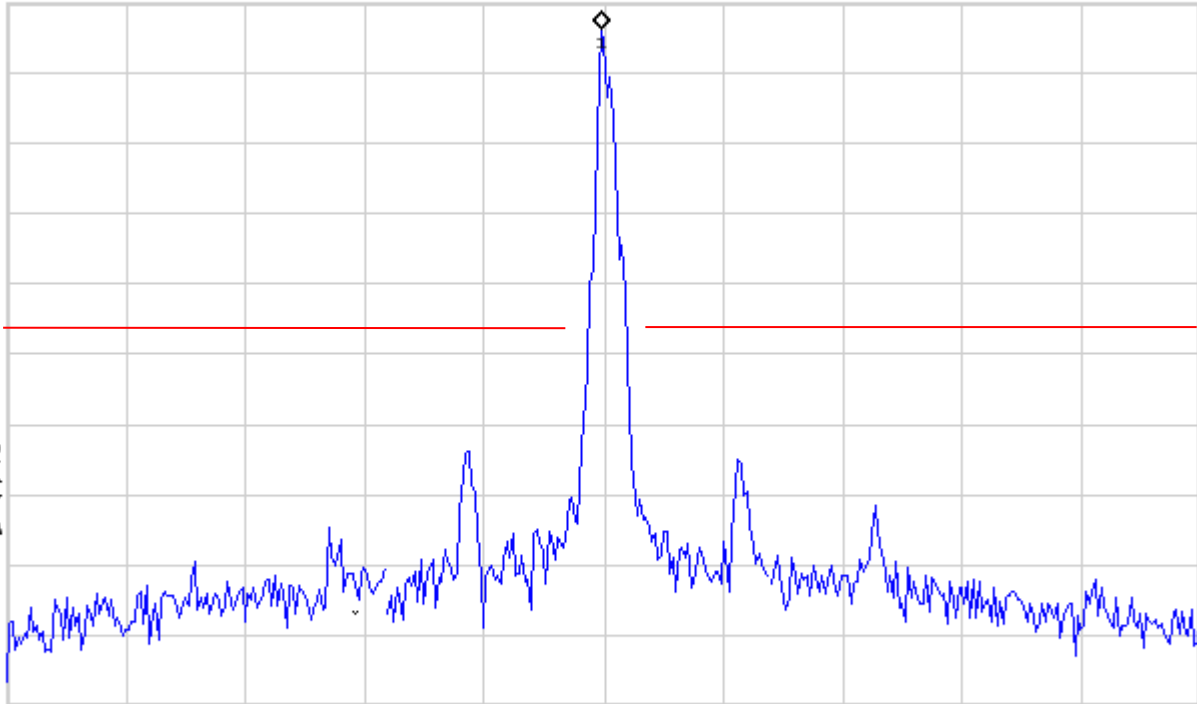
460.000MHz; PN9 MOD; D Mask; Ext.20db Attn.

Mkr1 459.99875 MHz

Ref 9.5 dBm

#Atten 20 dB

5.823 dBm

Peak  
Log  
10  
dB/V1 S2  
S3 FC  
AA

Center 460 MHz

Span 500 kHz

#Res BW 300 Hz

#VBW 1 kHz

Sweep 22.26 s (401 pts)

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

\* Agilent 15:23:34 Nov 4, 2015

R T

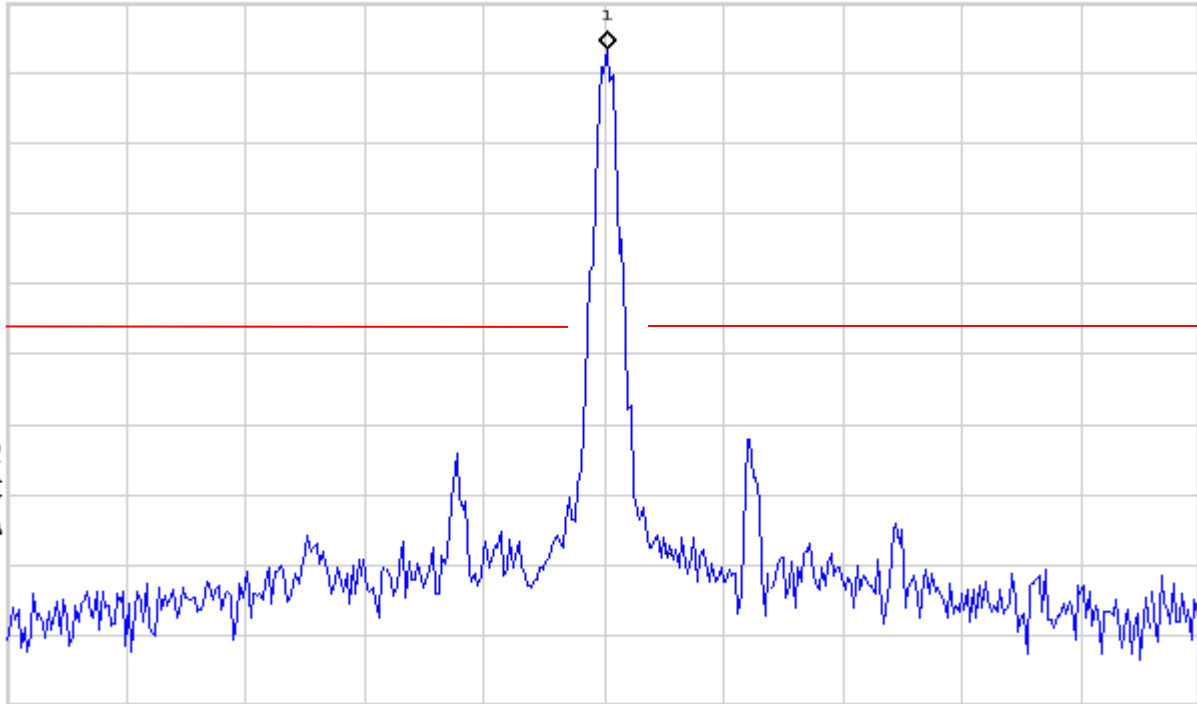
469.9875MHz; PN9 MOD; D Mask; Ext.20db Attn.

Mkr1 469.98875 MHz

Ref 9.5 dBm

#Atten 20 dB

2.841 dBm

Peak  
Log  
10  
dB/V1 S2  
S3 FC  
AA

Center 470 MHz

Span 500 kHz

#Res BW 300 Hz

#VBW 1 kHz

Sweep 22.26 s (401 pts)

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

Agilent 15:44:18 Nov 4, 2015

R T

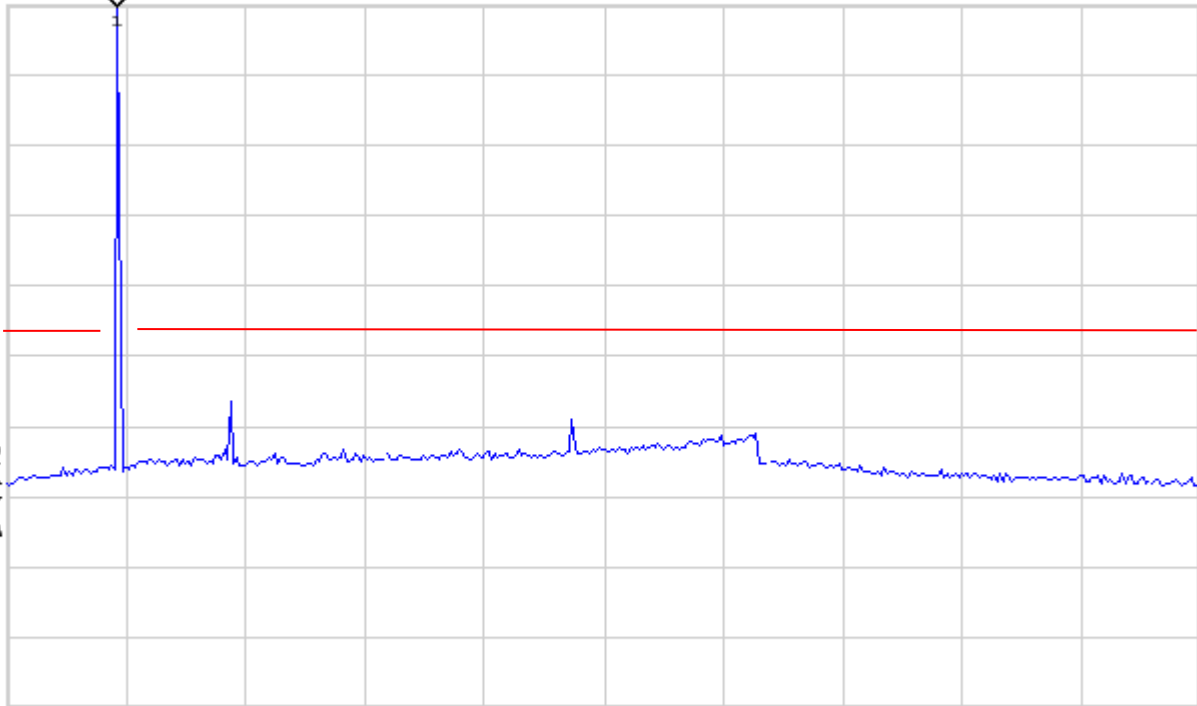
450.0250MHz; PN9 MOD; D Mask; 20db Ext Attn.

Mkr1 446 MHz

Ref 9.5 dBm

#Atten 20 dB

9.338 dBm

Peak  
Log  
10  
dB/M1 S2  
S3 FC  
AA

Start 7 MHz

Stop 4.75 GHz

#Res BW 100 kHz

#VBW 300 kHz

Sweep 491.4 ms (401 pts)

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

Agilent 15:40:17 Nov 4, 2015

R T

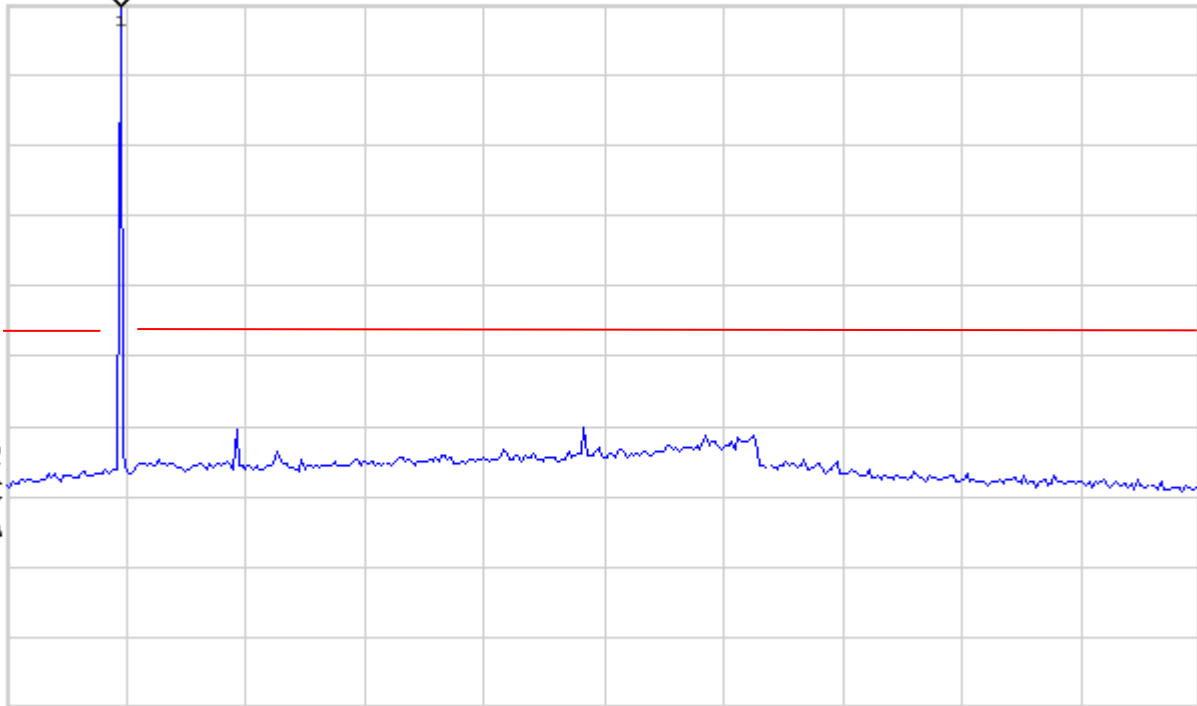
460.0000MHz; PN9 MOD; D Mask; 20db Ext Attn.

Mkr1 458 MHz

Ref 9.5 dBm

#Atten 20 dB

9.269 dBm

Peak  
Log  
10  
dB/V1 S2  
S3 FC  
AA

Start 7 MHz

Stop 4.75 GHz

#Res BW 100 kHz

#VBW 300 kHz

Sweep 491.4 ms (401 pts)

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

Agilent 15:37:19 Nov 4, 2015

R T

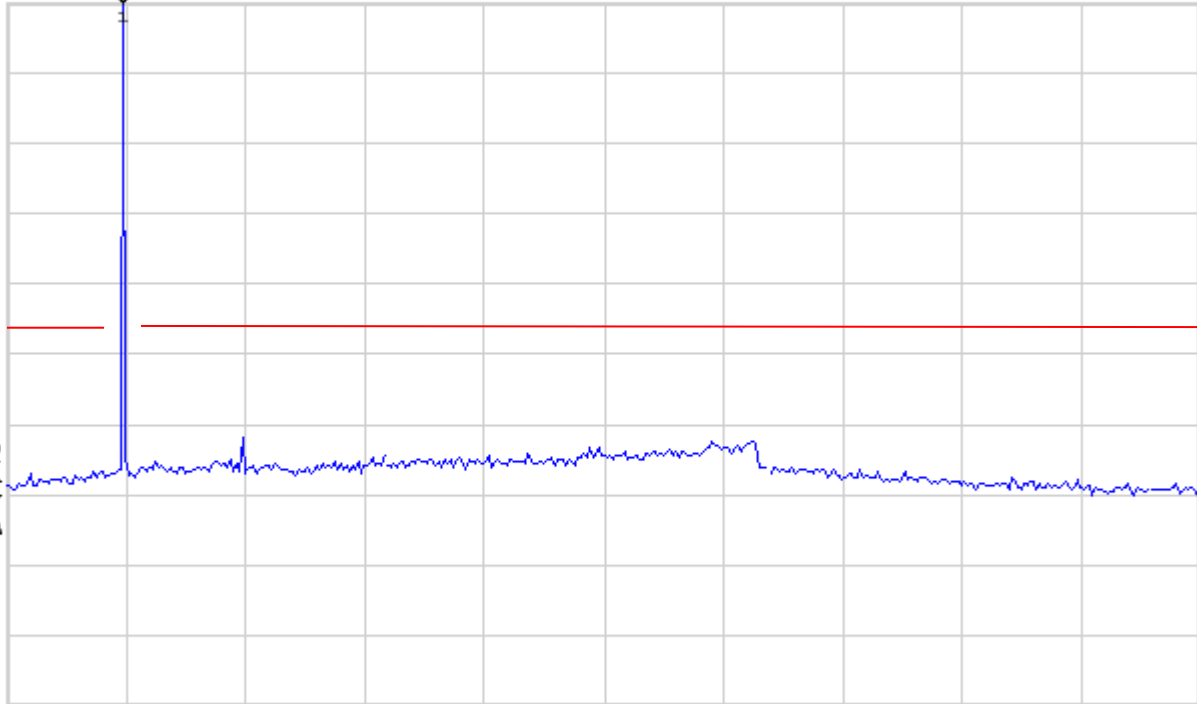
469.9875MHz; PN9 MOD; D Mask; 20db Ext Attn.

Mkr1 469 MHz

Ref 9.5 dBm

#Atten 20 dB

9.37 dBm

Peak  
Log  
10  
dB/V1 S2  
S3 FC  
AA

Start 7 MHz

Stop 4.75 GHz

#Res BW 100 kHz

#VBW 300 kHz

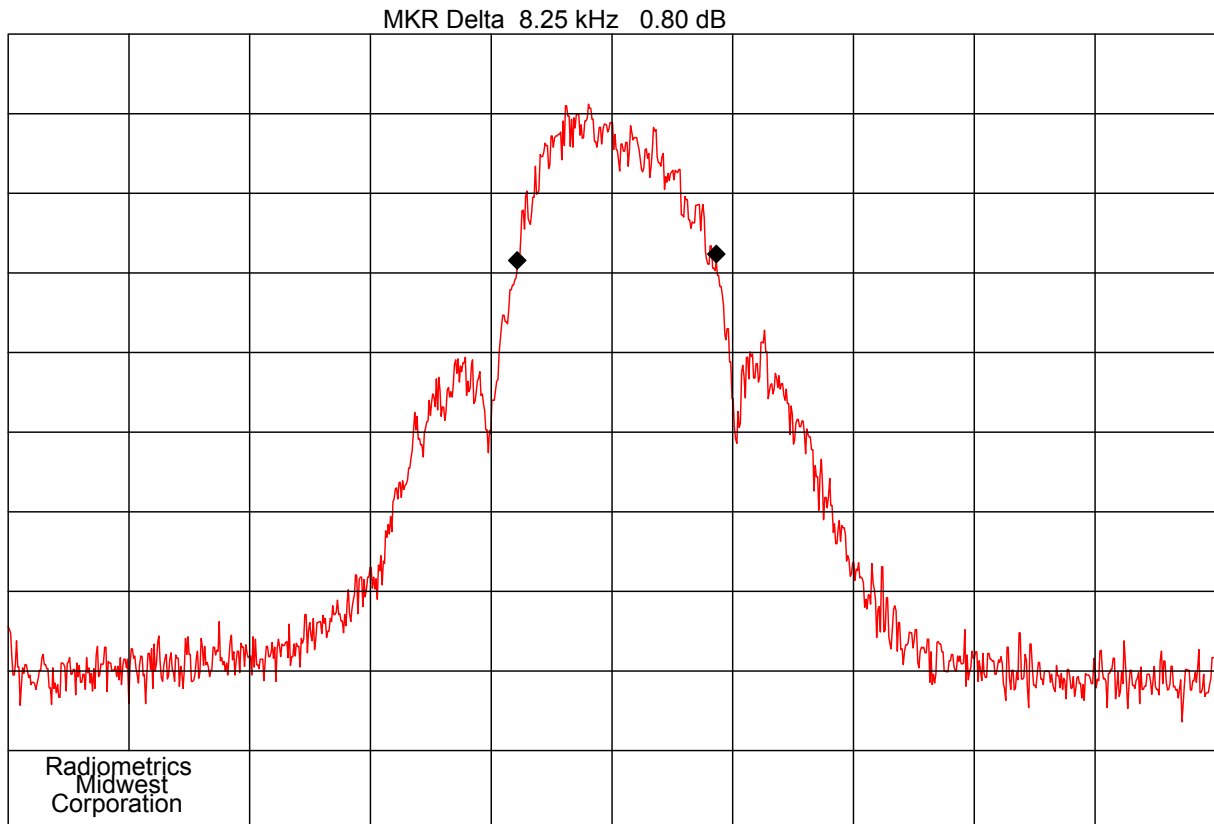
Sweep 491.4 ms (401 pts)

Judgement: Pass

## 10.2.1 Occupied bandwidth 99%

| Channel  | 20 dB OBW kHz |
|----------|---------------|
| 450.0250 | 8.25          |
| 460.0000 | 8.10          |
| 469.9875 | 8.65          |

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W



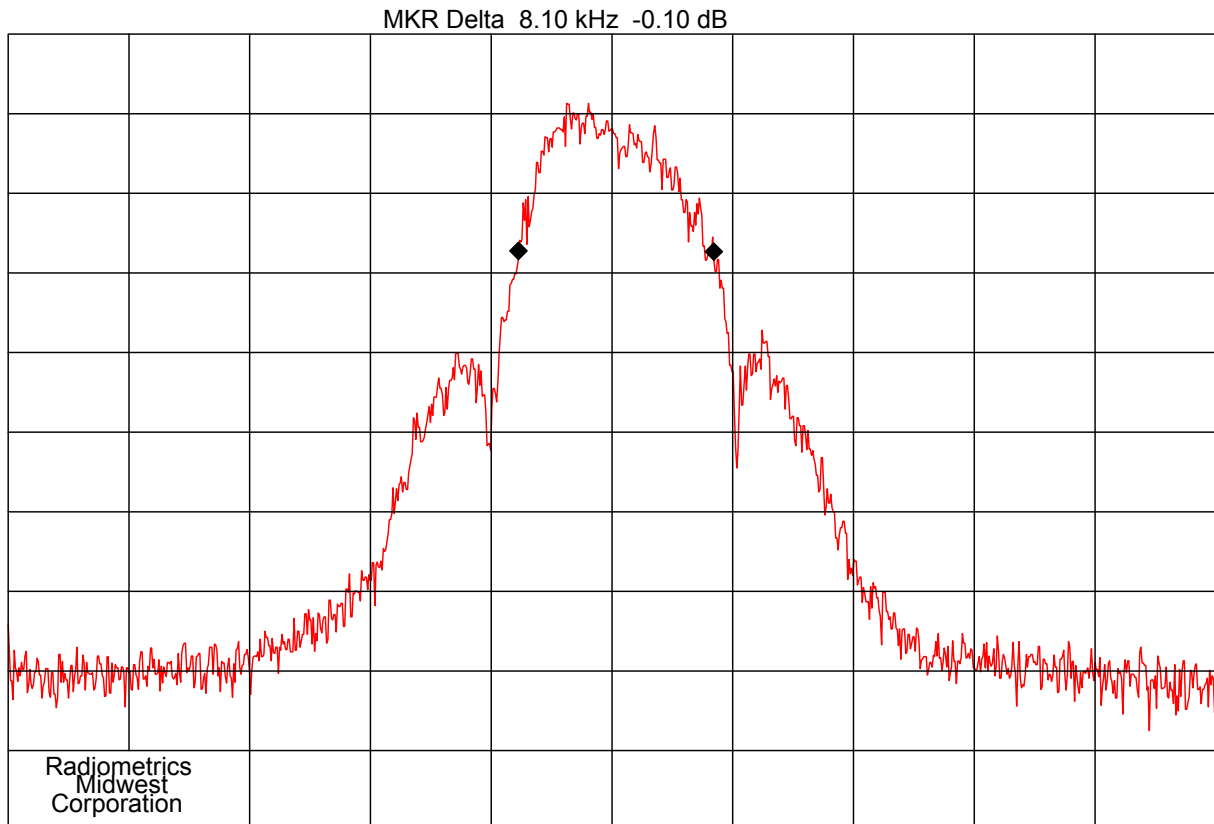
Company: Aclara Technologies  
CENTER 450.025 0 MHz  
RES BW 100 Hz  
10 dB/

Notes: 450.025 MHz PN9 Mod Occupied Bandwidth Test.,

ITEM : Series 4000  
REF 10.8 dBm  
VBW 100 Hz  
Time: 14:55

Date : 11-23-2015  
SPAN 50.0 kHz  
ATTEN 30 dB  
SWP 15.0 sec  
File: 450M-OBW

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

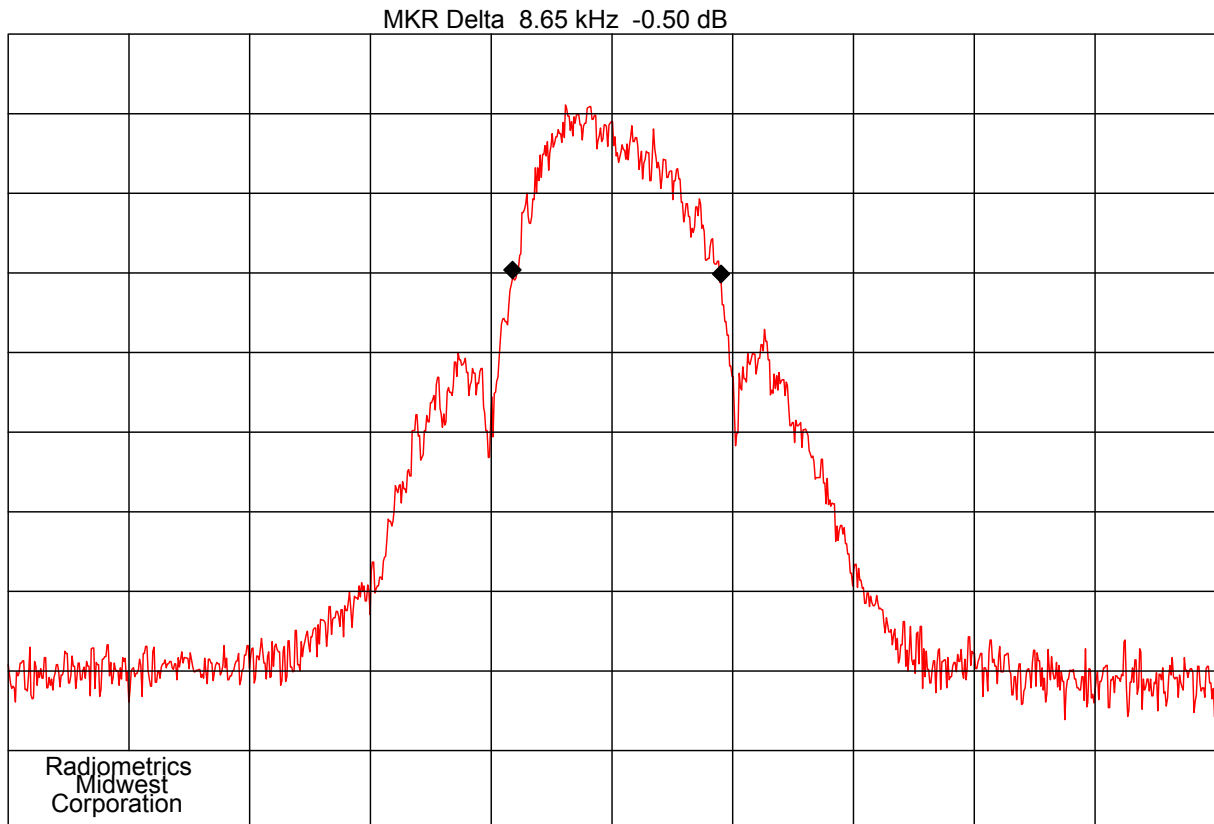


Company: Aclara Technologies  
CENTER 460.000 0 MHz  
RES BW 100 Hz  
10 dB/  
Notes: 460.000 MHz PN9 Mod Occupied Bandwidth Test.,

ITEM : Series 4000  
REF 10.5 dBm  
VBW 100 Hz  
Time: 14:43

Date : 11-23-2015  
SPAN 50.0 kHz  
ATTEN 30 dB  
SWP 15.0 sec  
File: 460M-OBW

## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W



Company: Aclara Technologies  
CENTER 469.987 5 MHz  
RES BW 100 Hz  
10 dB/

Notes: 469.9875 MHz PN9 Mod Occupied Bandwidth Test.,

ITEM : Series 4000  
REF 10.8 dBm  
VBW 100 Hz  
Time: 15:06

Date : 11-23-2015  
SPAN 50.0 kHz  
ATTEN 30 dB  
SWP 15.0 sec  
File: 469M-OBW

### 10.3 Field Strength of Unwanted Spurious Radiation

#### 10.3.1 Test Procedures

Radiated emission measurements in the Restricted bands were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. From 30 to 4700 MHz, a spectrum analyzer with a preselector was used for measurement. Radiated emissions measurements were performed at the anechoic chamber at a test distance of 3 meters. The entire frequency range from 30 to 4700 MHz was slowly scanned and the emissions in the restricted frequency bands were recorded. Measurements were performed using the peak detector function.

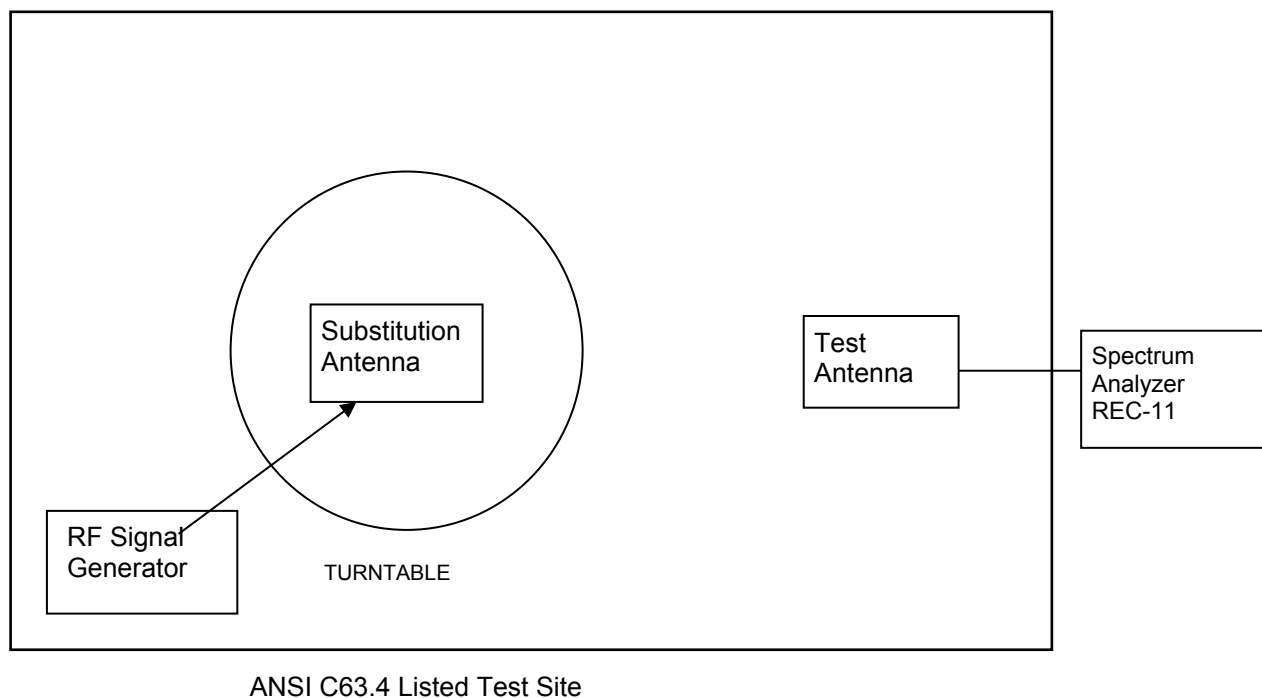
The spectrum analyzer was adjusted for the following settings:

- 1) Resolution Bandwidth = 100 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1GHz.
- 2) Video Bandwidth = 300 kHz for spurious emissions below 1 GHz, and 3 MHz for spurious emissions above 1 GHz.
- 3) Sweep Speed slow enough to maintain measurement calibration.
- 4) Detector Mode = Positive Peak.

The transmitter to be tested was placed on the turntable in the standard test site, or an FCC listed site compliant with ANSI C63.4. The transmitter is transmitting into a non-radiating load that is placed on the turntable (except for the fundamental reading which had an antenna). Since the transmitter has an integral antenna, the tests are to be run with the unit operating into the integral antenna. Measurements were made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier. The transmitter was keyed during the tests.

For each spurious frequency, the test antenna was raised and lowered from 1 m to 4m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable was rotated 360° to determine the maximum reading. This procedure was repeated to obtain the highest possible reading. This maximum reading was recorded.

Each measurement was repeated for each spurious frequency with the test antenna polarized vertically.

**Figure 1. Drawing of Radiated Emissions Setup****Notes:**

- Test Antenna height varied from 1 to 4 meters
- Distance from antenna to tested system is 3 meters
- Not to Scale

| Frequency MHz | Test Antenna | Substitution Antenna | Receiver to Coupler | Signal Generator |
|---------------|--------------|----------------------|---------------------|------------------|
| 30 - 200      | ANT-44       | ANT-03               | REC-11              | SIG-30           |
| 200 - 1000    | ANT-44       | ANT-06               | REC-11              | SIG-30           |
| 1000-5000     | ANT-13       | ANT-36               | REC-11              | SIG-30           |

The transmitter was removed and replaced with a broadband substitution antenna. The substitution antenna is calibrated so that the gain relative to a dipole is known. The center of the substitution antenna was approximately at the same location as the center of the transmitter.

The substitution antenna was fed at the transmitter end with a signal generator connected to the antenna by means of a non-radiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, the test antenna was raised and lowered to obtain a maximum reading at the spectrum analyzer. The level of the signal generator output was adjusted until the previously recorded maximum reading for this set of conditions was obtained.

The measurements were repeated with both antennas horizontally and vertically polarized for each spurious frequency.

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The power in dBm into a reference ideal half-wave dipole antenna was calculated by reducing the readings obtained in steps k) and l) by the power loss in the cable between the generator and the antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna by the following formula:

$$Pd(\text{dBm}) = Pg(\text{dBm}) - \text{cable loss (dB)} + \text{antenna gain (dB)}$$

where:

$Pd$  is the dipole equivalent power and

$Pg$  is the generator output power into the substitution antenna.

The  $Pd$  levels record in step m) are the absolute levels of radiated spurious emissions in dBm.

Any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least  $50 + 10 \log (P)$  dB.

Since by mathematical definition,  $P(\text{dBm}) - (50 + 10 \times \log P(\text{W})) = -20 \text{ dBm}$ , the limit for spurious emissions was set to -20 dBm equivalent radiated power.

### 10.3.2 Spurious Radiated Emissions Test Results

|               |                |               |                           |
|---------------|----------------|---------------|---------------------------|
| Model         | 4291-065-MBS2W | Specification | FCC Part 90.210           |
| Serial Number | 80010783       | Test Date     | November 9, 10 & 11, 2015 |
| Test Distance | 3 Meters       | Notes         | Transmit Mode             |

| Harmonic # | Tx Freq MHz | Measured Freq MHz | Equivalent Radiated power into Dipole |                | Limit dBm | Margin Under Limit |               |
|------------|-------------|-------------------|---------------------------------------|----------------|-----------|--------------------|---------------|
|            |             |                   | Vertical dBm                          | Horizontal dBm |           | Vertical dB        | Horizontal dB |
| 1          | 450.0250    | 450.03            | 28.9                                  | 20.8           | 33.0      | 4.1                | 12.3          |
| 2          | 450.0250    | 900.05            | -28.6                                 | -33.9          | -20.0     | 8.6                | 13.9          |
| 3          | 450.0250    | 1350.08           | -48.5                                 | -51.4          | -20.0     | 28.5               | 31.4          |
| 4          | 450.0250    | 1800.10           | -52.0                                 | -56.8          | -20.0     | 32.0               | 36.8          |
| 5          | 450.0250    | 2250.13           | -42.4                                 | -45.0          | -20.0     | 22.4               | 25.0          |
| 6          | 450.0250    | 2700.15           | -58.0                                 | -58.3          | -20.0     | 38.0               | 38.3          |
| 7          | 450.0250    | 3150.18           | -40.1                                 | -40.8          | -20.0     | 20.1               | 20.8          |
| 8          | 450.0250    | 3600.20           | -39.5                                 | -41.3          | -20.0     | 19.5               | 21.3          |
| 9          | 450.0250    | 4050.23           | -39.4                                 | -40.1          | -20.0     | 19.4               | 20.1          |
| 10         | 450.0250    | 4500.25           | -39.8                                 | -39.9          | -20.0     | 19.8               | 19.9          |
| 1          | 460.0000    | 460.00            | 29.6                                  | 21.4           | 33.0      | 3.4                | 11.6          |
| 2          | 460.0000    | 920.00            | -28.0                                 | -33.7          | -20.0     | 8.0                | 13.7          |
| 3          | 460.0000    | 1380.00           | -52.2                                 | -51.6          | -20.0     | 32.2               | 31.6          |
| 4          | 460.0000    | 1840.00           | -51.8                                 | -54.5          | -20.0     | 31.8               | 34.5          |
| 5          | 460.0000    | 2300.00           | -48.7                                 | -51.4          | -20.0     | 28.7               | 31.4          |
| 6          | 460.0000    | 2760.00           | -57.5                                 | -57.5          | -20.0     | 37.5               | 37.5          |
| 7          | 460.0000    | 3220.00           | -40.6                                 | -40.6          | -20.0     | 20.6               | 20.6          |
| 8          | 460.0000    | 3680.00           | -40.7                                 | -38.6          | -20.0     | 20.7               | 18.6          |
| 9          | 460.0000    | 4140.00           | -40.6                                 | -39.0          | -20.0     | 20.6               | 19.0          |
| 10         | 460.0000    | 4600.00           | -38.7                                 | -40.0          | -20.0     | 18.7               | 20.0          |
| 1          | 469.9875    | 469.99            | 30.6                                  | 20.0           | 33.0      | 2.4                | 13.0          |
| 2          | 469.9875    | 939.98            | -28.1                                 | -33.9          | -20.0     | 8.1                | 13.9          |
| 3          | 469.9875    | 1409.96           | -46.1                                 | -52.1          | -20.0     | 26.1               | 32.1          |

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|          | Tx       | Measured | Equivalent Radiated power into Dipole |            |       | Margin Under Limit |            |
|----------|----------|----------|---------------------------------------|------------|-------|--------------------|------------|
| Harmonic | Freq     | Freq     | Vertical                              | Horizontal | Limit | Vertical           | Horizontal |
| #        | MHz      | MHz      | dBm                                   | dBm        | dBm   | dB                 | dB         |
| 4        | 469.9875 | 1879.95  | -50.9                                 | -53.2      | -20.0 | 30.9               | 33.2       |
| 5        | 469.9875 | 2349.94  | -52.4                                 | -52.1      | -20.0 | 32.4               | 32.1       |
| 6        | 469.9875 | 2819.93  | -55.6                                 | -57.0      | -20.0 | 35.6               | 37.0       |
| 7        | 469.9875 | 3289.91  | -41.8                                 | -39.7      | -20.0 | 21.8               | 19.7       |
| 8        | 469.9875 | 3759.90  | -40.4                                 | -38.4      | -20.0 | 20.4               | 18.4       |
| 9        | 469.9875 | 4229.89  | -39.7                                 | -39.2      | -20.0 | 19.7               | 19.2       |
| 10       | 469.9875 | 4699.88  | -40.0                                 | -39.4      | -20.0 | 20.0               | 19.4       |

The fundamental emission limit is 2 watts.

Judgment: Spurious emissions passed by 8 dB.

## 10.4 Frequency Stability

### 10.4.1 Frequency Stability Vs Temperature

The chamber was then set to the lowest temperature. The transmitter was in the chamber and allowed to stabilize for 15 minutes. The transmitter was then keyed and the frequency was recorded. The chamber was then incremented in 10°C steps with a minimum of 15 minute stabilization period for each temperature measurement. The transmitter was off during the temperature transitions.

### 10.4.2 Frequency Stability Vs Supply Voltage

The EUT was allowed to stabilize with the nominal primary power supply voltage applied. The primary input voltage was varied from the lowest to the highest rated levels specified by the manufacturer. Frequency readings were taken at increments of 0.5 VDC.

### 10.4.3 Test Results for Frequency Stability

|                   |                                                                                      |               |                 |
|-------------------|--------------------------------------------------------------------------------------|---------------|-----------------|
| Model             | 4291-065-MBS2W                                                                       | Specification | FCC Part 90.213 |
| Serial Number     | 80010783                                                                             | Test Date     | 11/11/2015      |
| Test Personnel    | Rich Tichelaar                                                                       | Test Location | Chamber B       |
| Test Equipment    | Spectrum Analyzer (REC-11); Temperature Chamber TC-01<br>Digital Multimeter (DMM-08) |               |                 |
| Notes             | 15 minutes at each Temperature; 1 min at each voltage                                |               |                 |
| Nominal Frequency | 460.0000 MHz                                                                         |               |                 |

| Volts | Freq.      | Deviation |      |
|-------|------------|-----------|------|
| VAC   | (MHz)      | Hz        | PPM  |
| 3.8   | 460.000011 | 11        | 0.02 |
| 3.6   | 460.000012 | 12        | 0.03 |
| 3.4   | 460.000011 | 11        | 0.02 |
| 3.2   | 460.000012 | 12        | 0.03 |
| 3.0   | 460.000009 | 9         | 0.02 |
| 2.8   | 460.000008 | 8         | 0.02 |

| Temp  | Freq.      | Deviation |      |
|-------|------------|-----------|------|
| Deg C | (MHz)      | Hz        | PPM  |
| 50    | 460.000079 | 79        | 0.17 |

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|     |            |      |       |
|-----|------------|------|-------|
| 40  | 460.000019 | 19   | 0.04  |
| 30  | 459.999997 | -3   | -0.01 |
| 20  | 460.000018 | 18   | 0.04  |
| 10  | 459.999949 | -51  | -0.11 |
| 0   | 459.999900 | -100 | -0.22 |
| -10 | 459.999898 | -102 | -0.22 |
| -20 | 459.999918 | -82  | -0.18 |
| -30 | 459.999911 | -89  | -0.19 |

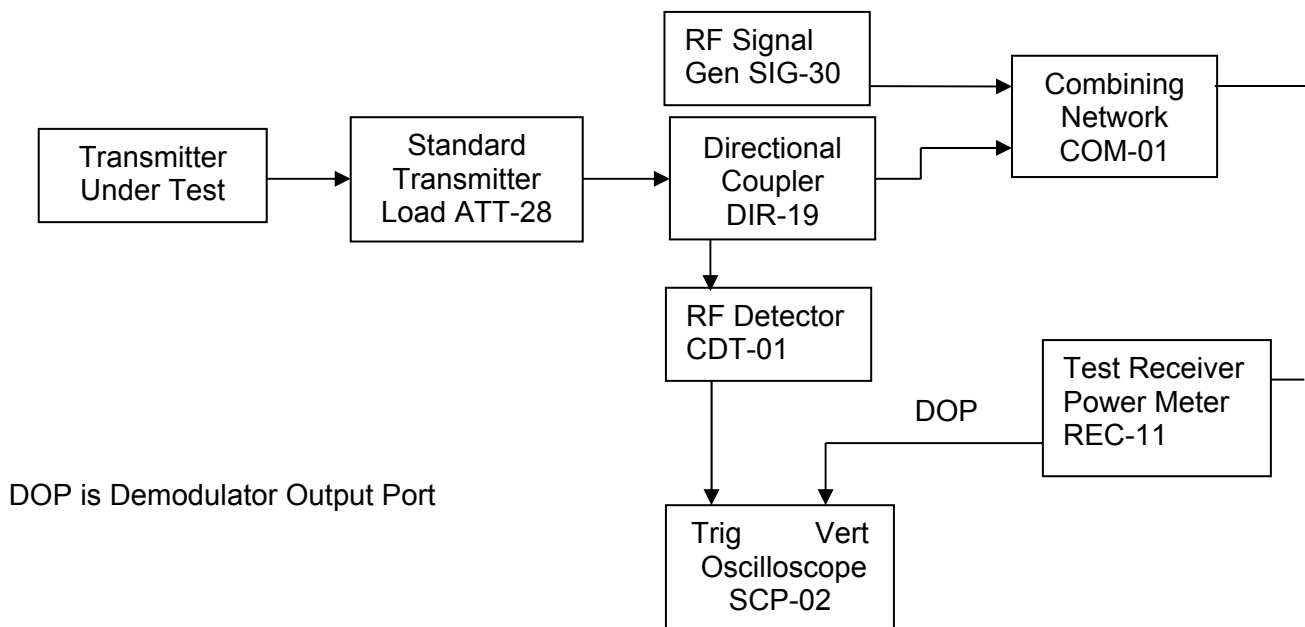
Test Requirements: Limit is 2.5 ppm

Judgement: Pass

## 10.5 Transient Frequency Behavior

### 10.5.1 Test method

The test was performed in accordance to TIA-603-C Section 2.2.19.3 Alternate Method of Measurement (Using a Test Receiver). The equipment was connected as shown below.



### 10.5.2 Limits of transient frequency

| Time intervals <sup>1,2</sup> | Maximum Frequency Difference <sup>3</sup> | 421 to 512 MHz Equipment Operating on 12.5 kHz Channels |
|-------------------------------|-------------------------------------------|---------------------------------------------------------|
| $t_1$ <sup>4</sup>            | ±12.5 kHz                                 | 10.0 ms                                                 |
| $t_2$                         | ±6.25 kHz                                 | 25.0 ms                                                 |
| $t_3$ <sup>4</sup>            | ±12.5 kHz                                 | 10.0 ms                                                 |

<sup>1</sup><sub>on</sub> is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

$t_1$  is the time period immediately following  $t_{on}$ .

$t_2$  is the time period immediately following  $t_1$ .

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$t_3$  is the time period from the instant when the transmitter is turned off until  $t_{off}$ .

$t_{off}$  is the instant when the 1 kHz test signal starts to rise.

<sup>2</sup>During the time from the end of  $t_2$  to the beginning of  $t_3$ , the frequency difference must not exceed the limits specified in § 90.213.

<sup>3</sup>Difference between the actual transmitter frequency and the assigned transmitter frequency.

<sup>4</sup>If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

### 10.5.3 Test Results

|                |                                      |               |                   |
|----------------|--------------------------------------|---------------|-------------------|
| Model          | 4291-065-MBS2W                       | Specification | FCC part 90.213   |
| Serial Number  | 80010783                             | Test Date     | November 18, 2015 |
| Test Personnel | Joseph Strzelecki<br>Rich Tichgelaar | Test Location | Chamber B         |
| Notes          |                                      |               |                   |

| Freq MHz | Channel<br>BW | Limits for Time interval/Freq difference |      |                |      |                |       | Test<br>Result |
|----------|---------------|------------------------------------------|------|----------------|------|----------------|-------|----------------|
|          |               | t <sub>1</sub>                           |      | t <sub>2</sub> |      | t <sub>3</sub> |       |                |
|          |               | mSec                                     | kHz  | mSec           | kHz  | mSec           | kHz   |                |
| 450.0250 | 12.5          | 10                                       | 12.5 | 25             | 6.25 | 10             | 12.5* | Pass           |
| 460.000  | 12.5          | 10                                       | 12.5 | 25             | 6.25 | 10             | 12.5* | Pass           |
| 469.9875 | 12.5          | 10                                       | 12.5 | 25             | 6.25 | 10             | 12.5* | Pass           |

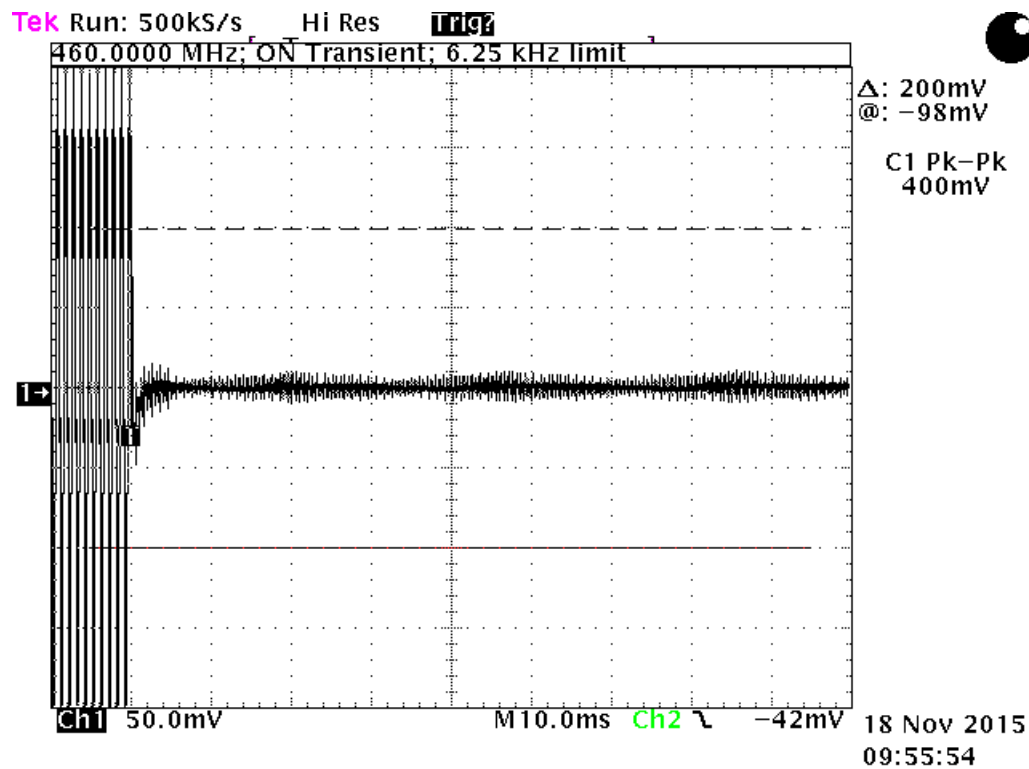
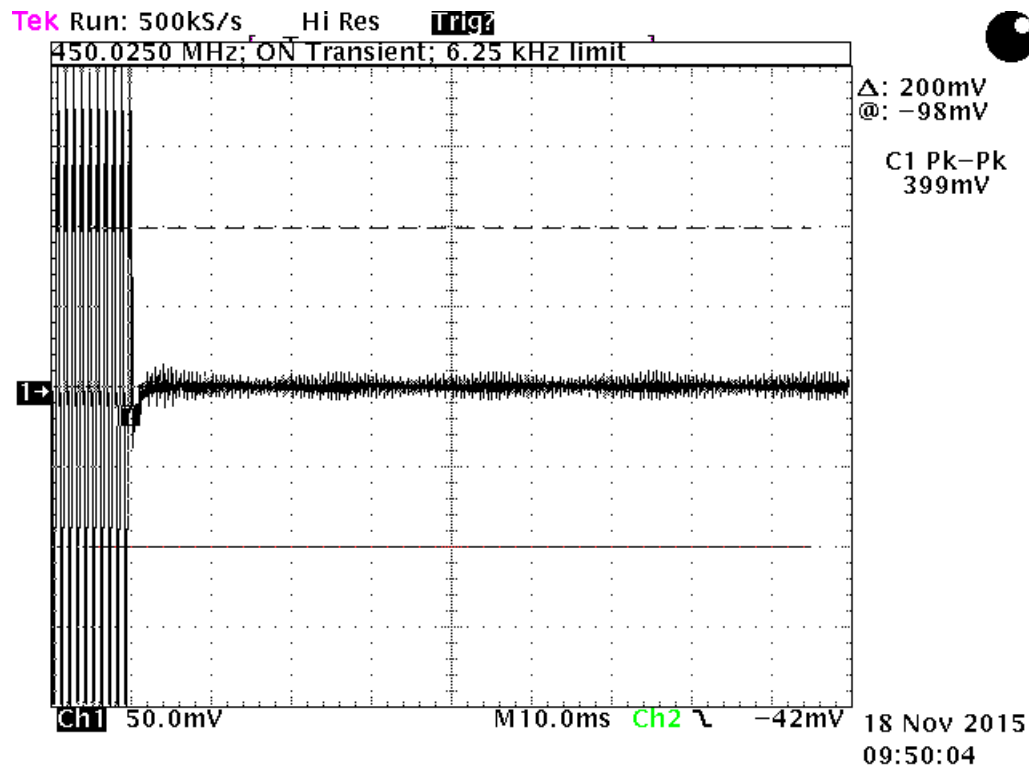
Judgement: Pass

\*Since the transmitter carrier output power is less than 6 watts, the frequency difference during the  $t_3$  time period may exceed the maximum frequency difference for this time period.

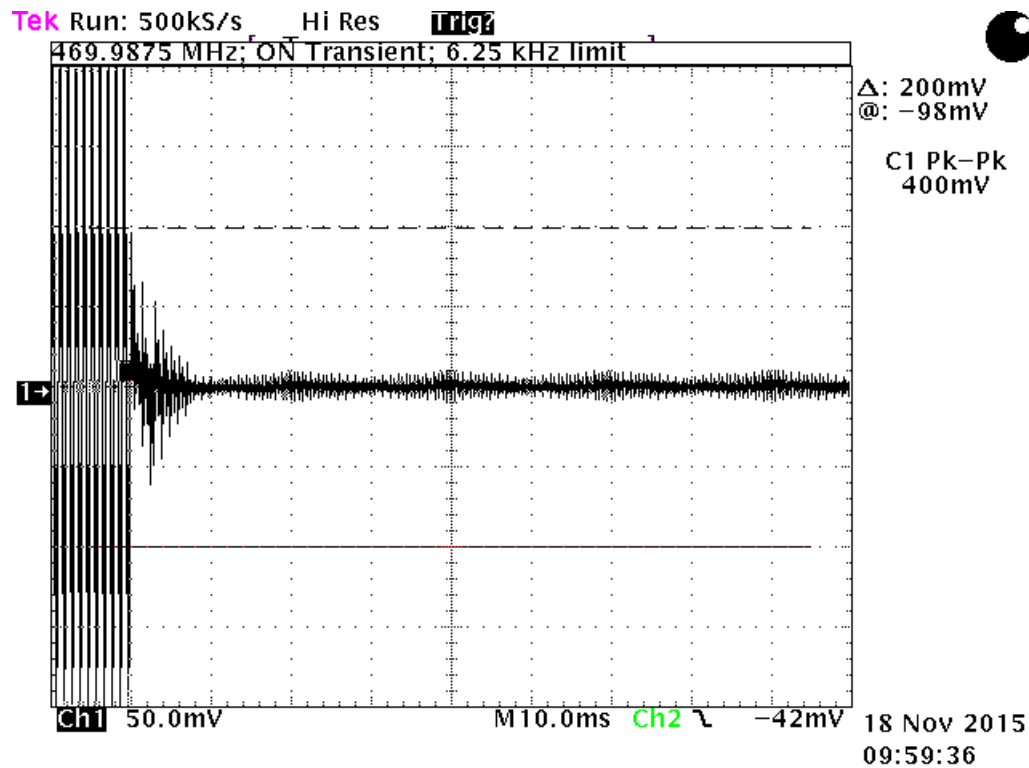
### 10.5.4 Results for Time Periods $t_1$ and $t_2$

The EUT passed the 6.25 kHz limit so the 12.5 limit is not shown.

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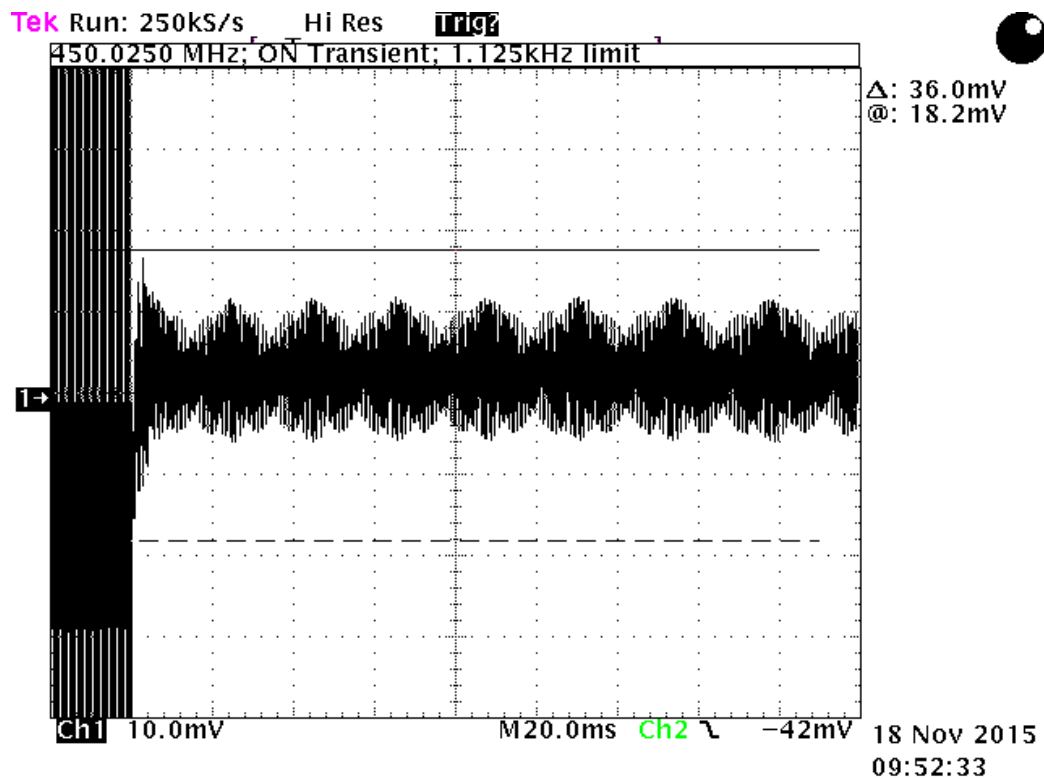


## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W

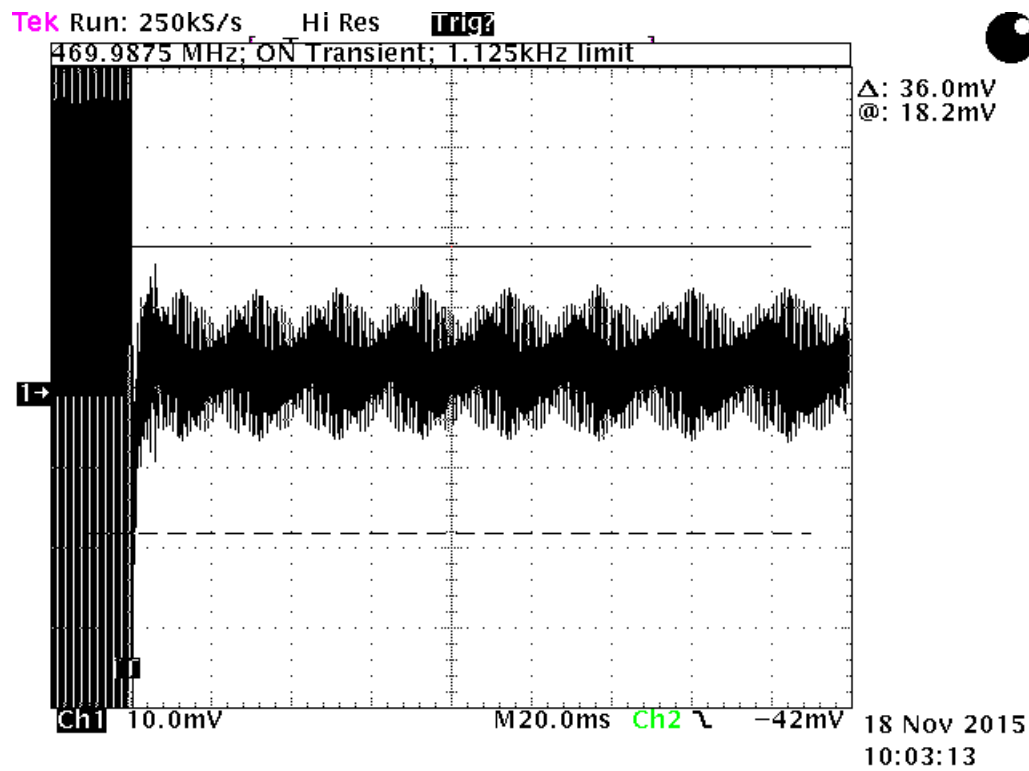
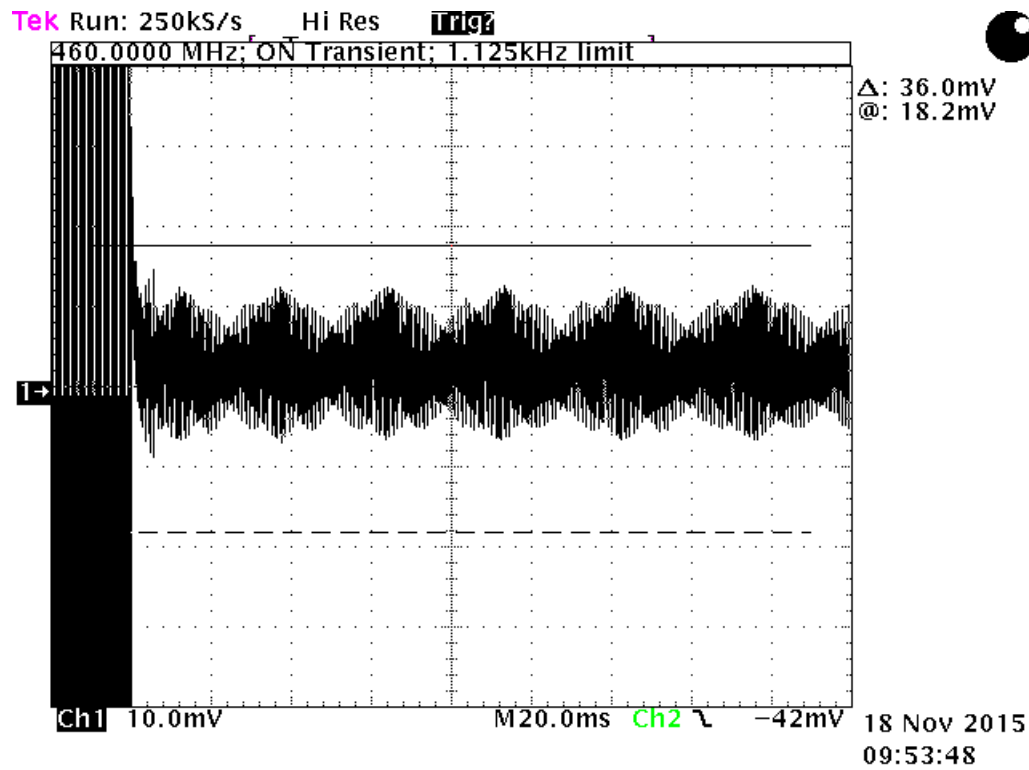


### 10.5.5 Results for Time Period between t2 and t3

The limit between t2 and t3 on all of the scope traces are calculated for the 450 MHz Channel since this is the lowest limit. This limit is  $450 \text{ MHz} \times 2.5 \text{ ppm}$  or 1125 Hz.

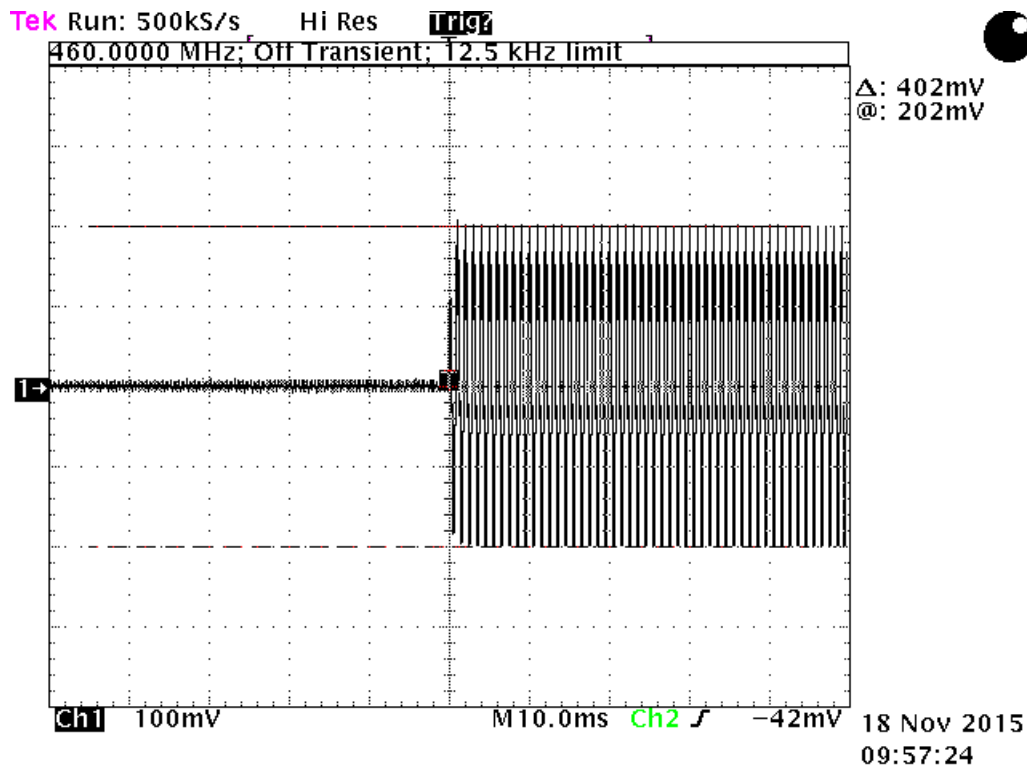
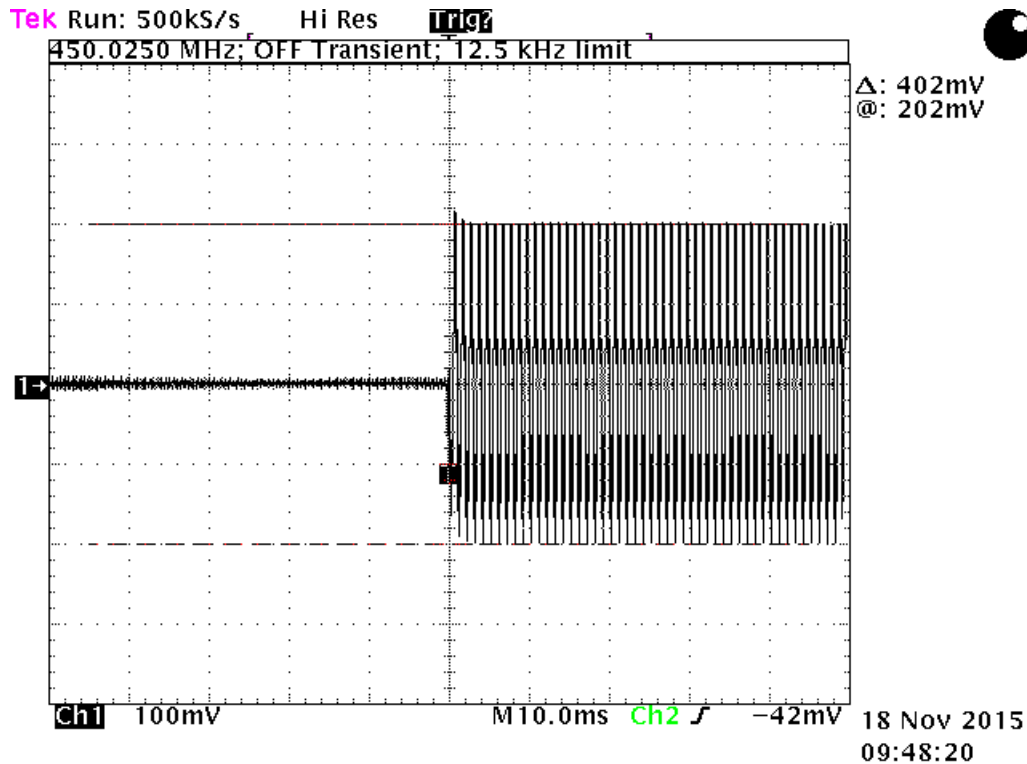


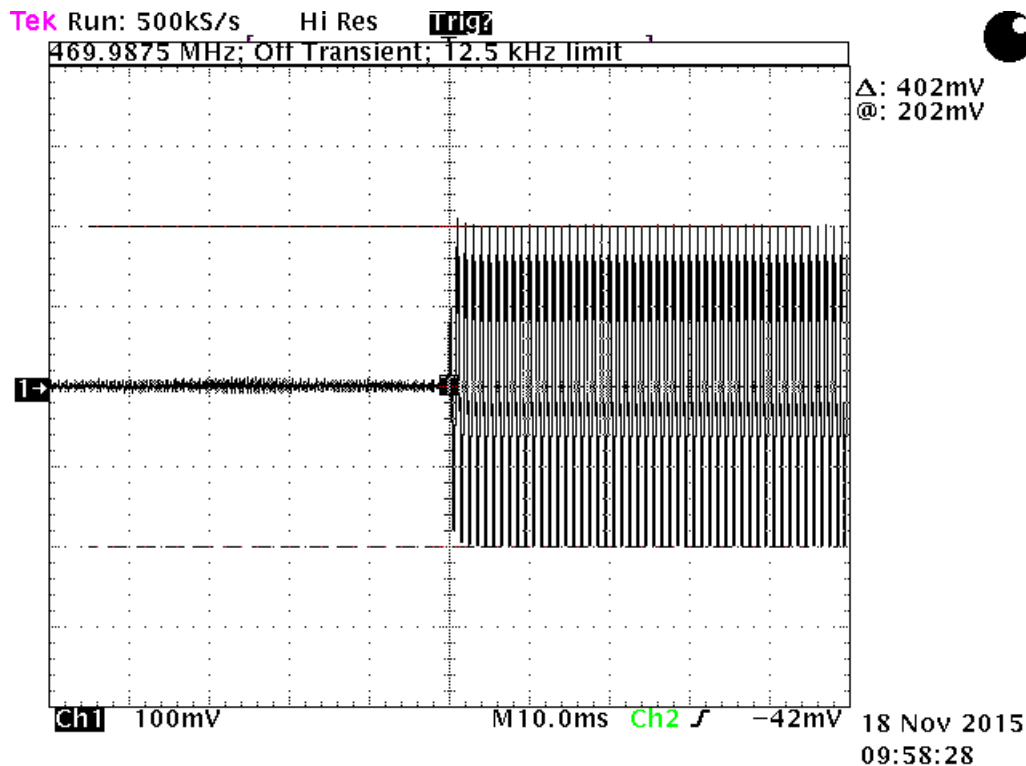
## Test Report for the Aclara, Series 4000 MTU, Model 4291-065-MBS2W



### 10.5.6 Results for Time Period t3

Since the transmitter carrier output power is less than 6 watts, the frequency difference during the t3 time period may exceed the maximum frequency difference for this time period.





## 10.6 Radiated Emissions (Receive Mode)

Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 150 kHz to 30 MHz is 9 or 10 kHz and the bandwidth from 30 MHz to 1000 MHz is 100 or 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

From 30 to 2000 MHz, an Anritsu spectrum analyzer was used. Final radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4 and CISPR 16-1. Chamber E is located at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 2000 MHz was slowly scanned with particular attention paid to those frequency ranges which appeared high. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

### 10.6.1 Radiated Emissions Field Strength Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

$$FS = RA + AF + CF - AG$$

Where: FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

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**10.6.2 Spurious Radiated Emissions Test Results (Receive Mode)**

|               |                                                                            |               |                       |
|---------------|----------------------------------------------------------------------------|---------------|-----------------------|
| Model         | 4291-065-MBS2W-1                                                           | Specification | FCC Part 15 Subpart B |
| Serial Number | 80010757                                                                   | Test Date     | 11/09/2015            |
| Tested by     | Richard Tichgelaar                                                         | Test Distance | 3 Meters              |
| Abbreviations | Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP |               |                       |
| Notes         | Corr. Factors = Cable Loss – Preamp Gain                                   |               |                       |
| Configuration | Receive Mode                                                               |               |                       |

| Freq. MHz | Meter Reading dBuV | Dect. | Ant. Pol. | Ant Factor | Cable & Amp Factors | Dist Fact dB | EUT dBuV/m | Limit dBuV/m | Margin Under Limit dB | Note   |
|-----------|--------------------|-------|-----------|------------|---------------------|--------------|------------|--------------|-----------------------|--------|
| 30.0      | 33.5               | P     | H         | 16.9       | -28.3               | 0.0          | 22.0       | 40.0         | 18.0                  |        |
| 35.0      | 38.1               | P     | H         | 16.6       | -28.2               | 0.0          | 26.4       | 40.0         | 13.6                  |        |
| 132.3     | 34.3               | P     | H         | 13.6       | -27.7               | 0.0          | 20.3       | 43.5         | 23.2                  |        |
| 204.9     | 34.6               | P     | H         | 10.3       | -27.5               | 0.0          | 17.4       | 43.5         | 26.1                  |        |
| 250.0     | 34.3               | P     | H         | 12.4       | -27.3               | 0.0          | 19.5       | 46.0         | 26.5                  |        |
| 258.1     | 33.4               | P     | H         | 12.9       | -27.3               | 0.0          | 19.0       | 46.0         | 27.0                  |        |
| 343.8     | 35.1               | P     | H         | 15.3       | -27.2               | 0.0          | 23.2       | 46.0         | 22.8                  |        |
| 420.0     | 35.7               | P     | H         | 17.0       | -27.0               | 0.0          | 25.7       | 46.0         | 20.3                  |        |
| 493.1     | 34.6               | P     | H         | 17.6       | -26.9               | 0.0          | 25.4       | 46.0         | 20.6                  |        |
| 522.5     | 33.6               | P     | H         | 19.1       | -26.7               | 0.0          | 26.0       | 46.0         | 20.0                  |        |
| 668.8     | 35.5               | P     | H         | 20.2       | -26.2               | 0.0          | 29.5       | 46.0         | 16.5                  |        |
| 863.8     | 34.2               | P     | H         | 21.1       | -25.4               | 0.0          | 29.9       | 46.0         | 16.1                  |        |
| 987.5     | 34.8               | P     | H         | 22.3       | -24.5               | 0.0          | 32.7       | 54.0         | 21.3                  |        |
| 1025.0    | 40.4               | P     | H         | 23.9       | -32.8               | 0.0          | 31.5       | 74.0         | 42.5                  | Note 1 |
| 1677.5    | 40.1               | P     | H         | 26.1       | -32.2               | 0.0          | 34.0       | 74.0         | 40.0                  | Note 1 |
| 1932.5    | 42.2               | P     | H         | 27.6       | -31.8               | 0.0          | 38.0       | 74.0         | 36.0                  | Note 1 |
| 1992.5    | 39.9               | P     | H         | 27.6       | -31.6               | 0.0          | 35.9       | 74.0         | 38.1                  | Note 1 |
| 30.0      | 34.1               | P     | V         | 16.9       | -28.3               | 0.0          | 22.7       | 40.0         | 17.3                  |        |
| 35.0      | 39.9               | P     | V         | 16.6       | -28.2               | 0.0          | 28.3       | 40.0         | 11.7                  |        |
| 49.8      | 39.2               | P     | V         | 14.3       | -28.1               | 0.0          | 25.4       | 40.0         | 14.6                  |        |
| 75.7      | 34.1               | P     | V         | 7.1        | -27.9               | 0.0          | 13.2       | 40.0         | 26.8                  |        |
| 185.6     | 34.6               | P     | V         | 9.4        | -27.5               | 0.0          | 16.5       | 43.5         | 27.0                  |        |
| 245.1     | 34.5               | P     | V         | 12.5       | -27.3               | 0.0          | 19.7       | 46.0         | 26.3                  |        |
| 255.0     | 34.5               | P     | V         | 12.9       | -27.3               | 0.0          | 20.1       | 46.0         | 25.9                  |        |
| 298.8     | 33.9               | P     | V         | 13.2       | -27.2               | 0.0          | 20.0       | 46.0         | 26.0                  |        |
| 425.6     | 34.2               | P     | V         | 17.2       | -27.0               | 0.0          | 24.4       | 46.0         | 21.6                  |        |
| 500.0     | 33.6               | P     | V         | 17.3       | -27.0               | 0.0          | 24.0       | 46.0         | 22.0                  |        |
| 518.8     | 34.5               | P     | V         | 19.0       | -26.8               | 0.0          | 26.7       | 46.0         | 19.3                  |        |
| 618.8     | 35.9               | P     | V         | 19.4       | -26.6               | 0.0          | 28.8       | 46.0         | 17.2                  |        |
| 805.0     | 36.0               | P     | V         | 20.1       | -25.8               | 0.0          | 30.3       | 46.0         | 15.7                  |        |
| 993.8     | 35.6               | P     | V         | 22.6       | -24.4               | 0.0          | 33.8       | 54.0         | 20.2                  |        |
| 1002.5    | 39.0               | P     | V         | 23.7       | -32.7               | 0.0          | 29.9       | 74.0         | 44.1                  | Note 1 |
| 1475.0    | 40.6               | P     | V         | 25.5       | -32.5               | 0.0          | 33.6       | 74.0         | 40.4                  | Note 1 |
| 1695.0    | 41.0               | P     | V         | 26.2       | -32.1               | 0.0          | 35.1       | 74.0         | 38.9                  | Note 1 |
| 1902.5    | 40.1               | P     | V         | 27.6       | -31.9               | 0.0          | 35.9       | 74.0         | 38.1                  | Note 1 |
| 1990.0    | 39.8               | P     | V         | 27.6       | -31.6               | 0.0          | 35.8       | 74.0         | 38.2                  | Note 1 |

Note 1; Peak reading meeting the average limit so the average reading is not required.

Judgment: Pass by at least 10 dB