VMD-TX-100-C Report of Measurements

RF Power Output

Modulation Characteristics-Deviation Frequency Response

Modulation Characteristics-Modulation Sensitivity

Occupied Bandwidth/Conducted Spurious Emissions/Emission Masks

Frequency Stability-Temperature Stability

Frequency Stability-Power Supply Stability

VMD-TX-100-C SAR Testing

Radiated Spurious Emissions

VMD-TX-100-C RF Power Output

Relevant FCC Chapters:
(a) 2.1046 Measurements required: RF power output.
For transmitters other than single side-band, independent side-band and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

2.1033 Application for certification.
(c) Applications for equipment other than that operating under parts 15 and 18 of the rules shall be accompanied by a technical report containing the following information:
(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

90.205 Power and antenna height limits.
Applicants for licenses must request and use no more power than the actual power necessary for satisfactory operation. Except where otherwise specifically provided for, the maximum power that will be authorized to applicants whose license applications for new stations are filed after August 18, 1995 is as follows:
(p) 4940–4990 MHz. Limitations on power are specified in § 90.1215.

90.1215 Power limits.

The transmitting power of stations operating in the 4940–4990 MHz band must not exceed the maximum limits in this section.

(a) The peak transmit power should not exceed:

Channel bandwidth (MHz)	Low power peak transmitter power (dBm)	**High power** peak transmitter power (dBm)
1	7	20
5	14	27
10	17	30
15	18.8	31.8
20	20	33

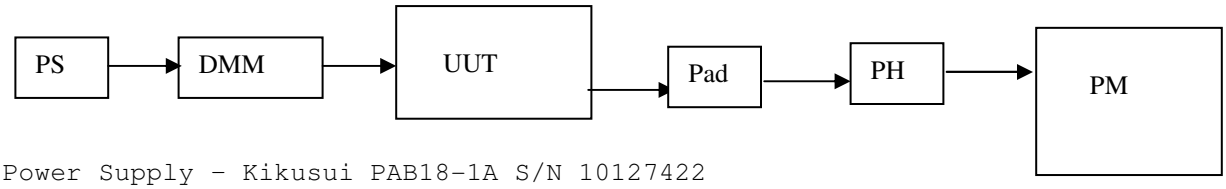
High power devices are also limited to a peak power spectral density of 21 dBm per one MHz. High power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 21 dBm/MHz.

The test results in Figure 1 below shows that the unit output power does not exceed 109mW, or 20.4dBm. Figure 1 in the later section entitled 'VMD-TX-100-C Spectrum Data – Occupied Bandwidth' shows a minimum Occupied Bandwidth of 1.1659MHz. This yields a maximum spectral density for this device of 109/1.1659 mW/MHz ≡ +19.7dBm/MHz, within the allowed limit of +21dBm/MHz.

As supporting evidence for spectral density conformance please also see the Emission Mask graphs. Note that, in these graphs, the spectral density limits have been recalculated, for the measurement Resolution Bandwidths of 100kHz & 30kHz, as follows:

90.1215 (a) limit = 21.0dBm (126mW)/MHz
≡ 11.0dBm (12.6mW)/100kHz
≡ 5.8dBm (3.8mW)/ 30kHz

Test Setup:
The setup for this test is shown below.

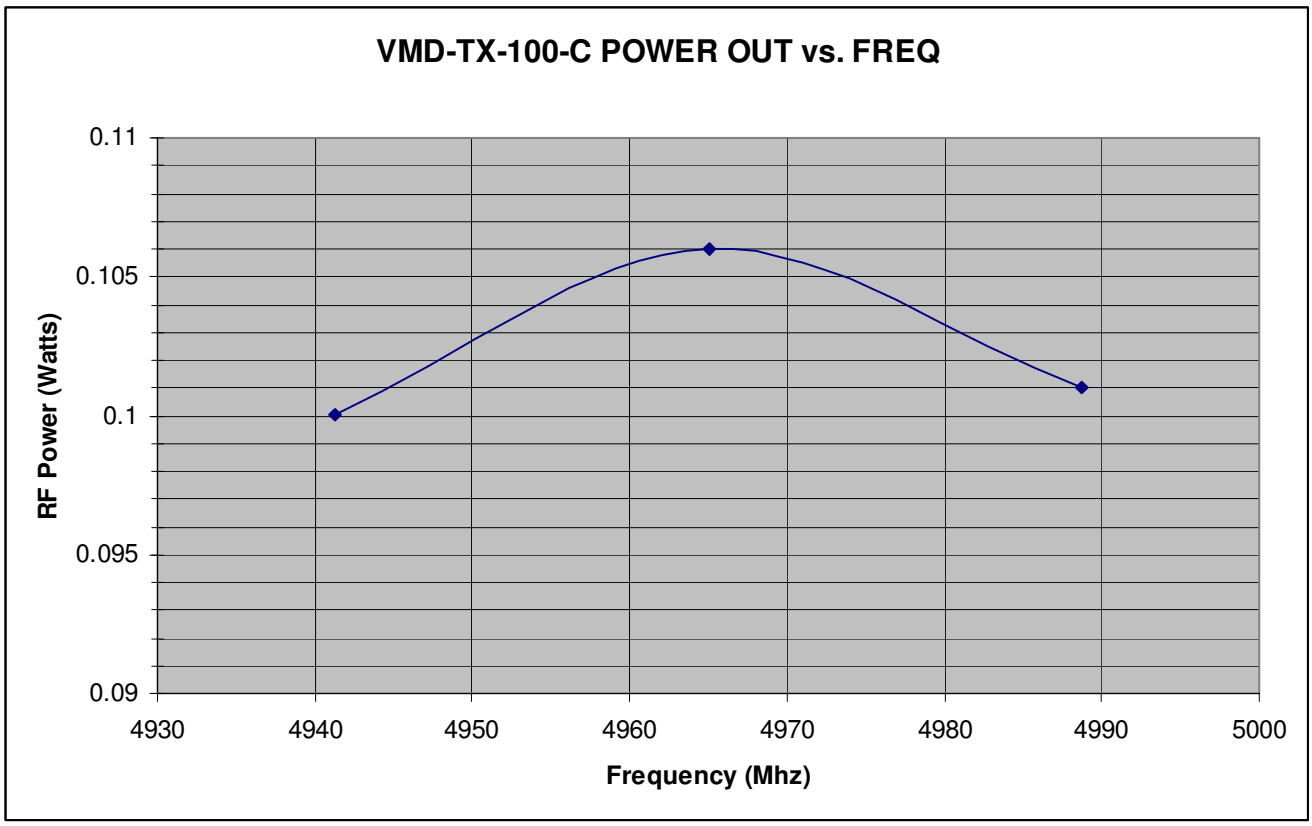


PS – Power Supply – Kikusui PAB18-1A S/N 10127422
DMM – Digital Multi-Meter Agilent 34401A S/N 3146A46206
UUT – VMD-TX-100-C
Pad – 20dB Pad – INMET 18N5W20
PH – Power Head – HP 8481A – SN 2702A82014
PM – Power Meter – HP 438A – SN 3513U06101

Figure 1 – RF Power Output vs Voltage and Frequency (Pursuant to FCC Requirement 2.1046) – Raw Data

Figure 2 – RF Power Output vs Frequency (Pursuant to FCC Requirement 2.1046)

Supply Volts	Power Out Vs Voltage		Power Out Vs Voltage		Power Out Vs Voltage	
	F= 4941.25 MHz		F= 4965.00 MHz		F= 4988.75 MHz	
	Power Out Watts	I dc Amp	Power Out Watts		Power Out Watts	I dc Amp
9.0	.099	.492	.106	9.0	.099	.492
9.5	.098	.466	.105	9.5	.098	.466
10.0	.099	.444	.106	10.0	.099	.444
11.0	.099	.408	.106	11.0	.099	.408
12.0	.100	.371	.106	12.0	.100	.371
13.0	.098	.345	.105	13.0	.098	.345
14.0	.103	.325	.109	14.0	.103	.325
15.0	.102	.303	.109	15.0	.102	.303



VMD-TX-100-C Modulation Characteristics – Deviation Frequency Response

Relevant FCC Chapter:
2.1047 Measurements required: Modulation characteristics.
(d) *Other types of equipment.* A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

Test Method: See below

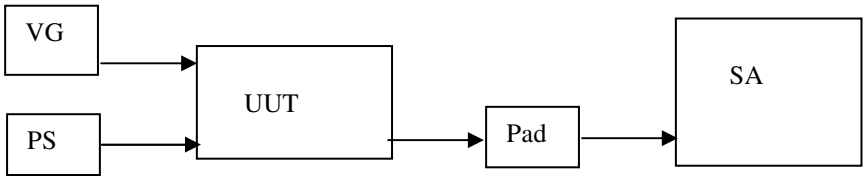
Test Results:
Whereas this is a pure Digital COFDM Video System with no audio sub-carriers, no test is relevant and none was performed.

VMD-TX-100-C Modulation Characteristics

Modulation Sensitivity

Relevant FCC Chapter:
2.1047 Measurements required: Modulation characteristics.
(d) *Other types of equipment.* A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

Test Setup:
The setup for this test is shown below.



VG – Video Generator – Compuvideo SVR-7000A S/N 5540
Power Supply – Kikusui PAB18-1A S/N 10127422
UUT – VMD-TX-100-C
Pad – 20 dB Pad – INMET 18N5W20
SA – Spectrum Analyzer – Agilent E4407B S/N US41442941

Test Results:
Since the nature of a digital COFDM modulation system is such that the video input signal has no effect on the modulated carriers, no test is relevant and none was performed.

VMD-TX-100-C Occupied Bandwidth / Spurious Emissions / Emission Masks

Relevant FCC Chapters:

2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(h) Transmitters employing digital modulation techniques—when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

2.1051 Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

90.210 Emission masks.

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (m) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth

From 90.210 table 'APPLICABLE EMISSION MASKS'

4940-4990 MHz Mask L or M

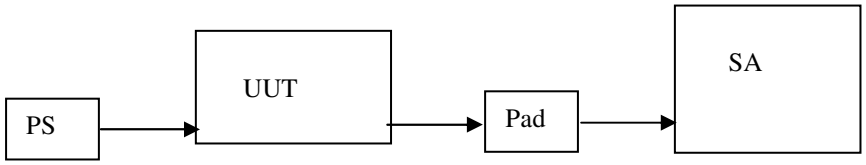
This transmitter has an nominal RF output power of 20dBm, but does usually output a few tenths of a dB above that level. Therefore Mask M "For high power transmitters greater that 20 dBm" rather than Mask L "For low power transmitters (20 dBm or less" has been used.

(m) Emission Mask M. For high power transmitters (greater that 20 dBm) operating in the 4940-4990 MHz frequency band, the power spectral density of the emissions must be attenuated below
the output power of the transmitter as follows:
(1) On any frequency removed from the assigned frequency between 0-45% of the authorized bandwidth (BW): 0dB.
(2) On any frequency removed from the assigned frequency between 45-50% of the authorized bandwidth: 568 log (%of (BW)/45) dB.
(3) On any frequency removed from the assigned frequency between 50-55% of the authorized bandwidth: 26 + 145log (% of BW/50) dB.
(4) On any frequency removed from the assigned frequency between 55-100% of the authorized bandwidth: 32 + 31 log (% of (BW)/55) dB.
(5) On any frequency removed from the assigned frequency between 100-150% of the authorized bandwidth: 40 + 57 log (% of (BW)/100) dB.

VMD-TX-100-C Occupied Bandwidth / Spurious Emissions / Emission Masks cont.

(6) On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50dB or 55 + 10 log (P) dB, whichever is
the lesser attenuation.
(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of
at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth
of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

Test Setup:
The setup for these tests is shown below.



Power Supply Kikusui PAB18-1A S/N 10127422
UUT – VMD-TX-100-C
Pad – 20 dB Pad – INMET 18N5W20
SA– Spectrum Analyzer– Agilent E4407B S/N US41442941

VMD-TX-100-C Spectrum Data – Occupied Bandwidth

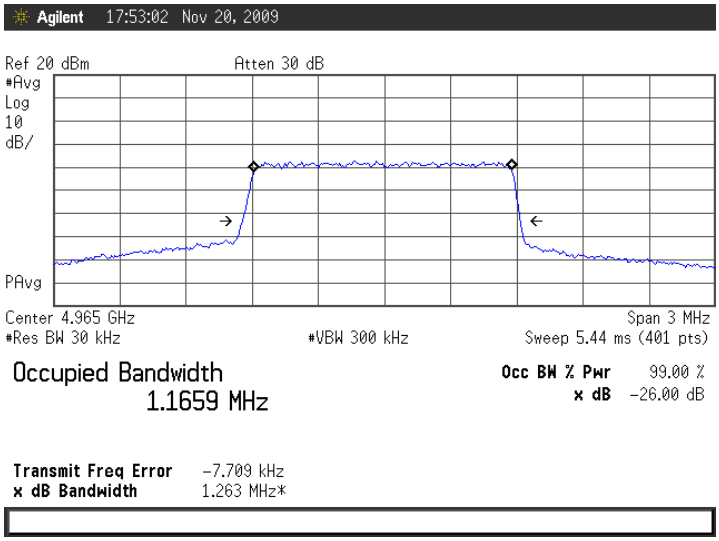


Fig. 1
Occupied Bandwidth Compliance
TX Mode = DOMO-N
Emission: 1M3W7D

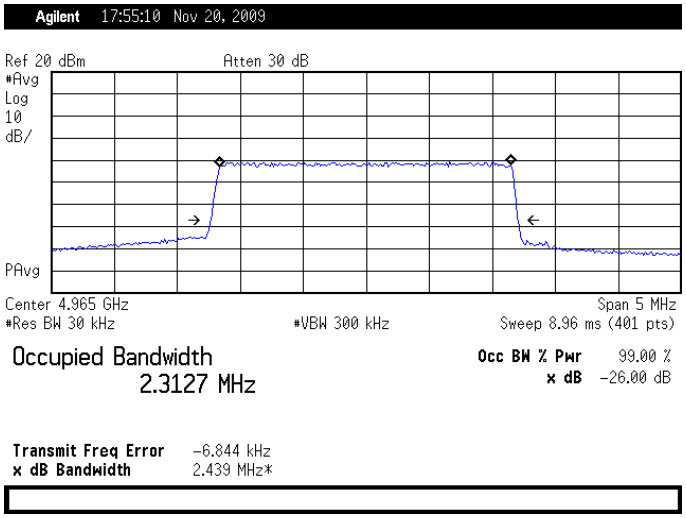


Fig. 2
Occupied Bandwidth Compliance
TX Mode = DOMO-W
Emission: 2M5W7D

VMD-TX-100-C Spectrum Data – Occupied Bandwidth, Continued

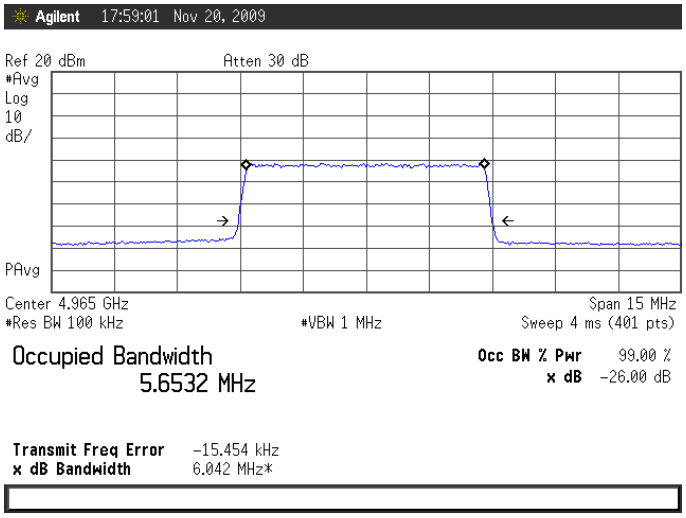


Fig. 3
Occupied Bandwidth Compliance
TX Mode = DVB-T 6 MHz
Emission: 6M0W7D

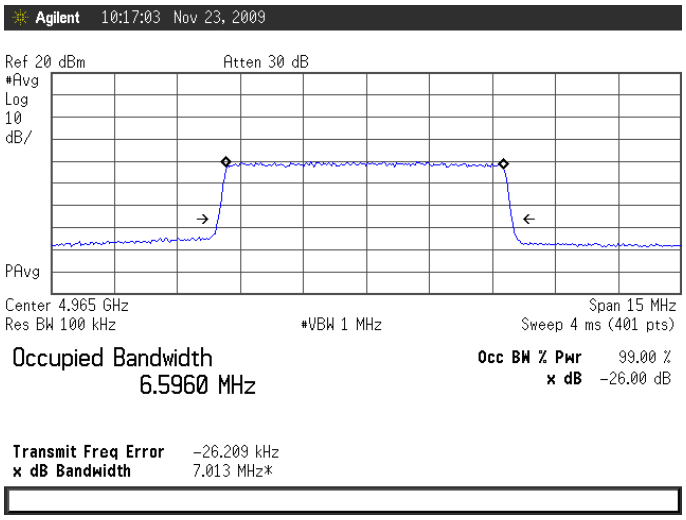


Fig. 4
Occupied Bandwidth Compliance
TX Mode = DVB-T 7 MHz
Emission: 7M0W7D

VMD-TX-100-C Spectrum Data – Occupied Bandwidth, Continued

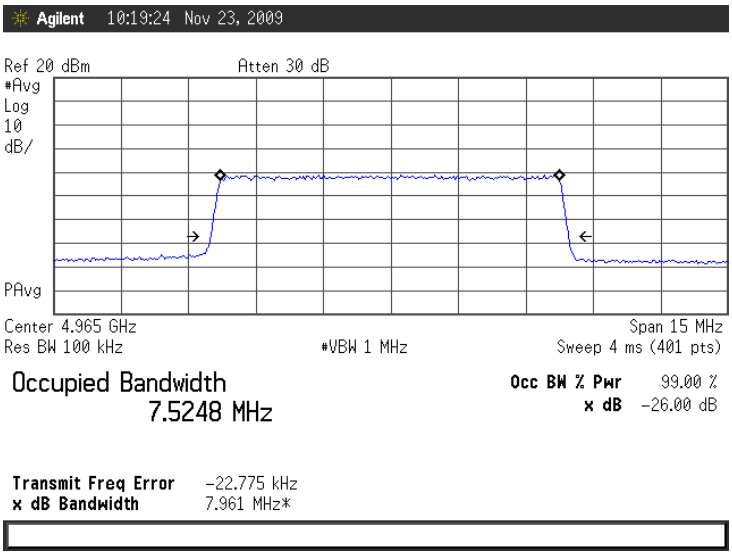


Fig. 5
Occupied Bandwidth Compliance
TX Mode = DVB-T 8 MHz
Emission: 8M0W7D

VMD-TX-100-C Spurious Emissions at Antenna Terminals

Test Results:
Frequency Range Investigated: 30 MHz to 40 GHz

UUT: VMD-TX-100-C
Measurement: Conducted Spurious
Frequency Range: 30 MHz to 40 GHz
FCC Limit(dBc) = 43 + 10*LOG(P)dBc = 43 +10*LOG(0.1) = -33dBc
Pcarrier = 100mW = +20 dBm
Fcc Limit(dBm) = +20dB(pad) -33dB(carrier) = **-13dBm**
Vsupply = 12VDC
Isupply = 0.6ADC

Figures 6 through 10 show UUT compliance to the -13dBm limit of conducted spurious emissions in each of the five TX modes.

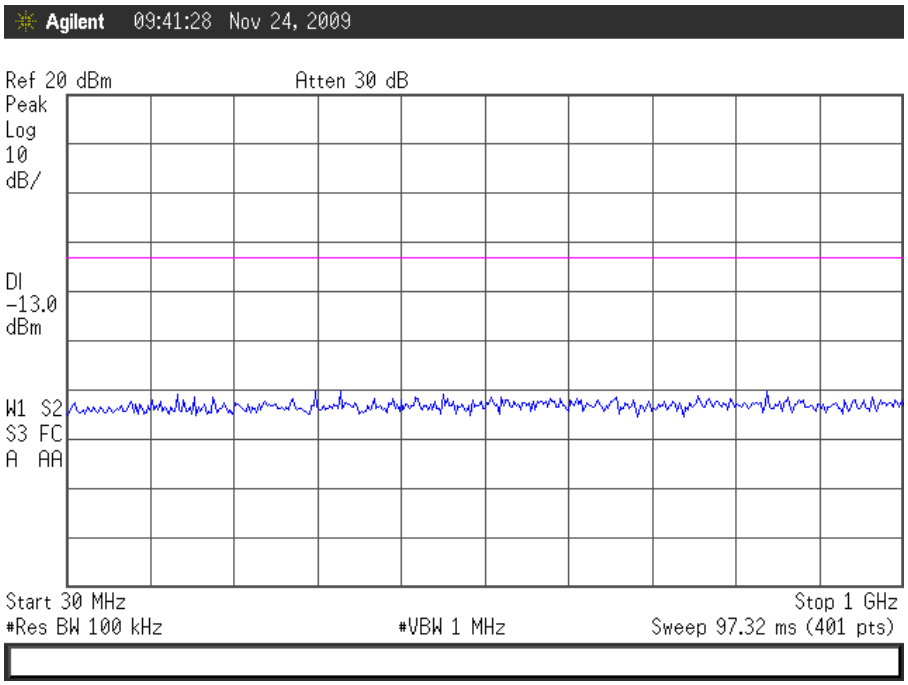


Fig. 6a
Spurious Emissions Compliance
30MHz – 1GHz
TX Mode = DOMO-N
Emission: 1M3W7D

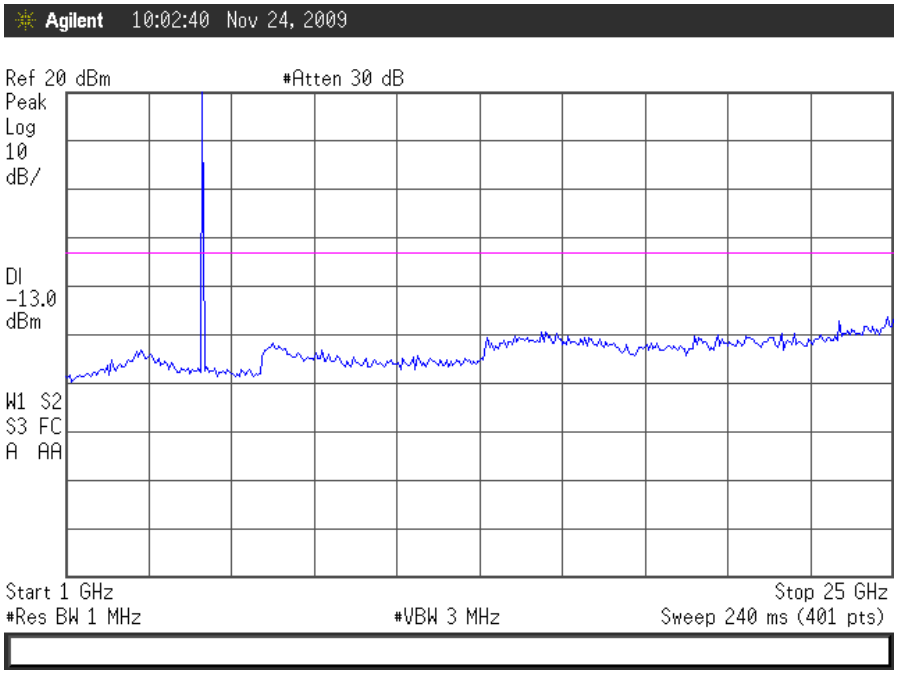


Fig. 6b
Spurious Emissions Compliance
1GHz – 25GHz
TX Mode = DOMO-N
Emission: 1M3W7D

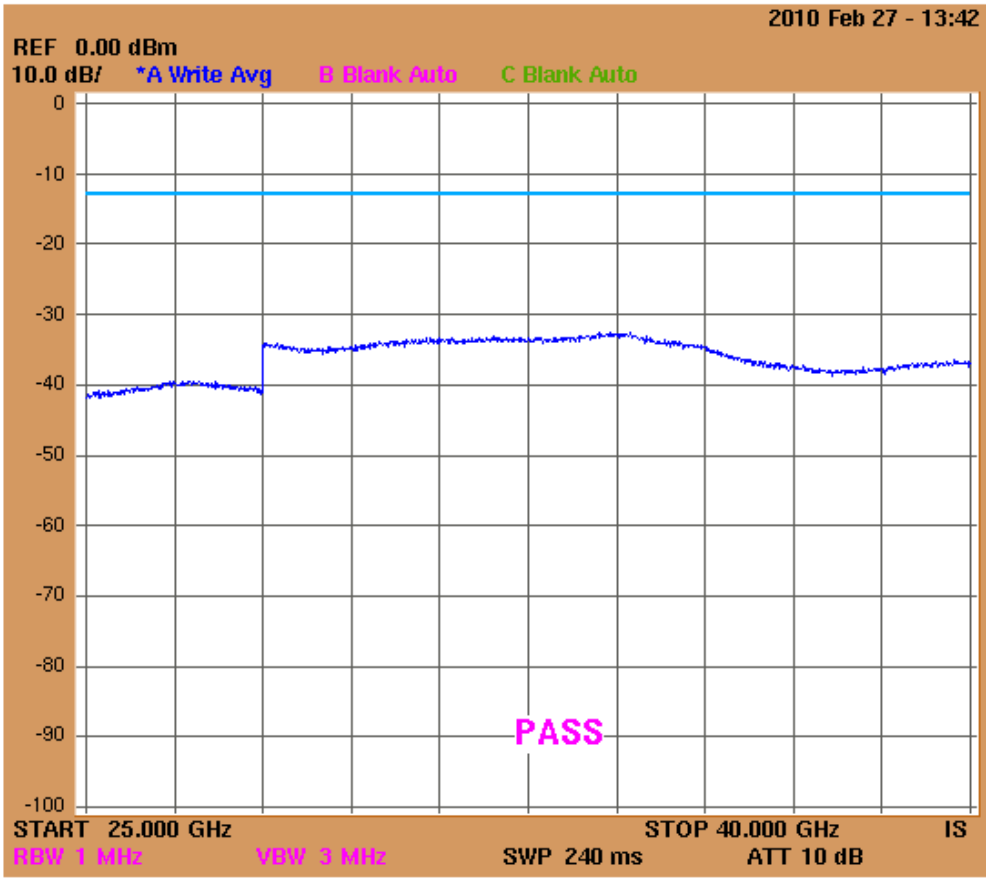


Fig. 6c
Spurious Emissions Compliance
25GHz – 40 GHz
TX Mode = DOMO-N
Emission: 1M3W7D

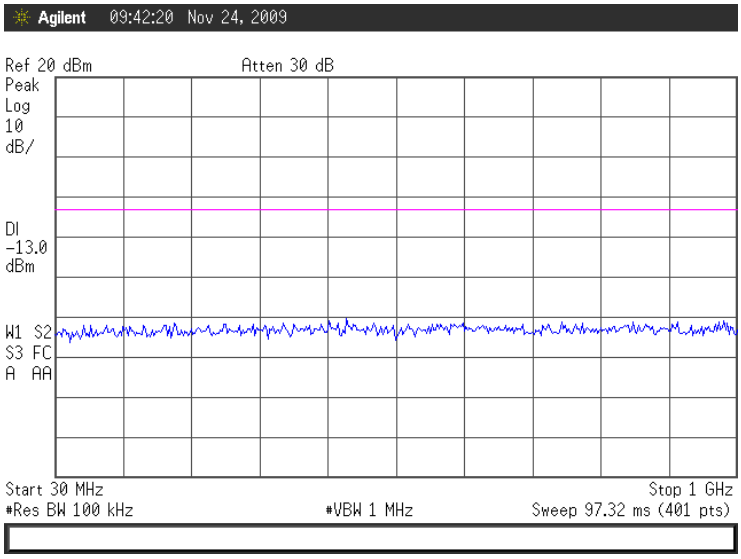


Fig. 7a
Spurious Emissions Compliance
30MHz – 1GHz
TX Mode = DOMO-W
Emission: 2M5W7D

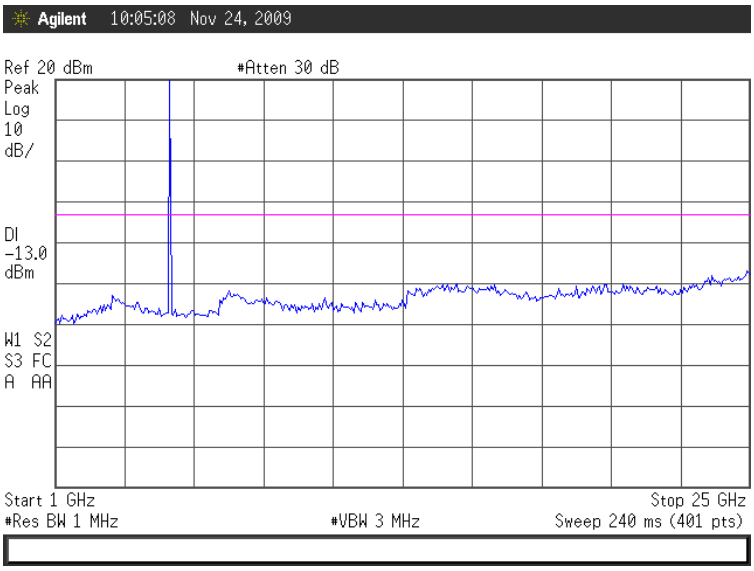


Fig. 7b
Spurious Emissions Compliance
1GHz – 25GHz
TX Mode = DOMO-W
Emission: 2M5W7D

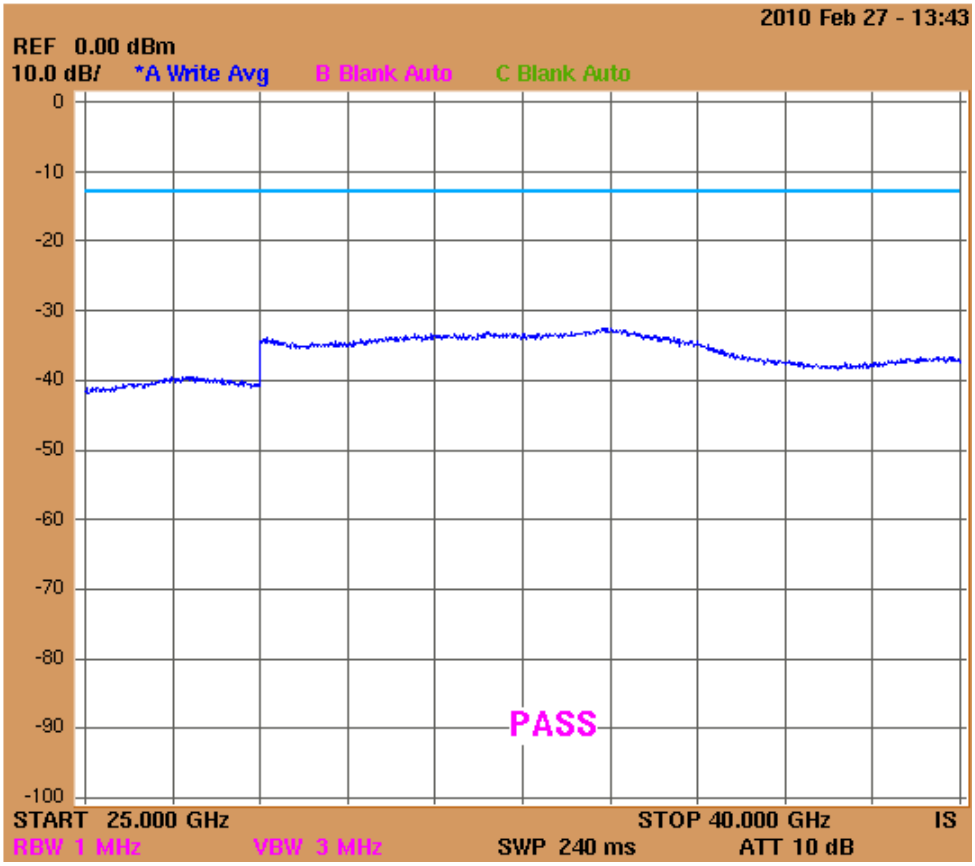


Fig. 7c
Spurious Emissions Compliance
25GHz – 40 GHz
TX Mode = DOMO-N
Emission: 2M5W7D

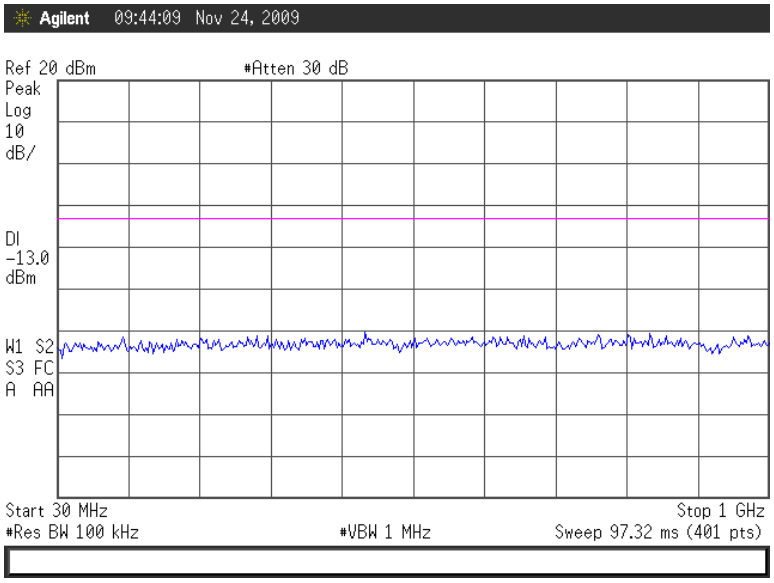


Fig. 8a
Spurious Emissions Compliance
30MHz – 1GHz
TX Mode = DVB-T
Emission: 6M0W7D

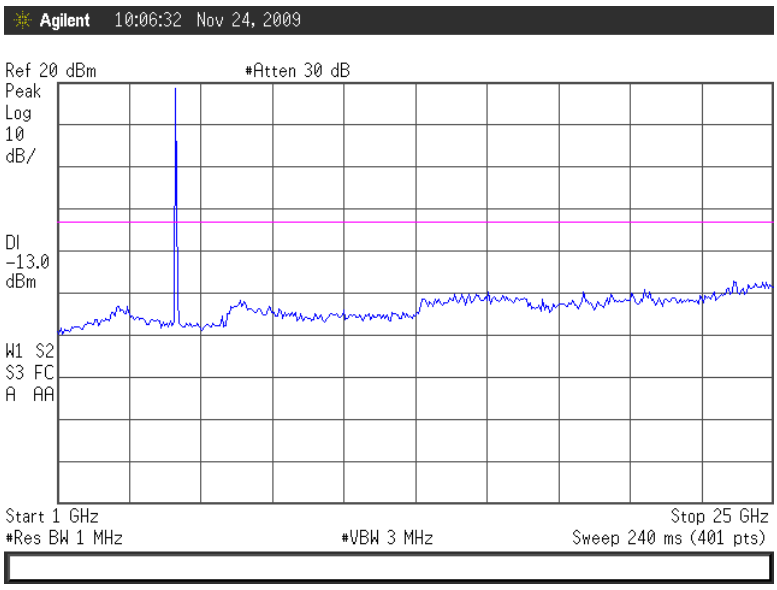


Fig. 8b
Spurious Emissions Compliance
1GHz – 25GHz
TX Mode = DVB-T
Emission: 6M0W7D

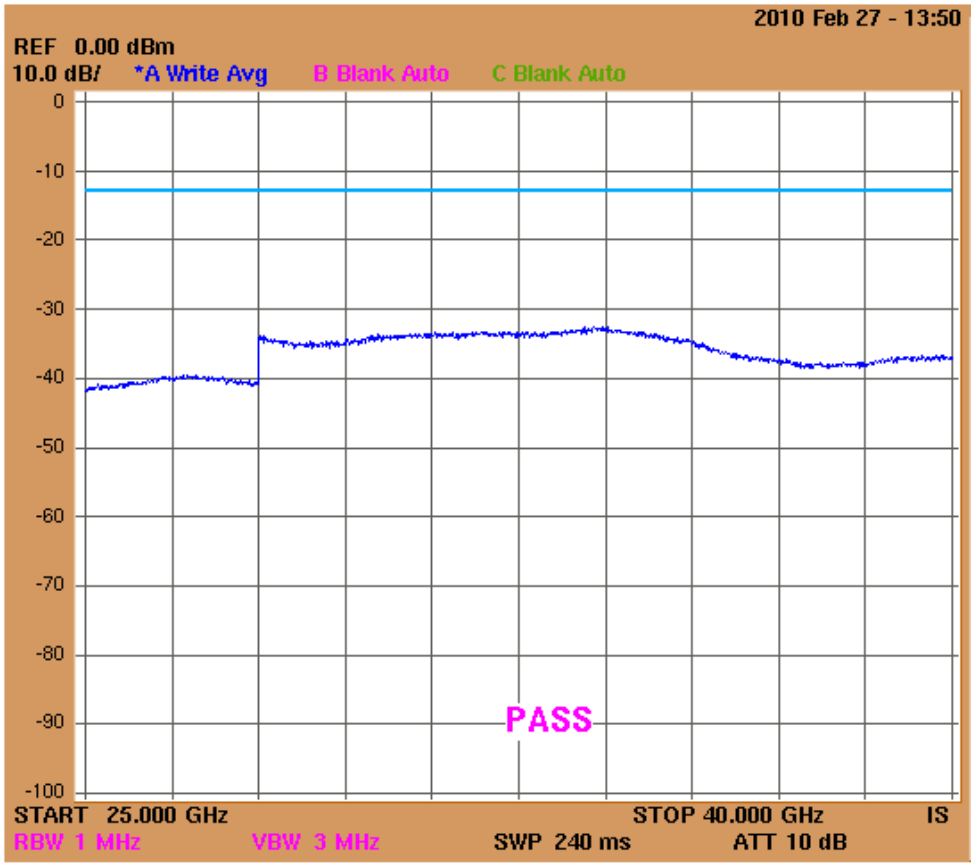


Fig. 8c
Spurious Emissions Compliance
25GHz – 40 GHz
TX Mode = DOMO-N
Emission: 6M0W7D

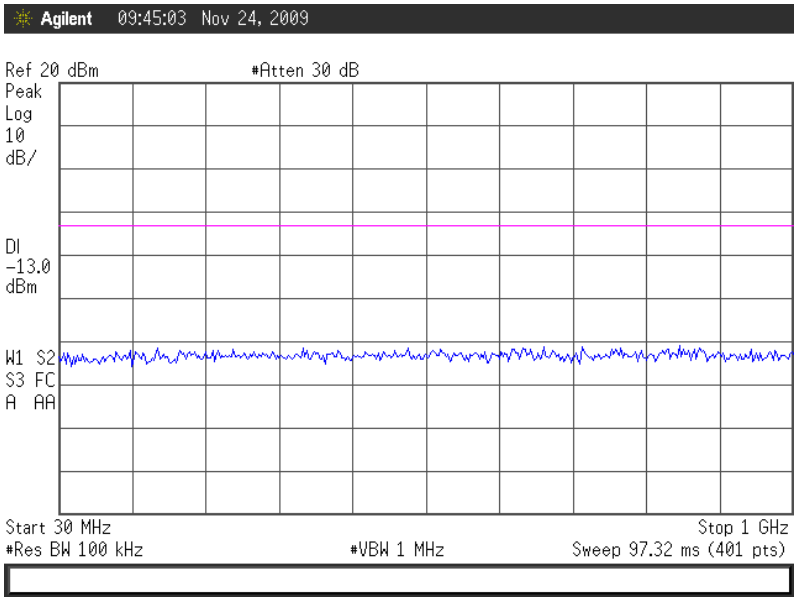


Fig. 9a
Spurious Emissions Compliance
30MHz – 1GHz
TX Mode = DVB-T
Emission: 7M0W7D

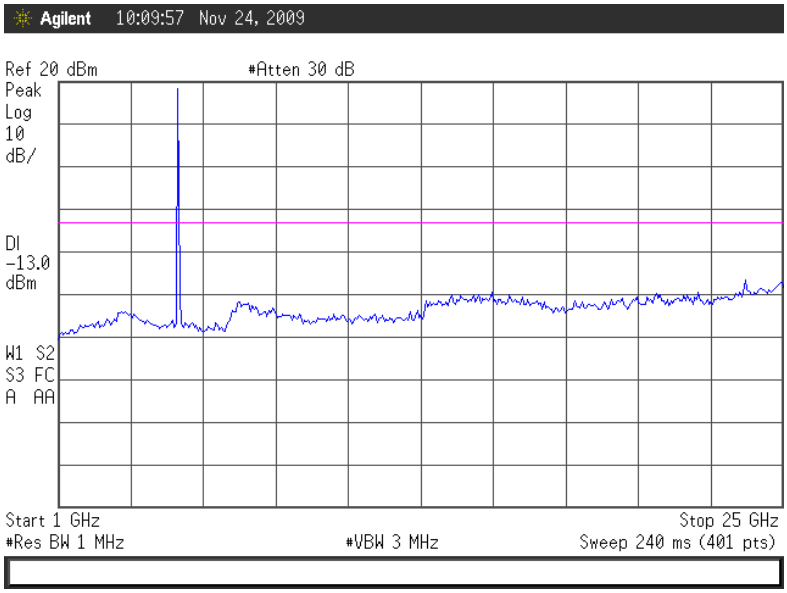


Fig. 9b
Spurious Emissions Compliance
1GHz – 25GHz
TX Mode = DVB-T
Emission: 7M0W7D

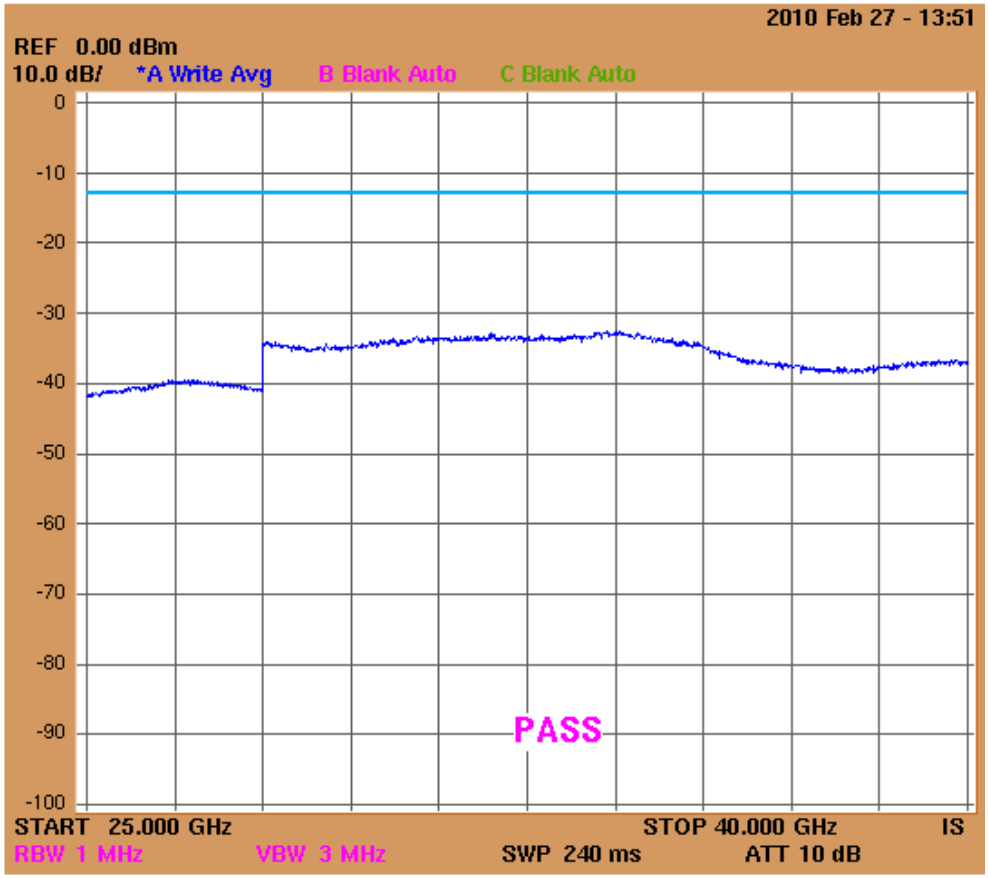


Fig. 9c
Spurious Emissions Compliance
25GHz – 40 GHz
TX Mode = DOMO-N
Emission: 7M0W7D

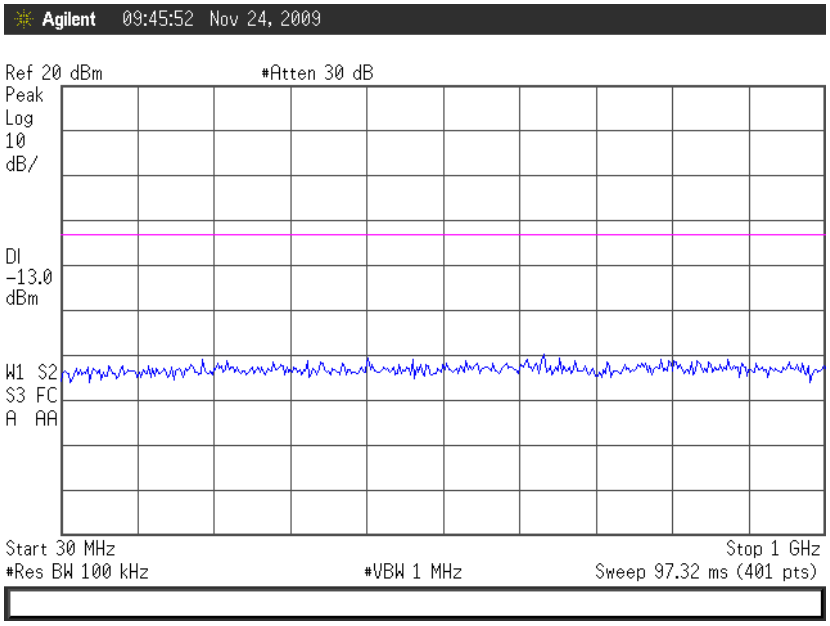


Fig. 10a
Spurious Emissions Compliance
30MHz – 1GHz
TX Mode = DVB-T
Emission: 8M0W7D

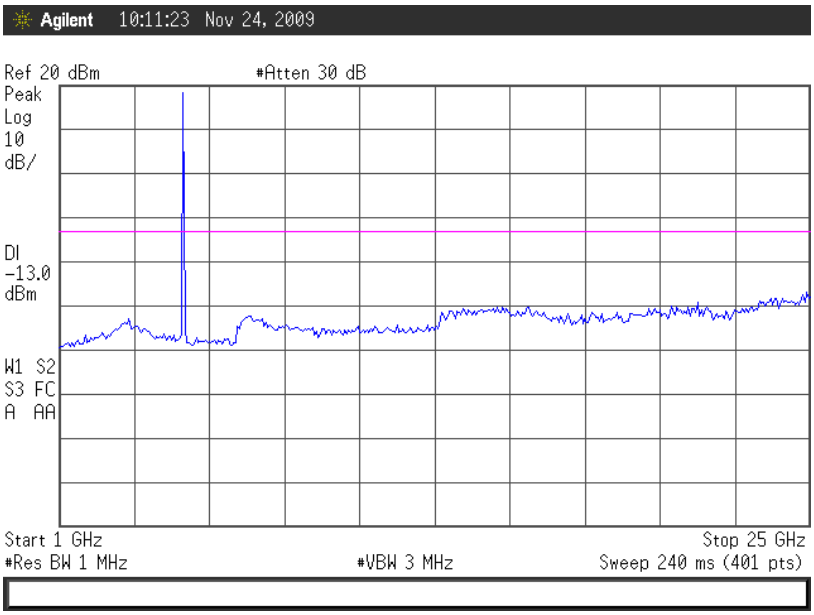


Fig. 10b
Spurious Emissions Compliance
1GHz – 25GHz
TX Mode = DVB-T
Emission: 8M0W7D

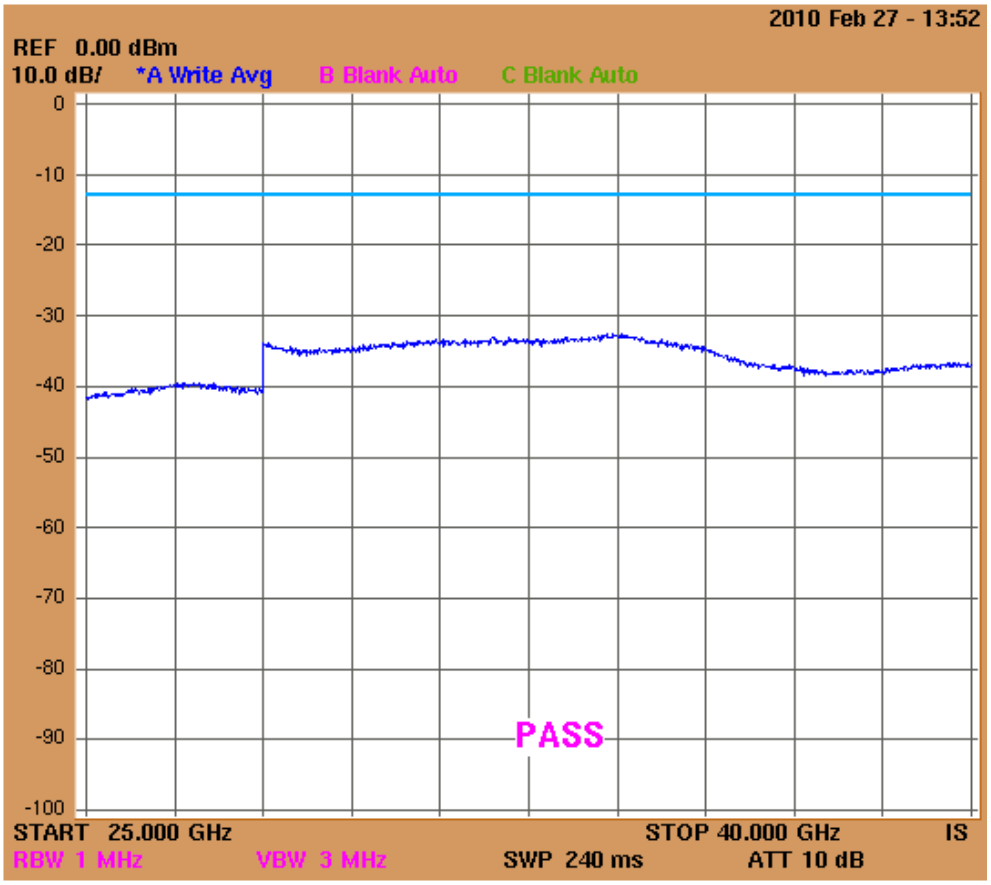


Fig. 10c
Spurious Emissions Compliance
25GHz – 40 GHz
TX Mode = DOMO-N
Emission: 8M0W7D

VMD-TX-100-C Emission Masks

Test Method

For the purpose of calculating mask segments, the power of the un-modulated carrier was 0.10 Watts, therefore the value calculated per 90.210 (m):

For the frequency region removed from the carrier by more than 150 percent of the authorized bandwidth, the emissions shall be less than:

Pmax(dBc) = 45dB (= -50dB or 55 + 10 log (0.1) dB, whichever is the lesser attenuation).

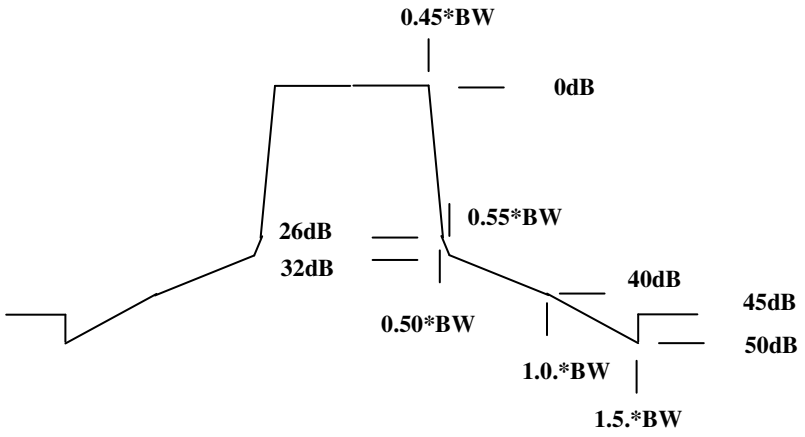


Figure 11
Mask Parameters for the Five TX Modes

TX Mode	0.5*BW (MHz)	1.0*BW (MHz)	2.5*BW (MHz)
DOMO-N	0.625	1.25	2.5
DOMO-W	1.25	2.5	5.0
DVB-T-6	3.0	6.0	12
DVB-T-7	3.5	7.0	14
DVB-T-8	4.0	8.0	16

Note that in the following graphs (Figs 12 – 16):

- the text “Pass Limit 1” is with reference to the Spectral Masks only.
- The red horizontal line denotes the maximum permissible spectral density, normalized to the measurement resolution bandwidth i.e:
  +21dBm/1MHz ≡ 5.8dBm (3.8mW)/ 30kHz ≡ 11.0dBm (12.6mW)/100kHz

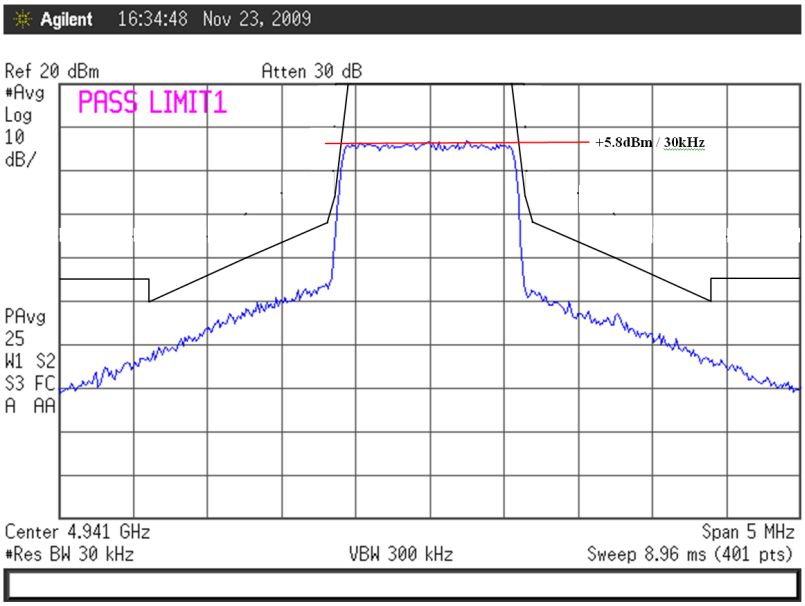


Fig. 12a
Emission Mask Compliance
TX Mode = DOMO-N
Emission: 1M3W7D
Lower Band Edge

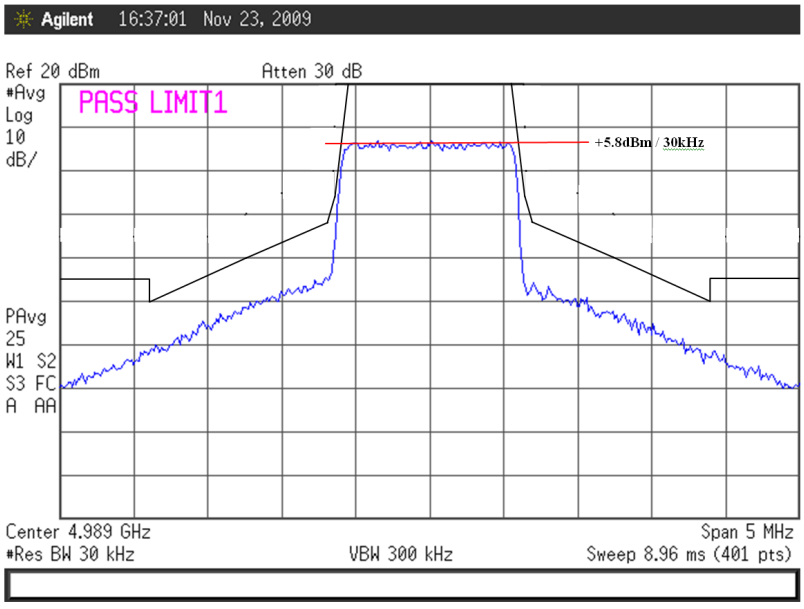


Fig. 12b
Emission Mask Compliance
TX Mode = DOMO-N
Emission: 1M3W7D
Upper Band Edge

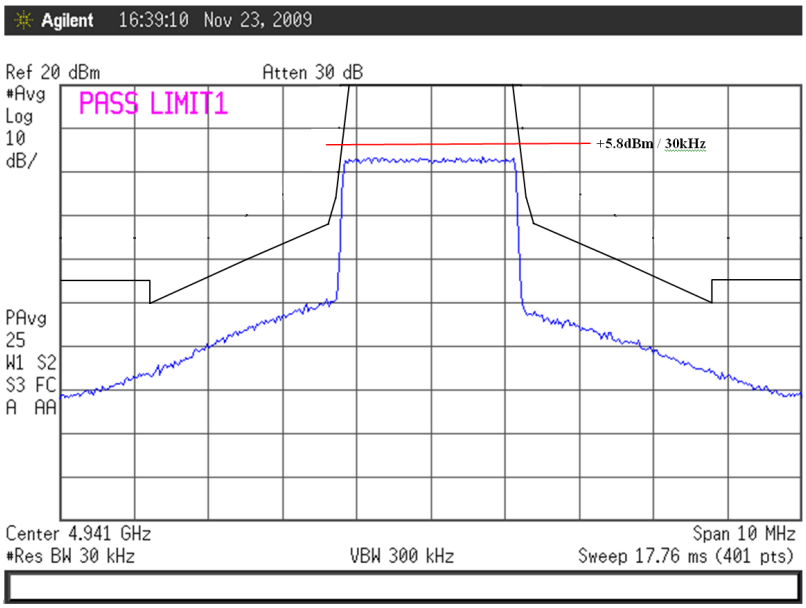


Fig. 13a
Emission Mask Compliance
TX Mode = DOMO-W
Emission: 2M5W7D
Lower Band Edge

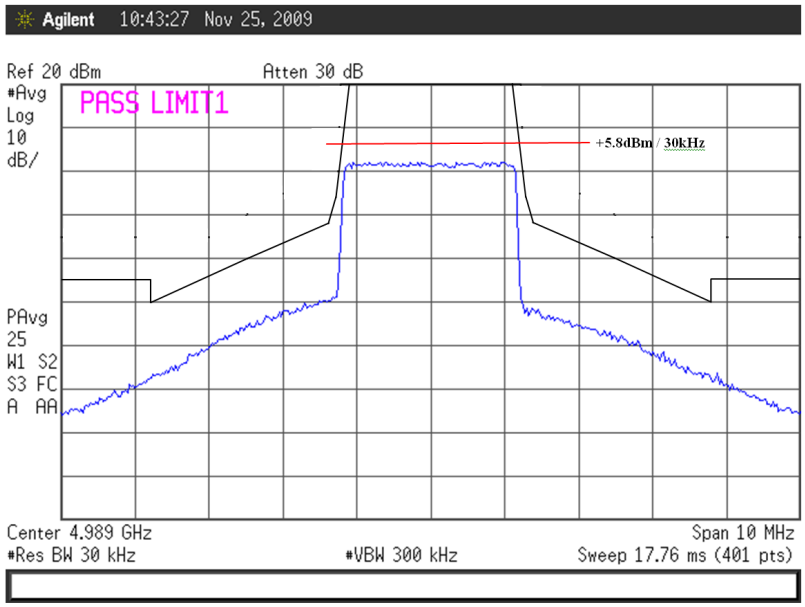


Fig. 13b
Emission Mask Compliance
TX Mode = DOMO-W
Emission: 2M5W7D
Upper Band Edge

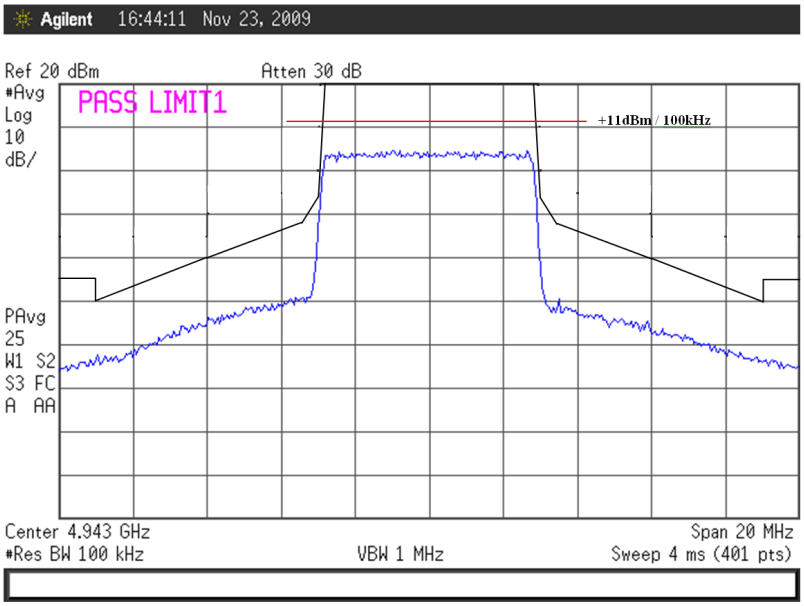


Fig. 14a
Emission Mask Compliance
TX Mode = DVB-T
Emission: 6M0W7D
Lower Band Edge

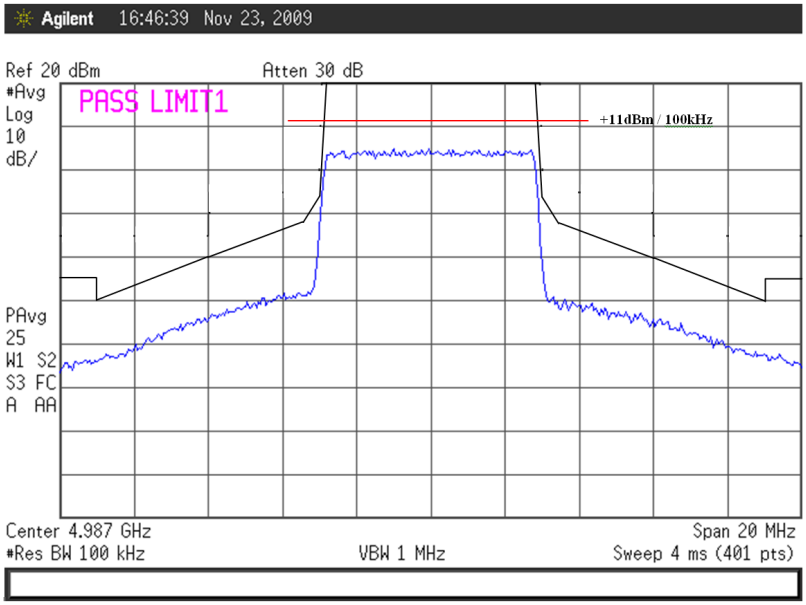


Fig. 14b
Emission Mask Compliance
TX Mode = DVB-T
Emission: 6M0W7D
Upper Band Edge

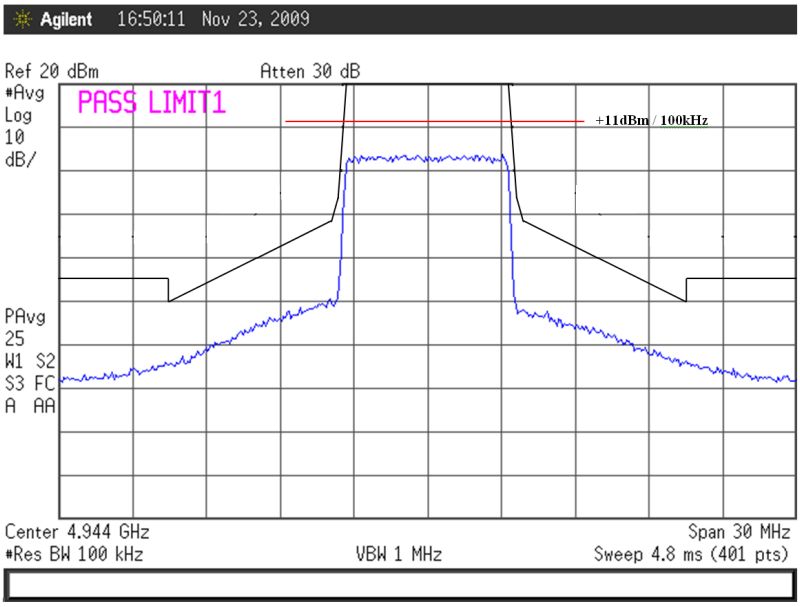


Fig. 15a
Emission Mask Compliance
TX Mode = DVB-T
Emission: 7M0W7D
Lower Band Edge

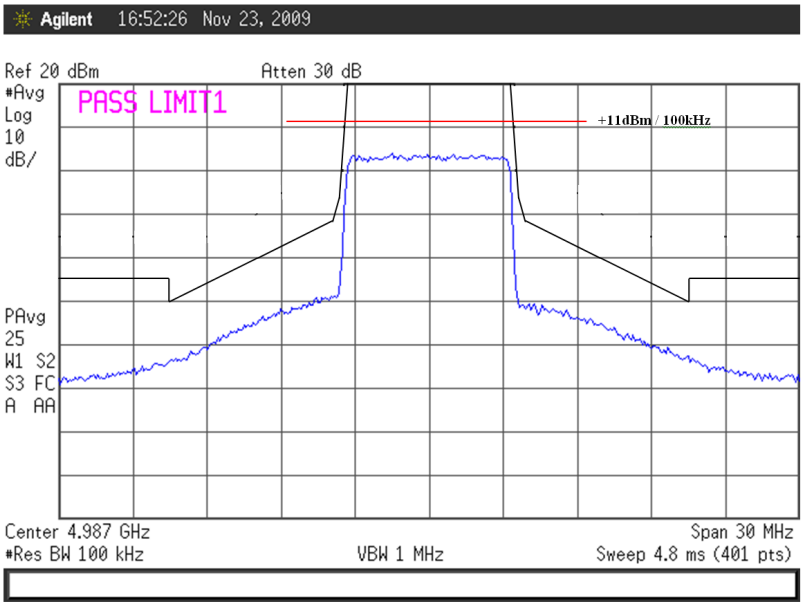


Fig. 15b
Emission Mask Compliance
TX Mode = DVB-T
Emission: 7M0W7D
Upper Band Edge

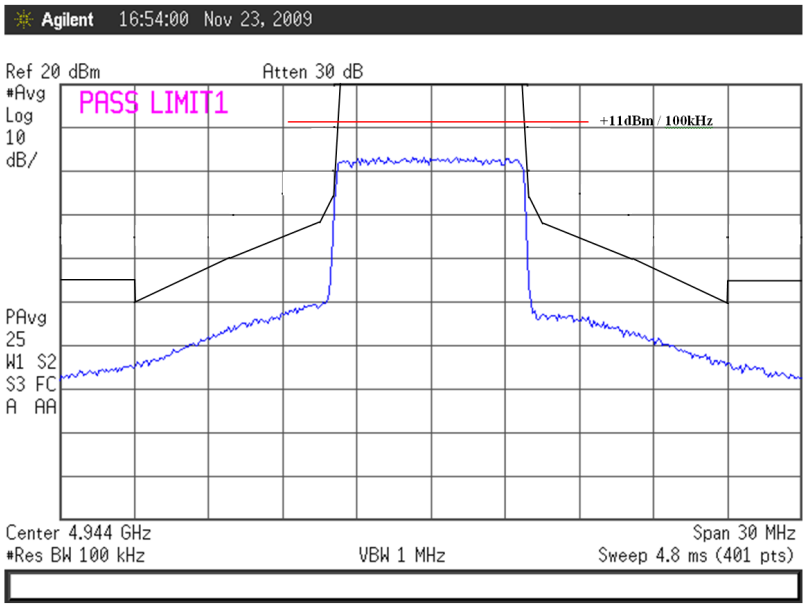


Fig. 16a
Emission Mask Compliance
TX Mode = DVB-T
Emission: 8M0W7D
Lower Band Edge

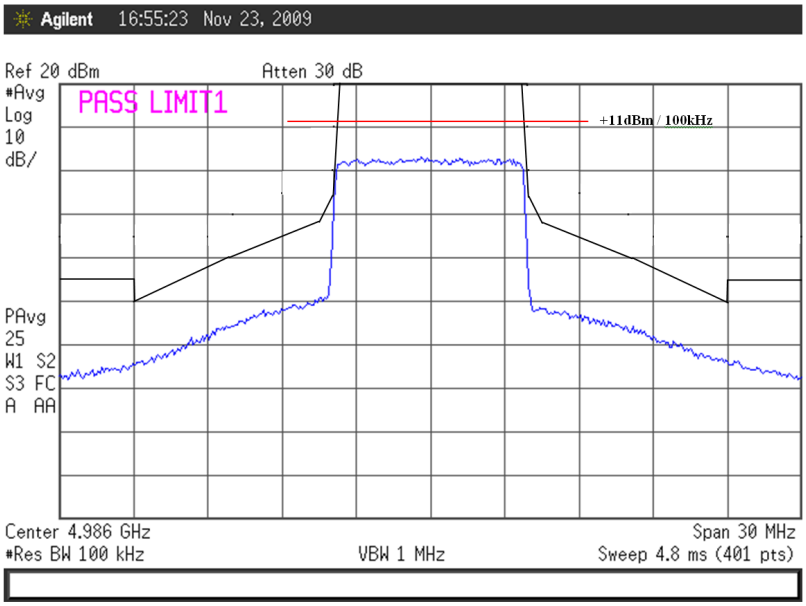


Fig. 16b
Emission Mask Compliance
TX Mode = DVB-T
Emission: 8M0W7D
Upper Band Edge

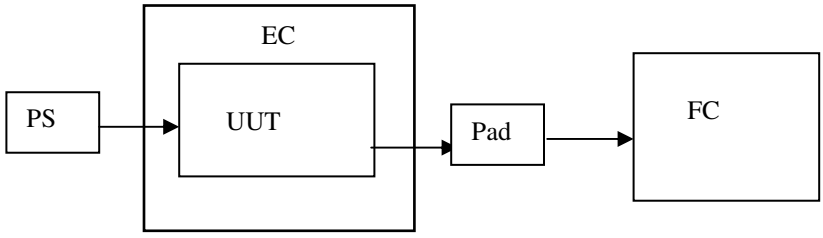
VMD-TX-100-C Frequency Stability – Temperature

Relevant FCC Chapter:
2.1055 Measurements required: Frequency Stability.
(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From –30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

[The VMD-TX-100-C does not qualify under part 90, chapter 2.1055 (a) (2) or (a) (3)]

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

Test Setup:
The setup for this test is shown below.



PS – Power Supply – Kikusui PAB18-1A S/N 10127422
EC – Environmental Chamber – Applied Systems BK-1101 – SN 8665
UUT – VMD-TX-100-C
Pad – 20 dB Pad – INMET 18N5W20
FC – Frequency Counter – Systron Donner 6420- S/N 61003-8

Test Method:
The unit under test was powered at 12.0 VDC and set to a carrier frequency of 4941.25 MHz. The digital modulation was disabled in order to allow the unit to transmit a single CW center frequency carrier. The Environmental Chamber was set to -30^{O} C and swept to $+50^{O}$ C in 10^{O} steps. Due to the small size of the chamber and the UUT, the unit was left at each temperature for 1 hour before the measurement was made. Since there is no method of keying the transmitter or any form of heating element in the UUT, those results are not required.

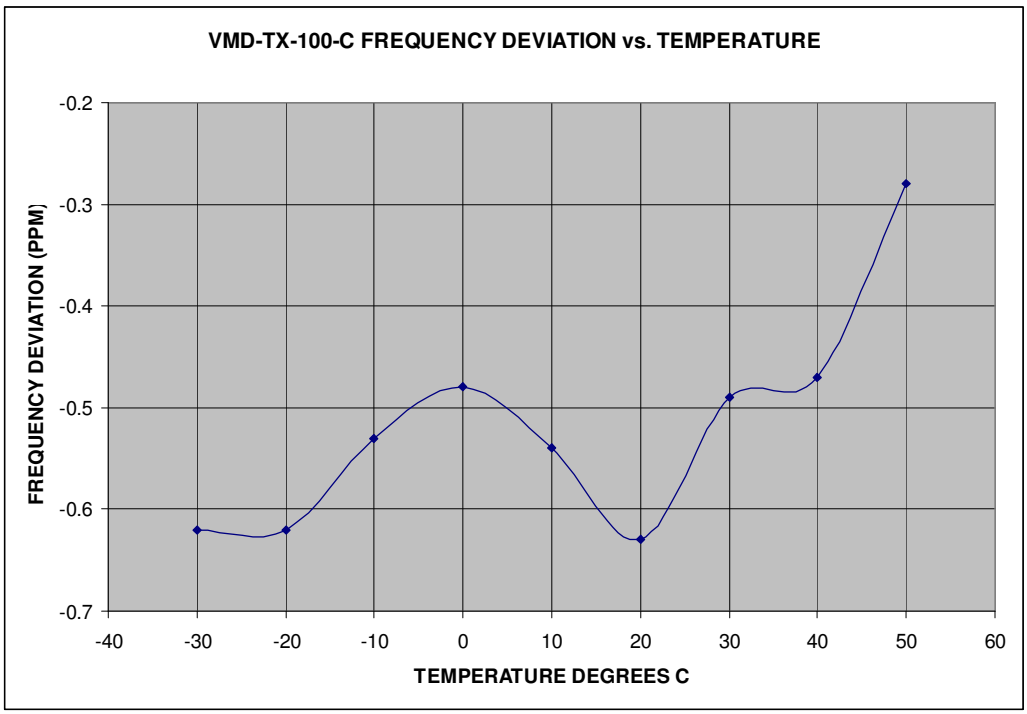
Test Results:
The results of the test are shown in Figures 17a and 17b.

Figure 17a – Frequency Stability as a Function of Temperature (Pursuant to FCC Requirement 2.1055a) – Raw Data

VMD-TX-100-C
SN# TT001004

Temp (deg C.)	Frequency (Hz)	Deviation (ppm)
-30	4,941,246,960	-0.62
-20	4,941,246,960	-0.62
-10	4,941,247,380	-0.53
0.0	4,941,247,610	-0.48
+10	4,941,247,310	-0.54
+20	4,941,246,880	-0.63
+30	4,941,247,600	-0.49
+40	4,941,247,660	-0.47
+50	4,941,248,600	-0.28

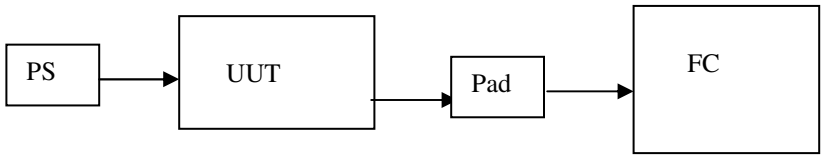
Figure 17b – Frequency Deviation as a Function of Temperature (Pursuant to FCC Requirement 2.1055a)



VMD-TX-100-C Frequency Stability – Power Supply

Relevant FCC Chapter:
2.1055 Measurements required: Frequency Stability.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

Test Setup:
The setup for this test is shown below.



PS – Power Supply – Kikusui PAB18-1A S/N 10127422
UUT – VMD-TX-100-C
Pad – 20 dB Pad – INMET 18N5W20
FC – Frequency Counter – Systron Donner 6420- S/N 61003-8

Test Method:
The output frequency of the unit under test was measured at supply voltages between 10 and 15VDC in 1V increments

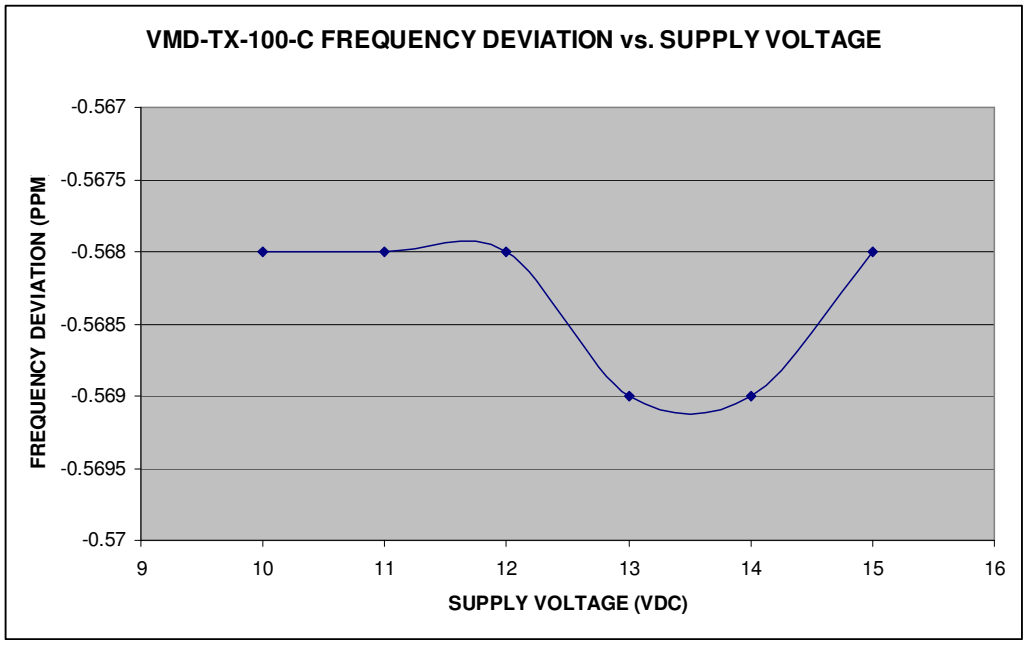
Test Results: The results of the test are shown in Figures 18a and 18b.

Frequency Deviation (PPM) as a function of supply voltage

Figure 18a – Frequency Stability as a Function of Supply Voltage (Pursuant to FCC Requirement 2.1055d) – Raw Data

Vsupply (VDC)	Frequency Vs Supply Voltage Fc = 4,940,000,000 Hz	
	Frequency (Hz)	Deviation (PPM)
10.0	4,939,997,195	-0.568
11.0	4,939,997,193	-0.568
12.0	4,939,997,192	-0.568
13.0	4,939,997,189	-0.569
14.0	4,939,997,190	-0.569
15.0	4,939,997,196	-0.568

Figure 18b – Frequency Deviation (PPM) as a Function of Supply Voltage (Pursuant to FCC Requirement 2.1055d)



VMD-TX-100-C SAR Testing

Relevant FCC Chapter:
2.1093 Radio frequency radiation exposure evaluation: portable devices.
2.1093
(c)Portable devices that operate in
the Cellular Radiotelephone Service,
the Personal Communications Service (PCS),
the Satellite Communications Services,
the General Wireless Communications Service,
the Wireless Communications Service,
the Maritime Services,
the Specialized Mobile Radio Service,
the 4.9 GHz Band Service,
the Wireless Medical Telemetry Service (WMTS)
and the Medical Implant Communications Service (MICS),
authorized under subpart H of part 22 of this chapter, parts 24, 25, 26, 27, 80, and 90 of this chapter, subparts H and I of part 95 of this chapter, and unlicensed personal communication service, unlicensed NII devices and millimeter wave devices authorized under subparts D and E, §§15.253, 15.255 and 15.257 of this chapter are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use. All other portable transmitting devices are categorically excluded from routine environmental evaluation for RF exposure prior to equipment authorization or use, except as specified in §§1.1307(c) and 1.1307(d) of this chapter.

The VMD-TX-100-C operates in the services delineated by 2.1093 (c). However, the VMD-TX-100-C is not specifically designed for body-worn applications and, as such, the VMD-TX-100-C Operator's Manual states that "a separation distance of at least 20 cm must be maintained between the antenna and the body of the user or nearby persons."

The antenna supplied with the VMD-TX-100-C has a gain of 2.1dBi. The MPE (Maximum Permissible Exposure) calculation for the VMD-TX-100-C, operating with this antenna, and the minimum body-antenna separation stated above (20cm), yields a Power Density of 0.04mW/cm^2. The limit for Maximum Permissible Exposure (MPE) (General Population) in the frequency band 1.50 – 100 GHz is 1 mW/cm^2 (47 CFR 1.1310).

The intended usage of the VMD-TX-100-C and the resulting MPE level exempt the VMD-TX-100-C from SAR testing and none was performed.

Spurious Radiated Emissions – 2.1053, 90.210(d)

Measurements performed by RETLIF TESTING LABS

See Test Report Attachment R-5263N, Pages 1 thru 20

ATTACHMENT FILE: R-5263N DTC Communications Digital Transmitter Data Package (VMD-TX-100-C).pdf