Measurement of RF Interference from an Aviation Communications Transceiver, Model VHF-4100/VHF-4100E

For : Rockwell Collins, Inc.
Melbourne, FL

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Specification : FCC "Code of Federal Regulations" Title 47
Part 15, Subpart B and Part 87, Subpart D

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Revision History

Revision	Date	Description
—	02/14/2006	Initial release

Measurement of RF Emissions from an Aviation Communications Transceiver,

Model VHF-4100/VHF-4100E

1.0 INTRODUCTION:

1.1 Description of Test Item - This document presents the results of the series of radio interference measurements performed on an Aviation Communications Transceiver, Model No.VHF-4100, Serial Number 21H9X, and Model No. VHF-4100E, Serial Number 21H9V (hereinafter referred to as the test item). The VHF-4100 is designed to transmit and receive in the frequency range of 118MHz to 137MHz using an external antenna. The VHF-4100E is designed to transmit and receive in the frequency rang of 118MHz to 152MHz using an external antenna. The receiver contained one local oscillator, IF, at 28.9MHz. The test item was submitted for testing by Rockwell Collins, Inc. located in Melbourne, FL.

1.2 Purpose - The test series was performed to determine if the test item meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109 for receivers, and the RF power output, modulation characteristics, occupied bandwidth, emissions limitations, spurious emissions at antenna terminal, field strength of spurious emissions, frequency stability, and transient frequency behavior requirements of Part 87, Subpart D. Testing was performed in accordance with ANSI C63.4-2003 and TIA-603-C-2004.

1.3 Deviations, Additions and Exclusions - There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 Applicable Documents - The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, dated 1 October 2004

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 87, dated 1 October 2004

- ANSI C63.4-2003, "American National Standard for 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”

1.5 Subcontractor Identification - This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP

Lab Code: 100278-0.

1.6 Laboratory Conditions The temperature at the time of the test was 22°C and the relative humidity was 24%.

2.0 TEST ITEM SET-UP AND OPERATION:

The test item is an Aviation Communications Transceiver, Model VHF-4100/VHF-4100E. The VHF-4100 is designed to transmit and receive in the 118MHz to 137MHz frequency range. The VHF-4100E is designed to transmit and receive in the 118MHz to 152MHz frequency range.

2.1 Power Input - A DC Power Supply was used to provide 27.5VDC to the NEXCOM VHF-4100 Test Fixture. The test item received 27.5VDC from the NEXCOM VHF-4100 Test Fixture via a Part No. 653-5025-005 cable.

2.2 Grounding - The test item was ungrounded during testing.

2.3 Peripheral Equipment - The test item was submitted for testing with the following peripheral equipment:

- Dell Optiplex GX150 computer
- CEI520 Transition Cable B/O Box
- NEXCOM VHF-4100 Test Fixture

2.4 Interconnect Cables - The Dell Optiplex GX150 computer was connected to the CEI520 Transition Cable B/O Box via a SCSI Cable. The "Tx 1" port of the CEI520 Transition Cable B/O Box was connected to the "CMU A In" port of the NEXCOM VHF-4100 Test Fixture. The "Tx 4" port of the CEI520 Transition Cable B/O Box was connected to the "Freq B In" port of the NEXCOM VHF-4100 Test Fixture. The "Rx 1" port of the CEI520 Transition Cable B/O Box was connected to the "CMU OUT" port of the NEXCOM VHF-4100 Test Fixture. The NEXCOM VHF-4100 Test Fixture was connected to the test item via a Part No. 653-5025-005 cable.

2.5 Operational Mode - For all receiver tests, the test item was set to receive separately at 118MHz, 128MHz, 136.975MHz, and 151.5MHz.

For RF Power Output Tests, Occupied Bandwidth Tests, and Spurious Emissions at Antenna Terminal Tests on the transmitter, the test item was set to transmit separately in the following modes:

-AM Voice Mode Double Sideband (CW), 118MHz
-AM Voice Mode Double Sideband (CW), 128MHz
-AM Voice Mode Double Sideband (CW), 136.975MHz
-AM Voice Mode Double Sideband (CW), 151.5MHz
-Data Link, 118MHz
-Data Link, 128MHz
-Data Link, 136.975MHz
-Digital Audio Link, 118MHz
-Digital Audio Link, 128MHz

-Digital Audio Link, 136.975MHz

For Frequency Response Tests and Compression Characteristics Tests on the transmitter, the test item was set to transmit at 118MHz with both 25kHz channel spacing and 8.33kHz channel spacing.

For Spurious Radiated Emissions Tests, the test item was set to transmit separately in the following modes:

-AM Voice Mode Double Sideband (CW), 118MHz
-AM Voice Mode Double Sideband (CW), 128MHz
-AM Voice Mode Double Sideband (CW), 136.975MHz
-AM Voice Mode Double Sideband (CW), 151.5MHz

For Frequency Stability Tests, the test item was set to transmit at 136.975MHz, AM Voice Mode Double Sideband (CW).

For Transient Frequency Behavior, the test item was set to transmit at 118MHz, 25kHz Channel Spacing.

2.6 Test Item Modifications - No modifications were required for compliance to the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109, and Part 87, Subpart D requirements.

3.0 TEST EQUIPMENT:

3.1 Test Equipment List - A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

3.2 Calibration Traceability - Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

3.3 Measurement Uncertainty - All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty budgets were based on guidelines in "ISO Guide to the Expression of Uncertainty in Measurements" and NAMAS NIS81 "The Treatment of Uncertainty in EMC Measurements".

The measurement uncertainty for these tests is presented below:

Conducted Emission Measurements		
Combined Standard Uncertainty	1.07 dB	-1.07 dB
Expanded Uncertainty (95% confidence)	2.1 dB	-2.1 dB

Radiated Emission Measurements		
Combined Standard Uncertainty	2.26 dB	-2.18 dB

Expanded Uncertainty (95% confidence)	4.5 dB	-4.4 dB

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 Receiver:

4.1.1 Powerline Conducted Emissions:

4.1.1.1 Requirements - Since the test item was powered with 27.5VDC from a power supply, no conducted emissions tests were performed.

4.1.2 Antenna Conducted Emissions Measurements:

4.1.2.1 Requirements - This test is performed to determine the test item configuration during the radiated RF emissions tests. The power at the antenna terminal over the frequency range 30MHz to 2000MHz may be measured. If the emissions at the antenna terminal exceed 2 nanowatts, it is necessary to perform the radiated RF emissions tests with the antenna port terminated with an equivalent antenna. If the test item does meet the 2 nanowatt requirement, the radiated emissions tests can be performed with the antenna port terminated with a shielded load.

4.1.2.2 Procedures - The measuring equipment was connected to the test item's antenna port. The emissions in the frequency range from 30MHz to 2000MHz were observed and then plotted.

4.1.2.3 Results - The results of the antenna conducted measurements are presented on data pages 28 through 31. The reference line shown on the data pages represents the 2 nanowatt requirement. As can be seen from the data pages, all emissions from the test item were below the 2 nanowatt requirement. Since the emissions were below the 2 nanowatt limit, the antenna port was terminated with a shielded load for radiated emissions measurements. Photographs of the test setup are shown on Figure 2.

4.1.3 Radiated Measurements:

4.1.3.1 Requirements - All emanations from a receiver shall be below the levels shown on the following table:

RADIATION LIMITS FOR RECIEVERS

Frequency MHz	Distance between Test Item And Antenna in Meters	Field Strength uV/m
30-88	3	100
88-216	3	150
216-960	3	200
Above 960	3	500

Note: The tighter limit shall apply at the edge between the two frequency bands.

4.1.3.2 Procedures - All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-

tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All power lines and signal lines entering the enclosure pass through filters on the enclosure wall. The power line filters prevent extraneous signals from entering the enclosure on these leads.

Since a quasi-peak detector requires long integration times, it is not practical to automatically sweep through the quasi-peak levels. Therefore, radiated emissions from the test item were first scanned using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured using the quasi-peak detector.

The broadband measuring antenna was positioned at a 3 meter distance from the test item. The frequency range from 30MHz to 2000MHz was investigated using a peak detector function with a bilog antenna. The maximum levels were plotted.

Final radiated emissions were performed on all significant broadband and narrowband emissions found in the preliminary sweeps using the following methods:

1) For all frequencies 1GHz and below, measurements were made using a broadband bi-log antenna.

2) For all frequencies above 1GHz, measurements were made using a waveguide antenna.

3) To ensure that the maximum, or worst case, emission levels were measured, the following steps were taken:

   (a) The test item was rotated so that all of its sides were exposed to the receiving antenna.

   (b) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

   (c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.

4.1.3.3 Results - The preliminary plots are presented on pages 32 through 35. These plots are presented for a reference only, and are not used to determine compliance.

The final radiated levels are presented on pages 36 through 39. As can be seen from the data, all emissions measured from the test item were within the specification limits. A block diagram of the radiated emissions test setup is shown on Figure 1. Photographs of the test configuration which yielded the highest or worst case radiated emission levels are shown on Figures 3 and 4.

4.2 Transmitter:

4.2.1 RF Power Output:

4.2.1.1 Requirements - In accordance with paragraph 87.131, the maximum power for Aircraft (Communications) is:

Class of Station	Frequency Band/ Frequency	Authorized Emissions	Maximum Power
Aircraft (Communication)	VHF	A3E, A9W, G1D	55 Watts

4.2.1.2 Procedures – With the test item operated in the AM Voice Mode Double Sideband (CW), the antenna port of the test item was connected to a power meter through a 50 dB attenuator. The output power of the item was then measured.

With the test item operated in the Data Link Mode and the Digital Audio Link mode, the antenna port of the test item was connected to a spectrum analyzer through a 50 dB attenuator. The output power of the test item was measured.

4.2.1.3 Results - The output power measurements are presented on pages 40 through 42. As can be seen from the data, the power output of each mode is below the maximum allowable power of 55 Watts. A photograph of the test configuration is shown on Figure 5.

4.2.2 Modulation Characteristics:

4.2.2.1 Requirements - In accordance with paragraph 87.141(a), when A3E emission is used, the modulation percentage must not exceed 100%. In accordance with paragraph 87.141(b), a double sideband full carrier amplitude modulated radiotelephone transmitter with rated carrier power output exceeding 10 watts must be capable of automatically preventing modulation in excess of 100%.

4.2.2.2 Procedures – The test item is set to transmit at 118MHz with 25kHz channel spacing. The antenna port of the test item was connected to a modulation analyzer through 50dB of attenuation. The output of an audio generator was connected to the Tx Voice input of the NEXCOM VHF-4100 Test Fixture.

(a) The audio generator was set to 1000Hz, with an output level of 250mVrms. This produced a modulation of approximately 90% at 1000Hz.
(b) While maintaining this output level on the audio generator, the audio generator is adjusted over the frequency range of 100Hz to 7000Hz.
(c) The modulation depth of the test item was recorded.
(d) Next, the audio generator was set to 1000Hz.
(e) The modulation depth of the test item was recorded as the output level of the audio generator was varied from 40mVrms to 1000mVrms.
(f) Step (e) was repeated with the output of audio generator set to 300Hz.
(g) Step (e) was repeated with the output of audio generator set to 600Hz.
(h) Step (e) was repeated with the output of audio generator set to 1000Hz.
(i) Step (e) was repeated with the output of audio generator set to 2000Hz.
(j) Step (e) was repeated with the output of audio generator set to 3000Hz.

(k) Step (e) was repeated with the output of audio generator set to 4000Hz.
(l) Step (e) was repeated with the output of audio generator set to 5000Hz.
(m) Steps (a) through (l) were repeated with the channel spacing set to 8.33kHz.

4.2.2.3 Results - The plots of the modulation characteristics are presented on pages 43 through 45. As can be seen from the data, no modulation in excess of 100% occurred. A photograph of the test configuration is shown on Figure 5.

4.2.3 Occupied Bandwidth:

4.2.3.1 Requirements – Per 87.135(a):

- The authorized bandwidth for A3E class of emission operating in the frequency range of 117.975MHz – 136MHz is 25kHz for transmitters approved after January 1, 1974.
- The authorized bandwidth for A9W class of emission is 25kHz.
- The authorized bandwidth for 14K0G1D emission designator is 25kHz.

4.2.3.2 Procedures - The test item was set to transmit at 118MHz in the AM Voice Mode.

(a) The antenna port of the test item was connected to a modulation analyzer.
(b) The output of an audio generator was connected to the Tx Voice input of the NEXCOM VHF-4100 Test Fixture.
(c) The output of the audio generator was set to 2500Hz and the output level was increased until 90% modulation was seen on the modulation analyzer.
(d) The output level of the audio generator was decreased until 45% modulation was seen on the modulation analyzer.
(e) The output level of the audio generator was increased by 16dB.
(f) The output of the test item was then connected to a spectrum analyzer through 50dB of attenuation.
(g) The resolution bandwidth of the spectrum analyzer was set to 100Hz.
(h) The spectrum analyzer then measured the 99% bandwidth of the signal.
(i) Steps (a) through (h) were repeated with the test item set to transmit at 128MHz in the AM Voice mode.
(j) Steps (a) through (h) were repeated with the test item set to transmit at 136.975MHz in the AM Voice mode.
(k) Steps (a) through (h) were repeated with the test item set to transmit at 151.5MHz in the AM Voice mode.
(l) Steps (f) through (h) were repeated, with the test item set to transmit at 118MHz in the Data Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(m) Steps (f) through (h) were repeated with the test item set to transmit at 128MHz in the Data Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(n) Steps (f) through (h) were repeated with the test item set to transmit at 136.975MHz in the Data Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(o) Steps (f) through (h) were repeated with the test item set to transmit at 118MHz in the Digital Audio Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(p) Steps (f) through (h) were repeated with the test item set to transmit at 128MHz in the Digital Audio Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(q) Steps (f) through (h) were repeated with the test item set to transmit at 136.975MHz

in the Digital Audio Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.

4.2.3.3 Results - The spectrum analyzer plots of the 99% bandwidth (occupied bandwidth) measurement for each transmit frequency and each transmit mode listed above are shown on pages 46 through 55. A table listing the 99% bandwidth (occupied bandwidth) for each transmit frequency and each transmit mode listed above is shown on page 56. As can be seen from the data, the 99% bandwidth (occupied bandwidth) for each transmit frequency and each transmit mode listed above was within the 25kHz authorized bandwidth. A photograph of the test configuration is shown on Figure 6.

4.2.4 Emissions Limitations:

4.2.4.1 Requirements - Per 87.139(a), the mean power of any emissions shall be attenuated below the mean output power of the transmitter as follows:

(1) When the frequency is removed from the assigned frequency by more than 50% up to and including 100% of the authorized bandwidth the attenuation must be at least 25dB.
(2) When the frequency is removed from the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth the attenuation must be at least 35dB.
(3) When the frequency is removed from the assigned frequency by more than 250% percent of the authorized bandwidth the attenuation must be at least 43 + 10log (Power)dB.

4.2.4.2 Procedures - The test item was set to transmit at 118MHz in the AM Voice Mode.

(a) The antenna port of the test item was connected to a modulation analyzer.
(b) The output of an audio generator was connected to the Tx Voice input of the NEXCOM VHF-4100 Test Fixture.
(c) The output of the audio generator was set to 2500Hz and the output level was increased until 90% modulation was seen on the modulation analyzer.
(d) The output level of the audio generator was decreased until 45% modulation was seen on the modulation analyzer.
(e) The output level of the audio generator was increased by 16dB.
(f) The output of the test item was then connected to a spectrum analyzer through 50dB of attenuation.
(g) The resolution bandwidth of the spectrum analyzer was set to 100Hz with a 200kHz span.
(h) The spectrum analyzer made several sweeps in the max hold mode and the plot was recorded.
(i) Steps (a) through (h) were repeated with the test item set to transmit at 128MHz in the AM Voice mode.
(j) Steps (a) through (h) were repeated with the test item set to transmit at 136.975MHz in the AM Voice mode.
(k) Steps (a) through (h) were repeated with the test item set to transmit at 151.5MHz in the AM Voice mode.
(l) Steps (f) through (h) were repeated with the test item set to transmit at 118MHz in the Data Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(m) Steps (f) through (h) were repeated with the test item set to transmit at 128MHz in the Data

Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(n) Steps (f) through (h) were repeated with the test item set to transmit at 136.975MHz in the Data Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(o) Steps (f) through (h) were repeated with the test item set to transmit at 118MHz in the Digital Audio Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(p) Steps (f) through (h) were repeated with the test item set to transmit at 128MHz in the Digital Audio Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.
(q) Steps (f) through (h) were repeated with the test item set to transmit at 136.975MHz in the Digital Audio Link mode and the resolution bandwidth of the spectrum analyzer set to 1kHz.

4.2.4.3 Results - The spectrum analyzer plots of the emissions of the test item for each transmit frequency and each transmit mode listed above are shown on pages 57 through 66. The limits, shown on the plots, are referenced to the power measured from the unmodulated carrier. As can be seen from the data, the test item did not produce spurious emissions in excess of the limit. A photograph of the test configuration is shown on Figure 6.

4.2.5 Spurious Emissions At Antenna Terminal:

4.2.5.1 Requirements - Per 87.139(a), the mean power of any emissions shall be attenuated below the mean output power of the transmitter as follows:

When the frequency is removed from the assigned frequency by more than 250% percent of the authorized bandwidth the attenuation must be at least 43 + 10log (Power)dB.

4.2.5.2 Procedures - The test item was set to transmit at 118MHz in the AM Voice Mode.

(a) The antenna port of the test item was connected to a modulation analyzer.
(b) The output of an audio generator was connected to the Tx Voice input of the NEXCOM VHF-4100 Test Fixture.
(c) The output of the audio generator was set to 2500Hz and the output level was increased until 90% modulation was seen on the modulation analyzer.
(d) The output level of the audio generator was decreased until 45% modulation was seen on the modulation analyzer.
(e) The output level of the audio generator was increased by 16dB.
(f) The output of the test item was then connected to a spectrum analyzer through 50dB of attenuation.
(g) The resolution bandwidth of the spectrum analyzer was set to 100kHz.
(h) A sweep was made from 30MHz to 1GHz.
(i) The resolution bandwidth of the spectrum analyzer was set to 1MHz.
(j) A sweep was made from 1GHz to 2GHz.
(k) Steps (a) through (j) were repeated with the test item set to transmit at 128MHz in the AM Voice mode.
(l) Steps (a) through (j) were repeated with the test item set to transmit at 136.975MHz in the AM Voice mode.
(m) Steps (a) through (j) were repeated with the test item set to transmit at 151.5MHz in the AM Voice mode.

(n) Steps (f) through (j) were repeated with the test item set to transmit at 118MHz in the Data Link mode.
(o) Steps (f) through (j) were repeated with the test item set to transmit at 128MHz in the Data Link mode.
(p) Steps (f) through (j) were repeated with the test item set to transmit at 136.975MHz in the Data Link mode.
(q) Steps (f) through (j) were repeated with the test item set to transmit at 118MHz in the Digital Audio Link mode.
(r) Steps (f) through (j) were repeated with the test item set to transmit at 128MHz in the Digital Audio Link mode.
(s) Steps (f) through (j) were repeated with the test item set to transmit at 136.975MHz in the Digital Audio Link mode.

4.2.5.3 Results - The plots of the antenna conducted output measurements are presented on pages 67 through 86. The limits, shown on the plots, are referenced to the power measured from the unmodulated carrier. As can be seen from the data, the test item did not produce spurious emissions in excess of the limit. A photograph of the test configuration is shown on Figure 6.

4.2.6 Field Strength Of Spurious Emissions:

4.2.6.1 Requirements - Per 87.139(a), the mean power of any emissions shall be attenuated below the mean output power of the transmitter as follows:

(1) When the frequency is removed from the assigned frequency by more than 50% up to and including 100% of the authorized bandwidth the attenuation must be at least 25dB.
(2) When the frequency is removed from the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth the attenuation must be at least 35dB.
(3) When the frequency is removed from the assigned frequency by more than 250% percent of the authorized bandwidth the attenuation must be at least 43 + 10log (Power)dB.

4.2.6.2 Procedures - All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4 2003 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

1. Preliminary radiated emissions measurements were first performed using a peak detector and automatically plotted. The broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 30MHz to 2GHz was investigated using a peak detector function. All preliminary tests were performed separately with the test item operating in the transmit at 118MHz, CW mode, transmit at 128MHz, CW mode, transmit at 136.975MHz, CW mode, and transmit at 151.5MHz, CW mode.

2. All significant broadband and narrowband signals found in the preliminary sweeps were then measured

using a peak detector at a test distance of 3 meters. The measurements were made with a tuned bilog or double ridged waveguide antenna over the frequency range of 30MHz to 2GHz.

3. To ensure that maximum emission levels were measured, the following steps were taken:

   a. The test item was rotated so that all of its sides were exposed to the receiving antenna.
   b. Since the measuring antennas are linearly polarized, both horizontal and vertical field components were measured.
   c. The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.

4. The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power a tuned dipole or double ridged waveguide antenna was set in place of the test item and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was corrected to compensate for cable loss, as required, and when the double ridged waveguide antenna was used, increased by the difference in gain between the dipole and the waveguide antenna.

4.2.6.3 Results - The preliminary radiated emissions plots are presented on pages 87 through 90. Factors for the antennas and cables were added to the data before it was plotted. This data is only presented for a reference, and is not used as official data.

The final radiated levels are presented on pages 91 through 94. The radiated emissions were measured through the 10th harmonic. As can be seen from the data, all emissions measured from the test item were within the specification limits. Photographs of the test configuration are shown on Figures 3 and 4.

4.2.7 Frequency Stability :

4.2.7.1 Requirements - In accordance with paragraph 87.133(a), for aircraft stations operating in the 100MHz to 137MHz frequency band, the carrier frequency must be maintained within 30 ppm.

4.2.7.2 Procedures - The antenna port of the test item was connected to a frequency counter. The test item was then placed in a humidity temperature chamber.

(a) The test item was turned on and set to transmit at 136.975MHz in the AM Voice Double Sideband (CW) mode. The transmit frequency was measured and recorded at ambient temperature.
(b) The temperature chamber was then set to -20ºC.
(c) Once the temperature chamber had reached -20ºC, the test item was allowed to soak for 30 minutes.
(d) After soaking at -20ºC for thirty minutes, the test item was turned on and set to transmit at 136.975MHz in the AM Voice Double Sideband (CW) mode and the transmit frequency was measured and recorded.
(e) Steps (b) through (d) were repeated at -10ºC.
(f) Steps (b) through (d) were repeated at 0ºC.
(g) Steps (b) through (d) were repeated at +10ºC.
(h) Steps (b) through (d) were repeated at +20ºC.

(i) Steps (b) through (d) were repeated at +30ºC.
(j) Steps (b) through (d) were repeated at +40ºC.
(k) Steps (b) through (d) were repeated at +50ºC.
(l) The test item was then removed from the temperature chamber and allowed to adjust to nominal room temperature.
(m) The supply voltage was checked and adjusted to the nominal level (27.5VDC). The test item was turned on and set to transmit at 136.975MHz in the AM Voice Double Sideband (CW) mode. The transmit frequency was measured and recorded at ambient temperature.
(n) The supply voltage was then varied to 85% of its nominal level (23.38VDC). The test item was turned on and set to transmit at 136.975MHz in the AM Voice Double Sideband (CW) mode. The transmit frequency was measured and recorded at ambient temperature.
(o) The supply voltage was then varied to 115% of its nominal level (31.63VDC). The test item was turned on and set to transmit at 136.975MHz in the AM Voice Double Sideband (CW) mode. The transmit frequency was measured and recorded at ambient temperature.

4.2.7.3 Results - The frequency stability measurements are presented on pages 95 and 96. As can be seen from the data, all frequency deviations were within the 30 ppm limit. A photograph of the test configuration is shown on Figure 6.

4.2.8 Transient Frequency Behavior:

4.2.8.1 Requirements - Per TIA-603-C, transmitters designed to operate in the 150 – 174MHz frequency band with 25kHz channel spacing must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals	Maximum Frequency Difference	Time (ms)
t_1	+/-25kHz	5.0
t_2	+/-12.5kHz	20.0
t_3	+/-25kHz	5.0

Where:

t_1 is the time period immediately following t_{on}

t_2 is the time period immediately following t_1

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

4.2.8.2 Procedures - Two test signals were connected to the test discriminator via a combining network. The transmitter was connected to a 50 ohm power attenuator. The output of the power attenuator was connected to the test discriminator via one input of the combining network. A test signal was connected to the second input of the combining network.

(a) The test signal was adjusted to the nominal frequency of the transmitter.

(b) The test signal was modulated by a 1 kHz signal with a deviation equal to the value of the relevant channel separation (25kHz).

(c) The test signal was adjusted to correspond to 0.5% of the power of the transmitter under test measured at the input of the test discriminator. This level was maintained throughout the measurement.

(d) The amplitude difference (ad) and the frequency difference (fd) output of the test discriminator were connected to a storage oscilloscope.

(e) The storage oscilloscope was set to display the channel corresponding to the (fd) input up to ±1 channel frequency difference, corresponding to the relevant channel separation, from the nominal frequency.

(f) The storage oscilloscope was set to a rate of 5 ms/div and set so that the triggering occurs at 1 div firm the left edge of the display.

(g) The 1 kHz test signal was shown continuously. The storage oscilloscope was set to trigger on the channel corresponding to the amplitude difference (ad) input at a low input level, rising.

(h) The transmitter was then switched on, without modulation, to produce the trigger pulse and a picture on the display. The result of the change in the ratio of power between the test signal and the transmitter output produced two separate sides, one showing the 1 kHz test signal, the other the frequency difference of the transmitter versus time.

(i) The transmit signal suppresses the 1 kHz test signal and produces the start of the test or t_{on}. During this test time the frequency difference was measured and recorded verses time.

(j) The transmitter was then switched off to produce the trigger pulse and a picture of the display. The result of the change in the ratio of power between the test signal and the transmitter output produced two separate sides, one showing the frequency difference of the transmitter versus time and the other showing the 1 kHz test signal.

(k) The transmitter signal no longer suppresses the 1 kHz test signal and produces t_3.

4.2.8.3 Results - The plots of the transient frequency behavior are shown on pages 97 and 98. As can be seen from the data, all transient frequencies were within the maximum frequency difference limits specified by TIA-603-C. A photograph of the test configuration is shown on Figure 7.

5.0 CONCLUSIONS:

It was determined that the Rockwell Collins, Inc., Aviation Communications Transceiver, Model No.VHF-4100, Serial Number 21H9X, and Model No. VHF-4100E, Serial Number 21H9V did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B, Sections 15.107 and 15.109 for receivers when tested per ANSI C63.4-2003.

It was determined that the Rockwell Collins, Inc., Aviation Communications Transceiver, Model

No.VHF-4100, Serial Number 21H9X, and Model No. VHF-4100E, Serial Number 21H9V did fully meet the RF power output, modulation characteristics, occupied bandwidth, emissions limitations, spurious emissions at antenna terminal, field strength of spurious emissions, frequency stability, and transient frequency behavior, requirements of the FCC "Code of Federal Regulations" Title 47, Part 87, Subpart D, when tested per TIA-603-C-2004.

6.0 CERTIFICATION:

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the test item at the test date. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

7.0 ENDORSEMENT DISCLAIMER:

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

TABLE I: TEST EQUIPMENT LIST

ELITE ELECTRONIC ENG. INC. Page: 1

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XZG3	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2421A03059	---		N/A	
Equipment Type: AMPLIFIERS								
APK3	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01593	1-26.5GHZ	06/03/05	12	06/03/06
Equipment Type: ANTENNAS								
NDP0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB3	311	140-400MHZ	02/01/05	12	02/01/06
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	02/01/05	12	02/01/06
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	08/15/05	12	08/15/06
NWF0	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	10/01/05	12	10/01/06
NWG0	RIDGED WAVE GUIDE (DCC-MAT	AEL	H1479	104	1-12.4GHZ	10/01/05	12	10/01/06
Equipment Type: ATTENUATORS								
T1EE	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	BN2321	DC-18GHZ	12/05/05	12	12/05/06
T2D4	20DB, 25W ATTENUATOR - FL	WEINSCHEL	46-20-43	AY9243	DC-18GHZ	03/08/05	12	03/08/06
T2D9	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-34	BH5445	DC-18HGZ	12/05/05	12	12/05/06
T2E0	20DB, 100W ATTENUATOR	BIRD ELECTRONIC	8343-200	1228	DC-1GHZ	02/08/06	12	02/08/07
Equipment Type: CHAMBERS (ENV)								
ETCC	SINGLE CHANNEL TEMPERATURE	WATLOW	F4SH-CCA0-01	008389-0339	PROGRAMMABLE		NOTE 1	
Equipment Type: CONTROLLERS								
CDS2	COMPUTER	GATEWAY	MFATXPNT NMZ	0028483108	1.8GHZ		N/A	
CMA0	MULTI-DEVICE CONTROLLER	EMCO	2090	9701-1213	---		N/A	
Equipment Type: METERS								
MFC0	MICROWAVE FREQ. COUNTER	HEWLETT PACKARD	5343A	2133A00591	10HZ-26GHZ	05/31/05	12	05/31/06
MPA0	POWER METER	HEWLETT PACKARD	432A	1141A08696	0.01-40GHZ	06/22/04	12	
MPAA	THERMISTOR MOUNT	HEWLETT PACKARD	8478B	1144A08340	0.01-18GHZ	10/20/04	24	10/20/06
MSQ1	DIGITAL OSCILLOSCOPE	LECROY	LT262	00124	DC-350MHZ	07/14/05	12	07/14/06
Equipment Type: POWER SUPPLIES								
SBB1	POWER SUPPLY DC, 40 VOLT/	XANTREX	XHR 40-25	28174	40 V, 25 A		NOTE 1	
Equipment Type: PRINTERS AND PLOTTERS								
HRE1	LASER JET 5P	HEWLETT PACKARD	C3150A	USHB061052	---		N/A	
Equipment Type: RECEIVERS								
RAC2	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3638A08770	100HZ-22GHZ	02/09/05	12	02/09/06
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	12/23/05	12	12/23/06
RAF4	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00320	0.01-1000MHZ	02/09/05	12	02/09/06
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	09/02/05	12	09/02/06
RYE0	MODULATION ANALYZER	HEWLETT PACKARD	8901B	3104A03410	0.15-1300MHZ	12/09/04	14	02/09/06
Equipment Type: SIGNAL GENERATORS								
GBR0	SIGNAL GENERATOR	HEWLETT PACKARD	8648B	3836U01992	9KHZ-2GHZ	06/16/05	12	06/16/06
GRD0	SIGNAL GENERATOR	HEWLETT PACKARD	E4432B	US38080222	250KHZ-3.0GHZ	09/28/05	12	09/28/06
GWF2	WAVEFORM GENERATOR	HEWLETT PACKARD	33120A	US34006558	.1HZ-15MHZ	05/11/05	12	05/11/06

Cal. Interval: Listed in Months I/O: Initial Only N/A: Not Applicable
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

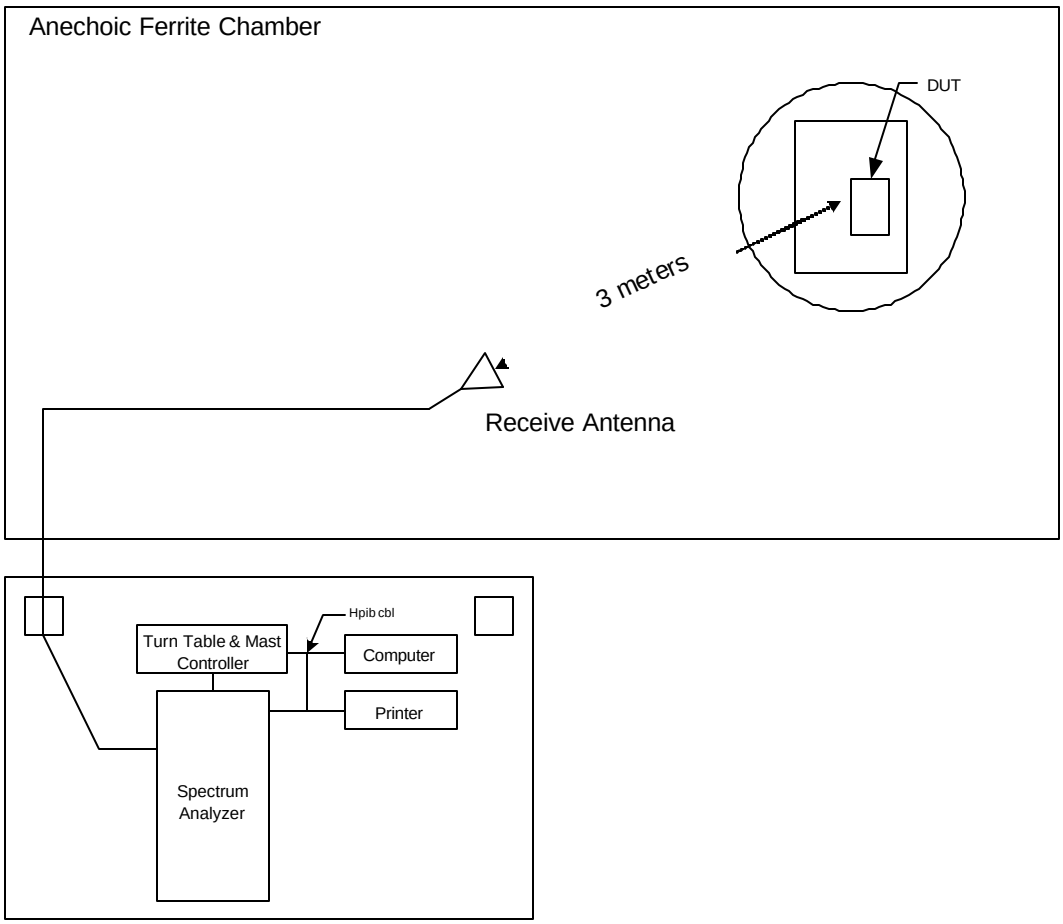
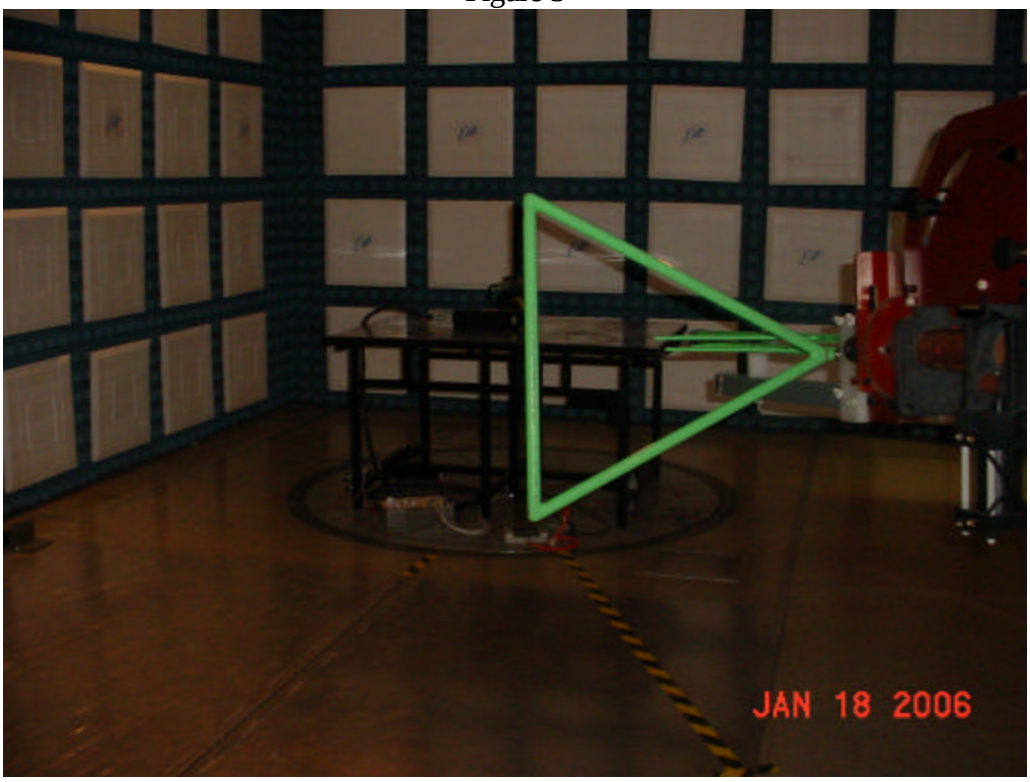


FIGURE 1 BLOCK DIAGRAM OF RADIATED EMISSIONS TEST SETUP

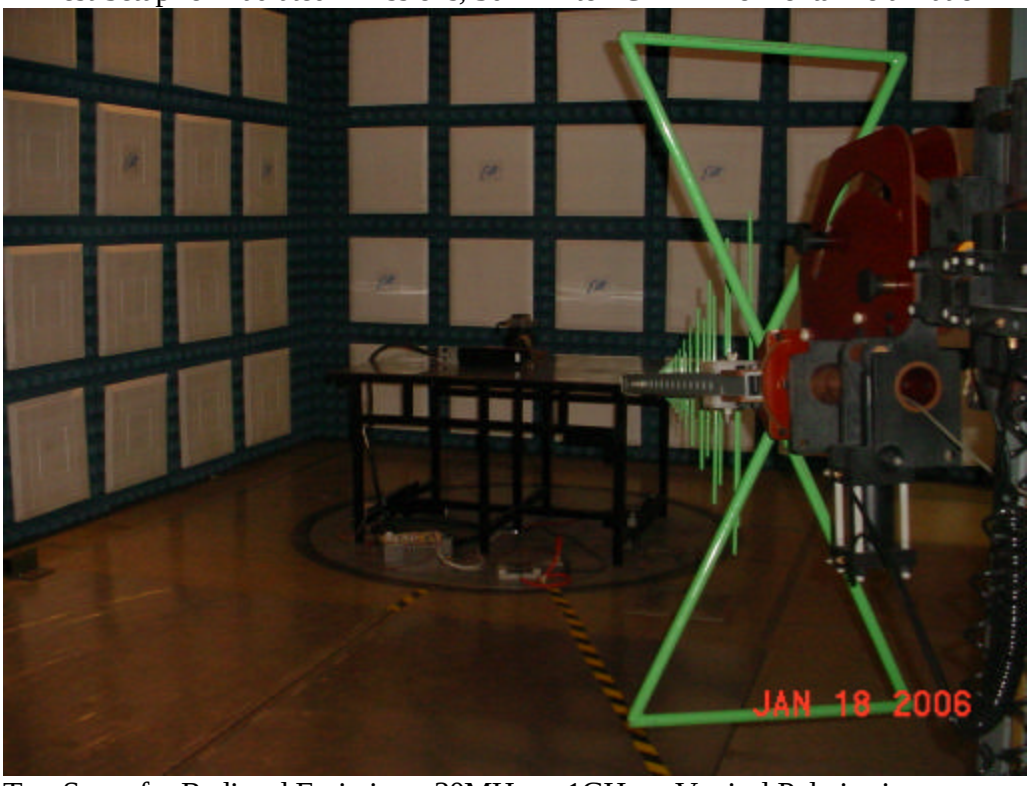
Figure 2

Test Setup for Antenna Conducted Emissions Tests, Receive Mode – 30MHz to 2 GHz

Figure 3



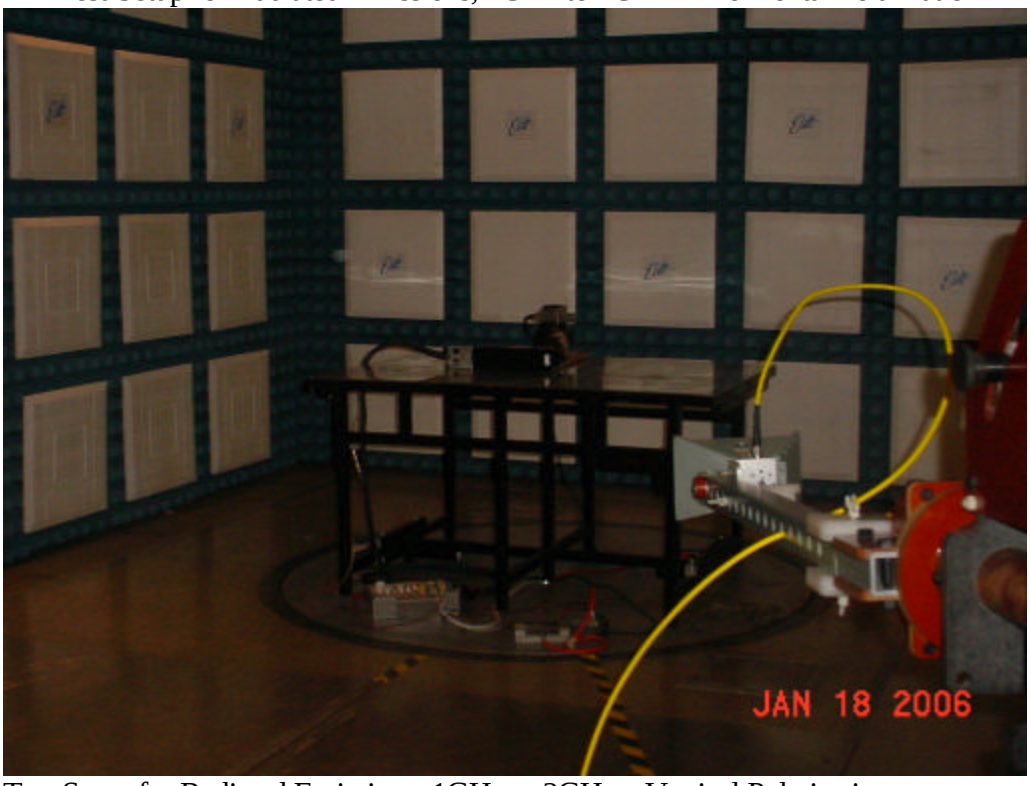
Test Setup for Radiated Emissions, 30MHz to 1GHz - Horizontal Polarization



Test Setup for Radiated Emissions, 30MHz to 1GHz - Vertical Polarization

Figure 4

Test Setup for Radiated Emissions, 1GHz to 2GHz - Horizontal Polarization



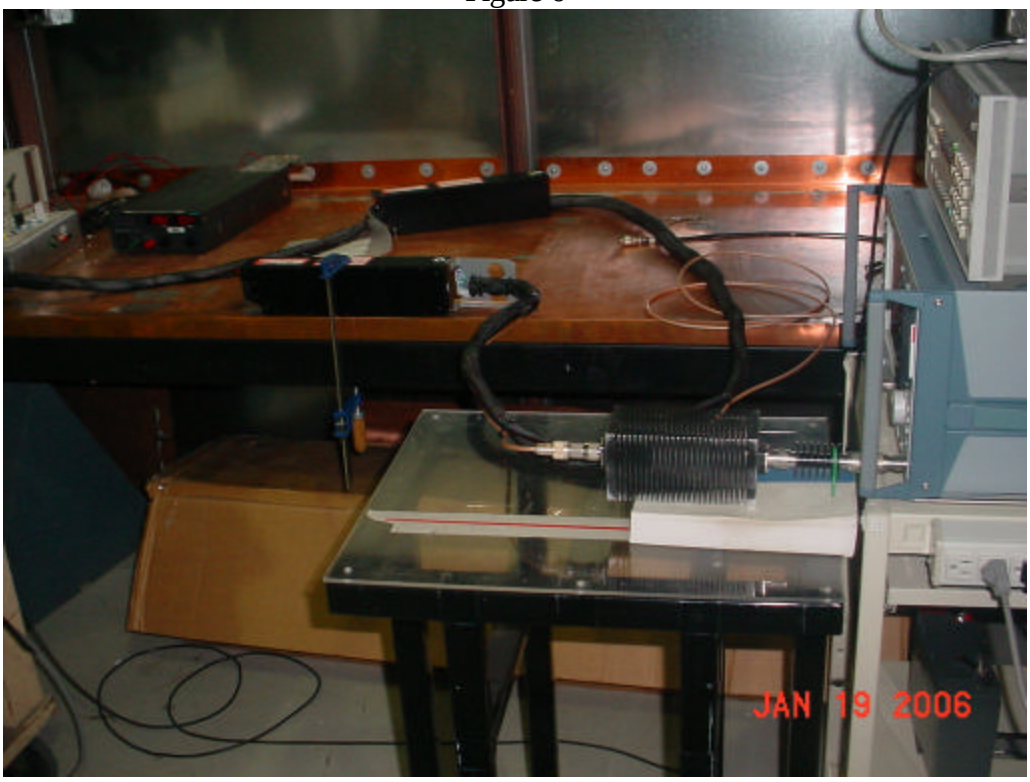
Test Setup for Radiated Emissions, 1GHz to 2GHz - Vertical Polarization

Figure 5

Test Setup for RF Power Output

Test Setup for Modulation Characteristics

Figure 6

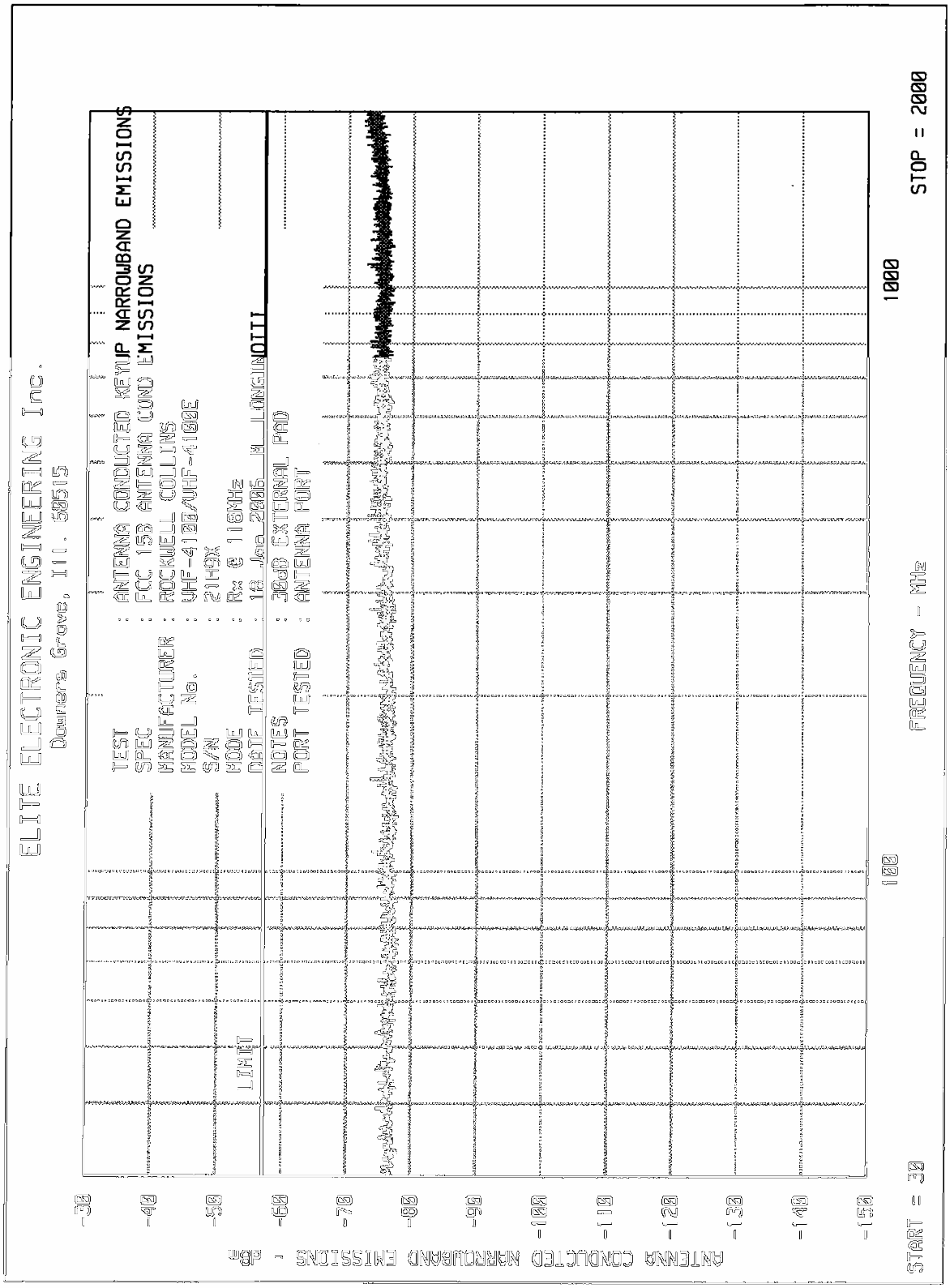


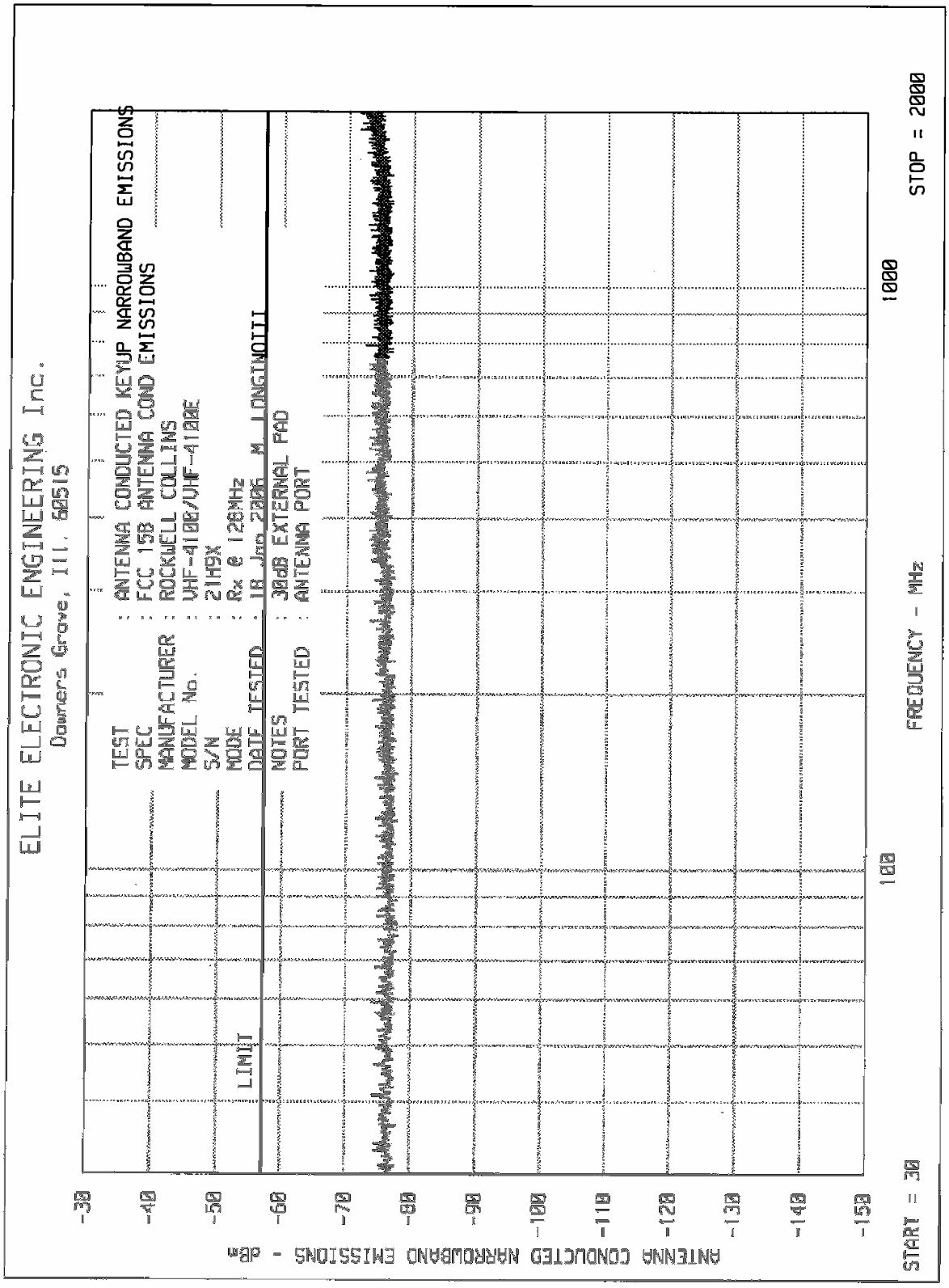
Test Setup for Occupied Bandwidth, Emissions Limitations, and Spurious Emissions at Antenna Terminal

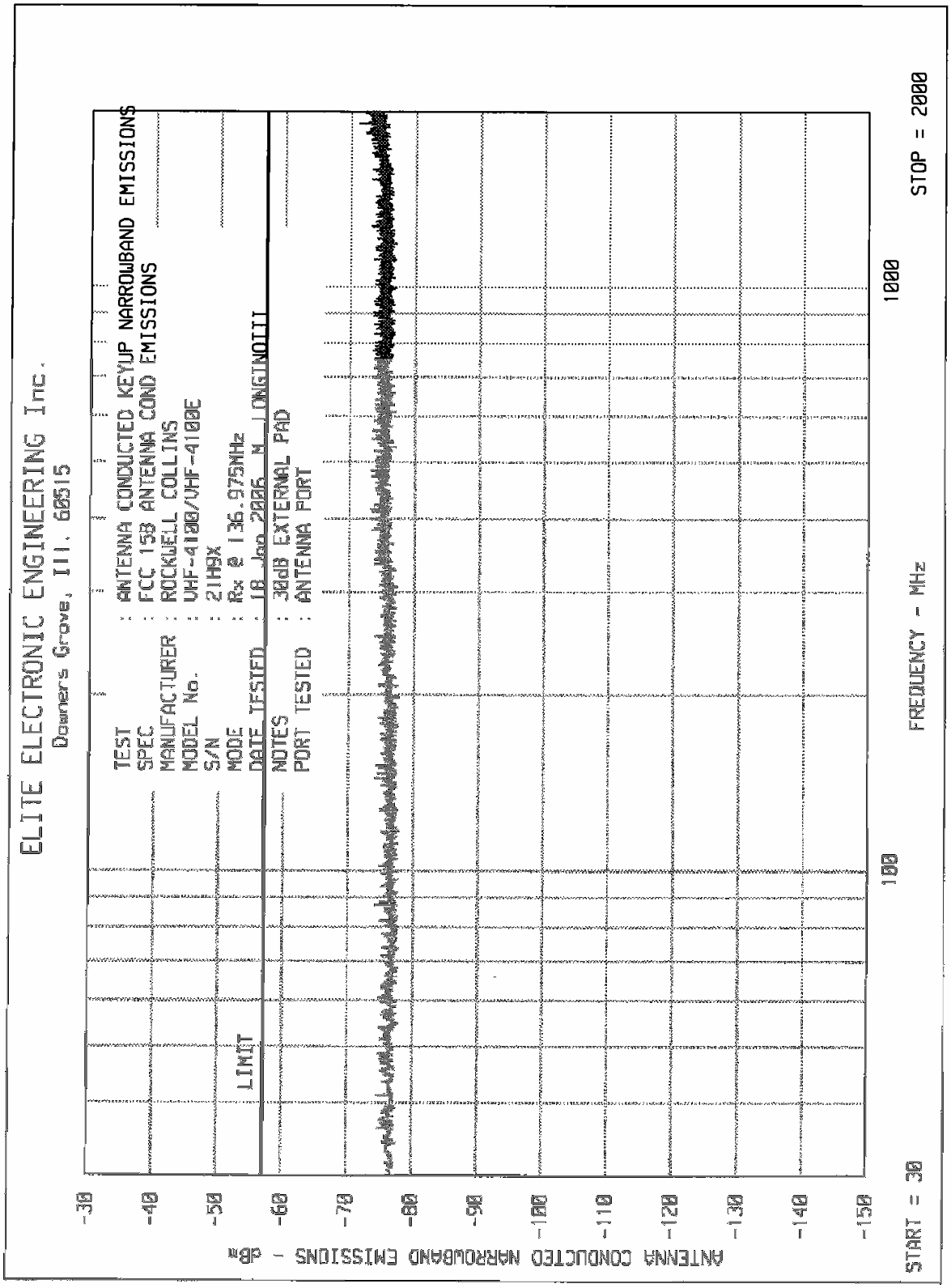
Test Setup for Frequency Stability

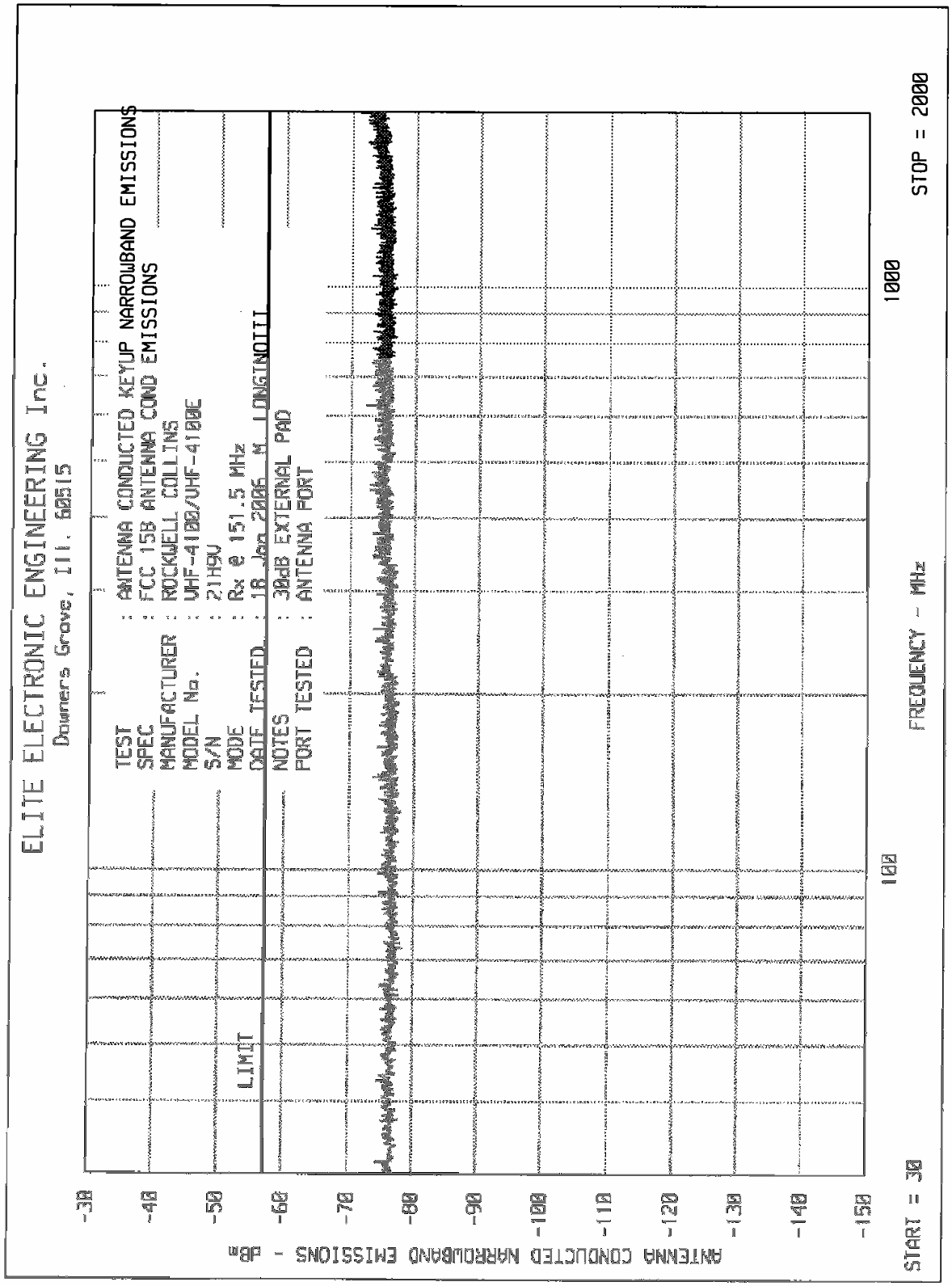
Figure 7

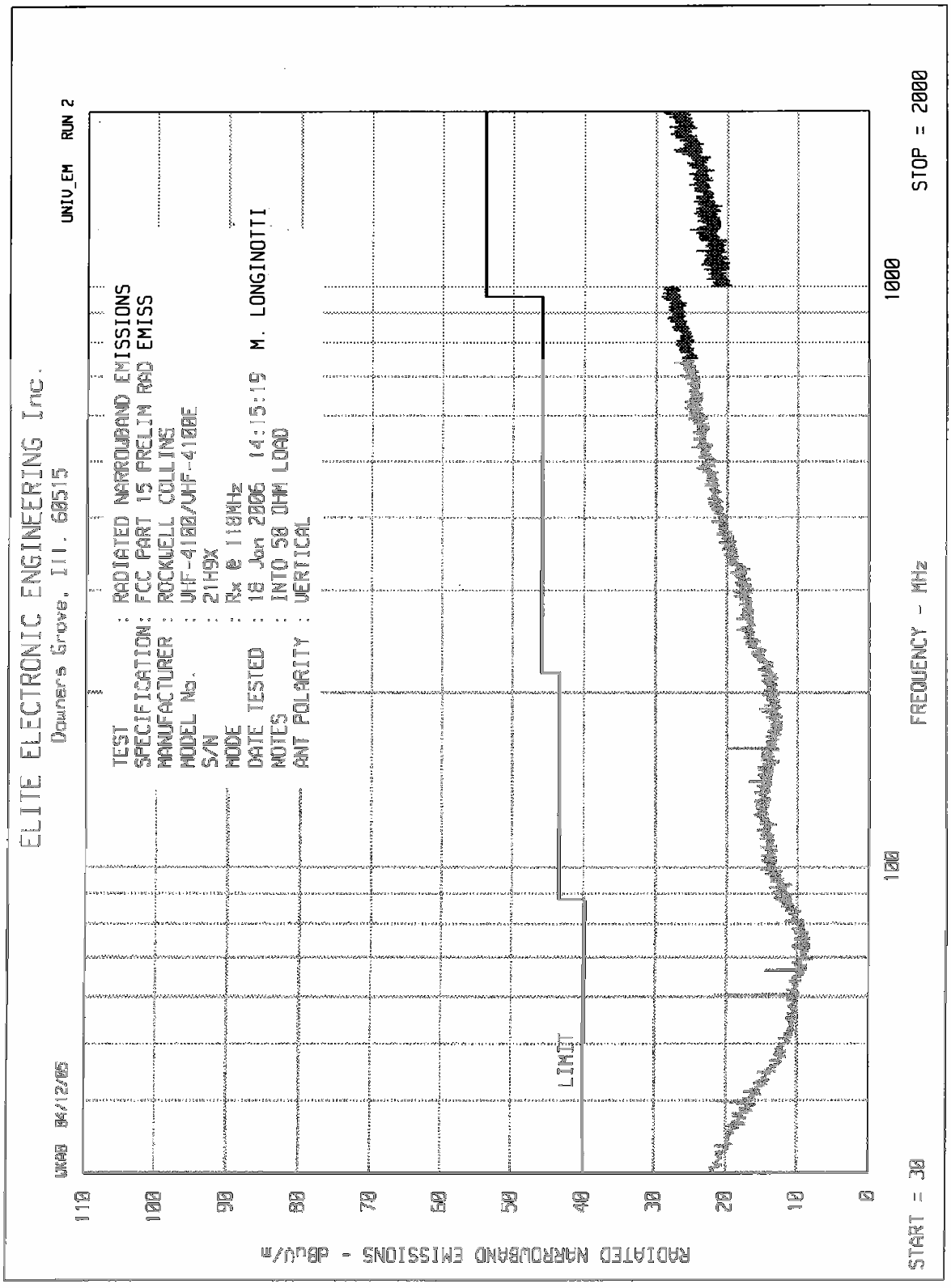
Test Setup for Transient Frequency Behavior

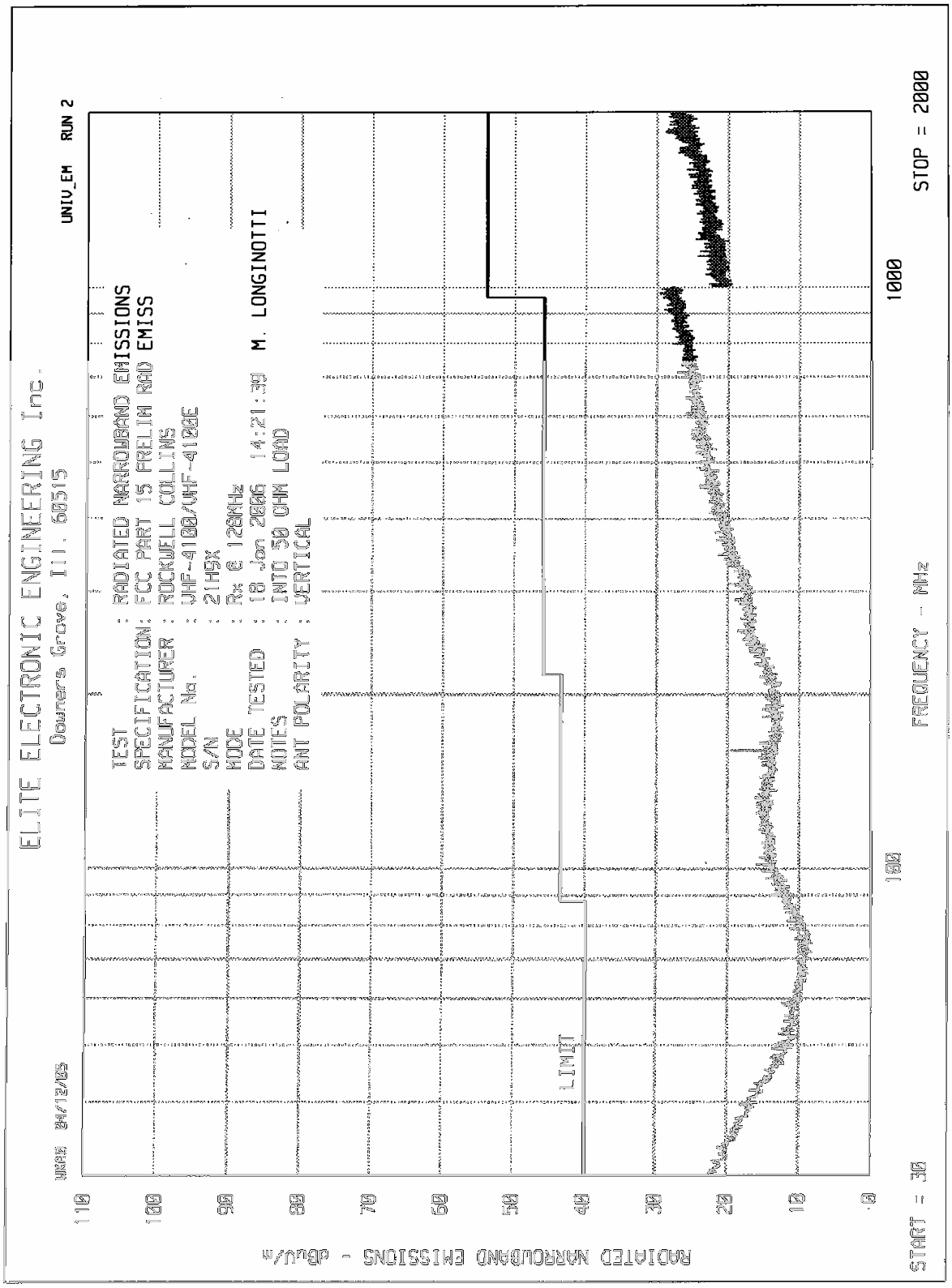

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
TEST : ANTENNA CONDUCTED MAXIMP NARROWBAND EMISSIONS
SPEC : FCC 15B ANTENNA COND EMISSIONS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : UHF-4102AUHF-4100E
S/N : 21H9X
MODE : Rx @ 116MHz
DATE TESTED : 13 Jun 2006 ILLUMINATION
NOTES : 30dB EXTERNAL PAD
PORT TESTED : ANTENNA PORT
ANTENNA CONDUCTED NARROWBAND EMISSIONS - dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz

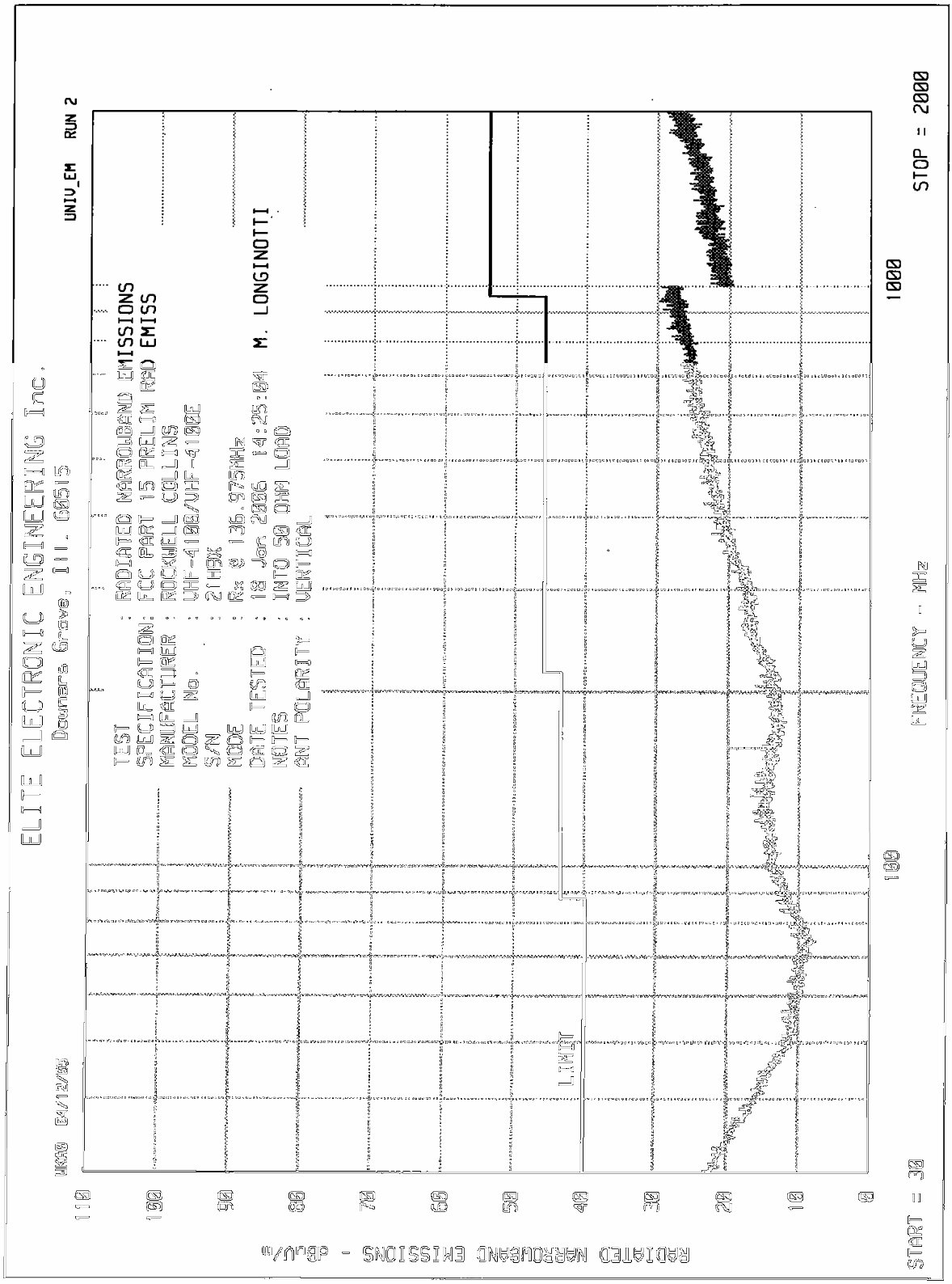

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
TEST : ANTENNA CONDUCTED KEYUP NARROWBAND EMISSIONS
SPEC : FCC 15B ANTENNA COND EMISSIONS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : VHF-4100/UHF-4100E
S/N : 21H9X
MODE : Rx @ 128MHz
DATE TESTED : 18 Jan 2006 M LONGTWOTII
LIMIT
NOTES : 30dB EXTERNAL PAD
PORT TESTED : ANTENNA PORT
ANTENNA CONDUCTED NARROWBAND EMISSIONS - dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz

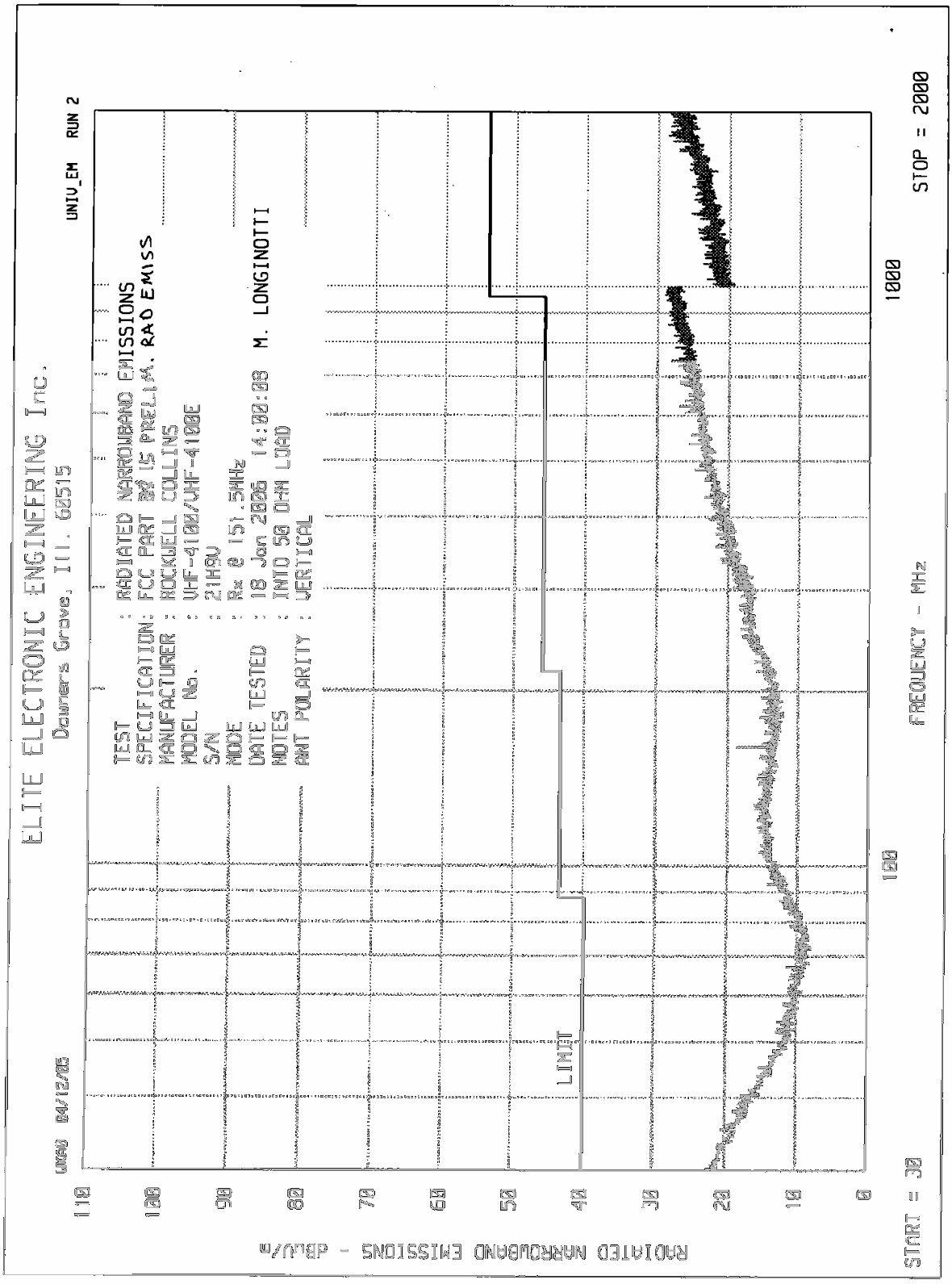

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
TEST : ANTENNA CONDUCTED KEYUP NARROWBAND EMISSIONS
SPEC : FCC 15B ANTENNA COND EMISSIONS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : VHF-4100/VHF-4100E
S/N : 21H9X
MODE : Rx @ 136.975MHz
DATE TESTED : 18 Jan 2006 M LONGITUDI
LIMIT
NOTES : 30dB EXTERNAL PAD
PORT TESTED : ANTENNA PORT
ANTENNA CONDUCTED NARROWBAND EMISSIONS - dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
TEST : ANTENNA CONDUCTED KEYUP NARROWBAND EMISSIONS
SPEC : FCC 15B ANTENNA COND EMISSIONS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : VHF-4100/UHF-4100E
S/N : 211HSV
MODE : Rx @ 151.5 MHz
DATE TESTED : 18 Jan 2005 M LONGITUDIL
LIMIT
NOTES : 30dB EXTERNAL PAD
PORT TESTED : ANTENNA PORT
ANTENNA CONDUCTED NARROWBAND EMISSIONS - dBm
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 15 PRELIM RAD EMISS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : VHF-4100/VHF-4100E
S/N : 21H9x
MODE : Rx @ 118MHz
DATE TESTED : 18 Jan 2006 14:15:19 M. LONGINOTTI
NOTES : INTO 50 OHM LOAD
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
FREQUENCY - MHz
START = 30
100
1000
STOP = 2000
110
100
90
80
70
60
50
40
30
20
10
0


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 15 PRELIM RAD EMISS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : VHF-4100/VHF-4120E
S/N : 21H5%
MODE : Rx @ 128MHz
DATE TESTED : 18 Jan 2006 14:21:39 M. LONGINOTTI
NOTES : INTO 50 OHM LOAD
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
FREQUENCY - MHz
START = 30
100
1000
STOP = 2000
110
100
90
80
70
60
50
40
30
20
10
0


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 15 PRELIM RAD EMISS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : VHF-4100/VHF-4190F
S/N : 21H9X
MODE : Rx @ 136.975MHz
DATE TESTED : 18 Jan 2006 14:25:04 M. LONGINOTTI
NOTES : INTO 50 OHM LOAD
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
FREQUENCY - MHz
START = 30
100
1000
STOP = 2000
110
100
90
80
70
60
50
40
30
20
10
0


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PART 87 IS PRELIM. RAD EMISS
MANUFACTURER : ROCKWELL COLLINS
MODEL No. : VHF-4100/VHF-4100E
S/N : 21H9U
MODE : Rx @ 151.5MHz
DATE TESTED : 18 Jan 2005 14:00:08 M. LONGINOTTI
NOTES : INTO 50 OHM LOAD
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz

MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : 21H9X
SPECIFICATION : FCC-15B Spurious Radiated Emissions
DATE : January 18, 2006
NOTES : Receive at 118MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Factor dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
146.900	H	2.1	AMB	0.8	11.5	0.0	14.4	5.2	150.0
146.900	V	4.3	AMB	0.8	11.5	0.0	16.6	6.7	150.0
293.800	H	4.5	AMB	1.3	13.7	0.0	19.4	9.4	200.0
293.800	V	3.8	AMB	1.3	13.7	0.0	18.7	8.6	200.0
440.700	H	5.2	AMB	1.6	17.4	0.0	24.1	16.1	200.0
440.700	V	5.6	AMB	1.6	17.4	0.0	24.5	16.9	200.0
587.600	H	5.0	AMB	1.7	19.4	0.0	26.1	20.1	200.0
587.600	V	4.6	AMB	1.7	19.4	0.0	25.7	19.2	200.0
734.500	H	5.3	AMB	1.8	20.5	0.0	27.6	24.0	200.0
734.500	V	4.7	AMB	1.8	20.5	0.0	27.0	22.4	200.0
881.400	H	4.6	AMB	1.9	22.2	0.0	28.7	27.3	200.0
881.400	V	4.8	AMB	1.9	22.2	0.0	28.9	28.0	200.0
1028.300	H	44.7	AMB	2.0	24.9	-35.4	36.3	65.6	500.0
1028.300	V	45.2	AMB	2.0	24.9	-35.4	36.8	69.5	500.0
1175.200	H	44.8	AMB	2.2	25.3	-35.1	37.2	72.4	500.0
1175.200	V	44.2	AMB	2.2	25.3	-35.1	36.6	67.6	500.0
1322.100	H	43.9	AMB	2.4	25.6	-34.9	37.0	70.5	500.0
1322.100	V	44.4	AMB	2.4	25.6	-34.9	37.5	74.6	500.0
1469.000	H	43.7	AMB	2.6	25.8	-34.7	37.4	73.8	500.0
1469.000	V	43.9	AMB	2.6	25.8	-34.7	37.6	75.5	500.0

V - Vertical

H - Horizontal

AMB - Ambient

Total (dBuV/m) = Meter Reading + Cable Factor + Antenna Factor – Preamp Gain

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : 21H9X
SPECIFICATION : FCC-15B Spurious Radiated Emissions
DATE : January 18, 2006
NOTES : Receive at 128MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Factor dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
156.900	H	4.7	AMB	0.8	11.0	0.0	16.6	6.7	150.0
156.900	V	4.3	AMB	0.8	11.0	0.0	16.2	6.4	150.0
313.800	H	4.4	AMB	1.3	14.1	0.0	19.8	9.8	200.0
313.800	V	4.3	AMB	1.3	14.1	0.0	19.7	9.7	200.0
470.700	H	5.3	AMB	1.6	17.5	0.0	24.4	16.6	200.0
470.700	V	5.0	AMB	1.6	17.5	0.0	24.1	16.0	200.0
627.600	H	4.8	AMB	1.7	19.7	0.0	26.2	20.4	200.0
627.600	V	4.9	AMB	1.7	19.7	0.0	26.3	20.6	200.0
784.500	H	5.0	AMB	1.9	20.9	0.0	27.8	24.5	200.0
784.500	V	5.0	AMB	1.9	20.9	0.0	27.8	24.5	200.0
941.400	H	5.3	AMB	2.0	22.7	0.0	30.0	31.6	200.0
941.400	V	4.4	AMB	2.0	22.7	0.0	29.1	28.5	200.0
1098.300	H	44.4	AMB	2.1	25.1	-35.2	36.4	66.1	500.0
1098.300	V	44.4	AMB	2.1	25.1	-35.2	36.4	66.1	500.0
1255.200	H	44.4	AMB	2.3	25.4	-35.0	37.2	72.2	500.0
1255.200	V	44.1	AMB	2.3	25.4	-35.0	36.9	69.7	500.0
1412.100	H	44.2	AMB	2.5	25.7	-34.8	37.6	76.1	500.0
1412.100	V	44.4	AMB	2.5	25.7	-34.8	37.8	77.9	500.0
1569.000	H	43.0	AMB	2.6	26.3	-34.7	37.3	73.0	500.0
1569.000	V	42.6	AMB	2.6	26.3	-34.7	36.9	69.7	500.0

V - Vertical

H - Horizontal

AMB - Ambient

Total (dBuV/m) = Meter Reading + Cable Factor + Antenna Factor – Preamp Gain

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : 21H9X
SPECIFICATION : FCC-15B Spurious Radiated Emissions
DATE : January 18, 2006
NOTES : Receive at 136.975MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Factor dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
165.875	H	5.7	AMB	0.9	10.4	0.0	16.9	7.0	150.0
165.875	V	4.2	AMB	0.9	10.4	0.0	15.4	5.9	150.0
331.750	H	4.8	AMB	1.4	14.5	0.0	20.6	10.8	200.0
331.750	V	6.1	AMB	1.4	14.5	0.0	21.9	12.5	200.0
497.625	H	5.7	AMB	1.6	18.5	0.0	25.9	19.6	200.0
497.625	V	5.3	AMB	1.6	18.5	0.0	25.5	18.8	200.0
663.500	H	5.3	AMB	1.8	19.9	0.0	27.0	22.3	200.0
663.500	V	4.9	AMB	1.8	19.9	0.0	26.6	21.3	200.0
829.375	H	4.3	AMB	1.9	21.6	0.0	27.8	24.5	200.0
829.375	V	5.0	AMB	1.9	21.6	0.0	28.5	26.6	200.0
995.250	H	4.3	AMB	2.0	23.1	0.0	29.4	29.5	500.0
995.250	V	4.7	AMB	2.0	23.1	0.0	29.8	30.9	500.0
1161.125	H	44.7	AMB	2.2	25.3	-35.1	37.0	71.0	500.0
1161.125	V	44.4	AMB	2.2	25.3	-35.1	36.7	68.6	500.0
1327.000	H	44.6	AMB	2.4	25.6	-34.9	37.7	76.6	500.0
1327.000	V	44.2	AMB	2.4	25.6	-34.9	37.3	73.1	500.0
1492.875	H	43.7	AMB	2.6	25.9	-34.7	37.4	74.5	500.0
1492.875	V	43.9	AMB	2.6	25.9	-34.7	37.6	76.3	500.0
1658.750	H	43.3	AMB	2.7	26.7	-34.6	38.2	81.0	500.0
1658.750	V	43.3	AMB	2.7	26.7	-34.6	38.2	81.0	500.0

V - Vertical

H - Horizontal

AMB - Ambient

Total (dBuV/m) = Meter Reading + Cable Factor + Antenna Factor – Preamp Gain

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : 21H9V
SPECIFICATION : FCC-15B Spurious Radiated Emissions
DATE : January 18, 2006
NOTES : Receive at 151.5MHz
: Test Distance is 3 meters

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Factor dB	Antenna Factor dB	Preamp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
180.400	H	3.7	AMB	0.9	9.9	0.0	14.5	5.3	150.0
180.400	V	3.8	AMB	0.9	9.9	0.0	14.6	5.4	150.0
360.800	H	5.1	AMB	1.4	15.3	0.0	21.8	12.4	200.0
360.800	V	4.5	AMB	1.4	15.3	0.0	21.2	11.5	200.0
541.200	H	4.7	AMB	1.7	18.9	0.0	25.3	18.3	200.0
541.200	V	5.6	AMB	1.7	18.9	0.0	26.2	20.3	200.0
721.600	H	5.2	AMB	1.8	20.4	0.0	27.4	23.4	200.0
721.600	V	4.8	AMB	1.8	20.4	0.0	27.0	22.4	200.0
902.000	H	4.8	AMB	1.9	22.2	0.0	29.0	28.1	200.0
902.000	V	4.8	AMB	1.9	22.2	0.0	29.0	28.1	200.0
1082.400	H	44.9	AMB	2.1	25.1	-35.3	36.8	69.4	500.0
1082.400	V	44.9	AMB	2.1	25.1	-35.3	36.8	69.4	500.0
1262.800	H	44.7	AMB	2.3	25.5	-35.0	37.5	75.0	500.0
1262.800	V	44.8	AMB	2.3	25.5	-35.0	37.6	75.9	500.0
1443.200	H	44.4	AMB	2.5	25.8	-34.8	38.0	79.0	500.0
1443.200	V	44.2	AMB	2.5	25.8	-34.8	37.8	77.2	500.0
1623.600	H	44.6	AMB	2.7	26.6	-34.6	39.2	91.6	500.0
1623.600	V	44.2	AMB	2.7	26.6	-34.6	38.8	87.5	500.0
1804.000	H	44.4	AMB	2.9	27.4	-34.5	40.2	102.1	500.0
1804.000	V	44.0	AMB	2.9	27.4	-34.5	39.8	97.5	500.0

V - Vertical

H - Horizontal

AMB - Ambient

Total (dBuV/m) = Meter Reading + Cable Factor + Antenna Factor – Preamp Gain

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : See Below
SPECIFICATION : FCC 87.131 Power Output
DATE : January 16, 2006
MODE : AM Voice Mode Double Sideband (CW)

Frequency MHz	Serial Number	Meter Reading dBm	Attenuation dB	Total Power dBm	Total Power Watts	Maximum Power Watts
118	21H9X	-6.9	50	43.1	20.42	55
128	21H9X	-6.9	50	43.1	20.42	55
136.975	21H9X	-6.9	50	43.1	20.42	55
151.5	21H9V	-7.7	50	42.3	16.98	55

Total Power (dBm) = Meter Reading (dBm) + Attenuation (dBm)

Checked By: MARK E. LONGINOTTI

MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : See Below
SPECIFICATION : FCC 87.131 Power Output
DATE : January 16, 2006
MODE : Data Link Mode

Frequency MHz	Serial Number	Meter Reading dBm	Attenuation dB	Total Power dBm	Total Power Watts	Maximum Power Watts
118	21H9X	-6.6	50	43.4	21.88	55
128	21H9X	-6.65	50	43.35	21.63	55
136.975	21H9X	-8.08	50	41.92	15.56	55

Total Power (dBm) = Meter Reading (dBm) + Attenuation (dBm)

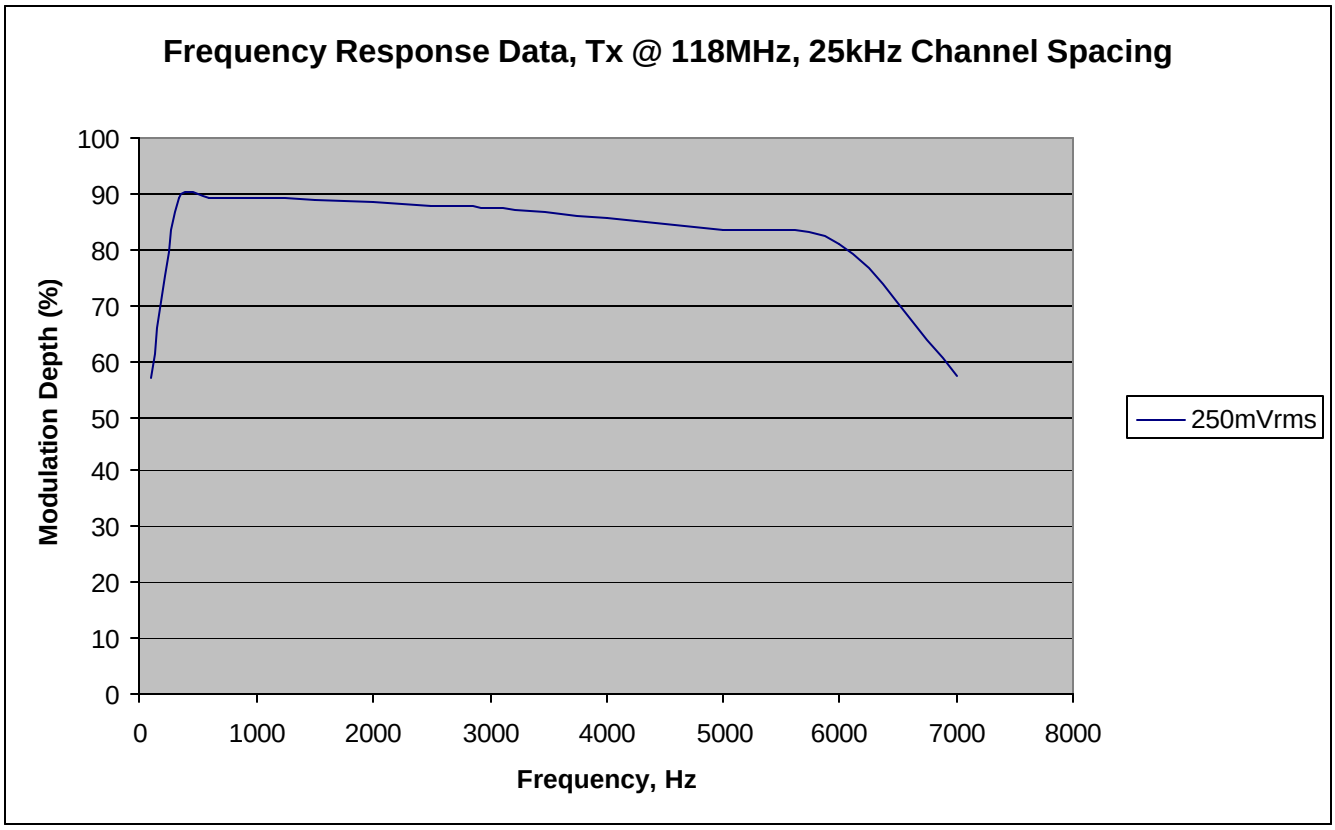
Checked By: MARK E. LONGINOTTI

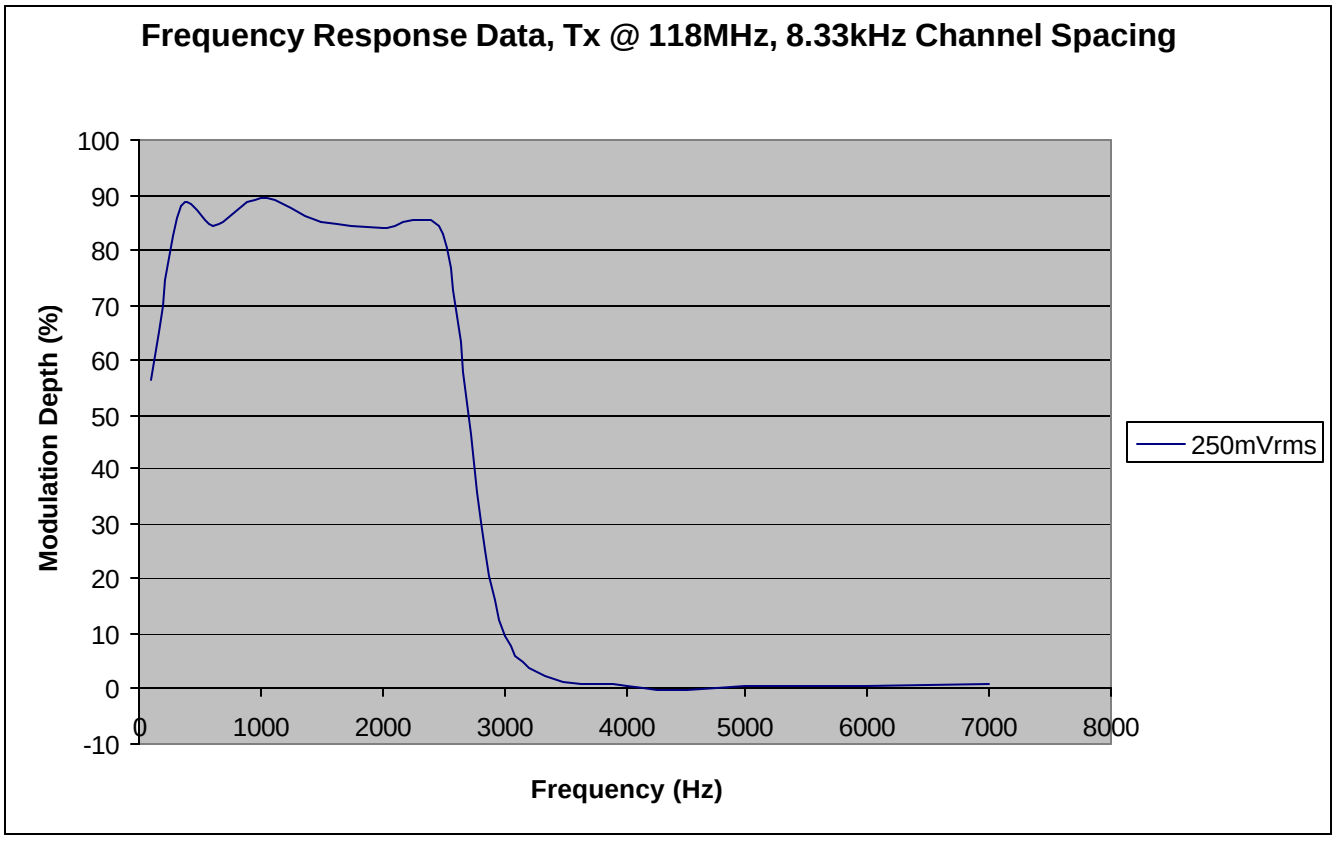
MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : See Below
SPECIFICATION : FCC 87.131 Power Output
DATE : January 16, 2006
MODE : Digital Audio Link

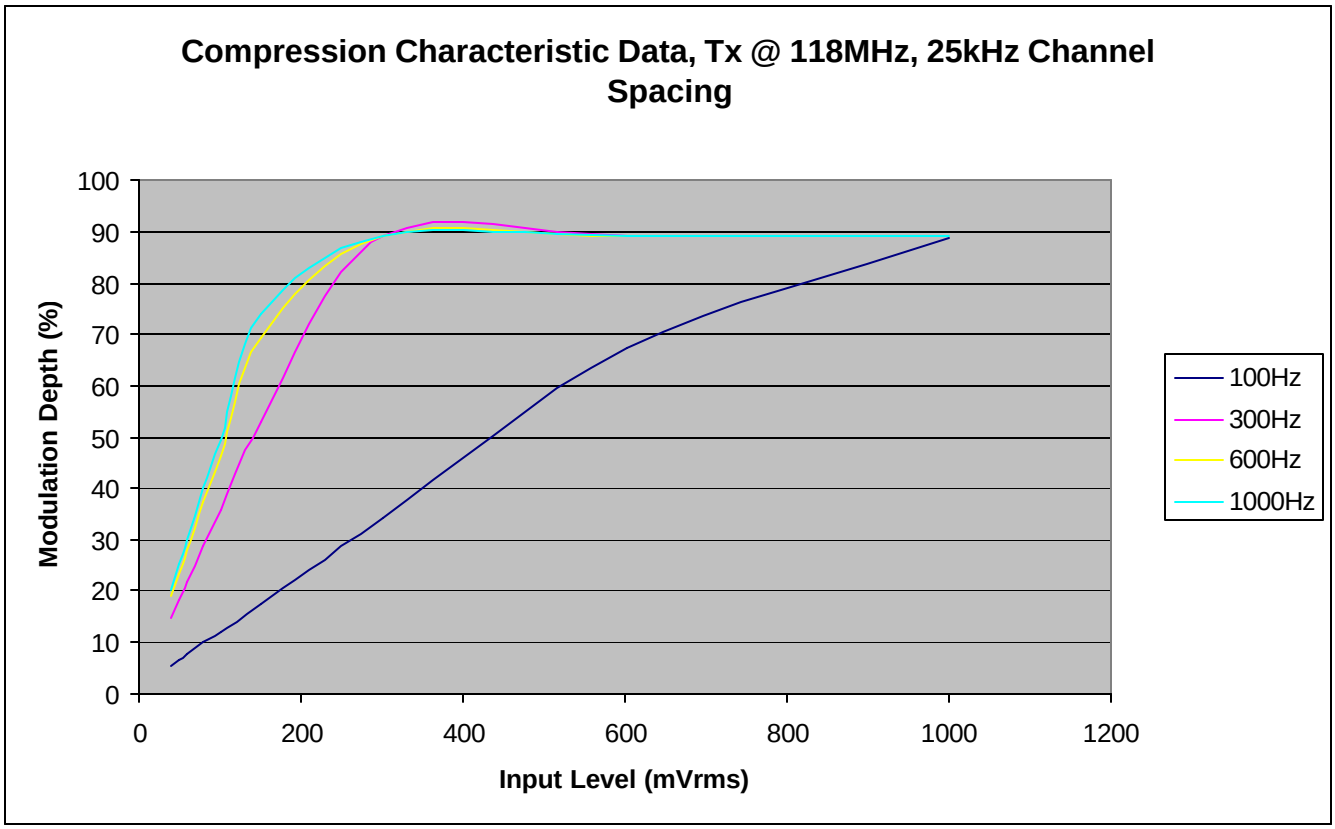
Frequency MHz	Serial Number	Meter Reading dBm	Attenuation dB	Total Power dBm	Total Power Watts	Maximum Power Watts
118	21H9X	-7.1	50	42.9	19.50	55
128	21H9X	-7.6	50	42.4	17.38	55
136.975	21H9X	-7.3	50	42.7	18.62	55

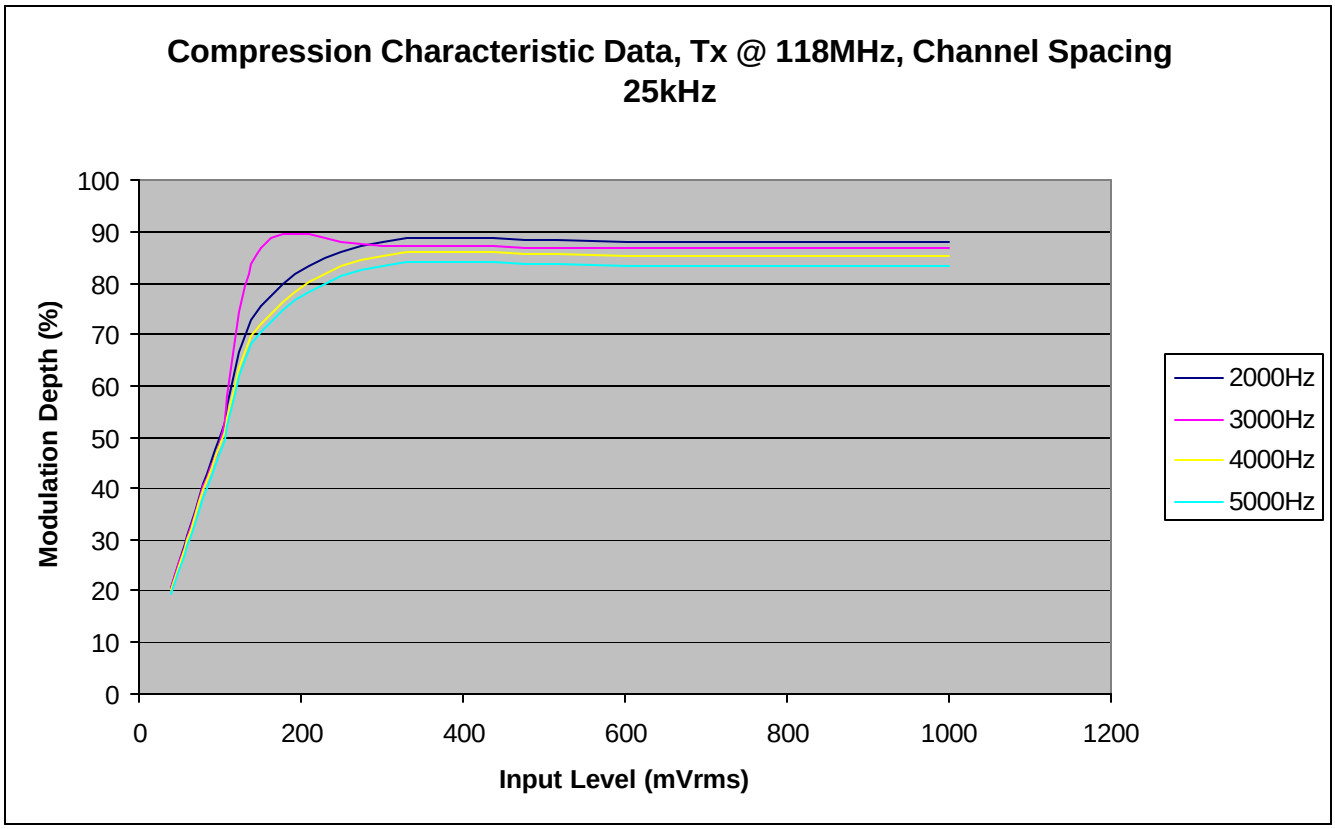
Total Power (dBm) = Meter Reading (dBm) + Attenuation (dBm)

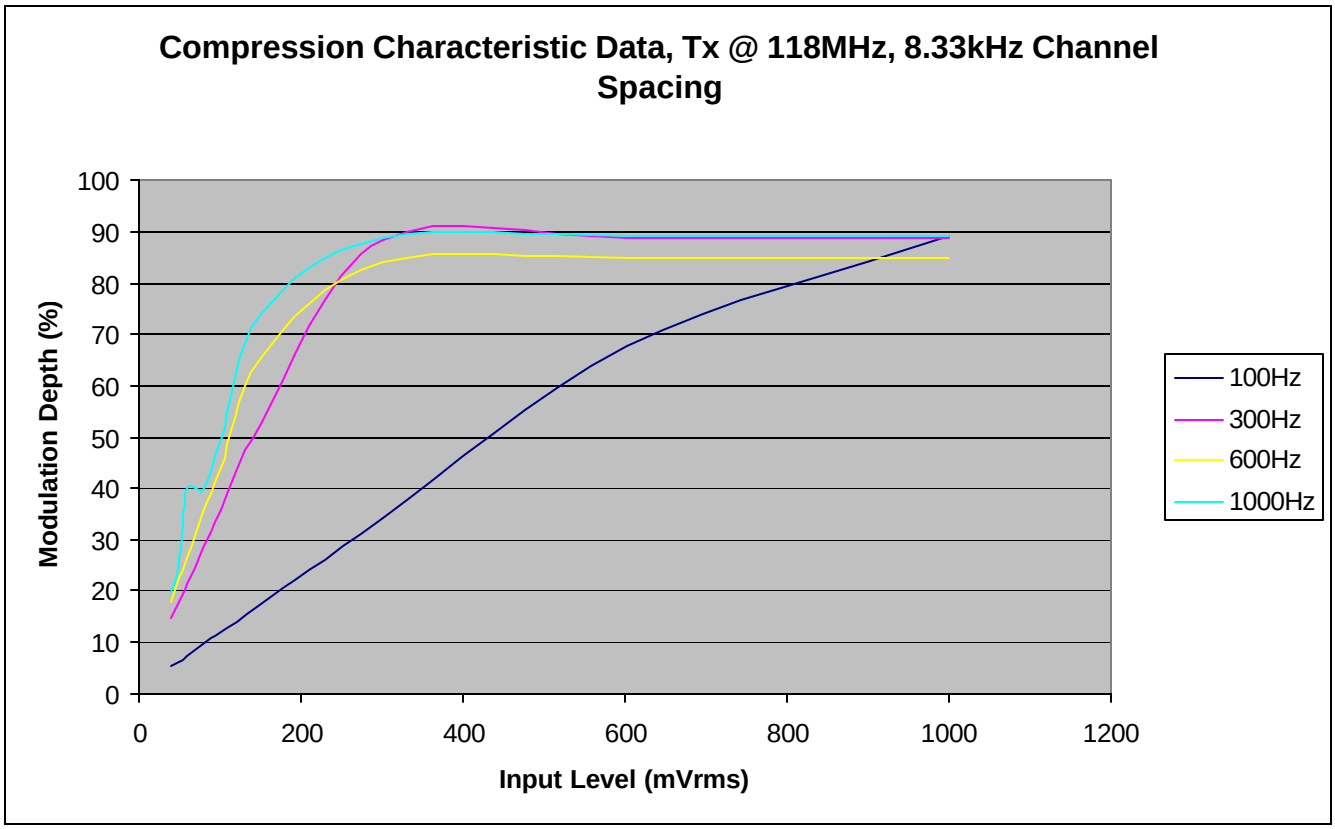
Checked By: MARK E. LONGINOTTI

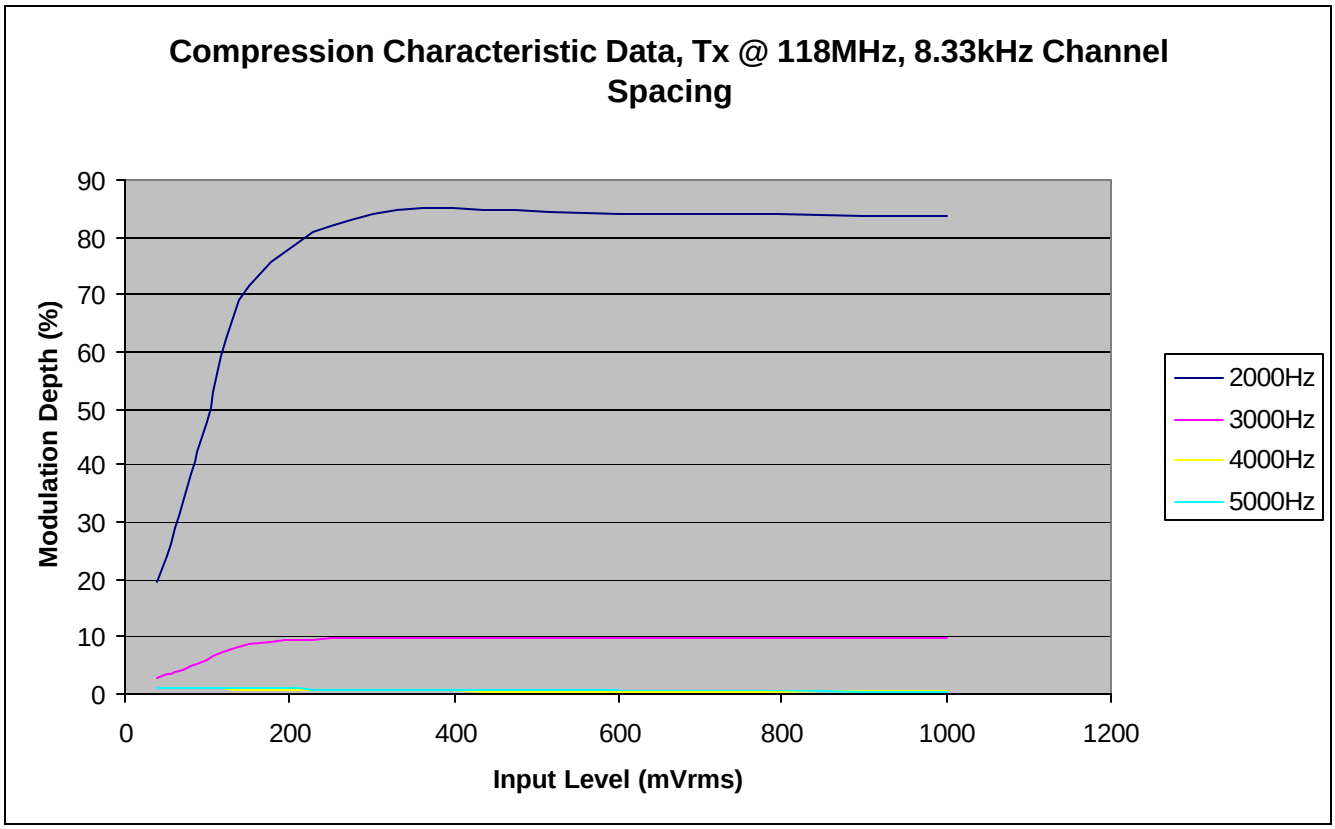

Frequency Response Data, Tx @ 118MHz, 25kHz Channel Spacing
Modulation Depth (%)
100
90
80
70
60
50
40
30
20
10
0
0
1000
2000
3000
4000
5000
6000
7000
8000
Frequency, Hz
250mVrms

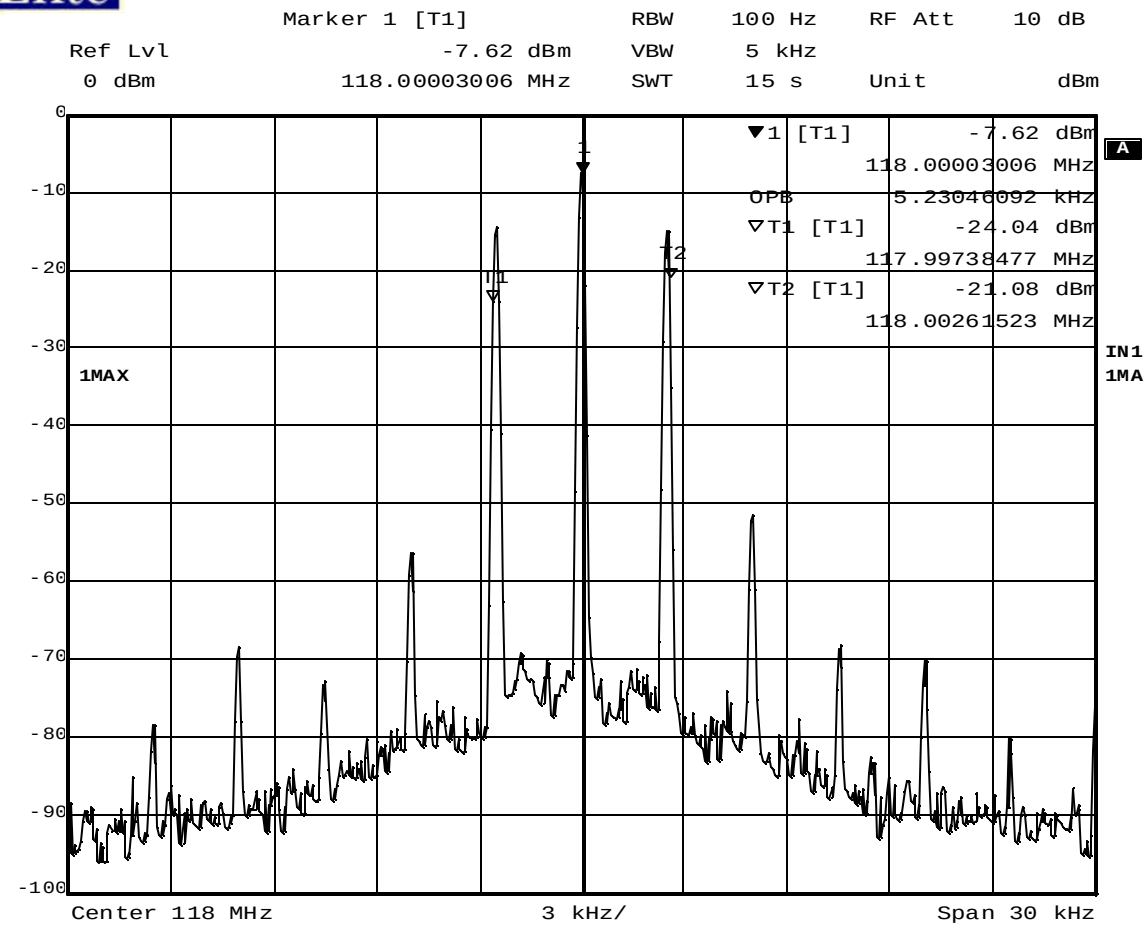

Frequency Response Data, Tx @ 118MHz, 8.33kHz Channel Spacing
Modulation Depth (%)
100
90
80
70
60
50
40
30
20
10
0
-10
0
1000
2000
3000
4000
5000
6000
7000
8000
Frequency (Hz)
250mVrms


Compression Characteristic Data, Tx @ 118MHz, 25kHz Channel Spacing
Modulation Depth (%)
0
10
20
30
40
50
60
70
80
90
100
0
200
400
600
800
1000
1200
Input Level (mVrms)
100Hz
300Hz
600Hz
1000Hz


Compression Characteristic Data, Tx @ 118MHz, Channel Spacing 25kHz
Modulation Depth (%)
0
10
20
30
40
50
60
70
80
90
100
0
200
400
600
800
1000
1200
Input Level (mVrms)
2000Hz
3000Hz
4000Hz
5000Hz


Compression Characteristic Data, Tx @ 118MHz, 8.33kHz Channel Spacing
Modulation Depth (%)
100
90
80
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
Input Level (mVrms)
100Hz
300Hz
600Hz
1000Hz

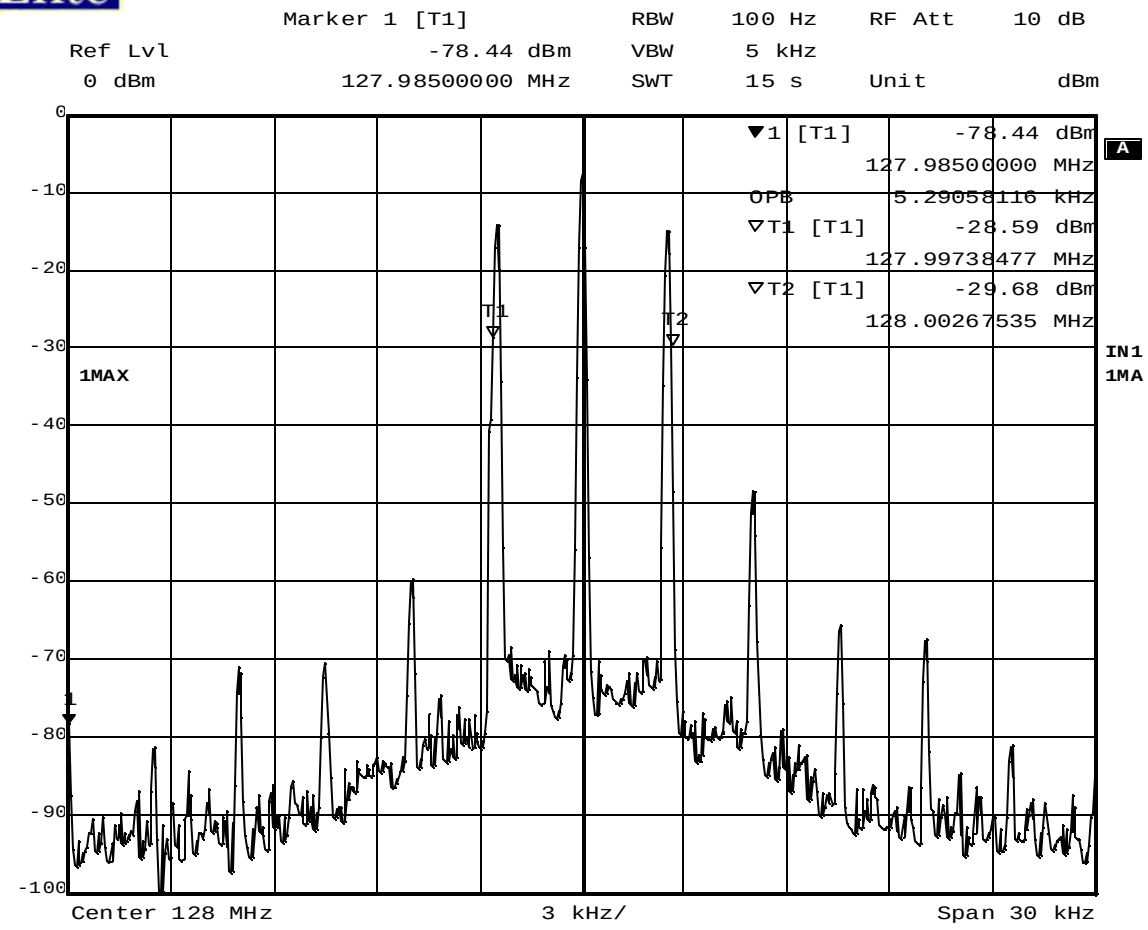

Compression Characteristic Data, Tx @ 118MHz, 8.33kHz Channel Spacing
Modulation Depth (%)
90
80
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
Input Level (mVrms)
2000Hz
3000Hz
4000Hz
5000Hz



Date: 17.JAN.2006 13:59:38

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : 99% Bandwidth
TEST PARAMETERS : Channel 118
NOTES : AM Voice Mode, 50dB external attenuation
EQUIPMENT USED : RBA0, GWF2, T2D9

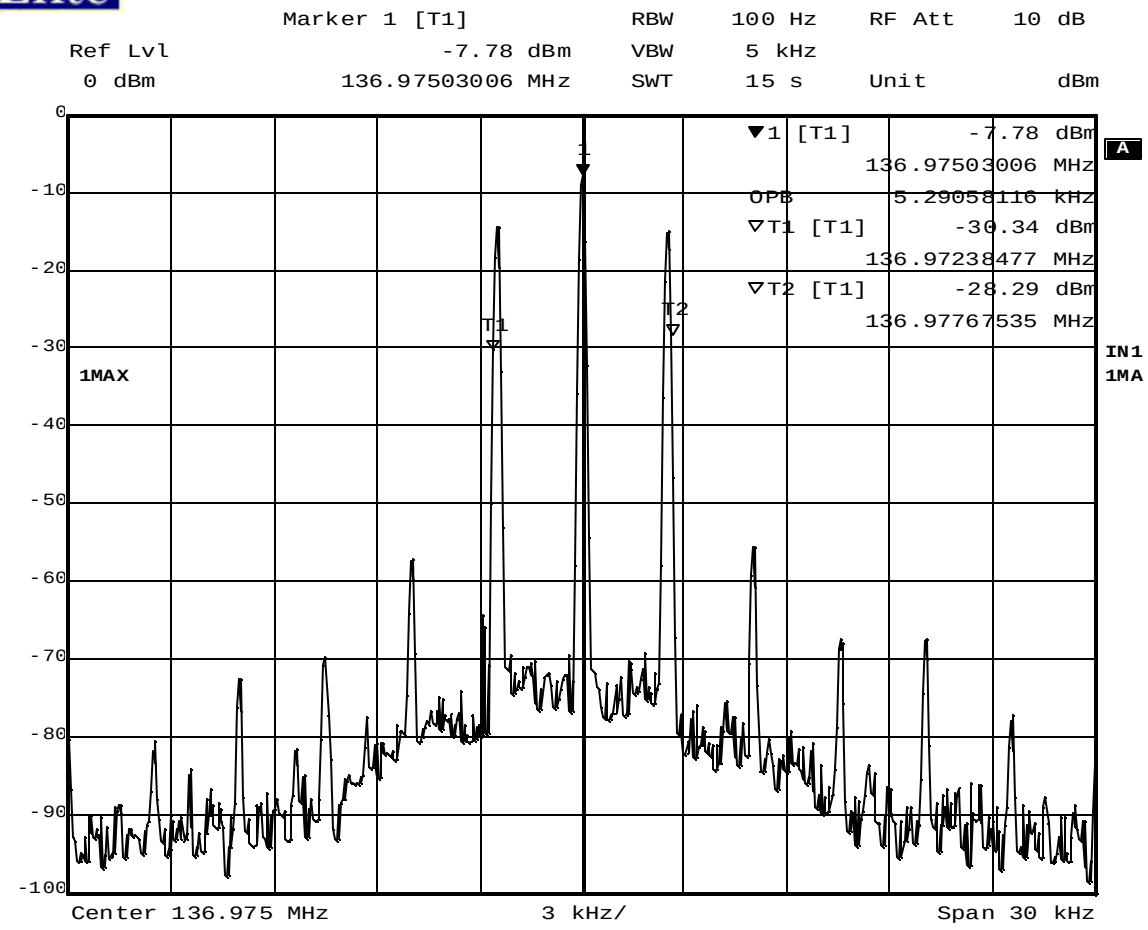
NOTES



Date: 17.JAN.2006 14:11:51

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : 99% Bandwidth
TEST PARAMETERS : Channel 128, 50dB external attenuation
NOTES : AM Voice Mode
EQUIPMENT USED : RBA0, GWF2, T2D9

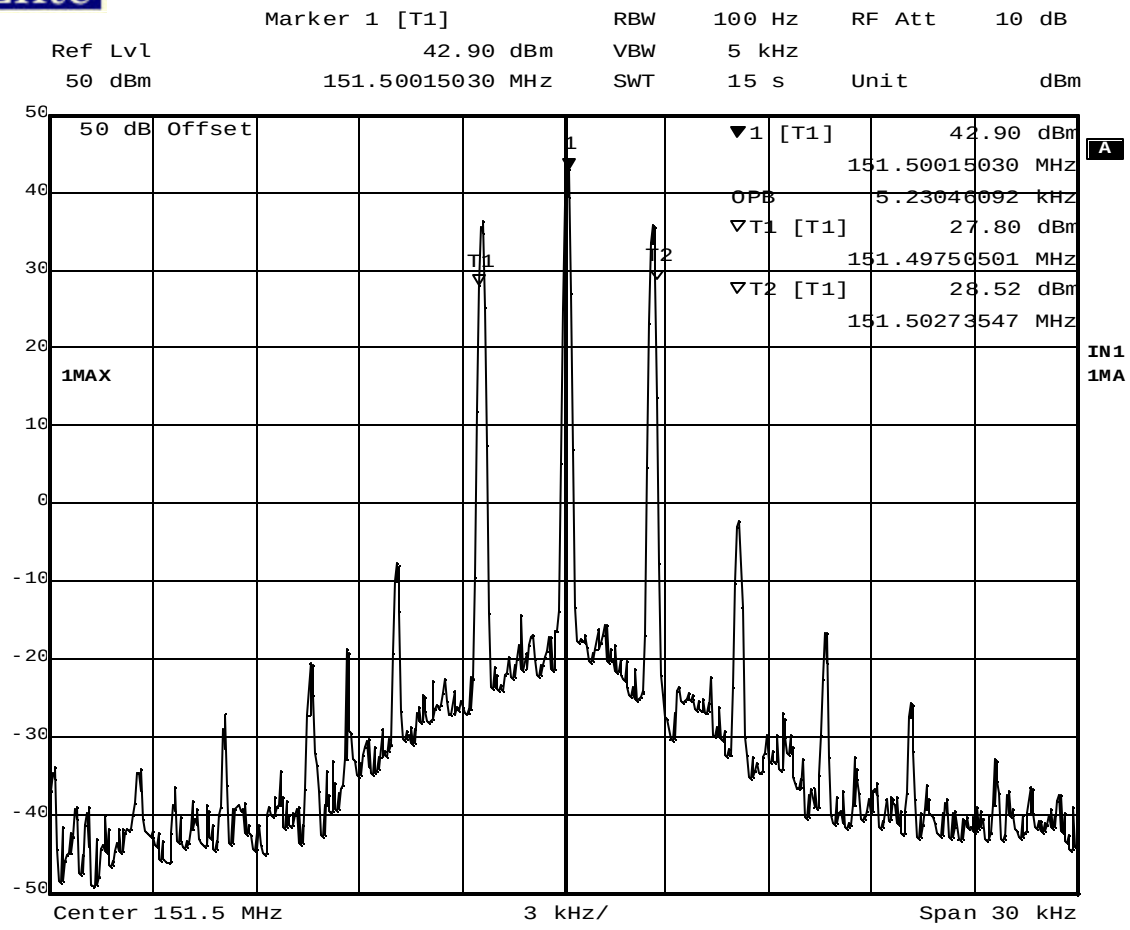
NOTES



Date: 17.JAN.2006 14:21:24

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : 99% Bandwidth
TEST PARAMETERS : Channel 136.975, 50dB external attenuation
NOTES : AM Voice Mode
EQUIPMENT USED : RBA0, GWF2, T2D9

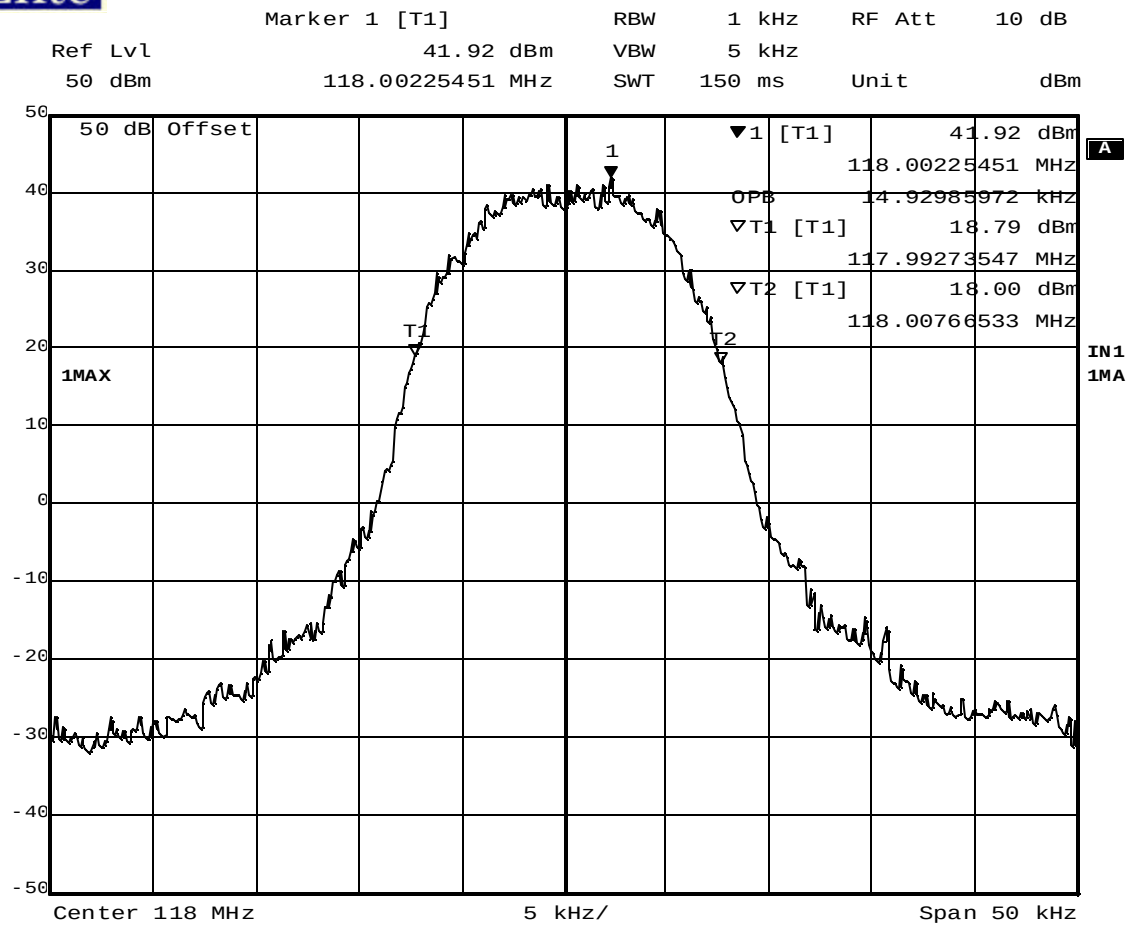
NOTES



Date: 19.JAN.2006 11:10:54

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9V
TEST MODE : 99% Bandwidth
TEST PARAMETERS : Channel 151.5 , 50dB external attenuation
NOTES : AM Voice Mode
EQUIPMENT USED : RBA0, GWF2, T2D9

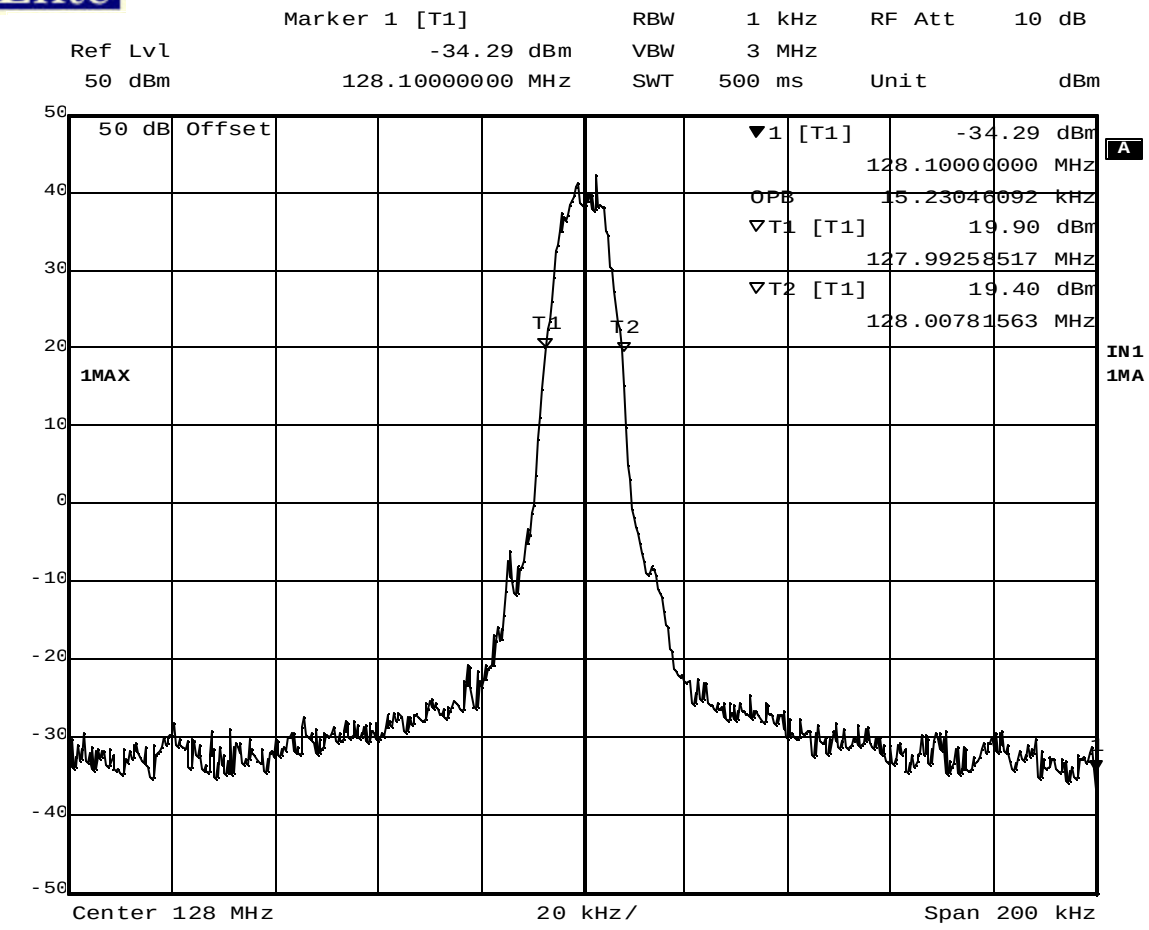
NOTES



Date: 17.JAN.2006 15:17:19

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : 99% Bandwidth
TEST PARAMETERS : Channel 118, 50dB external attenuation
NOTES : Data Link
EQUIPMENT USED : RBA0, GWF2, T2D9

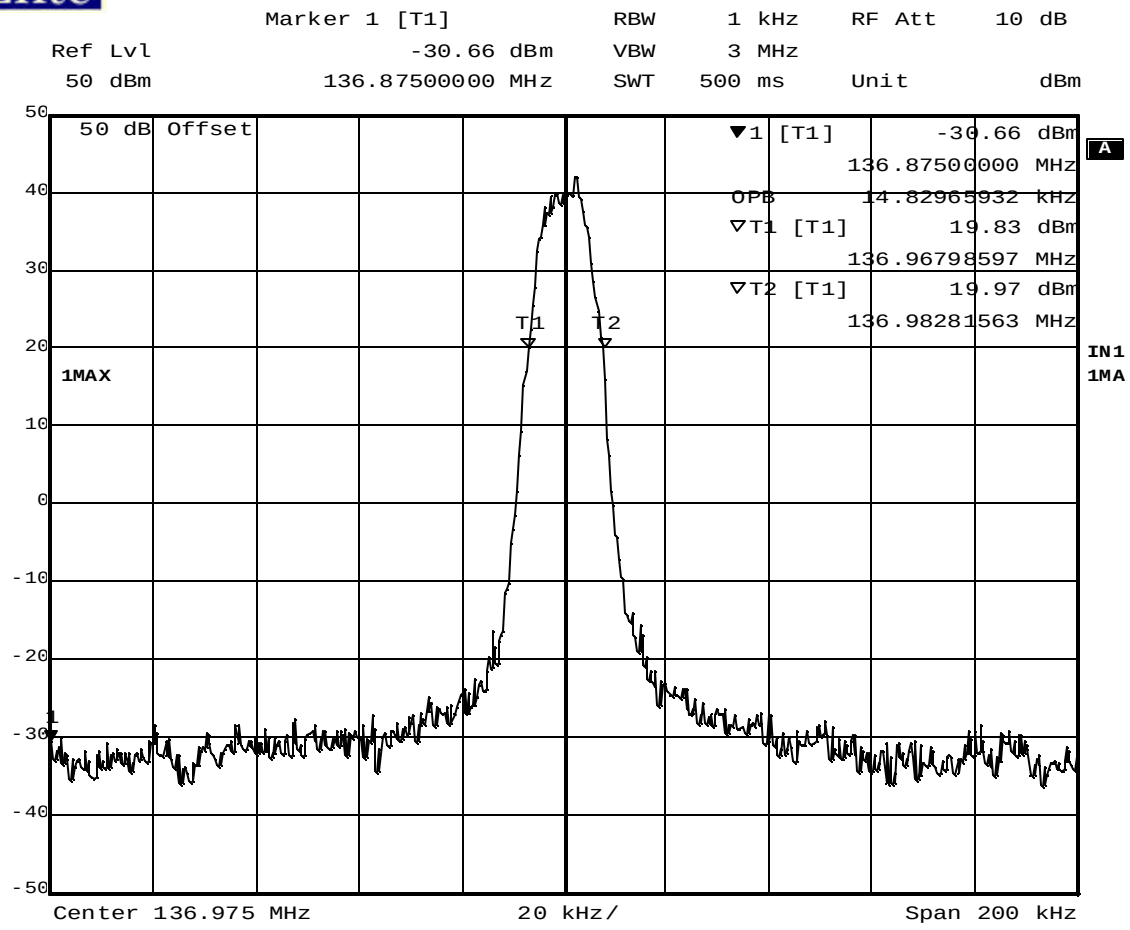
NOTES



Date: 17.JAN.2006 15:42:45

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 128, , 50dB external attenuation
NOTES : Data Link
EQUIPMENT USED : RBA0, GWF2, T2D9

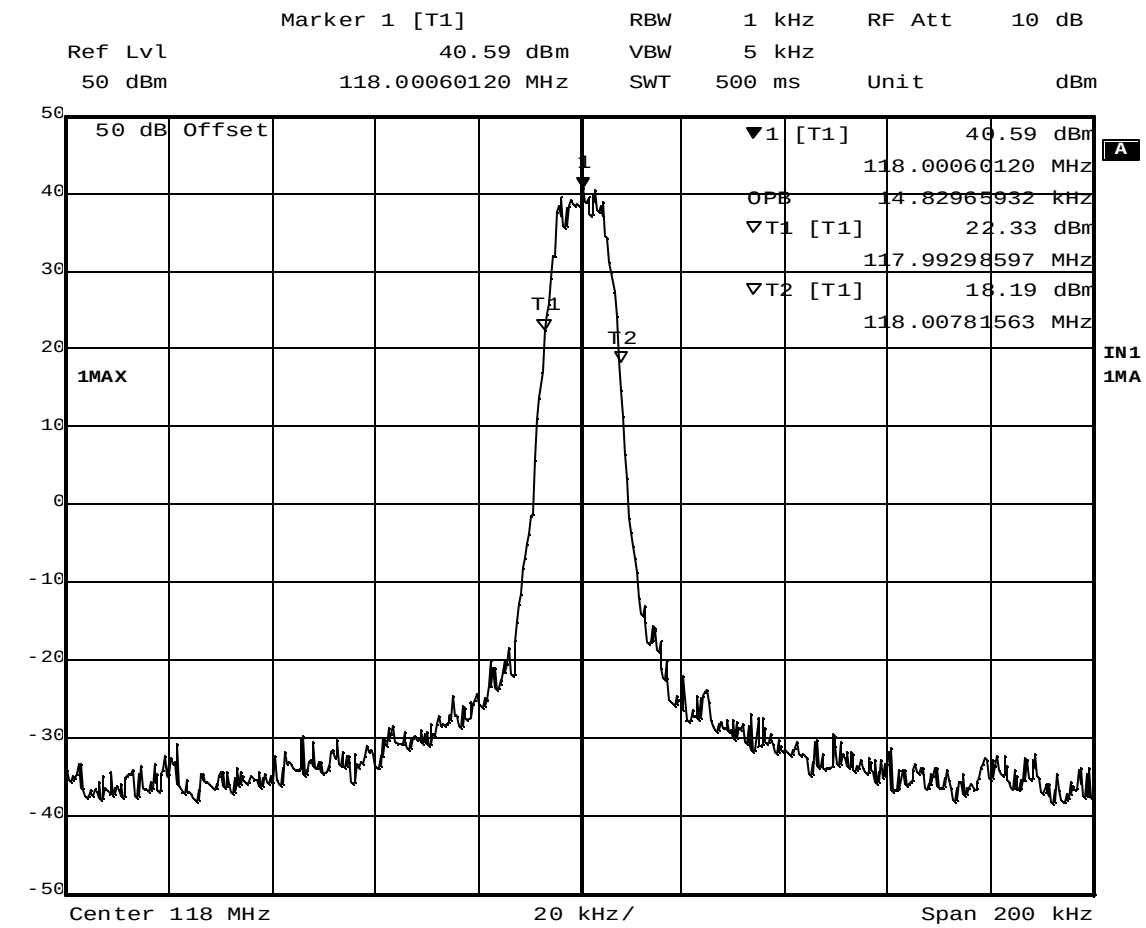
NOTES



Date: 17.JAN.2006 15:45:32

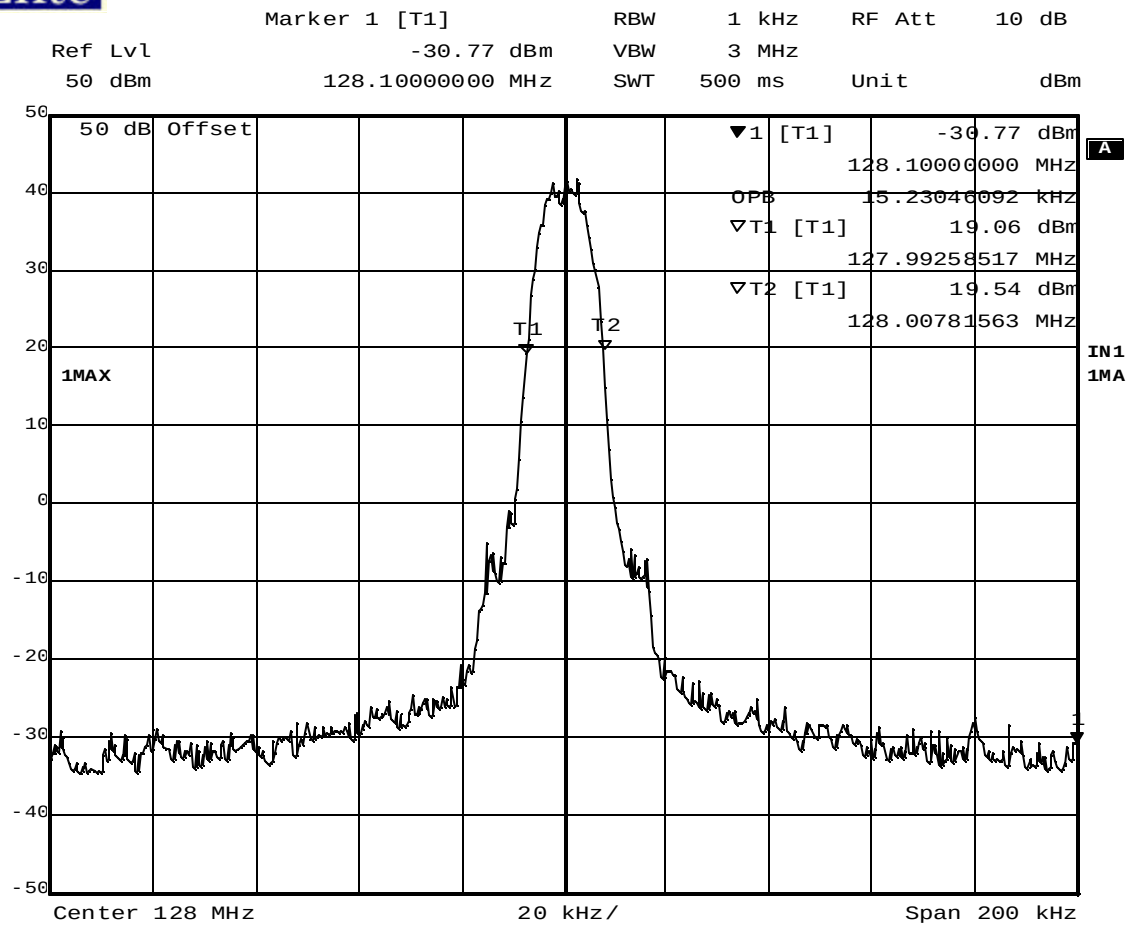
MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 136.975, 50dB external attenuation
NOTES : Data Link
EQUIPMENT USED : RBA0, GWF2, T2D9

NOTES



MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Conducted Emissions
TEST PARAMETERS : Channel 118 , 50dB external attenuation
NOTES : Digital Audio Link
EQUIPMENT USED : RBA0, GWF2, T2D9

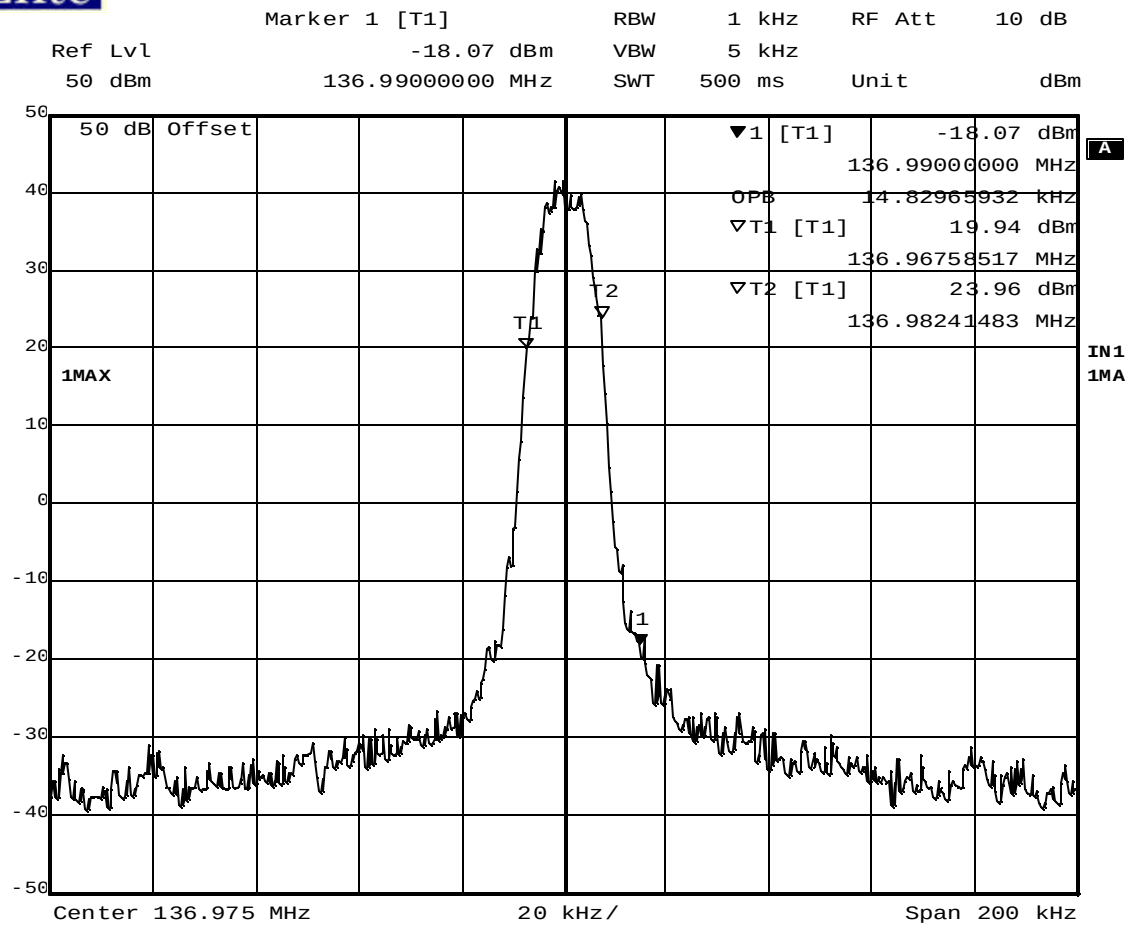
NOTES



Date: 17.JAN.2006 16:08:46

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 128 , 50dB external attenuation
NOTES : Digital Audio Link
EQUIPMENT USED : RBA0, GWF2, T2D9

NOTES



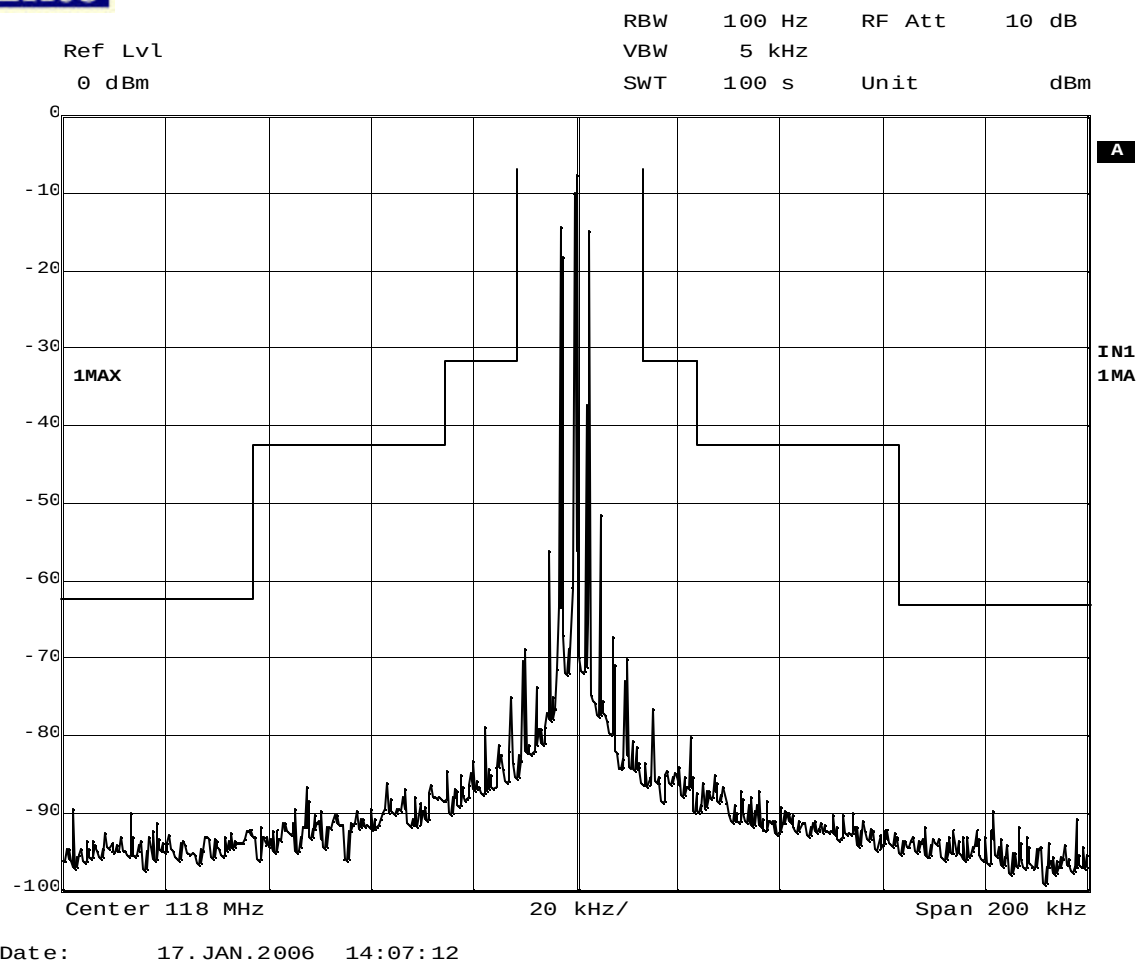
Date: 17.JAN.2006 15:59:44

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 136.975 , 50dB external attenuation
NOTES : Digital Audio Link
EQUIPMENT USED : RBA0, GWF2, T2D9

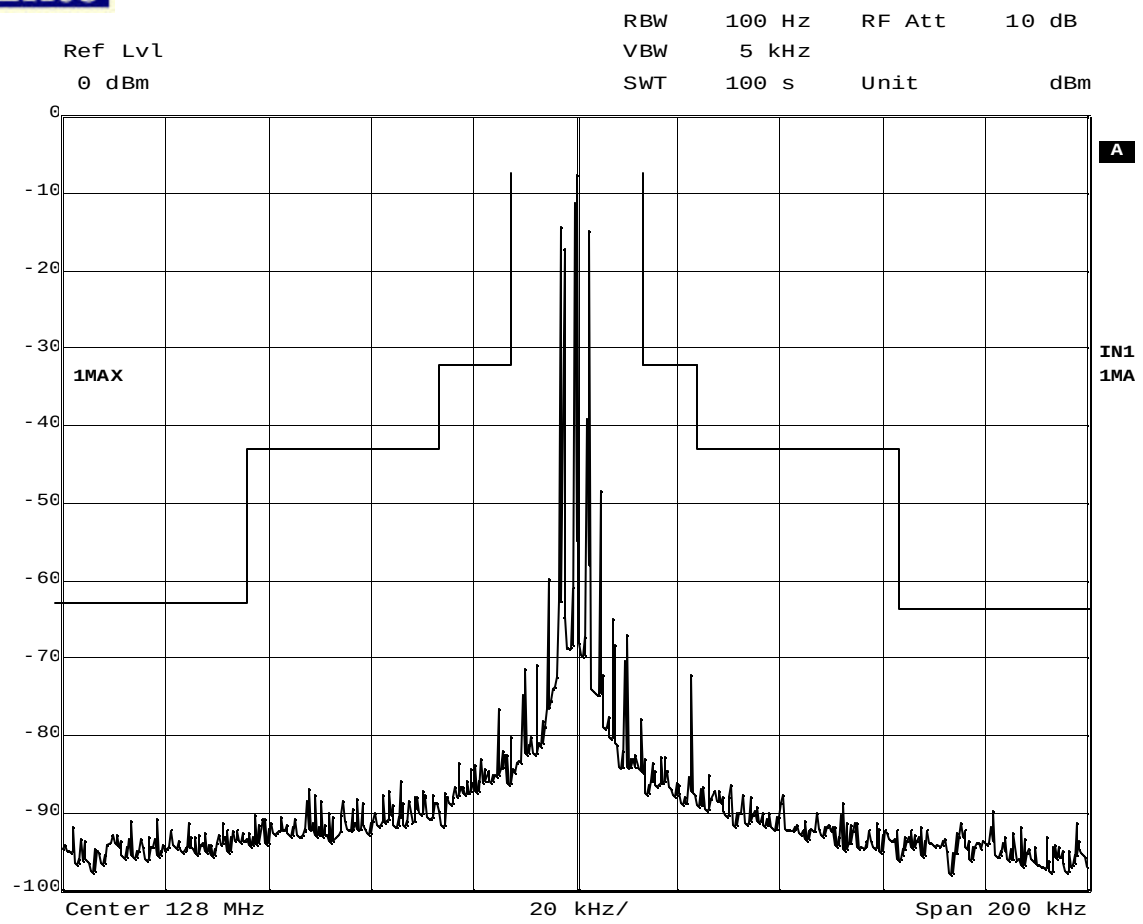
NOTES

MANUFACTURER : Rockwell Collins
MODEL : VHF-4100/VHF-4100E
SERIAL NO. : See Below
SPECIFICATION : FCC 87.137, 99% Bandwidth
DATE : January 17 through January 19, 2006
MODE : See Below

Mode	Transmit Frequency (MHz)	Serial No.	Occupied Bandwidth (kHz)	Authorized Bandwidth (kHz)
AM Voice Mode	118	21H9X	5.23	25
AM Voice Mode	128	21H9X	5.29	25
AM Voice Mode	136.975	21H9X	5.29	25
AM Voice Mode	151.5	21H9V	5.23	25
Data Link	118	21H9X	14.93	25
Data Link	128	21H9X	15.23	25
Data Link	136.975	21H9X	14.83	25
Digital Audio Link	118	21H9X	14.83	25
Digital Audio Link	128	21H9X	15.23	25
Digital Audio Link	136.975	21H9X	14.83	25



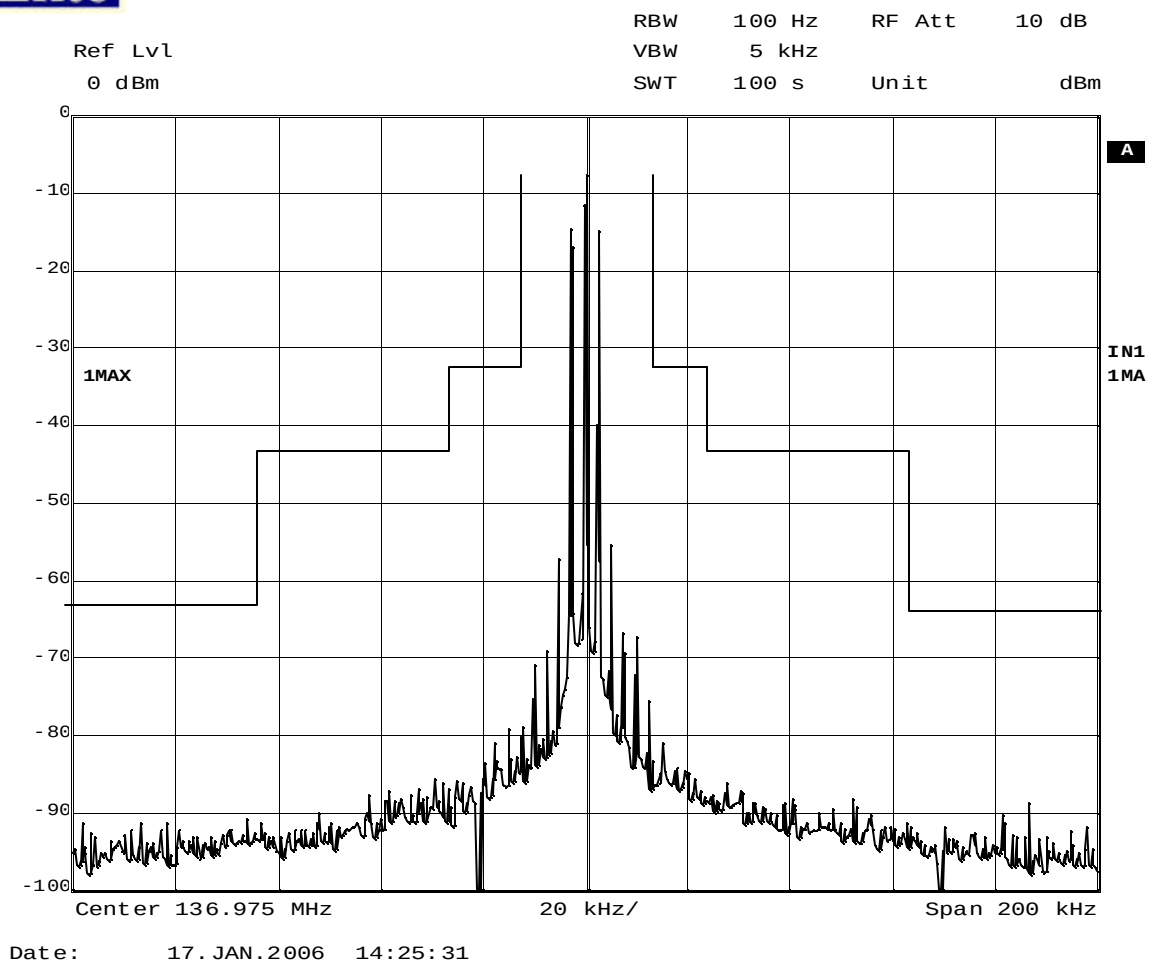
MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 118
NOTES : AM Voice Mode, 50dB external attenuation
EQUIPMENT USED : RBA0, GWF2, T2D9



Date: 17.JAN.2006 14:17:16

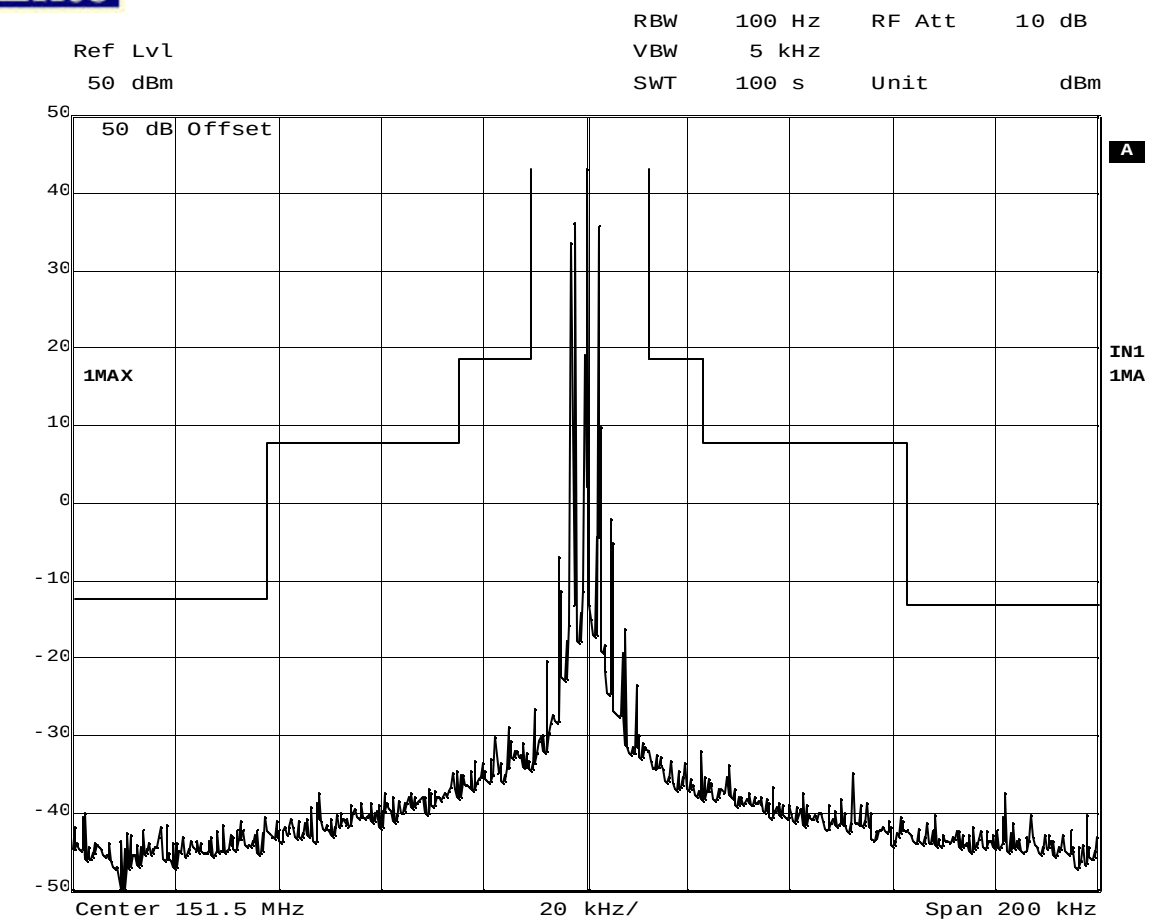
MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 128
NOTES : AM Voice Mode, 50dB external attenuation
EQUIPMENT USED : RBA0, GWF2, T2D9

NOTES



MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 136.975MHz
NOTES : AM Voice Mode, 50dB external attenuation
EQUIPMENT USED : RBA0, GWF2, T2D9 (50dB total external attn)

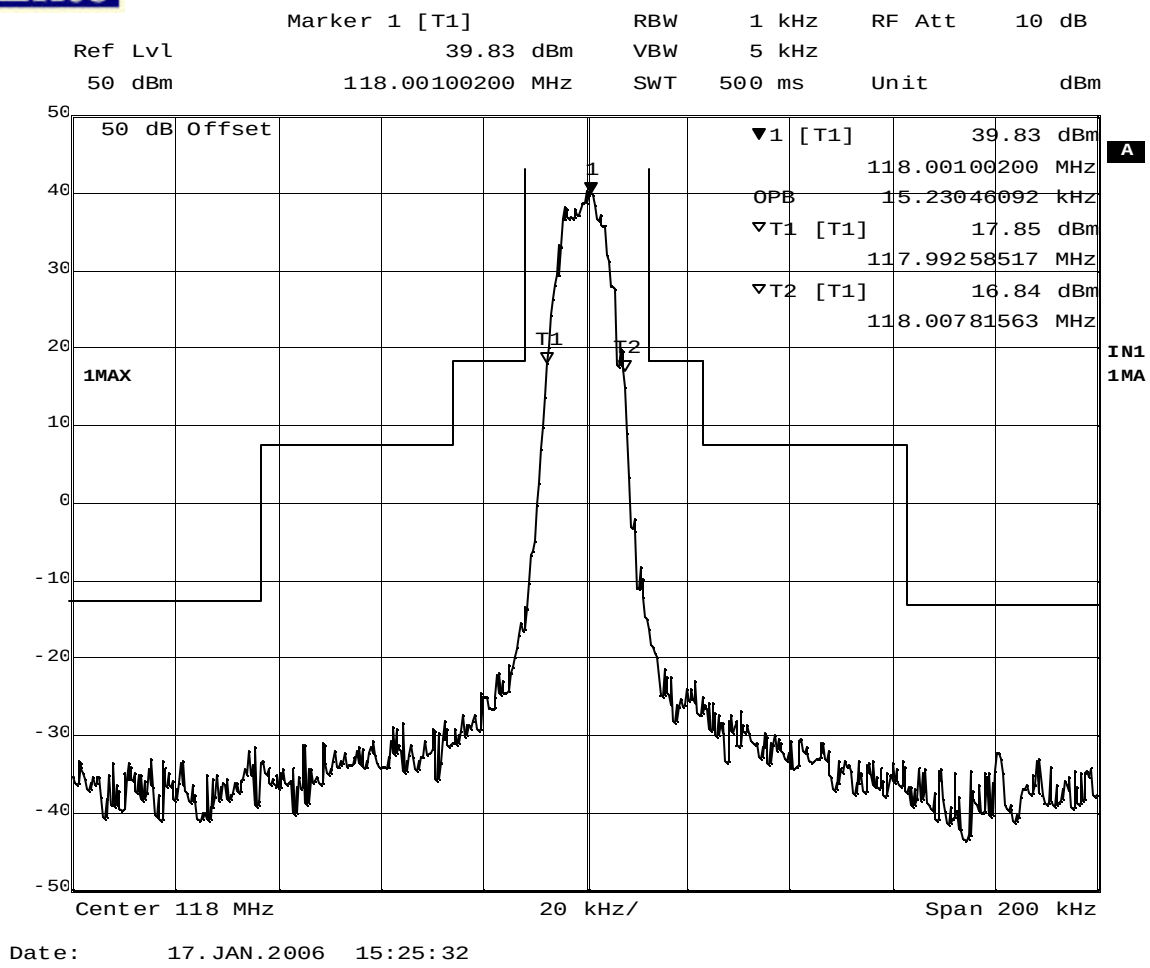
NOTES



Date: 19.JAN.2006 11:07:36

MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9V
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 151.5
NOTES : AM Voice, 50dB external attenuation
EQUIPMENT USED : RBA0, GWF2, T2D9

NOTES



MANUFACTURER : Rockwell Collins
MODEL NUMBER : VHF-4100/VHF-4100E
SERIAL NUMBER : 21H9X
TEST MODE : Occupied Bandwidth
TEST PARAMETERS : Channel 118
NOTES : Data Link
EQUIPMENT USED : RBA0, GWF2, T2D9

NOTES