



Nemko Test Report: 10230352RUS1

Applicant: Electronic Systems Technology, Inc
415 N. Quay Street Building B-1
Kennewick WA 99336

**Equipment Under Test:
(E.U.T.)** 210c
Industrial RF Modem

FCC ID: ENPESTEEM210C

In Accordance With: **FCC Part 90, Subpart I**
Private Land Mobile Transmitter

Tested By: Nemko USA Inc.
802 N. Kealy
Lewisville, TX 75057-3136

Tested By: 
Brian Boyea

Authorized By: 
David Light

Date: 4-Oct-2012

Total Number of Pages: 49

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EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

Section 1.0 Summary of Test Results

Manufacturer: Electronic Systems Technology

Model No.: 210c

Serial No.: 14013

General: **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 90, Subpart I.

- | | | | |
|-------------------------------------|----------------------------|-------------------------------------|---------------------|
| <input checked="" type="checkbox"/> | New Submission | <input type="checkbox"/> | Production Unit |
| <input type="checkbox"/> | Class II Permissive Change | <input checked="" type="checkbox"/> | Pre-Production Unit |

THIS TEST REPORT RELATES ONLY TO THE ITEM(S) TESTED.

THE FOLLOWING DEVIATIONS FROM, ADDITIONS TO, OR EXCLUSIONS FROM THE TEST SPECIFICATIONS HAVE BEEN MADE.

See " Summary of Test Data".

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EQUIPMENT: Industrial RF Modem

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Summary Of Test Data

NAME OF TEST	PARA. NO.	RESULT
RF Power Output	90.205	Complies
Audio Frequency Response	TIA EIA-603.3.2.6	N/A ¹
Audio Low-Pass Filter Response	TIA EIA-603.3.2.6	N/A ¹
Modulation Limiting	TIA EIA-603.3.2.6	Complies
Occupied Bandwidth	90.210	Complies
Spurious Emissions at Antenna Terminals	90.210	Complies
Field Strength of Spurious Emissions	90.210	Complies
Frequency Stability	90.213	Complies
Transient Frequency Behavior	90.214	Complies

Footnotes:

1. The radio is data only. There are no voice or audio circuits.

Section 2.0 General Equipment Specification

Transmitter

Supply Voltage Input:	12Vdc										
Frequency Range:	450 – 470 MHz										
Tunable Bands:	450 – 470 MHz										
Necessary Bandwidth:	11.25 kHz (12.5 kHz channel spacing), 6 kHz (6.25 kHz channel spacing)										
Type(s) of Modulation:	<table border="0" style="margin-left: 40px;"> <tr> <td style="text-align: center;">F3E (Voice)</td> <td style="text-align: center;">F1D</td> <td style="text-align: center;">F2D</td> <td style="text-align: center;">D7W</td> <td style="text-align: center;">Other</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input checked="" type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> </table>	F3E (Voice)	F1D	F2D	D7W	Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F3E (Voice)	F1D	F2D	D7W	Other							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>							
Data Rate(s) 6.25 kHz Ch.	9 kbps (4 QAM), 18 kbps (16 QAM), 27 kbps (64 QAM)										
Data Rate(s) 12.5 kHz Ch.	18 kbps (4 QAM), 36 kbps (16 QAM), 54 kbps (64 QAM)										
Internal/External Data Source:	Internal data modulation circuits										
Emission Designator:	6K00D7W, 11K3D7W										
Output Impedance:	50 ohms										
RF Power Output (rated):	2 watts avg./10 watts pk.										
Channel Spacing(s):	6.25kHz and 12.5kHz										
Operator Selection of Operating Frequency:	Software Controlled										
Power Output Adjustment Capability:	Software Controlled										

EQUIPMENT: **Industrial RF Modem**

PROJECT NO.: **10230352RUS1**

Receiver

Frequency Range:

450 – 470 MHz

Tunable Bands:

450 – 470 MHz

Local Oscillator:

First RX LO: 495-515 MHz, Second RX LO: 180 MHz

Operator Selection of Operating Frequency:

Software Controlled

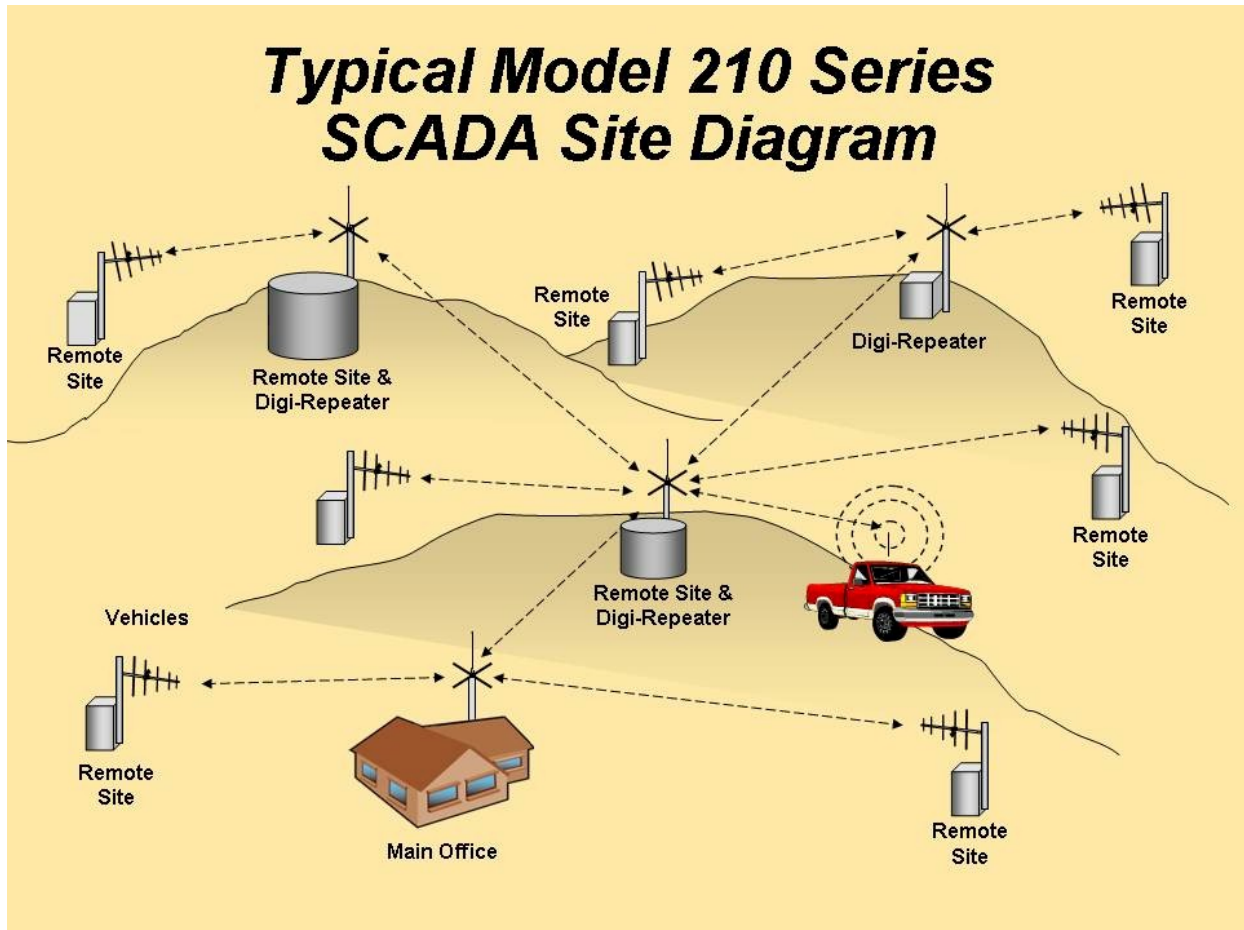
Modifications Made During Testing

There were no modifications done during testing.

System Description

The ESTeem Model 210C with *one Ethernet port (10/100/1G) and one independent Serial RS-232C data port* is the perfect radio solution designed for the rigors of the Industrial, Public Safety, and Federal markets when the low UHF band is needed for terrain coverage.

System Diagram



EQUIPMENT: Industrial RF Modem

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Section 3.0 RF Power Output

NAME OF TEST: RF Power Output	PARA. NO.: 2.985
TESTED BY: Brian Boyea	DATE: 13 September 2012

Measurement Results: Complies.

Measurement Data:

Frequency (MHz)	Measured Power (dBm)	Rated Power (dBm)	Measured/Rated (dB)
450.00625	40.5	40.0	+0.5
460.00000	40.4	40.0	+1.4
469.99375	40.7	40.0	+0.7

Spectrum analyzer settings:

RBW: 1 MHz

VBW: 3 MHz

Detector: Max Peak

Measurement Conditions:

Temperature: 23.2 °C

Humidity: 51.6 %

Measurement Uncertainty: +/-0.78 dB

EQUIPMENT: Industrial RF Modem

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Section 4.0 Modulation Characteristics

NAME OF TEST: Modulation Characteristics	PARA. NO.: 2.987
TESTED BY: Brian Boyea	DATE: 13 September 2012

Measurement Results: Complies.

Measurement Data: See following pages

Measurement Conditions: Temperature: 23.2 °C
Humidity: 51.6 %

Measurement Uncertainty: +/-0.05 kHz

Description of modulation: Modulation is Quadrature Amplitude Modulation

Description of baseband filtering: In-phase and Quadrature-phase channels are digitally filtered. Since the baseband signal is digital only, modulation levels are limited.

EQUIPMENT: **Industrial RF Modem**

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Section 4.1 Modulation Limiting

NAME OF TEST: Modulation Limiting	PARA. NO.: 2.987(b)
TESTED BY: Brian Boyea	DATE: 13 September 2012

The baseband modulation signal digitally modulates the rf carrier. The modulation input is buffered and cannot exceed the nominal modulation level.

EQUIPMENT: Industrial RF Modem

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Section 5.0 Occupied Bandwidth

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 2.989
TESTED BY: Brian Boyea	DATE: 13-Sept-2012

Measurement Results: Complies.

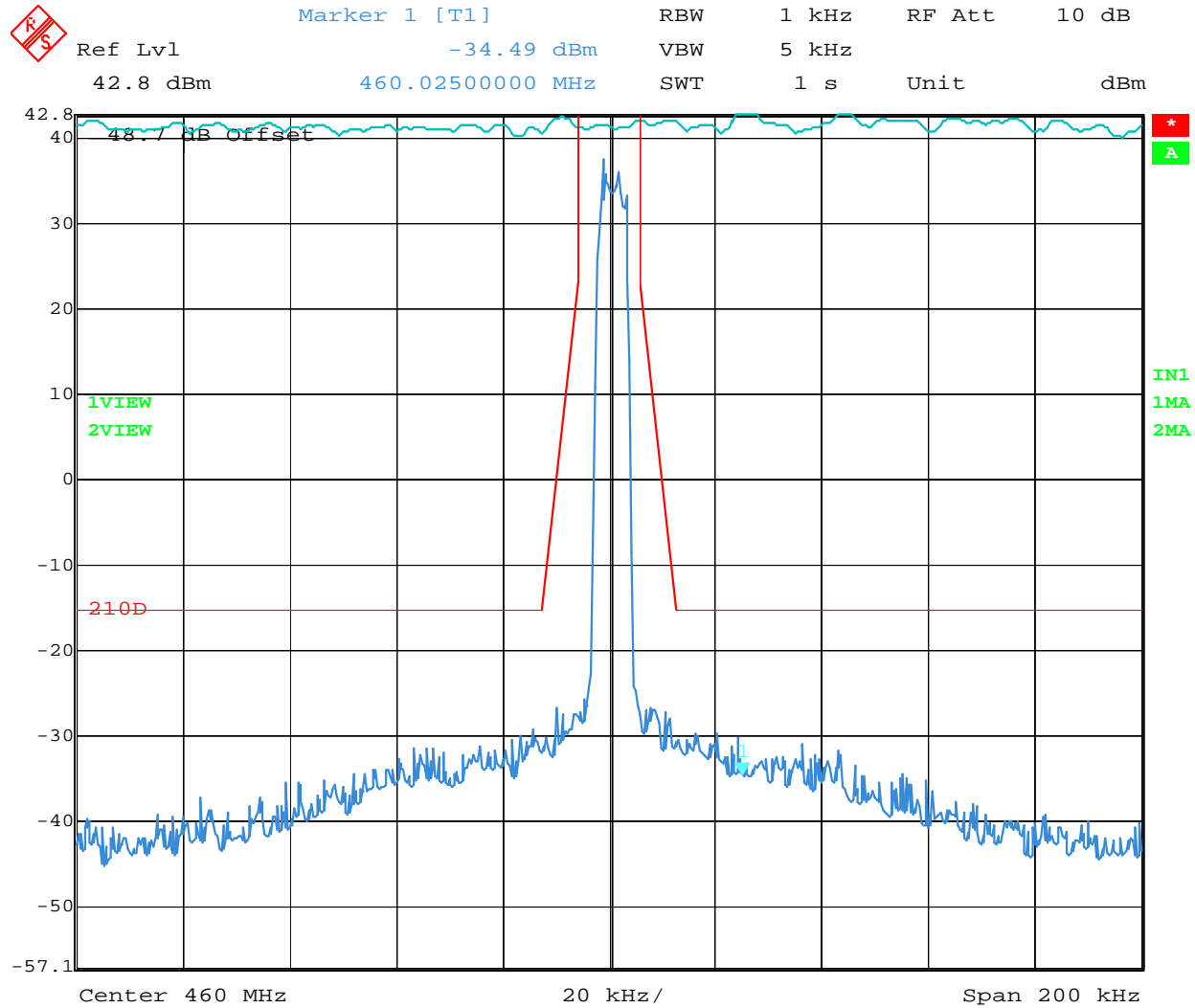
Measurement Data: See attached data

Measurement Conditions: Temperature: 23.2 °C
Humidity: 51.6 %

Measurement Uncertainty: +/-1.7dB

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

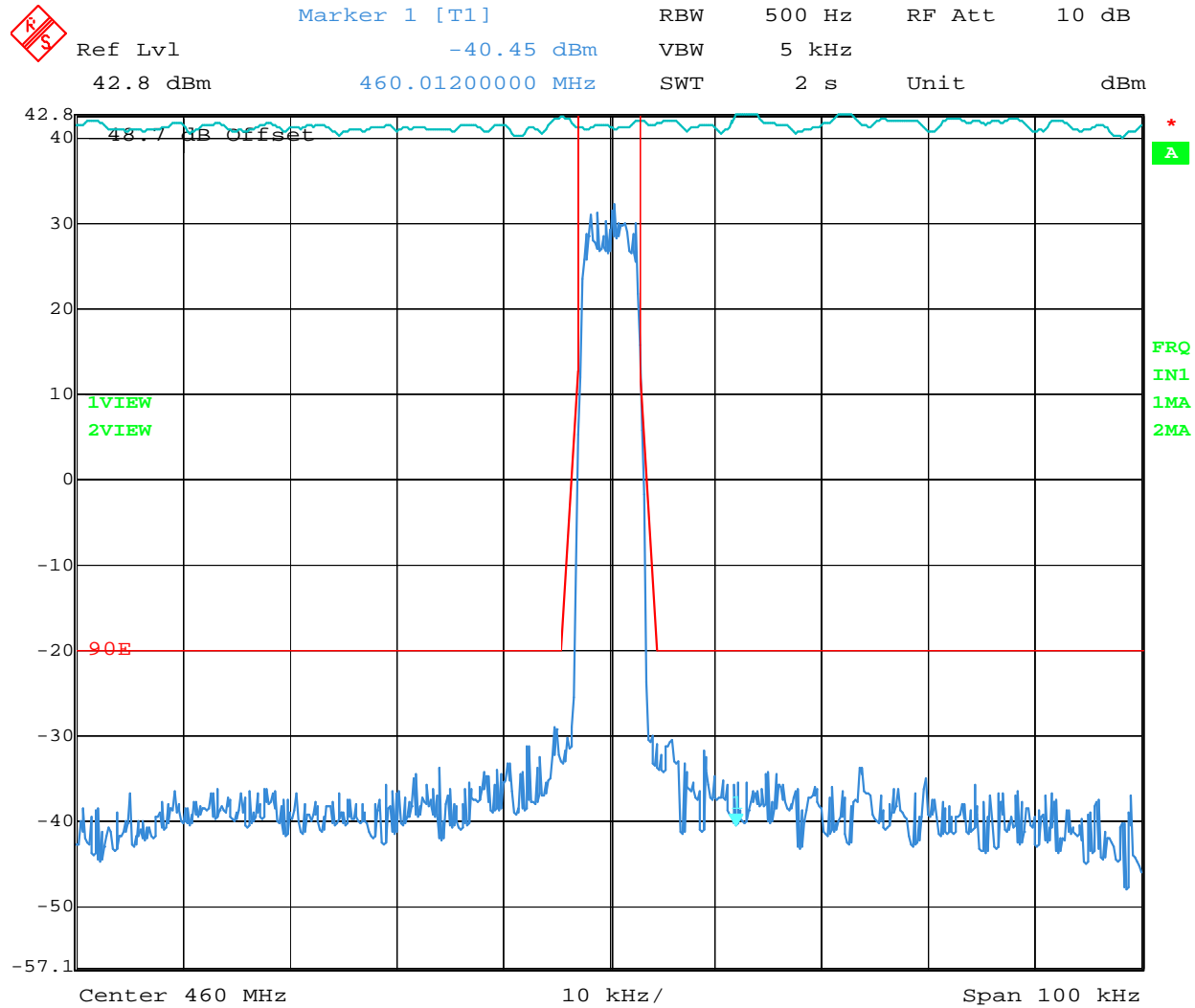


Date: 13.SEP.2012 15:37:09

OBW 64 QAM – 6.25 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

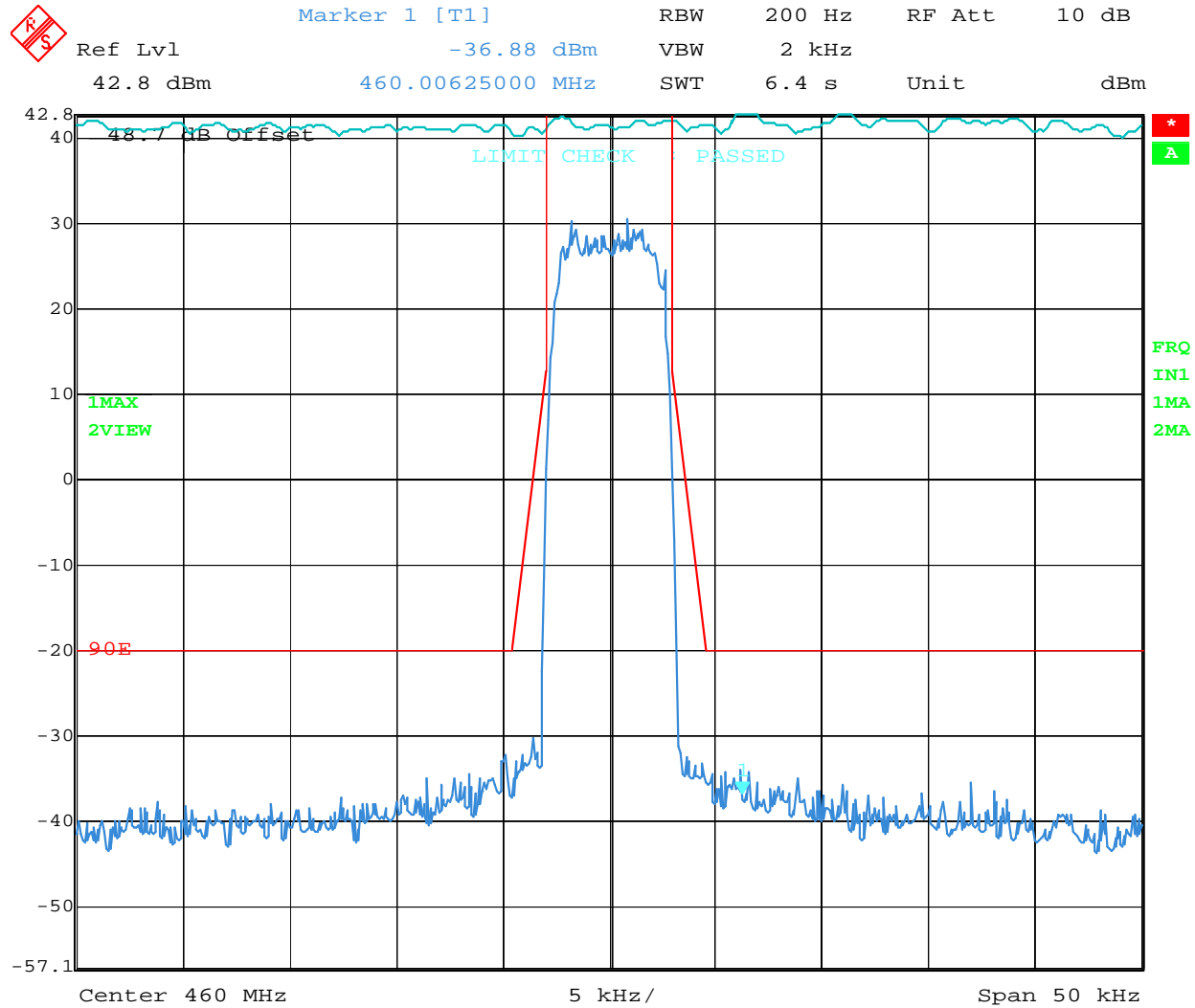


Date: 13.SEP.2012 15:48:42

OBW 64 QAM 6.25 kHz chan

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

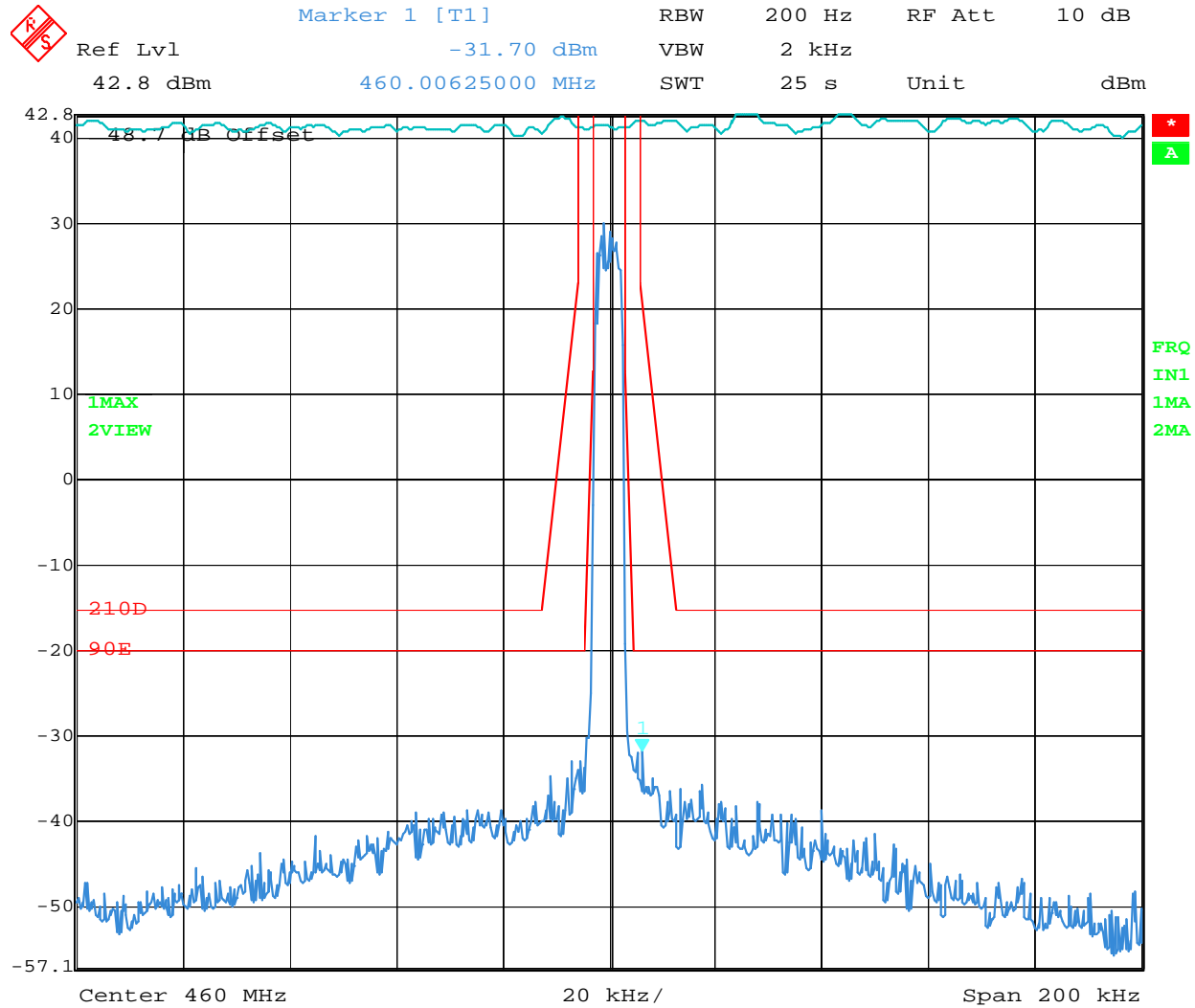


Date: 13.SEP.2012 15:51:56

OBW 16 QAM 6.25 kHz Channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

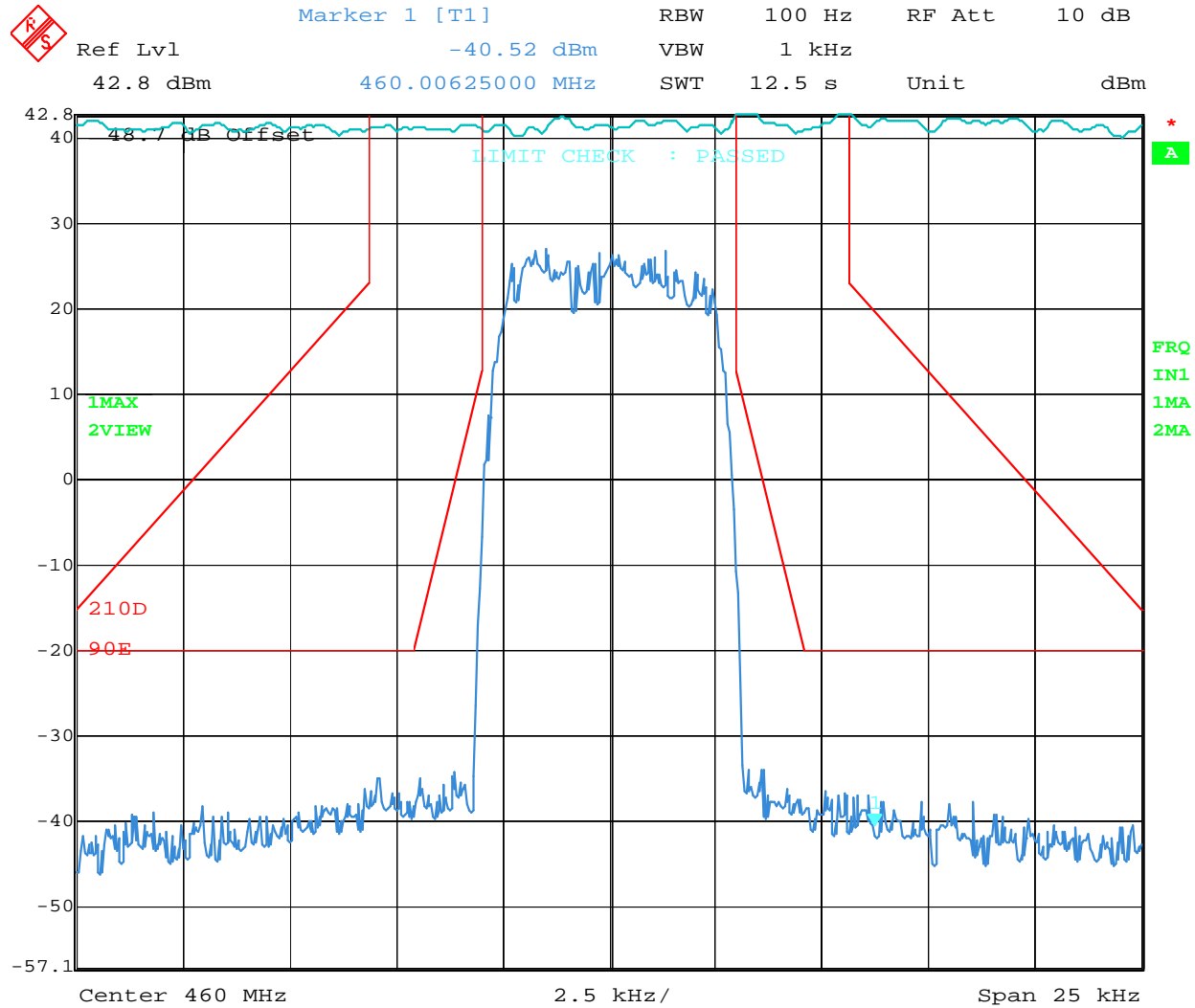


Date: 13.SEP.2012 15:56:44

OBW 16 QAM 200 kHz Span – 6.25 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

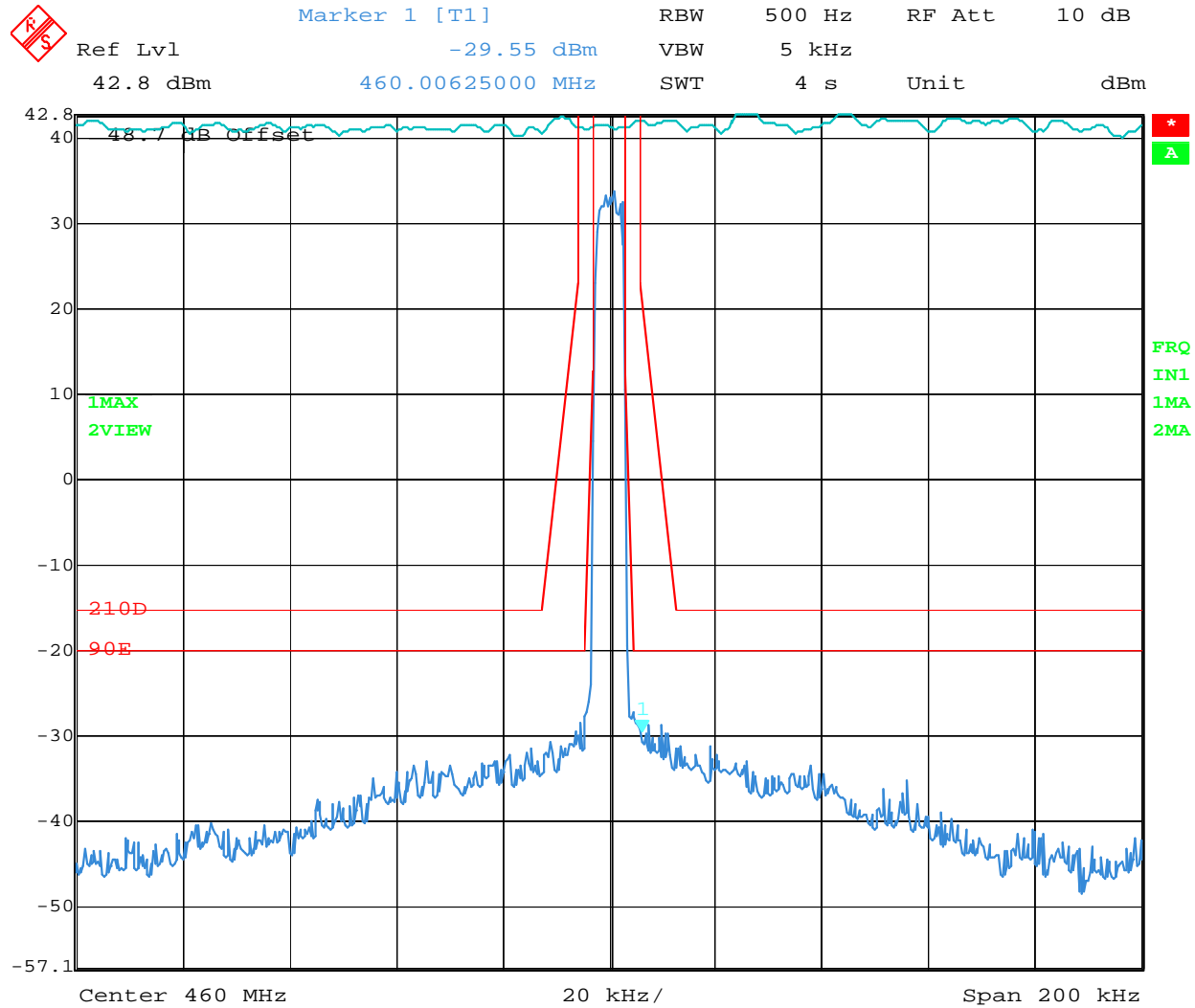


Date: 13.SEP.2012 16:00:52

OBW 4 QAM – 6.25 kHz Span

EQUIPMENT: Industrial RF Modem

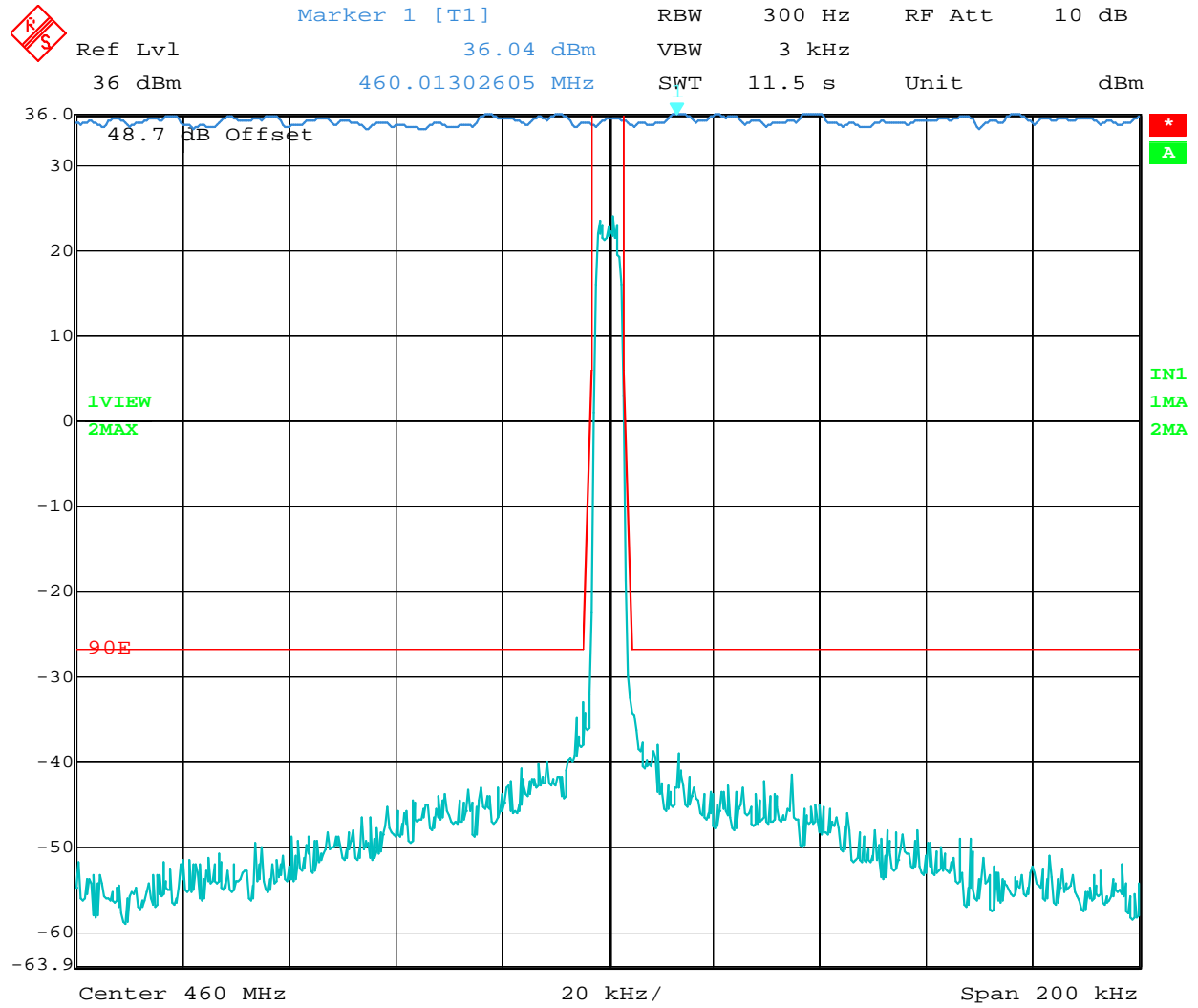
PROJECT NO.: 10230352RUS1



Date: 13.SEP.2012 16:02:19
OBW 4 QAM 200 kHz - 6.25 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

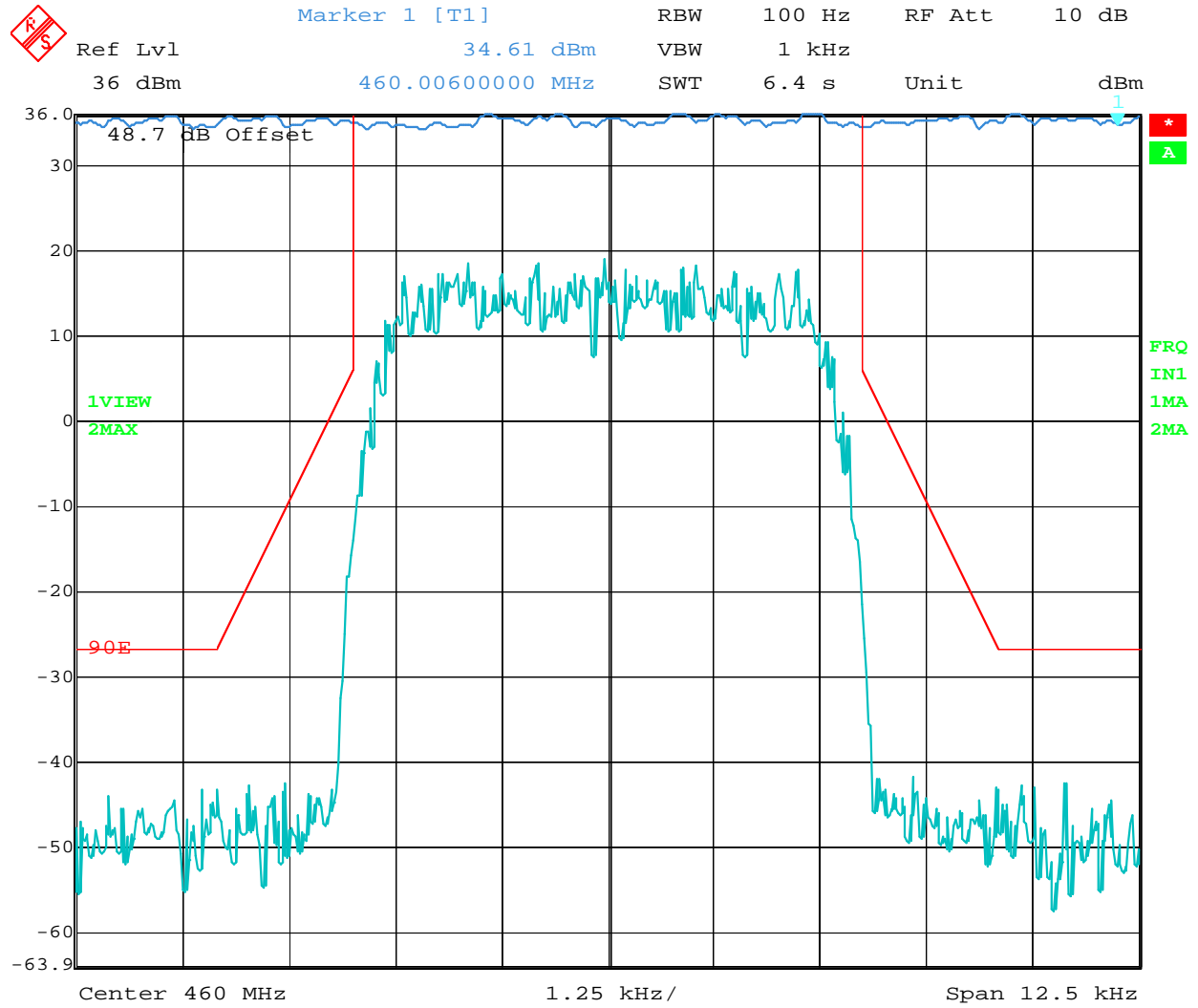


Date: 13.SEP.2012 16:51:21

4 QAM – 12.5 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

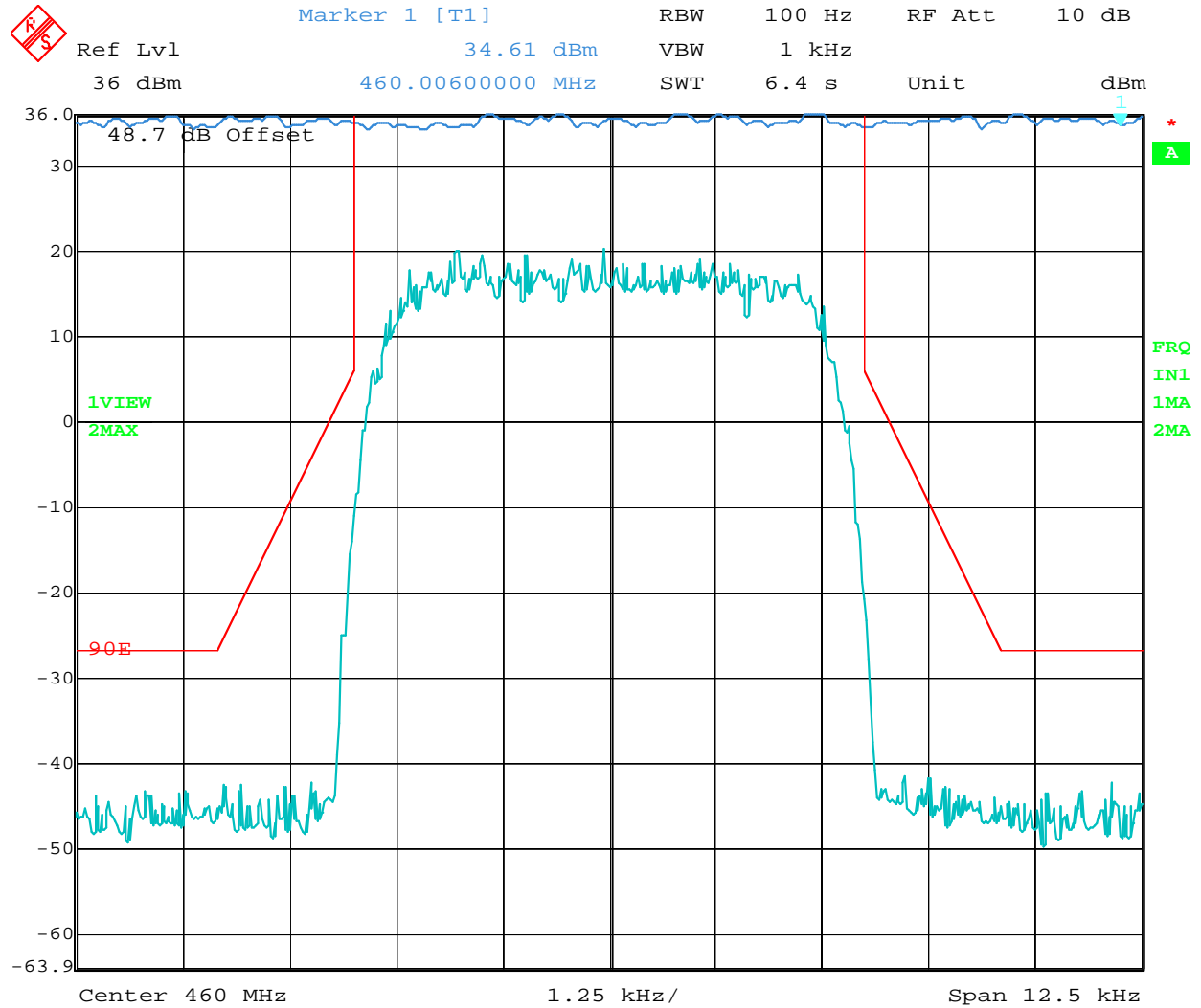


Date: 13.SEP.2012 16:56:25

16 QAM – 12.5 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

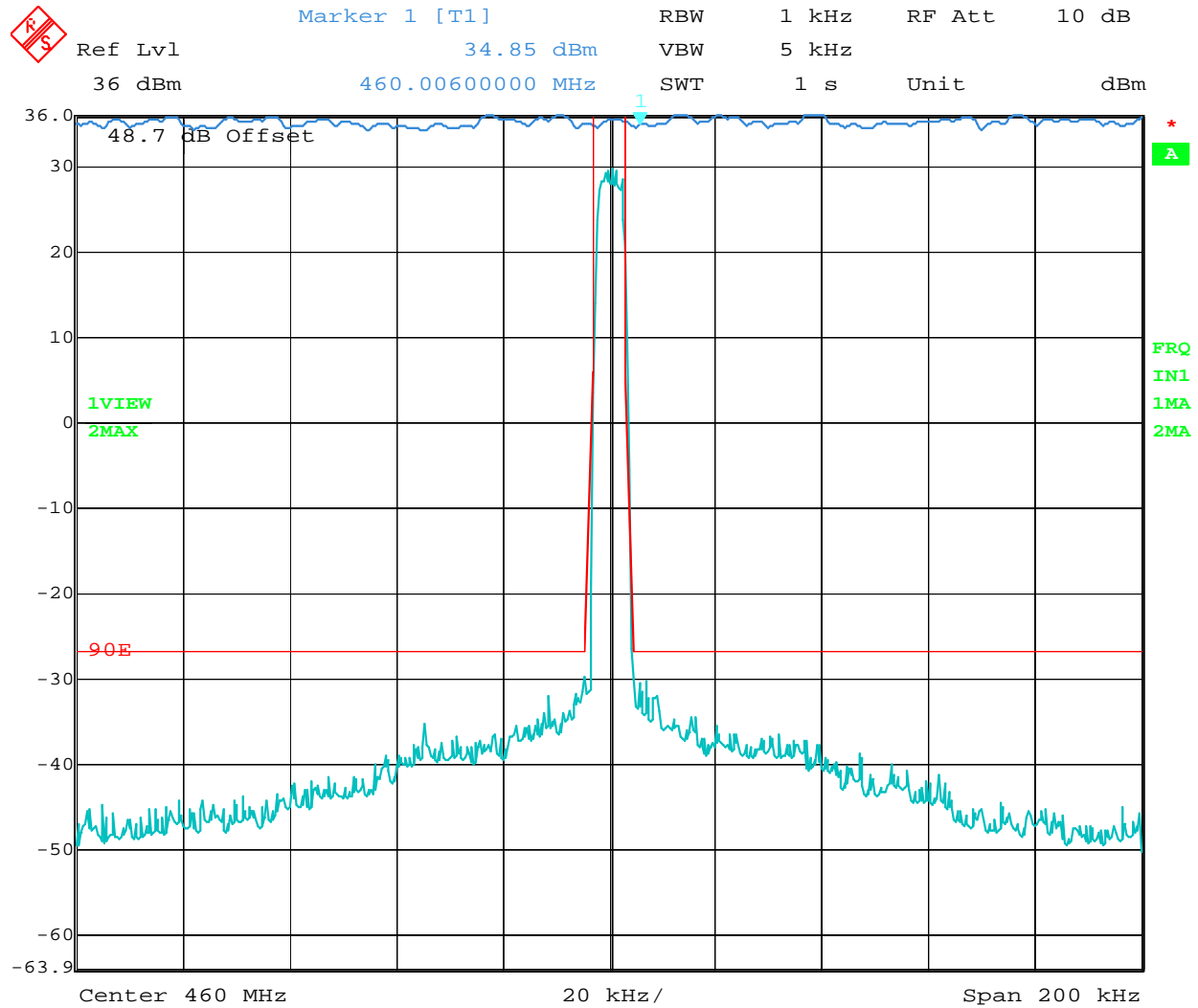


Date: 13.SEP.2012 16:58:00

16 QAM – 12.5 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1



Date: 13.SEP.2012 16:59:30
64 QAM – 12.5 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

Section 6.0 Spurious Emissions at Antenna Terminals

NAME OF TEST: Spurious Emissions @ Antenna Terminals	PARA. NO.: 2.991
TESTED BY: Brian Boyea	DATE: 13-Sept-2012

Measurement Results: Complies.

Measurement Data: See attached data

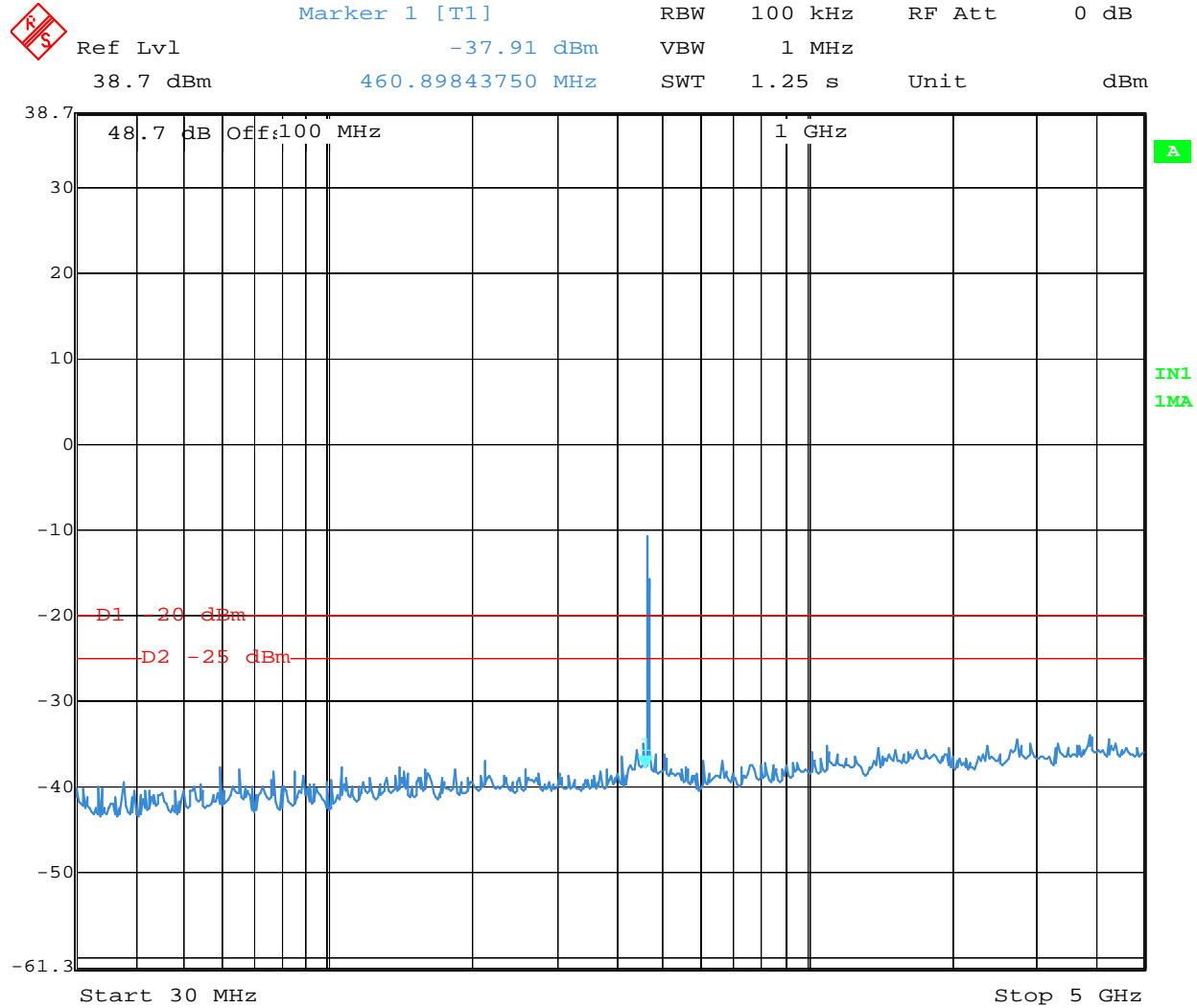
Measurement Conditions: Temperature: 23.2 °C
Humidity: 51.6 %

Measurement Uncertainty: +/-1.7dB

The fundamental transmit emission is filtered to prevent non-linear response in the test receiver.

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

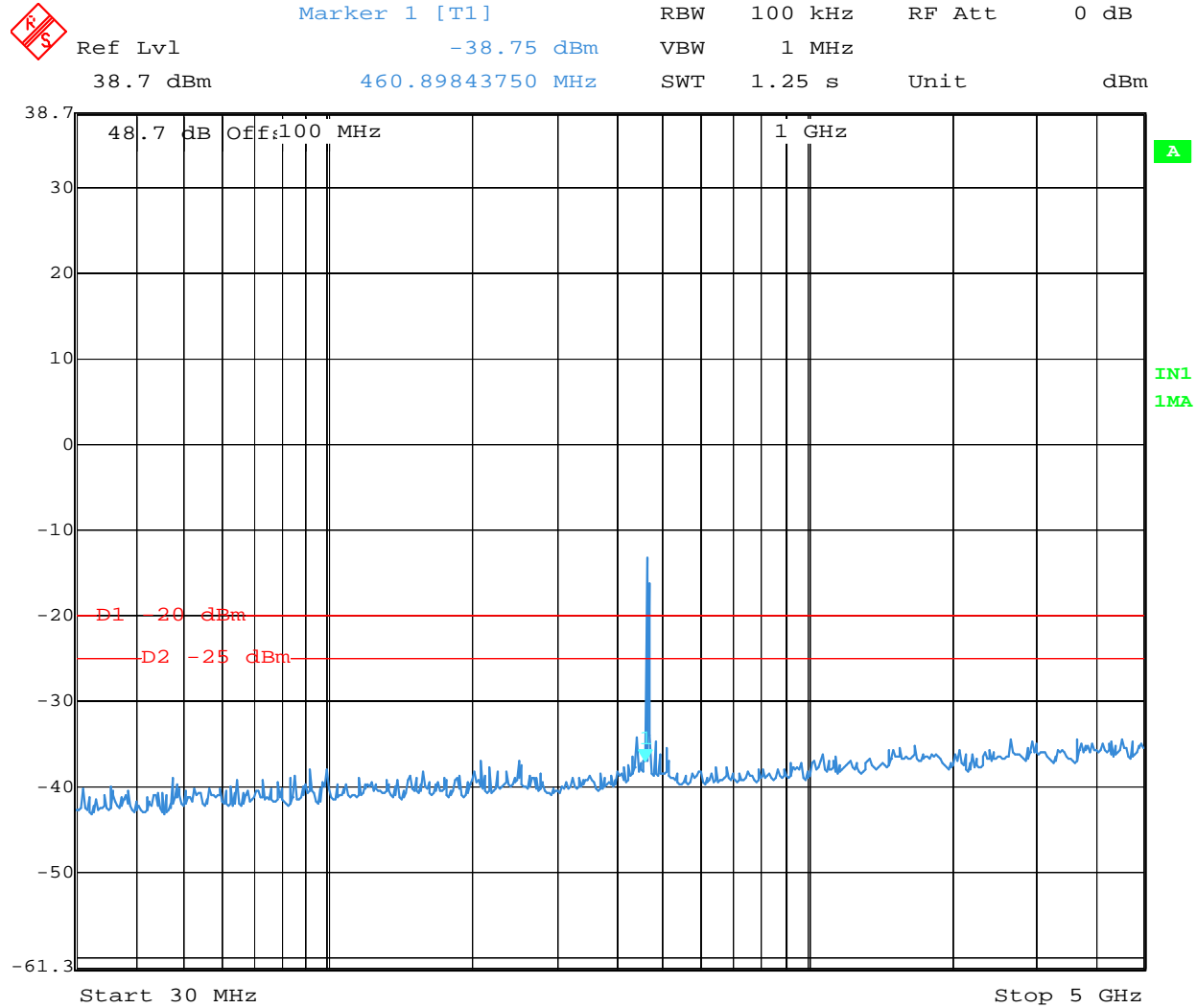


Date: 13.SEP.2012 16:23:36

4 QAM – 12.5 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

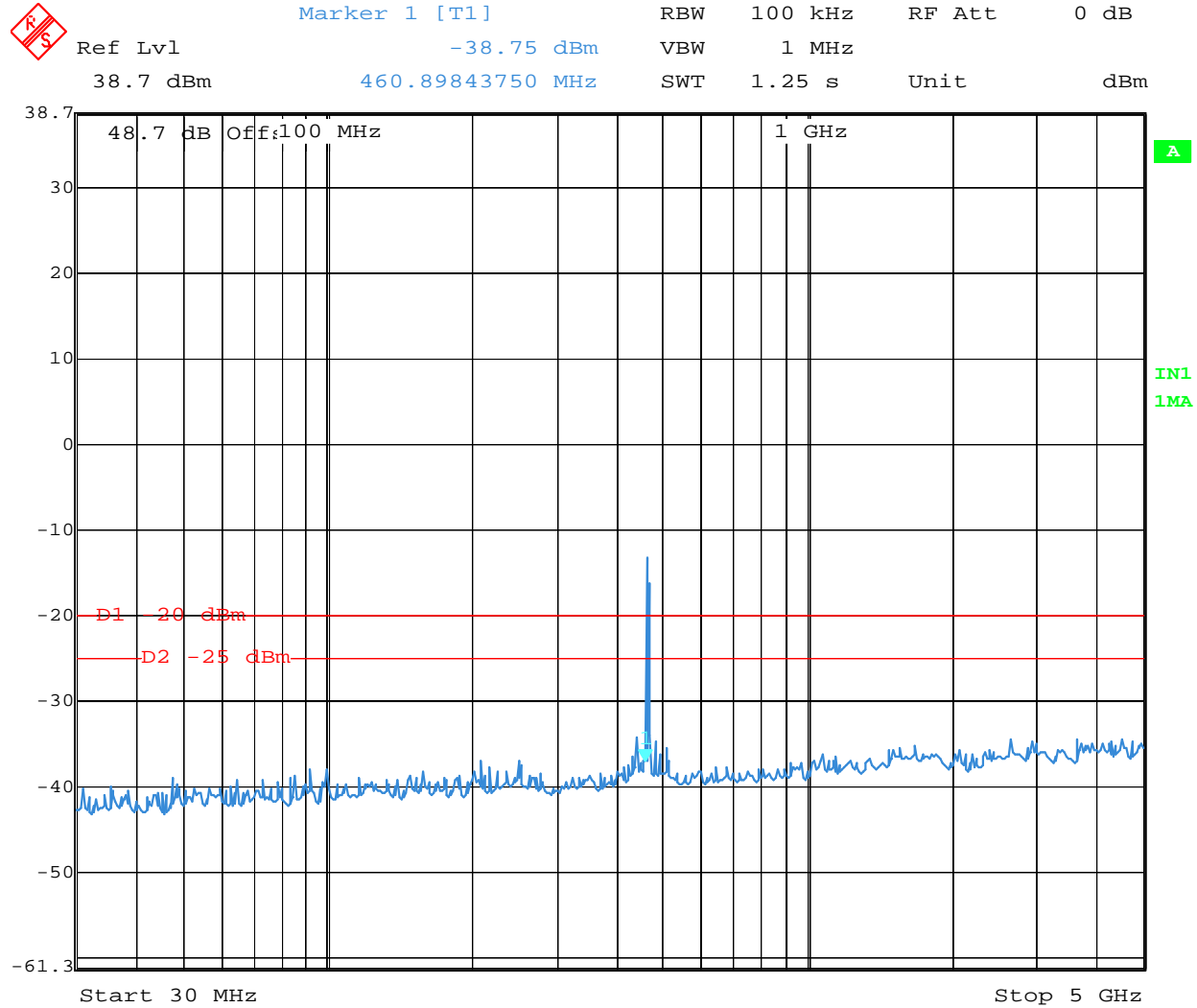


Date: 13.SEP.2012 16:24:30

16 QAM – 6.25 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

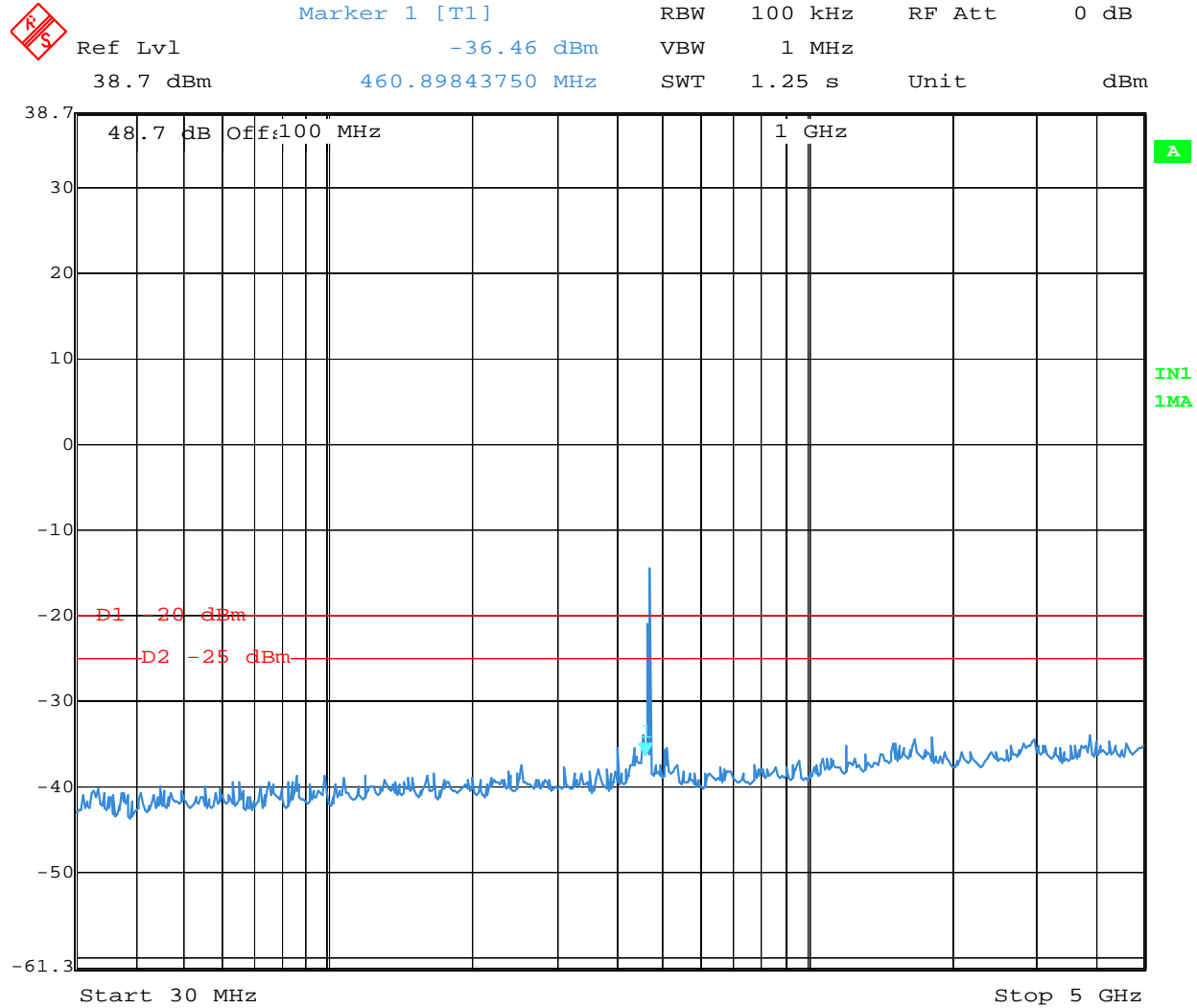


Date: 13.SEP.2012 16:24:30

64 QAM – 6.25 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

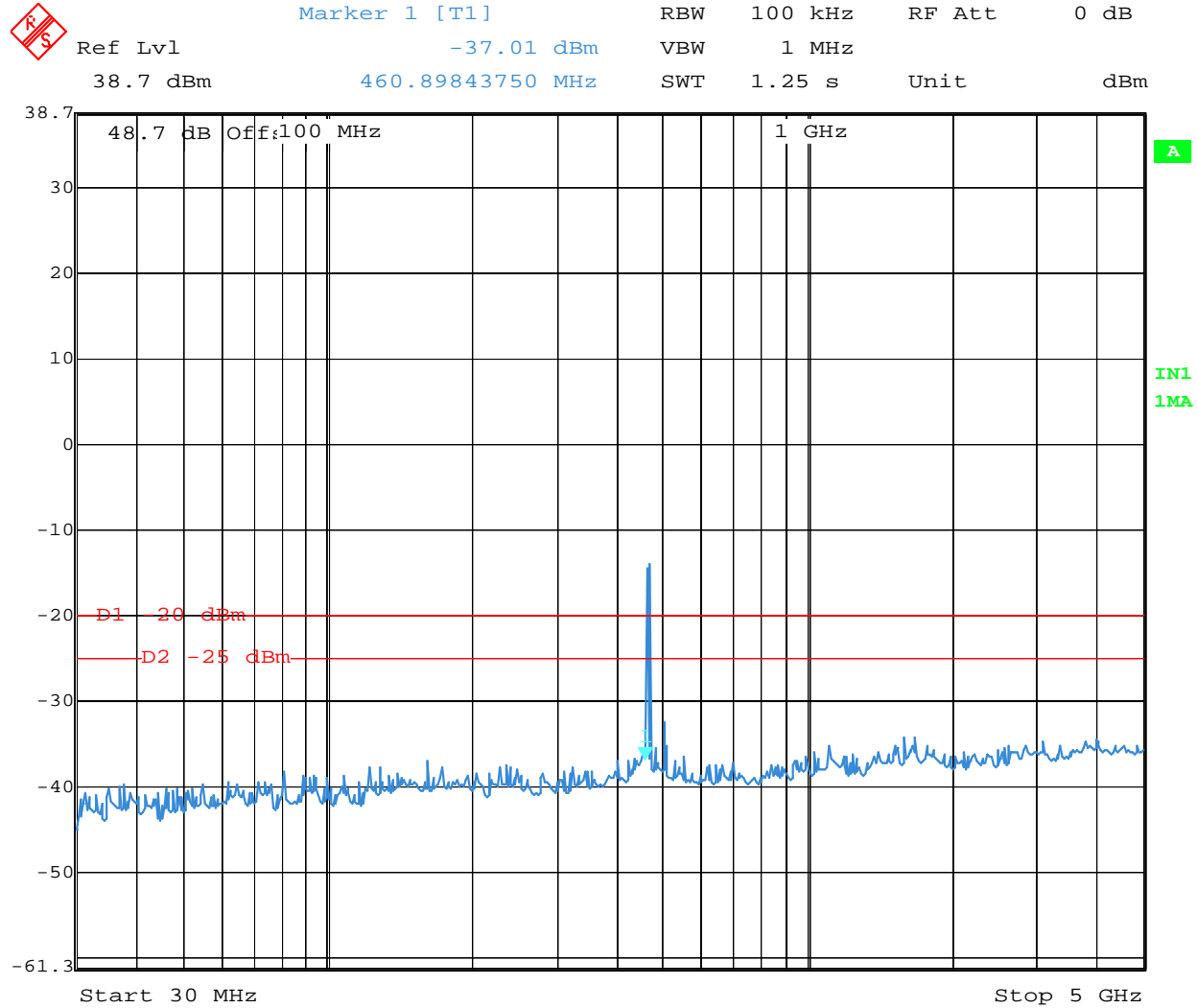


Date: 13.SEP.2012 16:41:05

64 QAM – 6.25 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

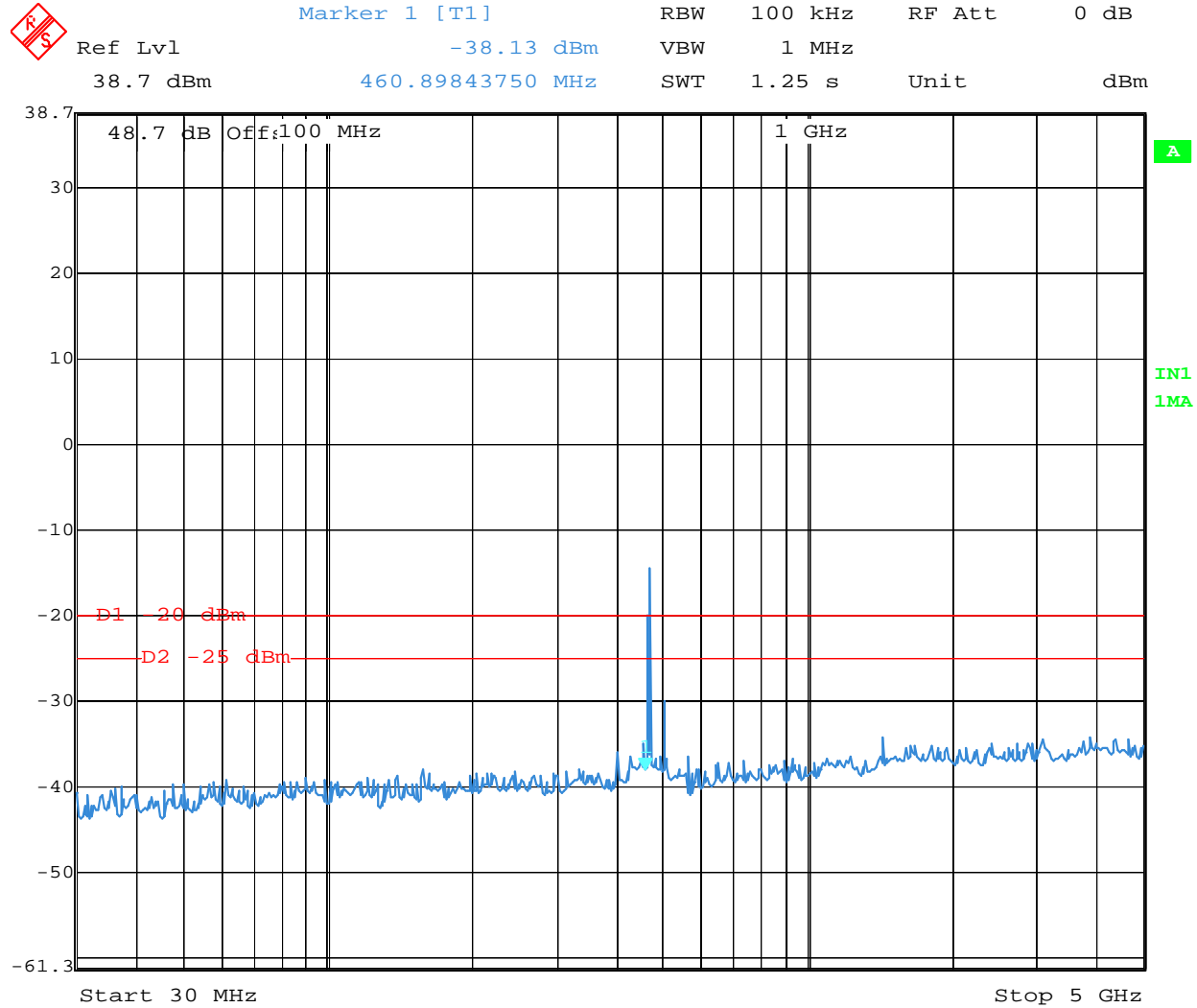


Date: 13.SEP.2012 16:42:39

16QAM – 6.25 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1



Date: 13.SEP.2012 16:45:01

4 QAM – 12.5 kHz channel

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

Section 7.0 Field Strength of Spurious Emissions

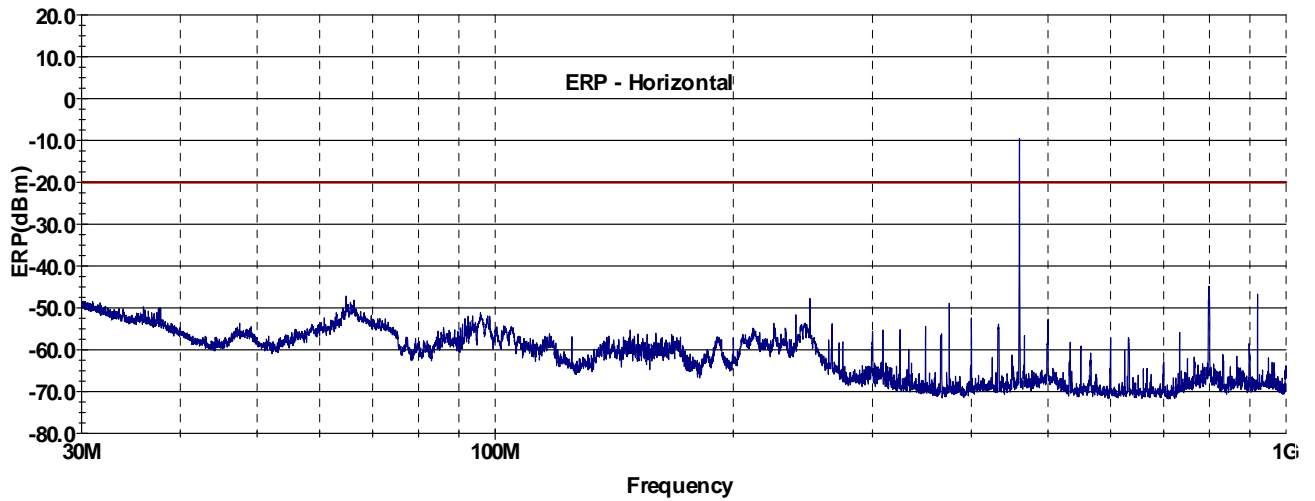
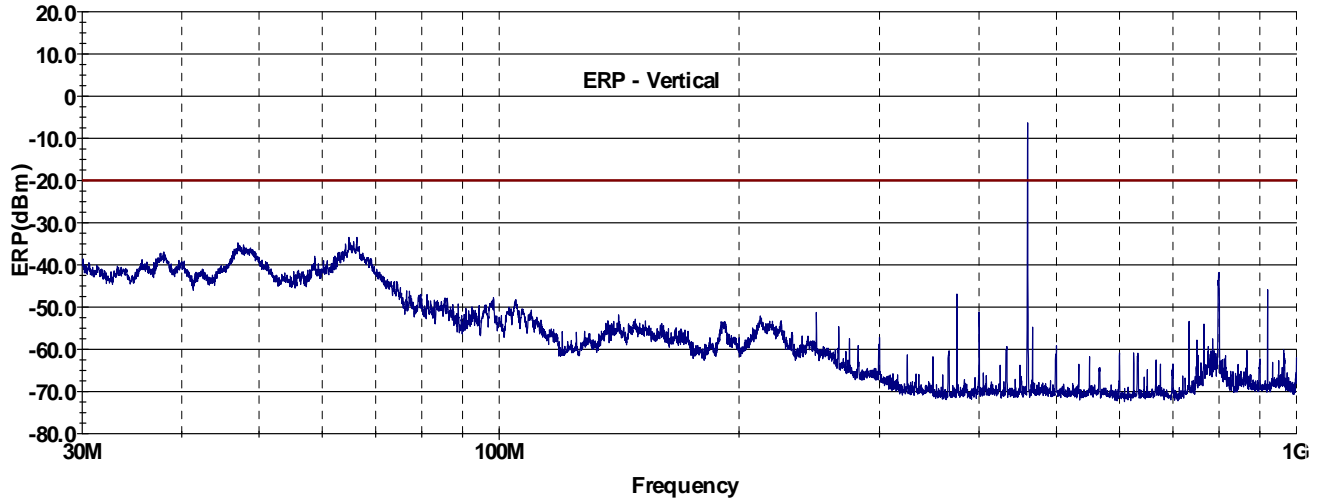
NAME OF TEST: Field Strength of Spurious Emissions	PARA. NO.: 2.993
TESTED BY: Brian Boyea	DATE: 12-Sept-2012

Measurement Results: Complies.

Measurement Data: See attached data

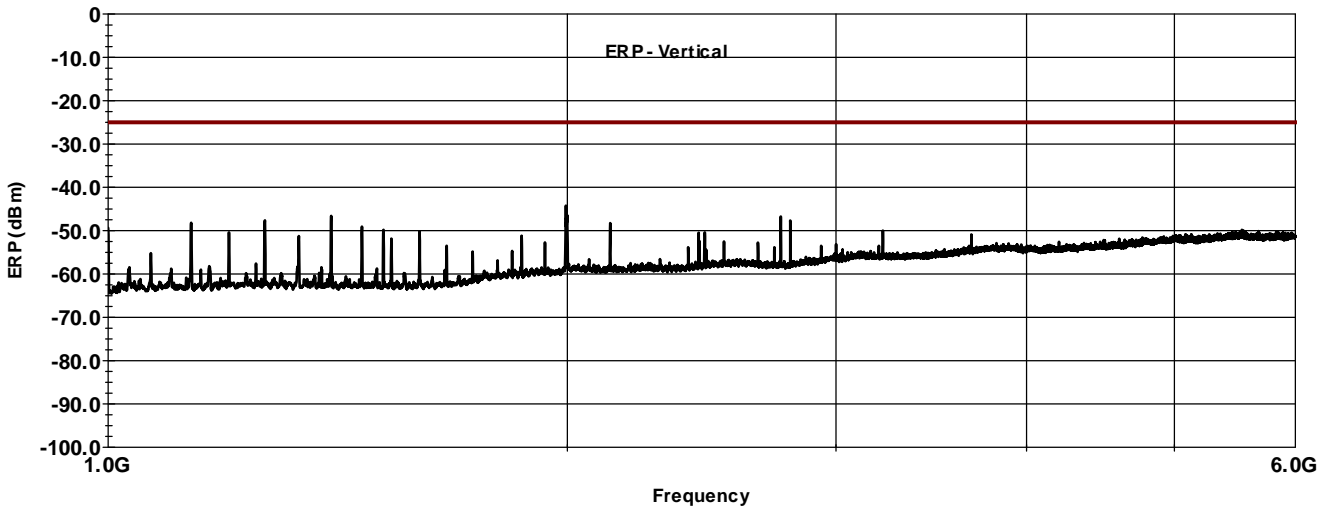
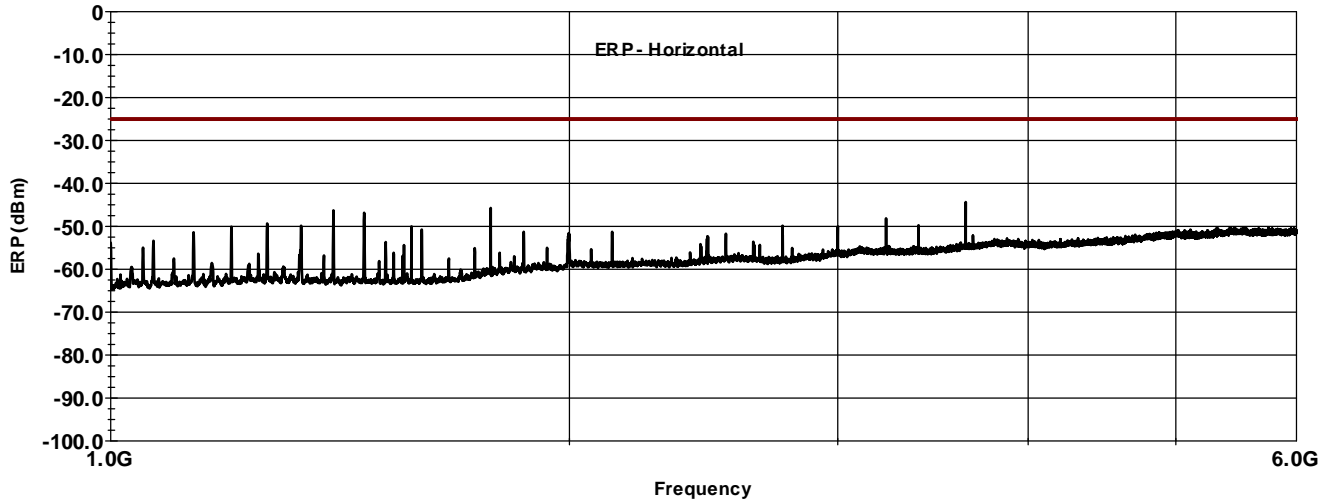
Measurement Conditions: Temperature: 23.2 °C
Humidity: 51.9 %

Measurement Uncertainty: +/-1.7dB



EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1



EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

Section 8.0 Frequency Stability

NAME OF TEST: Frequency Stability	PARA. NO.: 2.995
TESTED BY: Brian Boyea	DATE: 14-Sept-2012

Measurement Results: Complies.

Measurement Data: See attached data

Measurement Conditions: Temperature: 23.2 °C
 Humidity: 51.9 %

Measurement Uncertainty: 1 x 10⁻¹²

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

Temp (°C)	Measured Frequency (MHz)	Test Voltage	Frequency Error (Hz)	Limit (+/-Hz)	Error (ppm)	Comment
20	460.000100	12Vdc	100	2300.0	0.22	
50	460.000010	12Vdc	10	2300.0	0.02	
40	460.000060	12Vdc	60	2300.0	0.13	
30	460.000070	12Vdc	70	2300.0	0.15	
10	460.000160	12Vdc	160	2300.0	0.35	
0	460.000130	12Vdc	130	2300.0	0.28	
-10	460.000080	12Vdc	80	2300.0	0.17	
-20	459.999970	12Vdc	-30	2300.0	-0.07	
-30	460.000260	12Vdc	260	2300.0	0.57	

$$F_{\text{MHz}} \times \text{ppm} = \text{Drift}_{\text{Hz}}$$

$$\text{ppm} = \text{Drift}_{\text{Hz}} / F_{\text{MHz}}$$

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

Section 9.0 Transient Frequency Behavior

NAME OF TEST: Transient Frequency Behaviour	PARA. NO.: 90.214
TESTED BY: Brian Boyea	DATE: 21-Sept-2012

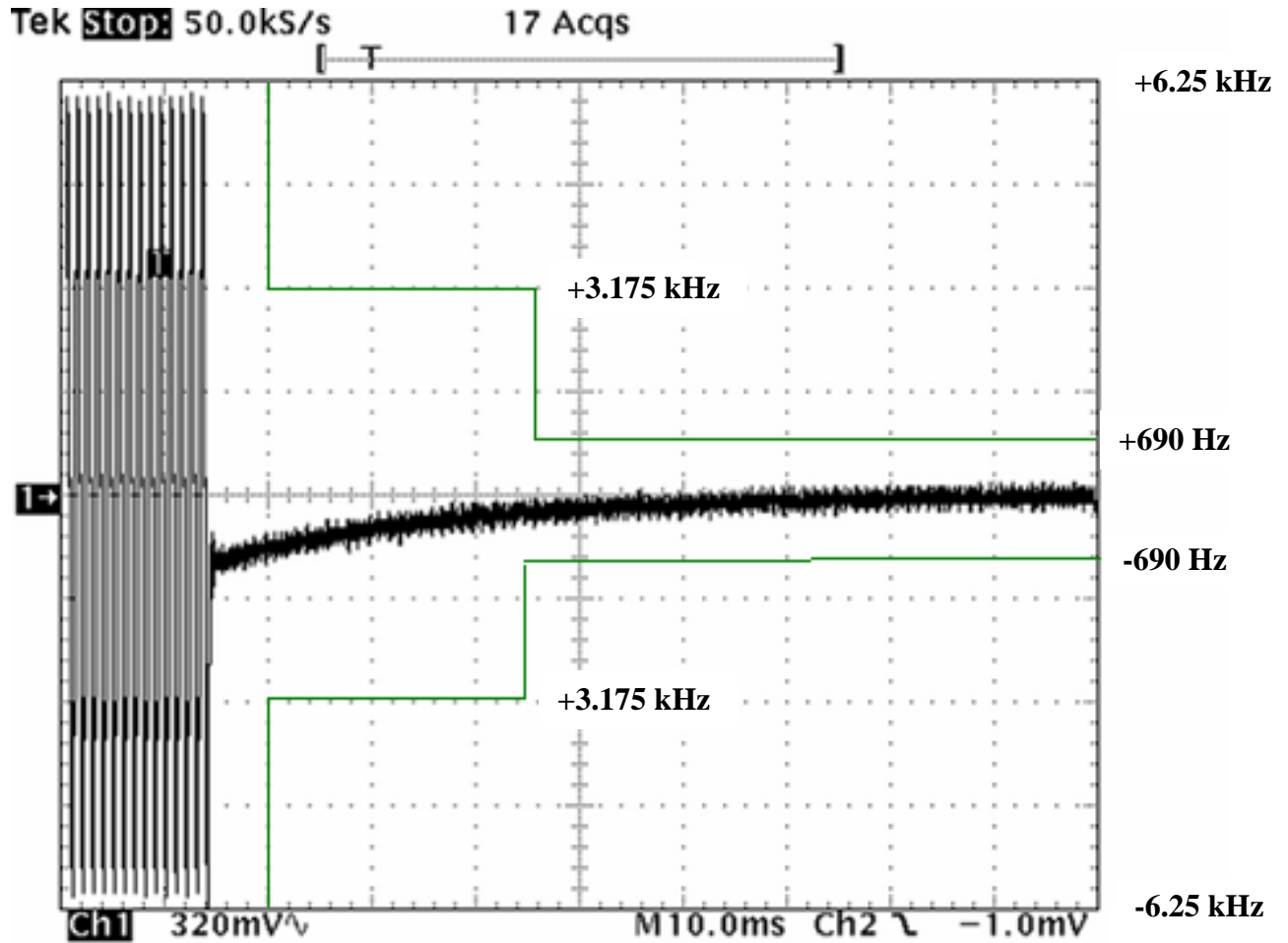
Measurement Results: Complies.

Measurement Data: See attached data

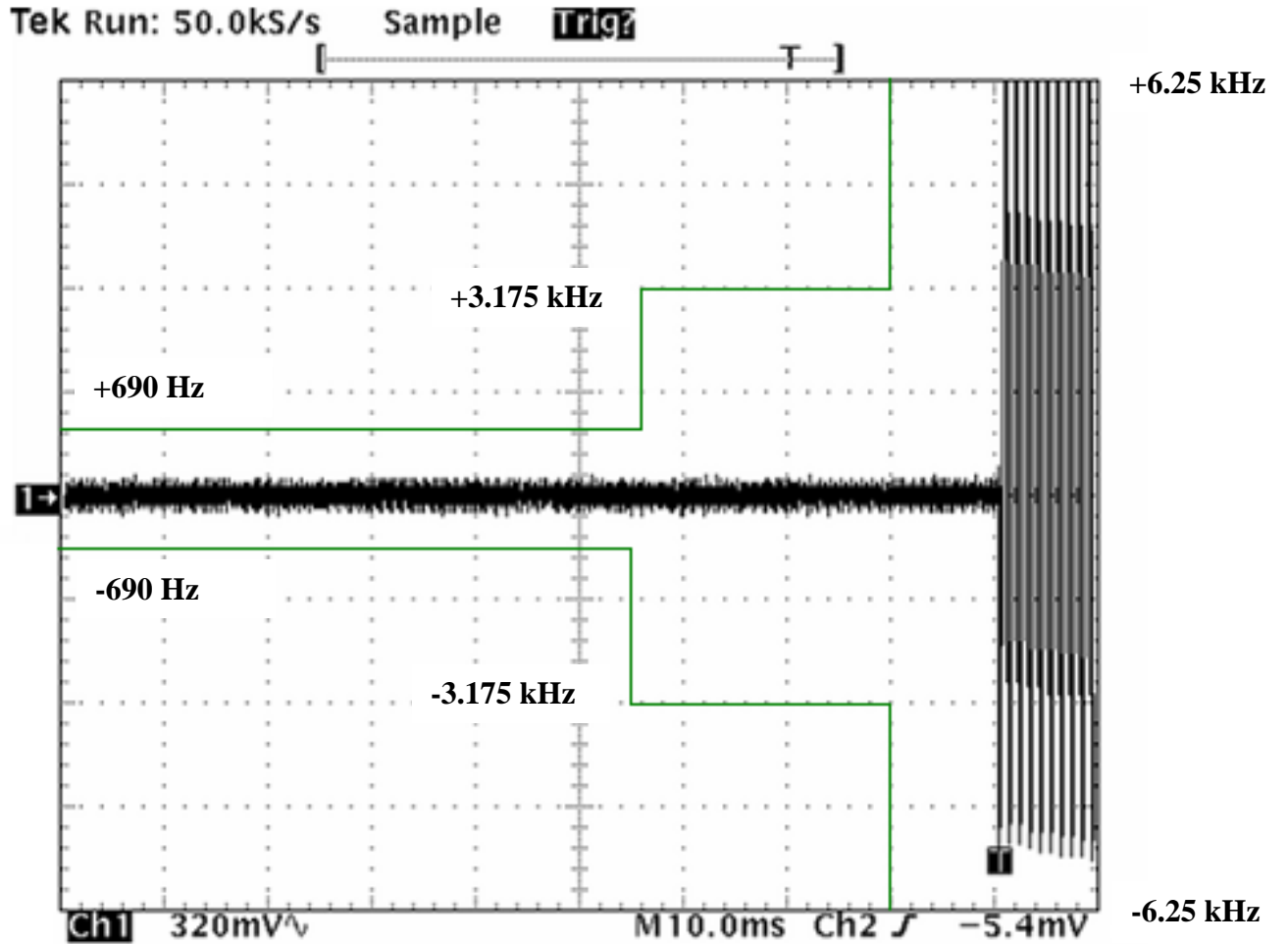
Measurement Conditions: Temperature: 23.2 °C
Humidity: 49.6 %

Measurement Uncertainty: +/-1.7dB

ON TRANSIENT - 6.25 kHz



OFF TRANSIENT – 6.25 kHz channel



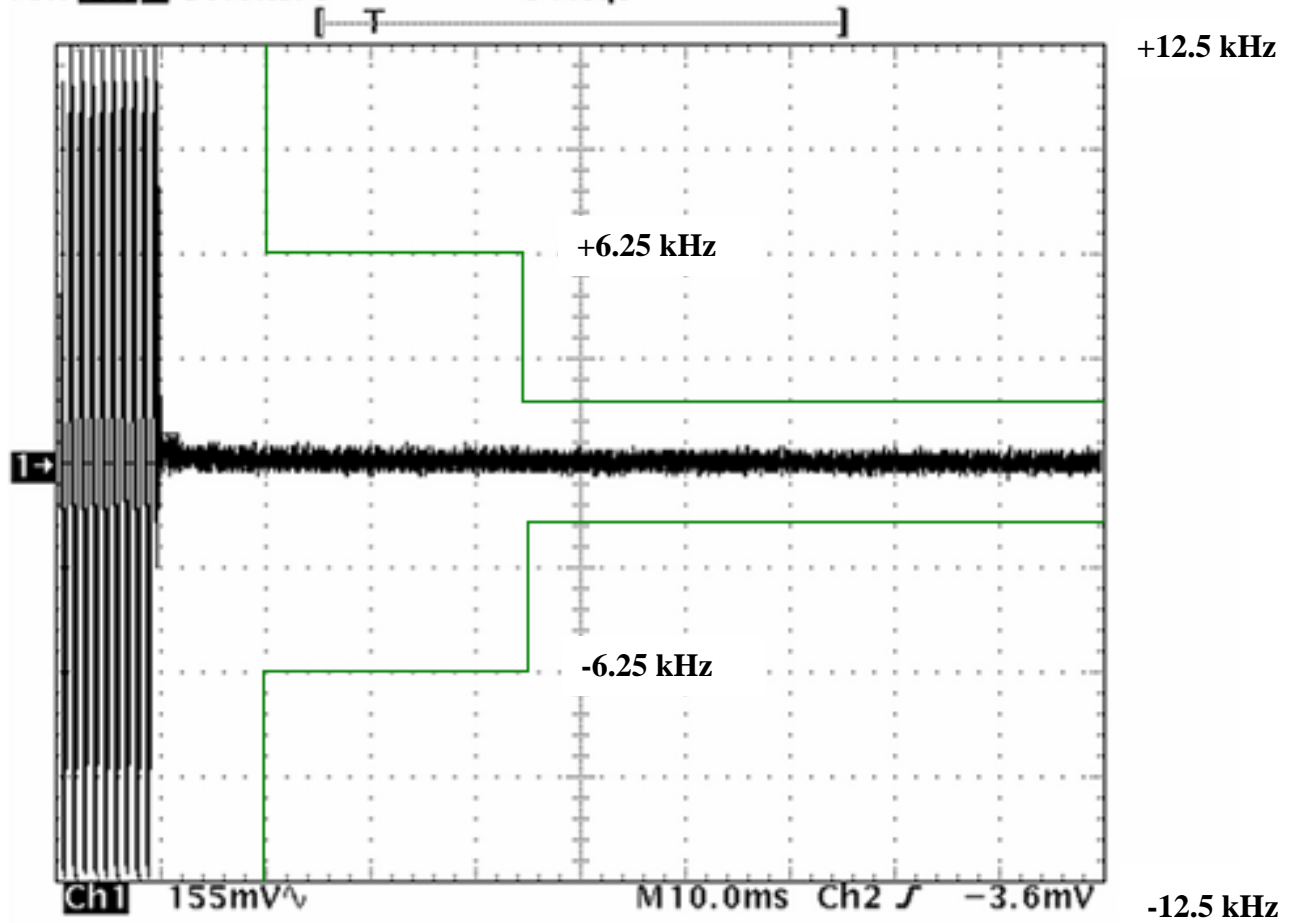
EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

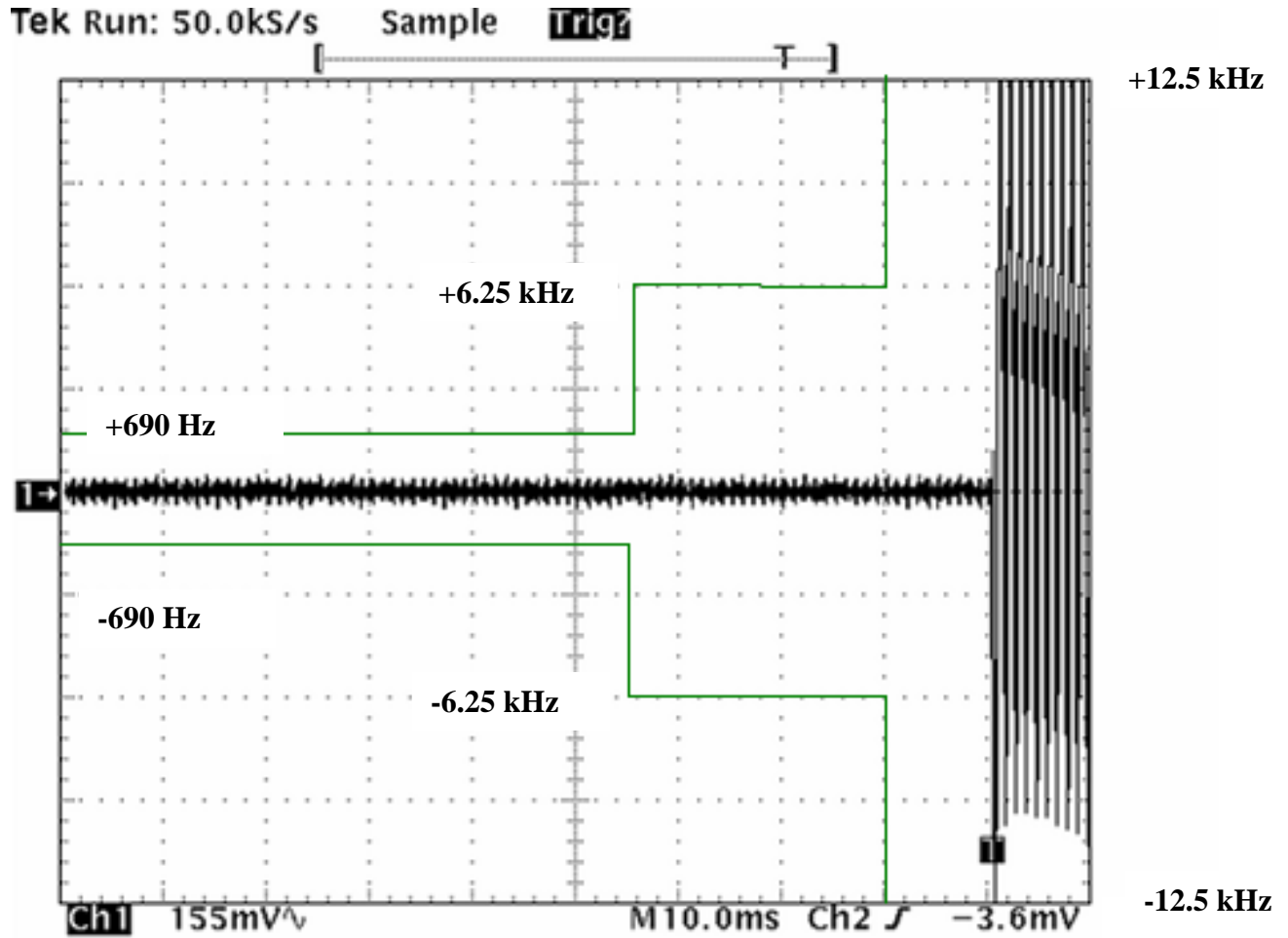
ON TRANSIENT – 12.5 kHz channel

Tek Stop: 50.0kS/s

3 Acqs



OFF TRANSIENT



EQUIPMENT: Industrial RF Modem

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Section 10.0 Test Equipment List

Asset No.	Description	Manufacturer	Model	Serial No.	Last Cal.	Cal. Due
1	3m Semi-Anechoic Chamber	Nemko USA, Inc.	Chamber	1	25-Sep-2012	25-Sep-2013
1767	Receiver, EMI Test 20Hz - 26.5 GHz - 150 - +30 dBm LCD	Rohde & Schwartz	ESIB26	837491 /0002	09-Dec-2011	09-Dec-2012
1783	Cable Assy, 3m Chamber	Nemko	Chamber		26-Sep-2011	26-Sep-2012
1839	Environmental Chamber (Temperature only)	Tenney	T-14	14	N/R	

ANNEX A - TEST METHODOLOGIES

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

NAME OF TEST: RF Power Output

PARA. NO.: 2.985

Minimum Standard: Para. No. 90.205(a). The maximum allowable station ERP is dependent upon the stations HAAT and required service area and will be authorized in accordance with Table 1 of 90.205(d).

Method Of Measurement:

Detachable Antenna:

The peak power at antenna terminals is measured using an in-line peak power meter. Power output is measured with the maximum rated input level.

EQUIPMENT: Industrial RF Modem

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NAME OF TEST: Audio Frequency Response

PARA. NO.: 2.987(a)

Test Method: TIA/EIA-603

Minimum Standard: TIA/EIA-603, Para. 3.2.6 from 300 Hz to 3000 Hz. The transmitter audio frequency response shall have a nominal 6 dB per octave pre-emphasis characteristic.

NAME OF TEST: Audio Low-Pass Filter Frequency Response

PARA. NO.: 2.987(a)

Test Method: TIA/EIA-603

Minimum Standard: TIA/EIA-603

NAME OF TEST: Modulation Limiting

PARA. NO.: 2.987(a)

Test Method: TIA/EIA-603

Minimum Standard: TIA/EIA-603

EQUIPMENT: Industrial RF Modem

PROJECT NO.: 10230352RUS1

NAME OF TEST: Occupied Bandwidth	PARA. NO.: 2.989
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Minimum Standard: Para. No. 90.210, see table 1 below for applicable mask.

Table 1

Frequency Band (MHz)	Mask for equipment with Low Pass Filter	Mask for equipment without Low Pass Filter
Below 25	A or B	A or C
25 - 50	B	C
72 - 76	B	C
150 - 174	B, D or E	C, D or E
150 Paging only	B	C
220 - 222	F	F
421 - 512	B, D or E	C, D or E
450 paging only	B	H
806 - 821/ 851 - 866	B	G
821 - 824/ 866 - 869	B	H
896 - 901/ 935 - 940	I	J
902 - 928	K	K
929 - 930	B	G
Above 940	B	C
All other bands	B	C

Test Method:

RBW: 1% of emission bandwidth in 0 - 1 GHz range. 1 MHz at frequencies above 1 GHz.
VBW: ≥ RBW

The spectrum is search up to 10 times the fundamental frequency.

EQUIPMENT: **Industrial RF Modem**

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NAME OF TEST: Field Strength of Spurious

PARA. NO.: 2.993

Minimum Standard: Para. No. 90.210, see table 1 for applicable mask.

Test Method: TIA/EIA-603

An initial scan is made and any emissions within 6 dB of the specification limit are measured using the reference antenna substitution method as described in EIA 603.

EQUIPMENT: Industrial RF Modem

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NAME OF TEST: Frequency Stability **PARA. NO.: 2.995**

Minimum Standard: Para. No. 990.213. The transmitter carrier frequency shall remain within the assigned frequency below in ppm.

Table 2

Frequency Band (MHz)	Fixed And Base Stations	Mobile Stations	
		> 2 Watts o/p pwr	< 2 Watts o/p pwr
Below 25	100	100	200
25 - 50	20	20	50
72 - 76	5	-	50
150 - 174	5	5	5
220 - 222	0.1	1.5	1.5
421 - 512	2.5	5	5
806 - 821	1.5	2.5	2.5
821 - 824	1.0	1.5	15
851 - 866	1.5	2.5	2.5
866 - 869	1.0	1.5	1.5
869 - 901	0.1	1.5	1.5
902 - 928	2.5	2.5	2.5
929 - 930	1.5	-	-
935 - 940	0.1	1.5	1.5
1427 - 1435	300	300	300
Above 2450	-	-	-

NAME OF TEST: Transient Frequency Behaviour **PARA. NO.: 2.214**

Minimum Standard:

Transient Frequency Behaviour for Equipment Designed to Operate on 25 kHz Channels

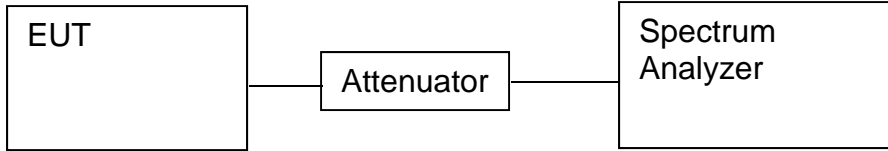
Time intervals ^{1,2}	Maximum Frequency difference ³ (kHz)	Frequency ranges (MHz) All equipment					
		Base station and portable radios			Mobile Radios		
		150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)	150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)
t ₁ ⁴	± 25	5.0	10.0	20.0	5.0	10.0	5.0
t ₂	± 12	20.0	25.0	50.0	20.0	25.0	20.0
t ₃ ⁴	± 25	5.0	10.0	10.0	5.0	10.0	5.0

Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz & 6.25 kHz Channels

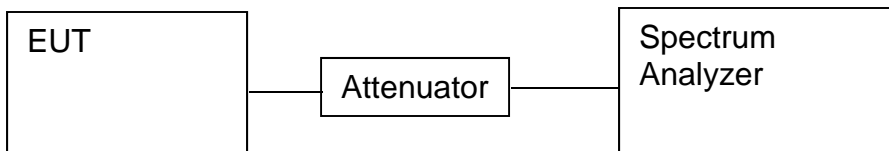
Time intervals ^{1,2}	Maximum Frequency difference ³ (kHz)	Frequency ranges (MHz) All equipment		
		150 - 174 (ms)	450 - 500 (ms)	500 - 512 (ms)
t ₁ ⁴	± 12.5 / ± 6.25	5.0	10.0	20.0
t ₂	± 6.25 / ± 3.125	20.0	25.0	50.0
t ₃ ⁴	± 12.5 / ± 6.25	5.0	10.0	10.0

ANNEX B - TEST DIAGRAMS

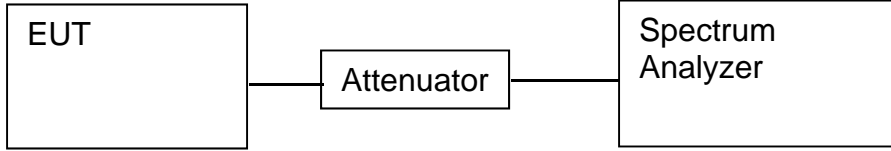
Para. No. 2.985 - R.F. Power Output



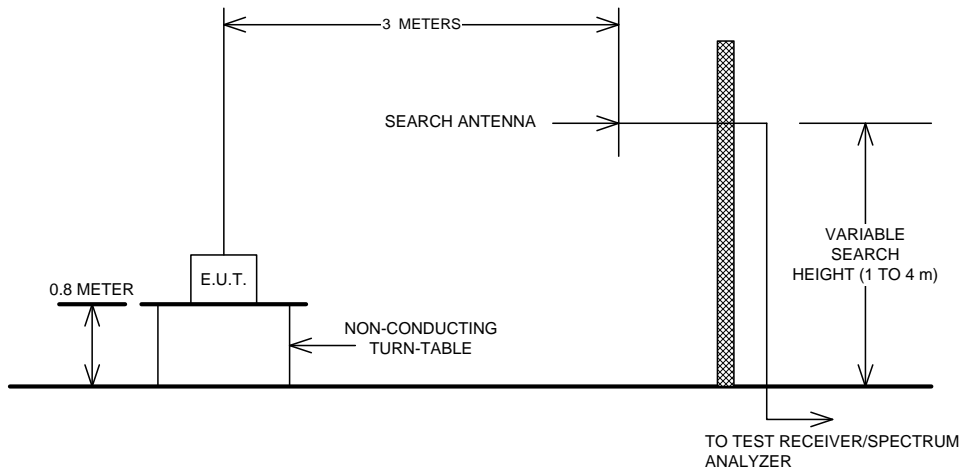
Para. No. 2.989 - Occupied Bandwidth



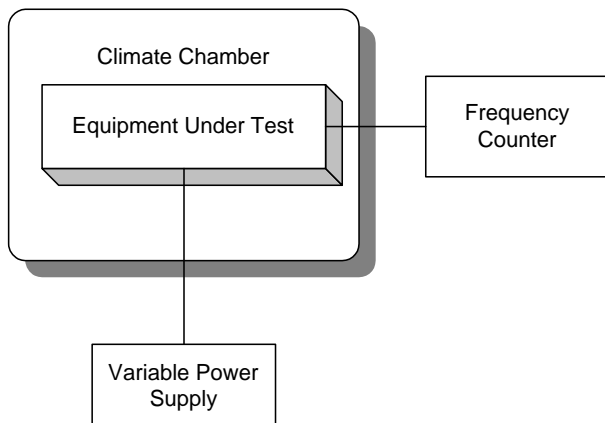
Para. No. 2.991 - Spurious Emissions at Antenna Terminals



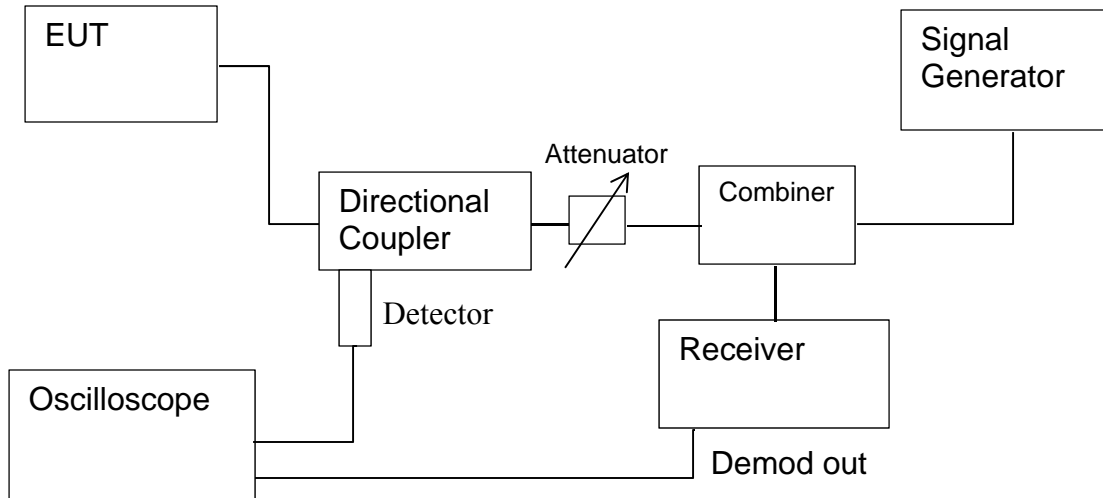
Para. No. 2.993 - Field Strength of Spurious Radiation



Para. No. 2.995 - Frequency Stability



Para. No. 90.214 - Transient Frequency Behaviour



Voice

This measurement was made using measurement procedure TIA/EIA Land Mobile FM or PM Communications Equipment Measurement and Performance Standards TIA/EIA-603 February 1993 Telecommunications Industry Association (American National Standard ANSI/TIA/EIA-603-1992 Approved: October 27, 1992) Para. no. 2.2 Methods of Measurement for Transmitters Para. no. 2.2.19 Transient Frequency Behaviour (page no. 83).

Data

This measurement was made using measurement procedure TIA/EIA Digital C4FM/CQPSK Transceiver Measurement Methods TSB102.CAAA Para. no. 2.2.17 Transient Frequency Behaviour (page no. 74).