APPLICATION		
DASH NO.	NEXT ASSY	USED ON
-003		064-50000

TITLE SHEET

INDEX

Typed signatures constitute approval. Actual signatures on file at Honeywell in Redmond WA.

CONTRACT NO.	PRECIOUS METAL INDICATOR CODE:	
------------------	NA	**Honeywell International Inc.** Redmond, Washington 98073-9701 Honeywell

DRAWN	C. Wilson	15-Apr-02	**FCC TYPE REPORT, TRANSMITTER SECTION OF THE RTA-44D VHF DATA RADIO, MODE 2 HONEYWELL PN 064-50000-2000, -2051**
CHECK	NA	.	
ENGR	S. Bijoor	15-Apr-02	
MFG	NA	.	
QA	A. Noble	15-Apr-02	SIZE: A; CAGE CODE: 97896; DWG NO.: 076-0963-003; REV.: B
APVD	.	.	
APVD	.	.	SCALE: NONE; SHEET 1 OF 52

REVISION STATUS OF SHEETS INDEX											
		ADDED SHEETS						ADDED SHEETS			
SHEET NUMBER	REV LTR	SHEET NUMBER	REV LTR	SHEET NUMBER	REV LTR	SHEET NUMBER	REV LTR	SHEET NUMBER	REV LTR	SHEET NUMBER	REV LTR
1 - 52	B										

REVISIONS				
SH	REV	DESCRIPTION	DATE	APPROVED
6	A	Changed Type of Emission in Paragraph 4.1.2 from “7K00A9E” to “7K00A9W”	24 APR 02 24 APR 02 24 APR 02	C. Wilson S. Bijoor A. Noble
36	A	Inserted negative sign in harmonic spurious emissions at 136.975MHz section of Table 7		
		REASON: 05 SEVERITY: 10		
6	B	Added “M2” to the FCC Identifier in paragraph 3.2	18 JUL 02 18 JUL 02 18 JUL 02	C. Wilson S. Bijoor A. Noble
13	B	Updated Figure 4 to reflect change in FCC Identifier.		
		REASON: 05 SEVERITY: 10		

Table of Contents

1 SCOPE

This document contains the test procedures and data required for the FCC certification of the Honeywell International, Inc. RTA-44D VHF Data Radio, PN 064-50000-2051 and -2000.

2 REFERENCE DOCUMENTS

2.1	CFR – Title 47, Telecommunications	Part 2 -Frequency allocations and radio treaty matters; general rules and regulations Part 87 – Aviation Services
2.2	RTCA D0-160D Change Notice 1	Environmental Conditions and Test Procedures for Airborne Equipment
2.3	RTCA DO-186A	Minimum Operational Performance Standards for Airborne Radio Communications Equipment Operating within the Radio Frequency Range 117.975-137.000 MHz
2.4	RTCA DO-207	Minimum Operational Performance Standards for Devices that Prevent Block Channels Used in Two-way Radio Communications
2.5	RTCA DO-224A	Signal-In-Space Minimum Aviation System Performance Standards (MASPS) For Advanced VHF Digital Data Communications Including Compatibility With Digital Voice Techniques
2.6	RTCA Draft VDL Mode 2 MOPS (v4.3)	Minimum Operational Performance Standards for Aircraft VDL Mode 2 - Physical, Link and Network Layer, Draft Version 4.3, Revisions Accepted October 2001
2.7	EUROCAE ED-92	Minimum Operational Performance Specification for an Airborne VDL Mode-2 Transceiver Operating in the Frequency Range 118-136.975MHz
2.8	ARINC 716-10	Airborne VHF Communications Transceiver
2.9	ARINC 750-3	VHF Data Radio
2.10	Boeing D6-16050-4 Rev. C	Electromagnetic Interference Control Requirements
2.11	Honeywell 064-50000-2000	Outline Drawing for the RTA-44D VHF Data Radio Mode 2
2.12	Honeywell 998-2858-200	System Requirements Specification, RTA-44D VHF Data Radio Mode 2
2.13	Honeywell 076-0963-101	Qualification Test Procedure for the RTA-44D VHF Data Radio Mode 2, Honeywell PN 064-50000-2000, -2051
2.14	Honeywell 076-0963-401	Qualification Test Report for the RTA-44D VHF Data Radio Mode 2, Honeywell PN 064-50000-2000, -2051

3 GENERAL APPLICATION INFORMATION

3.1 Applicant Name and Address (paragraph 2.1033(c.)(1) of Reference Document 2.1)

Honeywell Aerospace Electronic Systems (AES)
15001 NE 36th Street
Redmond, WA 98073-9701

3.2 FCC Identifier (paragraph 2.1033(c.)(2) of Reference Document 2.1)

AOIRTA-44DM2

4 TECHNICAL DESCRIPTION

4.1 Types of Emission (paragraph 2.1033(c.)(4) of Reference Document 2.1)

4.1.1 ARINC 716 Double Sideband Amplitude Modulation (DSB-AM) Voice – 7K00A3E
4.1.2 ARINC 716 DSB-AM Data and 750 Mode A DSB Minimum Shift Keyed (MSK) Data – 7K00A9W
4.1.3 ARINC 750 Mode 2 Differential Eight Phase Shift Keyed (D8PSK) Data – 14K0G1D

4.2 Frequency Range (paragraph 2.1033(c.)(5) of Reference Document 2.1)

4.2.1 118.000 to 136.975MHz, 760 channels, 25kHz spaced (all modes)
4.2.2 118.000 to 136.975MHz, 2280 channels, 8.33kHz spaced (ARINC 716 Mode Voice only)

4.3 Operating Power Levels (paragraph 2.1033(c.)(6) of Reference Document 2.1)

4.3.1 25Watts average (or RF carrier) power nominally for ARINC 716 and ARINC 750 Mode A
4.3.2 17.5 +/-2Watts for ARINC 750 Mode 2

4.4 Maximum Power Rating (paragraph 2.1033(c.)(7) of Reference Document 2.1)

4.4.1 Per paragraph 87.131, “Power and Emissions”, of Reference Document 2.1, the maximum output power is:

4.4.1.1 55W mean power (pY) for AM emissions of 716 Mode and 750 Mode A, and

4.4.1.2 55W peak envelope power (pX) for single sideband emissions of 750 Mode 2

4.5 DC Voltages and Currents on Final Amplifier (paragraph 2.1033(c.)(8) of Reference Document 2.1)

4.5.1 27.5V and 5.5A on final stage (typically)

4.6 Transmitter Alignment Procedure (paragraph 2.1033(c.)(9) of Reference Document 2.1)

This procedure is specified when it is necessary to test, replace, and align the transmitter module within the RTA-44D using readily available test equipment. All transmitter alignments, both original and when required following a repair, are performed at the factory in Lawrence, KS. The procedure does require a VHF communication interface panel which can power and control the RTA-44D as well as a PTM tool which communicates through the RS232 port to configure certain SW parameters. The antenna output of the RTA-44D should be connected to a high power 40dB Attenuator unless specified otherwise.

4.6.1 Verify that the low voltage power supply cable (with +12V, -12V, and +5V) is connected to J8018 on the Unit Under Test (UUT)

4.6.2 Verify that the 28 VDC power supply is connected to the UUT 28 VDC input terminals (P8039 = Positive, PJ038 = Negative).

4.6.3 Disconnect the transmitter RF Drive cable (P8065) from the transmitter synthesizer output.

4.6.4 Set potentiometers R205, R228, R238, R285, and R305 to fully counter-clockwise; set potentiometer R221 to fully clockwise.

4.6.5 Power up the RTA-44D.

4.6.6 With the transmitter keyed, monitor the gate of each of the specified transistors in the table below and adjust the corresponding potentiometer for 1.0 VDC nominal.

Monitor Device	Adjust Potentiometer	Final Current Adjustment
Q207	R205	350mA
Q206	R228	1A
Q208	R238	3A

4.6.7 With the transmitter unkeyed, measure the gate voltage of the transistors again and verify all gate voltages are now less than 0.10 VDC.

4.6.8 Key the transmitter and while monitoring the current output of the 28 VDC power supply, adjust the transistor bias of the 3 FETs until the final current values as listed for each transistor in the table of 4.6.6 are reached. Keep in mind that this will be a cumulative adjustment such that, when complete, the 28VDC supply should show 4.35A more current than when this adjustment was begun.

4.6.9 Setup the Network Analyzer for a transmission measurement with 0dBm output power and a frequency range of 100-150MHz.

4.6.10 Connect the RF output of the Network Analyzer through the 40dB to the RF input of the Network Analyzer and normalize the measurement so the Network Analyzer should read 0dB across the band.

4.6.11 Reset the Network Analyzer for –30dBm power output, set the reference level at 65dB and the scale to 2dB/div.

4.6.12 Connect the RF output of the Network Analyzer to the transmitter RF drive input cable (P8065) and reconnect the RF Antenna output of the unit to the input of the 40dB attenuator which is still connected to the RF input of the Network Analyzer.

4.6.13 Key the transmitter and adjust trimmer capacitors C244, C266, and C272 for maximum gain and flatness (<3dB variation from 118 to 137MHz).

4.6.14 Disconnect transmitter RF drive input cable (P8065) from RF output of Network Analyzer and connect to RF Signal Generator.

4.6.15 Disconnect RF Antenna output from 40dB attenuator and connect to Wattmeter.

4.6.16 Setup RF Signal Generator for 127MHz, -12dBm output with no Modulation.

4.6.17 Adjust R221 four turns counter-clockwise.

4.6.18 Key the transmitter and adjust R221 until the transmitter output power measures between 25 and 26 Watts. Unkey the transmitter.

4.6.19 Connect the Antenna output to the 40dB attenuator and the output of the attenuator to an oscilloscope and modulation analyzer (or some other linear audio detector instrument). Connect detected audio output to audio or distortion analyzer.

4.6.20 With the oscilloscope set up to capture the turn-on of the transmitter, key the transmitter as necessary and adjust UUT R305 to just minimize amplitude overshoot. Do not over-adjust R305 such that the overshoot peak begins to shift out in time.

4.6.21 Key the transmitter and monitor the distortion at 118 MHz, 127 MHz, and 136.975 MHz. Adjust R285 for lowest distortion possible. If adjustment of R285 causes the distortion at one frequency to degrade too much, some fine adjustments of the trimmer capacitors in step 4.6.13 may help. If adjustment of these capacitors is necessary, verify that output power is acceptable (25-30W) across frequency band.

4.6.22 Disconnect transmitter RF drive input cable (P8065) from RF signal generator and connect to transmitter synthesizer output.

4.6.23 Connect an audio source of 0.25Vrms, 1kHz to the microphone input.

4.6.24 Key the transmitter with the PTT switch and measure modulation depth modulation analyzer.

4.6.25 With the PTM tool, adjust the Transmitter Modulation Voice Level as necessary for between 90-98%.

4.6.26 Enable the data discrete on the UUT.

4.6.27 Key the transmitter with the Data Key switch and measure modulation depth modulation analyzer.

4.6.28 With the PTM tool, adjust the Transmitter Modulation Data Level as necessary for between 90-98%.

4.6.29 Disconnect audio source from microphone and disconnect Antenna output from attenuator and connect to Wattmeter.

4.6.30 Recycle power on RTA-44D with D8PSK test mode enabled. (Data discrete and D8PSK test discrete, MP-D9, grounded)

4.6.31 With PTM tool, zero out Mode 2 Reference Power Levels 1 and 2 and set Mode 2 I and Q bias to "128".

4.6.32 Tune RTA-44D to 127MHz, key the transmitter and measure output power.

4.6.33 With PTM tool, adjust Mode 2 I and Q Gain levels to set output power between 13 and 20W. Remeasure and readjust as necessary.

4.6.34 With PTM tool set Mode 2 Reference Power Level 2 to "100".

4.6.35 Key transmitter and measure output power. Adjust Mode 2 Reference Power Level 2 as necessary to set output power between 17.5 and 18.5W.

4.6.36 Disconnect antenna output from Wattmeter and connect through 40dB attenuator to Vector Signal Analyzer.

4.6.37 Configure Vector Signal Analyzer to look at signal magnitude of transmitter rise time in vector signal analysis mode.

4.6.38 With PTM tool set Mode 2 Reference Power Level 1 to "100".

4.6.39 Key transmitter and measure the relative amplitude of the first symbol of the VDL Mode 2 synchronization sequence with the 3rd symbol prior to this point (transmitter ramp-up). Adjust Mode 2 Reference Power Level 1 as necessary such that the difference is within +/-0.5dB.

4.6.40 Configure Vector Signal Analyzer to measure modulation characteristics, specifically RMS Error Vector Magnitude over the first 100 symbols.

4.6.41 With the PTM tool, adjust Mode 2 I and Q Bias (which affects LO leakage due to modulator imbalance) and Mode Q gain level (which compensates I and Q channel imbalance) as necessary to minimize the Error Vector Magnitude, with a target value of less than 8% rms.

4.6.42 Power down RTA-44D and replace all covers on RF module and UUT.

4.7 Transmitter Theory of Operation (paragraph 2.1033(c.)(10) of Reference Document 2.1)

4.7.1 The transmitter portion of RF module of the RTA-44D VHF Data Radio is comprised of 3 sections: the transmitter synthesizer which directly generates the RF carrier frequency and contains the modulator, the anti-alias filters for the baseband I/Q inputs which modulate the RF, and the transmitter RF amplification chain.

4.7.1.1 Transmitter Synthesizer

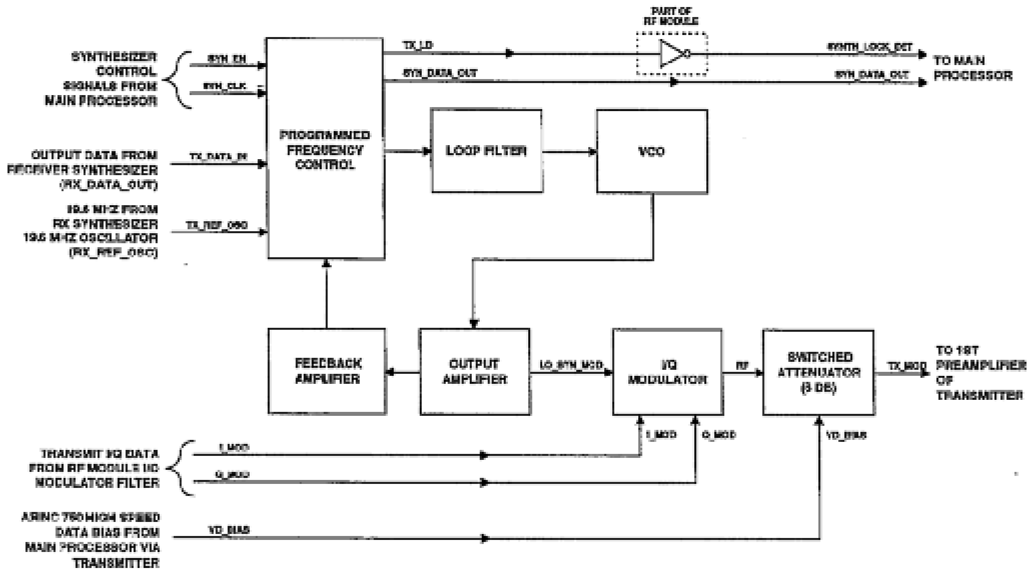


Figure 1: Transmitter Synthesizer Block Diagram

The transmitter synthesizer (refer to Figure 1) tuning range is 118-136.992MHz with a resolution of 8.33kHz steps. It consists of a PLL integrated circuit (IC), loop filter, voltage-controlled oscillator VCO, buffer amplifier and feedback amplifier which generate the RF carrier and the Quadrature (I/Q) modulator which modulates the RF with the baseband I/Q signals.

The PLL IC (MC145193) performs frequency scaling and phase comparison of a reference oscillator and the feedback signal from the VCO. The frequency scaling is performed by programmable counters where the reference oscillator is scaled down to the minimum tuning step size while the scaling factor for the feedback signal is chosen to produce the correct frequency. The programming of the PLL ICs is done serially through clock (SYN_CLK), data (SYN_DATA_IN), and enable (SYN_EN) interfaces with the DSP of the main processor module. The PLL IC of the transmitter synthesizer is daisy-chained with the receive synthesizer such that the transmitter PLL IC receives its data (TX_DATA_IN) from the receiver PLL IC (RX_DATA_OUT). The clock and enable lines are shared in parallel. Depending on the polarity of errors in phase comparison, the PLL IC will source or sink current (at the 8.33kHz rate) to tune to the proper frequency.

The loop filter is an active low-pass filter, which filters out the 8.33kHz and harmonics of the charge pump as well as reduces noise which could modulate the VCO. It produces a DC voltage which biases the varactor of the VCO, the output frequency of the which is directly related to this DC input signal.

The output of the VCO is buffered by a cascode amplifier which presents a constant impedance to the VCO, provides isolation from succeeding stages, and enough gain to drive the modulator (approximately +7dBm LO_SYN_MOD). In addition to the synthesizer output, a loosely coupled feedback path is provided to close the loop of the PLL. The loosely coupled signal is filtered and amplified before being passed to the PLL. The amplifier is a monolithic microwave integrated circuit (MMIC) to boost the loosely coupled signal level above the sensitivity threshold of the PLL IC.

The reference oscillator is a 19.6MHZ temperature compensated crystal oscillator (TCXO) which is integrated with the receiver synthesizer but provides the reference signal (RX_REF_OSC and RX_REF_OSC) for both PLL ICs. The TCXO provides excellent frequency stability (better than +/-5ppm) over temperature and time.

In addition to the PLL, the transmitter synthesizer has integrated the I/Q modulator. The I/Q modulator is a Quadrature Modulator, which takes baseband I/Q inputs from the DSP of the main processor, splits the LO into quadrature (90 degrees out of phase) to be modulated by I and Q channels separately and then sums the resulting RF signals to form the modulated RF signal. Regardless of mode of operation (716 Mode Voice/Data, 750 Mode A, or 750 Mode 2), the I/Q modulator is used to generate all required modulation formats – DSB-AM, DSB-AM-MSK, and D8PSK. For amplitude modulation, the I and Q channels are normally DC biased into one quadrant (of I/Q space) and the I and Q AC voltages are varied in synchronization but never more than twice the DC bias (i.e.- less than 100% AM). For D8PSK signals, there are very small bias currents only to eliminate carrier leakage due to I/Q offset which occurs with imbalance in the modulator diodes. I and Q AC signals vary as required to pass through the eight phase states equally spaced on a constant magnitude circle of the I/Q space (i.e. – passes through all quadrants).

4.7.1.2 I/Q Modulator Data Filters

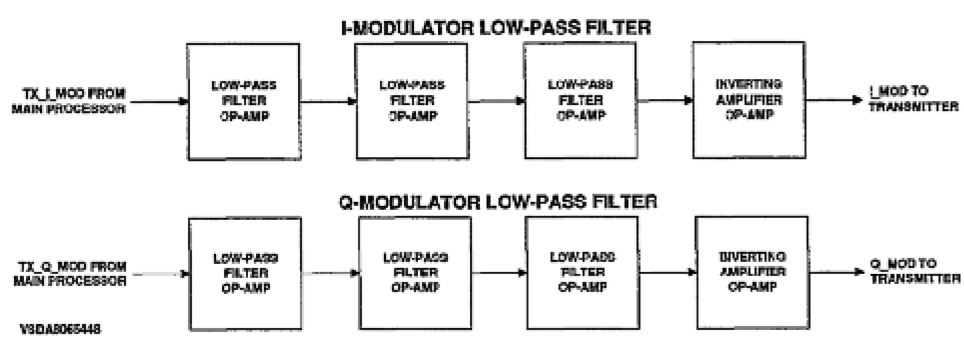


Figure 2: I/Q Modulator Filters Block Diagram

The RF module I/Q modulator filter circuits (refer to Figure 2) are six-pole active low-pass filters with voltage-to-current converter outputs. They are identical chains for the I and Q channels which filter the spurs and limit the wideband noise. The filters are designed to have maximally-flat group delay and unity gain amplitude response. They are Butterworth design with a 1dB rolloff at 10kHz. The input to the filters are the I and Q baseband voltage signals supplied by the DAC on the main processor module. For 750 Mode 2 D8PSK signals, the spectrum is controlled by the pulse shaping raised cosine filters with an alpha factor of 0.6 by the DSP as defined in paragraph 3.2.1.2 of Reference Document 2.5. The output of the I/Q filters are I and Q current signals which drive the I/Q modulator in the transmitter synthesizer.

4.7.1.3 Transmitter Amplification

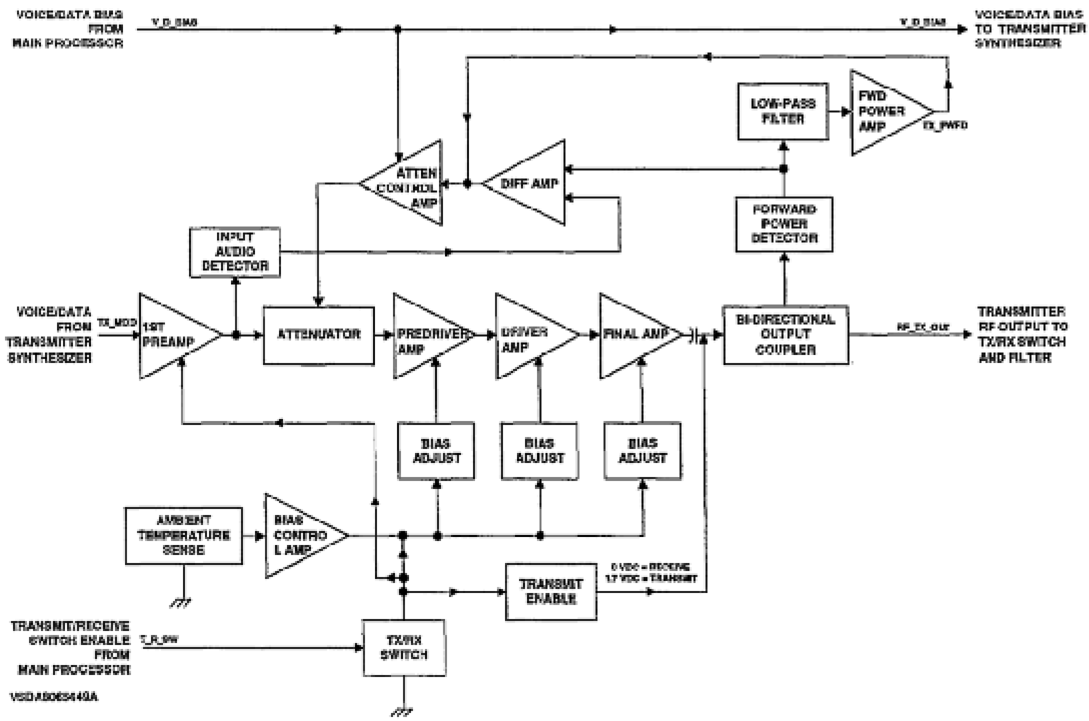


Figure 3: Transmitter Amplification Block Diagram

The transmitter (refer to figure 3) operates as a linear, class-AB amplifier to provide 25Watts nominal output in 716 Mode or 750 Mode A, or 17.5W +/- 2W in 750 Mode 2. It consists of four gain stages with monitor and control circuitry for enabling transmissions, output power leveling and reducing distortion.

A transmission can be initiated when the microphone is keyed (PTT) in 716 Voice Mode or the management unit (MU) initiates a transmission either with the Data Key in 716 Data Mode or a communications bus (429) request in 750 Mode A or 750 Mode 2. When keyed or a transmission requested, the main processor module supplies the transmit/receive switch enable (T_R_SW) signal to the transmitter which turns on the bias to the first preamplifier, turns on gate biases to the predriver, driver, and final MOSFETs, and passes a bias voltage on to the T/R switch in the filter/switch module.

The transmitter RF drive from the transmitter synthesizer is approximately –12dBm for 716 Mode and 750 Mode A and between –22 and –18dBm for the 750 Mode2. There is a larger range for the 750 Mode 2 signals because power control is implemented by adjusting transmitter drive level.

The transmitter drive passes through a 6dB fixed attenuator before the first preamplifier. The first preamplifier is a common base amplifier with approximately 15dB of gain. A peak detector is loosely coupled at the input of the preamplifier which will be used to reduce distortion in 716 Modes and 750 Mode A. At the output of the preamplifier is a variable attenuator circuit with an approximate linear range of 12dB which is used for power leveling in 716 Modes and 750 Mode A. Both the detector and attenuator will be discussed later with the control loop.

The output of the variable attenuator is fed to the next stage, a MOSFET (BLF245) configured as a class A predriver amplifier. With 28VDC on the drain and an input gate voltage of three to three-and-a-half volts, tuned for 350mA of drain current, the predriver provides approximately 14 to 15dB gain.

The next amplification stage, the driver stage, uses the same MOSFET (BLF245) and also 28VDC on the drain, but the gate voltage is between three-and-a-half to four volts, tuned for 1A of drain current, which provides approximately 16-17dB gain. At the output of the driver stage, the RF signal level is approximately one watt.

The final amplifier is a power MOSFET (BLF147) which is biased class AB with 28VDC on the drain. With four to four-and-a-half volts on the gate, which is tuned for 3A of drain current, the gain is between 15 and 16dB. The output of the final amplifier is routed through a bi-directional coupler, which samples forward and reverse power, and through a coaxial cable to the filter/switch module (RF_TX_OUT).

There is an analog control loop for power leveling and distortion in 716 Mode and 750 Mode A, while the 750 Mode 2 has only a power leveling loop which is controlled by the DSP on the main processor module. All control loops have adjustments which are tuned during alignment (see section 4.6)

The analog control loop for 716 Modes and 750 Mode A samples the forward power after the final amplifier from the bidirectional coupler with a diode peak detector circuit. This signal is fed through an integrator and comparator which then supplies a voltage to the variable attenuator between the first amplifier and predriver amplifier. The comparator stage has an adjustable reference voltage which is used to set the power output during alignment. An adjustable bias voltage, which is effectively switched out with the TR_SW control, is summed with the forward power signal to limit the initial output power and reduce overshoot and settling time. In addition, the detected signal from the input to the first amplifier is fed back through a tunable gain stage and summed with the power control voltage on the variable attenuator. The tunable gain stage is adjusted during alignment to improve distortion by adjusting attenuation for the audio peaks.

In 750 Mode 2, the detected forward power signal is fed to the DSP of the main processor module which makes corrections for power during the initial pre-key of a 750 Mode 2 transmission only. The 750 Mode 2 signal has five pre-key zero symbols which produce an unmodulated carrier and thus a constant detected voltage. Using a programmable reference voltage, the DSP compares voltages during this period and accordingly adjusts the I/Q data output voltages to reduce the RF drive level from the transmitter synthesizer and regulate the output power of the transmitter. In addition to power level control, the DSP of the main processor module has configurable control over the transmitter I and Q amplitude balance and I/Q modulator bias in order to reduce transmitter symbol constellation error.

Other notable features of the transmitter include:

- Impedance matching to 50 ohms between stages which is accomplished through microstrip printed-circuit coils and transmission lines as well as discrete surface-mount components.
- An ambient temperature sense circuit which controls the gate bias voltages of the three MOSFETs to maintain nearly constant current across temperature. This improves linearity of the transmitter over temperature.
- And a VSWR monitoring function (750 Mode A and 750 Mode 2 only) to detect problems at the antenna port.

4.7.2 Other Control Circuitry

4.7.2.1 Modulation Control

Modulation control in 716 Modes is accomplished through the use of compressor circuitry on the audio inputs as well as I/Q voltage output control within the DSP of the main processor module. The compressor begins to limit the audio input to the Analog to Digital Converter (ADC) at around 250mV rms. The I/Q voltage outputs have a DC bias and a synchronized AC component from the DSP to the I/Q modulator which is set by a transmitter modulation level parameter. This is programmed during LRU alignment with a target value of between 90-98% modulation (see section 4.6).

For 750 Mode A and 716 Mode 2, there are no analog data inputs to the RTA-44D for transmission. Transmissions are initiated through a serial (ARINC429) bus request which contains the data. The DSP of the main processor module performs all modulation control through its generation of I/Q data for the modulator. For 750 Mode A, the digital data is converted by the DSP to be transmitted as an amplitude modulated waveform, whereas the DSP uses the 716 Mode I/Q alignments for modulation control. For 750 Mode 2, the modulation scheme is as defined in paragraph 3.2.1.2 of Reference Document 2.5 with a pulse shaping raised cosine filter with an alpha factor of 0.6.

4.7.2.2 Spurious Emission Control Circuit

In addition to directly generating the RF carrier, which eliminates unwanted mixer products or spurs associated with upconversion, there is a low pass filter module at the output of the transmit/receive switch/filter module in order to reduce the harmonic emissions of the transmitter. It is a five pole low-pass filter with a corner frequency of approximately 170MHz and provides >30dB of attenuation at the transmitter second harmonic.

4.8 Identification Plate (paragraph 2.1033(c.)(11) of Reference Document 2.1)

4.8.1 The RTA-44D identification plate will be per Honeywell PN 620-1687-002

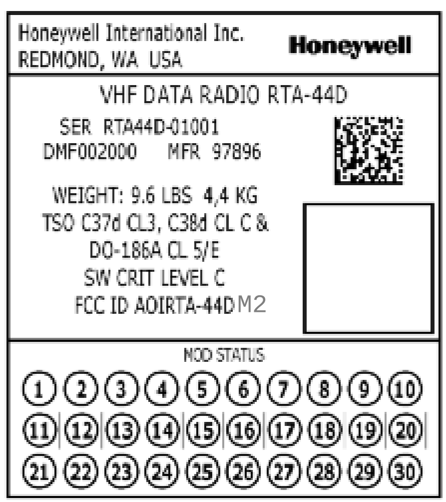


Figure 4: Identification Nameplate

4.9 Photographs of Unit (paragraph 2.1033(c.)(12) of Reference Document 2.1)

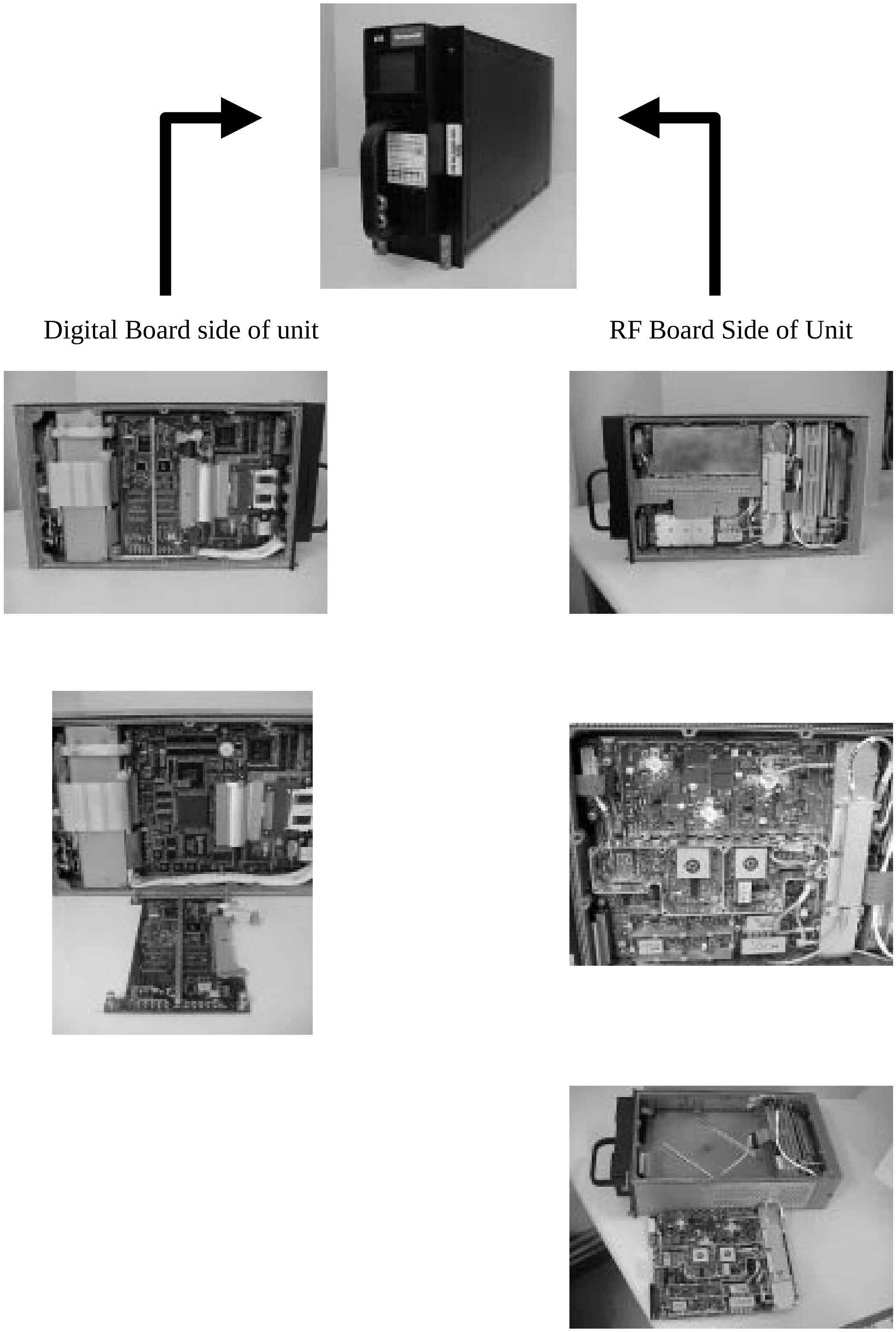


Figure 5: Photographs representative of Construction of the RTA-44D

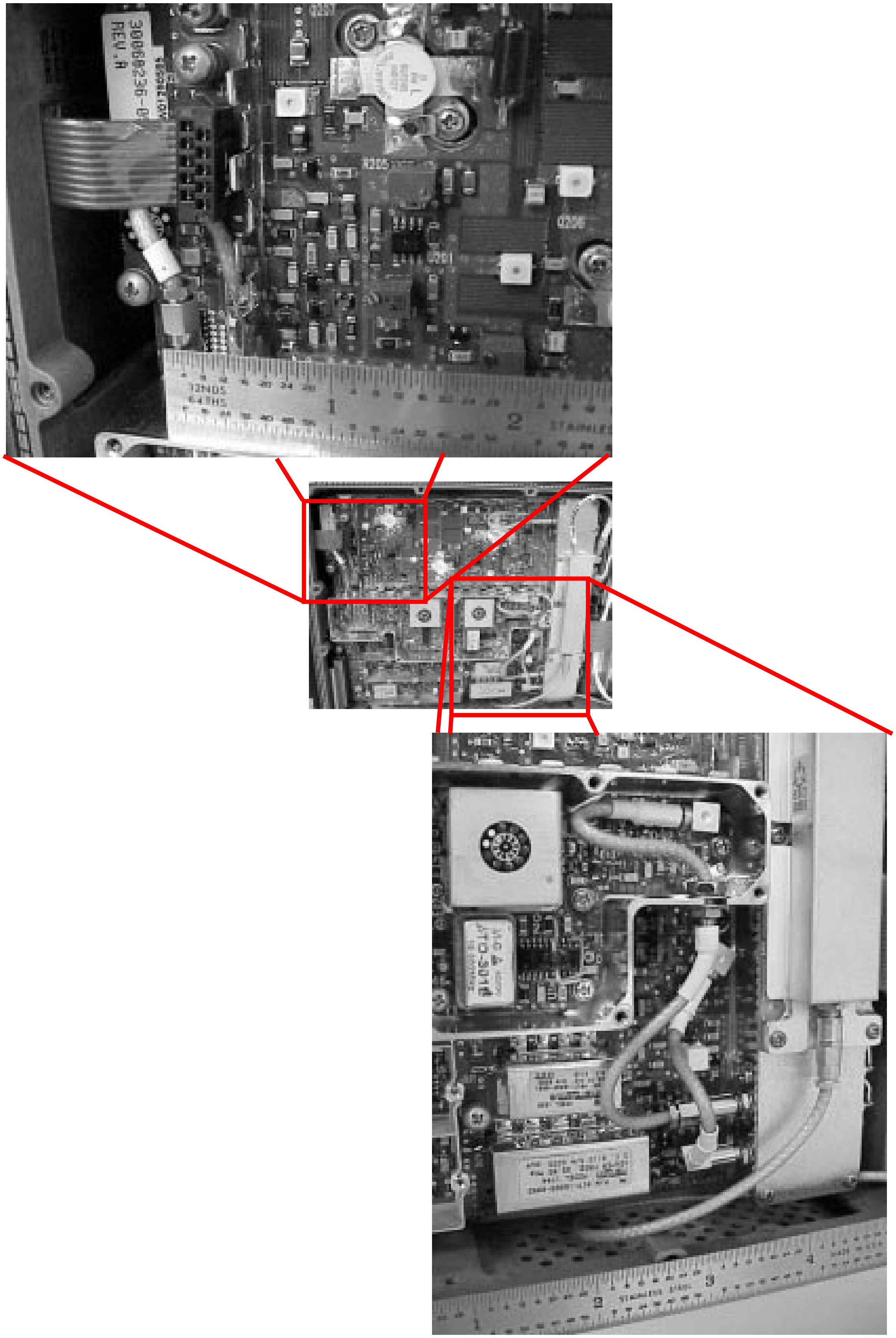


Figure 6: Close-up photographs of the RF board to show typical construction features.

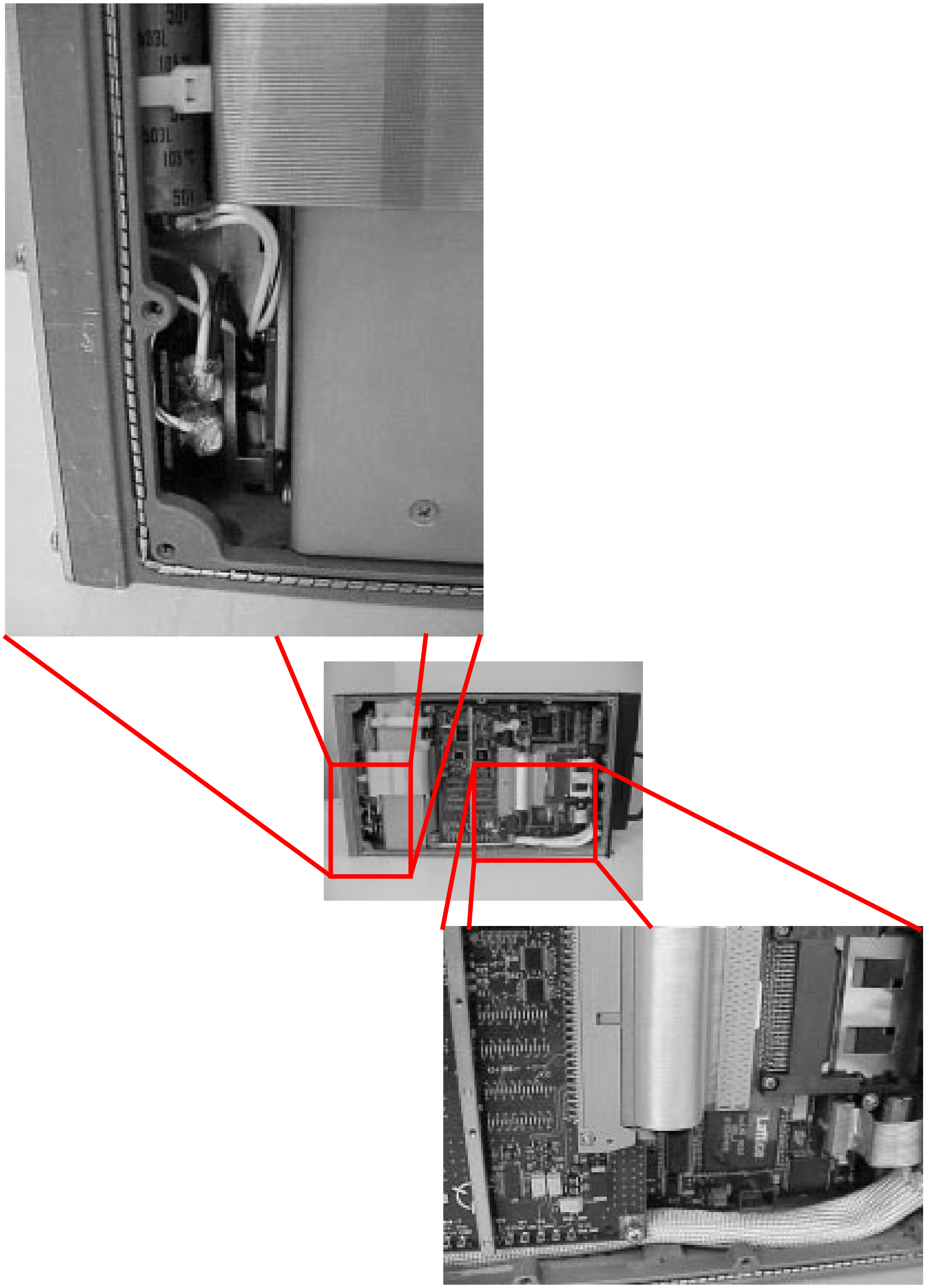


Figure 7: Close-up photographs of the Digital board to show typical construction features.

4.10 Description of Digital Modulation System (paragraph 2.1033(c.)(13) of Reference Document 2.1)

4.10.1 750 Mode 2 employs a D8PSK digital modulation system as defined by paragraph 3.2.1 of Reference Document 2.5 most of which is implemented in the DSP of the main processor module.

4.10.2 In addition to the processing and filtering which is performed in the DSP of the main processor module, each of the I and Q channels has a low-pass anti-alias filter on the RF Module as described in section 4.7.1.2. They are 10kHz (1dB) bandwidth Butterworth filters with unity gain and linear phase.

5 Transmitter Data

5.1 General Test Requirements

5.1.1 Equipment Required

5.1.1.1 VHF Communications Interface Panel with 28V Power Supply

5.1.1.2 Protocol Analyzer

5.1.1.3 Power Meter – Boonton 4400A

5.1.1.4 Modulation Analyzer – HP8901B

5.1.1.5 Signal Generator (for Reference Oscillator) - Marconi 2030

5.1.1.6 Audio Signal Generator – HP33120A (or HP8903B Audio Analyzer)

5.1.1.7 Spectrum Analyzer – Rohde&Schwarz FSEM-30

5.1.1.8 Directional Coupler – Narda 3002-10

5.1.1.9 Cavity Bandstop Filters – TX/RX Systems 20-35-02

5.1.1.10 40dB High Power Attenuator – Weinschel 40-40-33

5.1.1.11 20dB High Power Attenuator – Pasternak PE7026-30

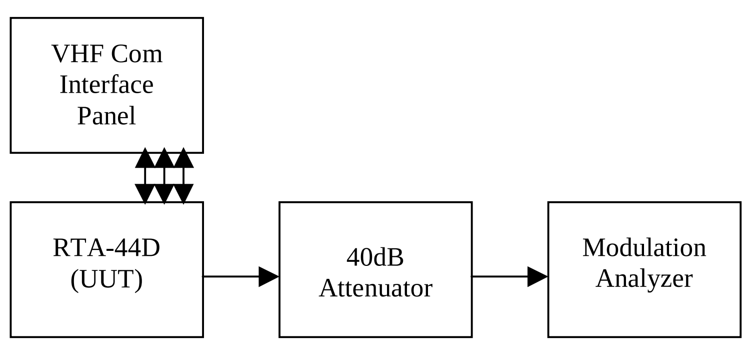
5.1.1.12 Amplifier – Mini-Circuits ZHL-1217MLN.

5.1.2 All test equipment shall operated in accordance with the manufacturer's published operational procedures and be up-to-date within its normal calibration cycle.

5.2 RF Output Power (paragraph 2.1046 of Reference Document 2.1)

5.2.1 716 Mode and 750 Mode A

5.2.1.1 Test Setup



5.2.1.2 Test Procedure

5.2.1.2.1 Connect UUT to VHF Com interface panel and connect RF Antenna of UUT through high power attenuator to Modulation Analyzer as shown. Enter the measured loss through cables and attenuator into modulation analyzer cal factor. Do not connect any signal to audio/microphone input.

5.2.1.2.2 Power up UUT in 716 Mode with Voice/Data discrete set to VOICE and D8PSK Test Enable discrete open.

5.2.1.2.3 Tune UUT to 118MHz.

5.2.1.2.4 Key transmitter (switch PTT) and measure output power.

5.2.1.2.5 Repeat measurement roughly every 1 MHz through 136.975MHz.

5.2.1.3 Test Requirement

5.2.1.3.1 Average Power must be less than 55W (see paragraph 4.4)

5.2.1.4 Test Results

UUT: SN5460
SW: 998-2887-5Q0
Date: 3/9/2002

Frequency (MHz)	Pout (W)
118	27.6
119	27.6
120	27.5
121	27.4
122	27.3
123	27.3
124	27.2
125	27.1
126	27
127	26.9
128	26.7
129	26.4
130	26.1
131	26.2
132	27.1
133	27.2
134	27.2
135	27.2
136	27.2
136.975	27.1

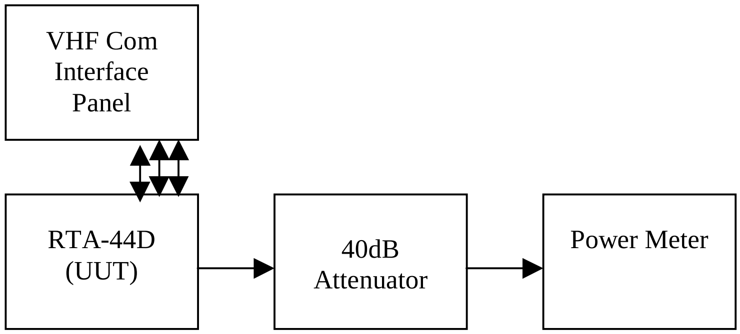
Table 1: 716 Mode Average Power Data

5.2.2 750 Mode A

All RF generation and power control circuitry for 750 Mode A is identical to that of 716 Mode operation. The only difference between the modes is that in 750 Mode A, the modulation is internally generated. Therefore, the power data for 716 mode shall be acceptable for 750 Mode A operation.

5.2.3 750 Mode 2

5.2.3.1 Test Setup



5.2.3.2 Test Procedure

5.2.3.2.1 Connect UUT to VHF Com interface panel and connect RF Antenna through attenuator power meter as shown.

5.2.3.2.2 Configure power meter to measure peak and average power and enter the measured loss through cables and attenuator for the power meter cal factor.

5.2.3.2.3 Power up UUT in D8PSK Test mode with Voice/Data discrete set to DATA and D8PSK Test Enable discrete grounded (enabled).

5.2.3.2.4 Tune UUT to 118MHz.

5.2.3.2.5 Key transmitter (switch Data Key) and measure output power.

5.2.3.2.6 Repeat measurement for 127MHz (center of band) and 136.975MHz (edge of band).

5.2.3.3 Test Requirement

5.2.3.3.1 Peak Envelope Power must be less than 55W (see paragraph 4.4)

5.2.3.4 Test Results

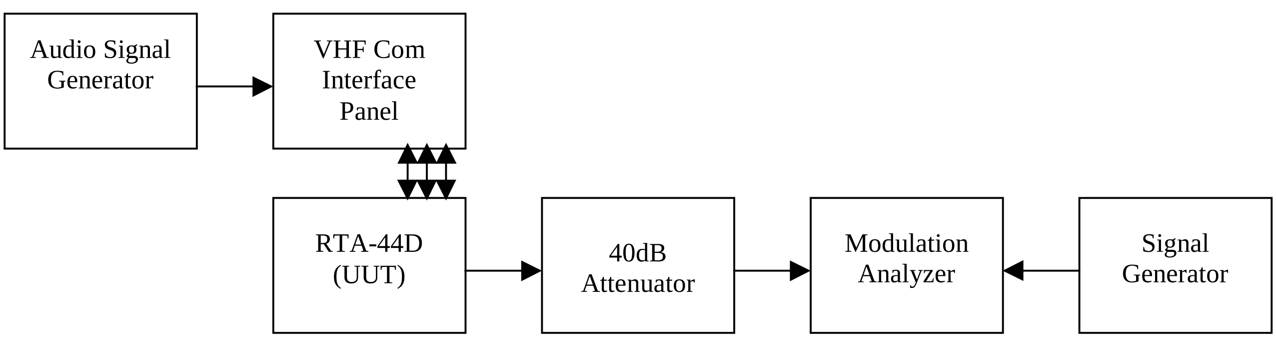
Frequency	Average Power Out (W)	Peak Envelope Power Out (W)
118 MHz	19.5	40.7
127MHz	19.7	40.7
136.975MHz	19.8	40.7

Table 2: 750 Mode 2 Average and Peak Power Data

5.3 Modulation Characteristics (paragraph 2.1047 of Reference Document 2.1)

5.3.1 716 Mode

5.3.1.1 Test Setup



5.3.1.2 Test Procedure

5.3.1.2.1 Connect UUT to VHF Com interface panel and connect RF Antenna through attenuator to modulation analyzer as shown.

5.3.1.2.2 Connect Audio Signal Generator to audio/microphone input.

5.3.1.2.3 Configure the Audio Signal Generator to produce a 1kHz tone at 0.25Vrms.

5.3.1.2.4 Power up UUT in 716 Mode with Voice/Data discrete set to VOICE and D8PSK Test Enable discrete open.

5.3.1.2.5 Tune UUT to 127MHz.

5.3.1.2.6 Key transmitter (switch PTT) and measure modulation depth and normalize (set to relative measurement on a log scale).

5.3.1.2.7 Without changing the audio signal generator voltage, key transmitter and measure relative modulation for audio frequencies from 100 to 5000Hz.

5.3.1.2.8 Reset modulation analyzer to measure absolute modulation depth.

5.3.1.2.9 Reset Audio Signal Generator for 1kHz tone and measure the modulation depth as the audio voltage is varied from 0.02Vrms to 4.0Vrms.

5.3.1.3 Test Requirement

5.3.1.3.1 Audio bandwidth from 350 to 2750Hz (< 6dB variation)

5.3.1.3.2 Modulation must be limited to less than 100% (section 87.141(b))

5.3.1.4 Test Results

5.3.1.4.1 Frequency response of modulation:

UUT: SN5460
SW: 998-2887-5Q0
Date: 3/9/2002

Audio Freq. (Hz)	Modulation Depth Relative to 1kHz (dB)
300	-1.6
350	-0.6
500	0
750	0.2
1000	0
1250	-0.1
1500	0
1750	0.4
2000	0.3
2250	0.1
2500	0
3000	-15
3500	-22

Table 3: 716 Mode Frequency Response of Modulation

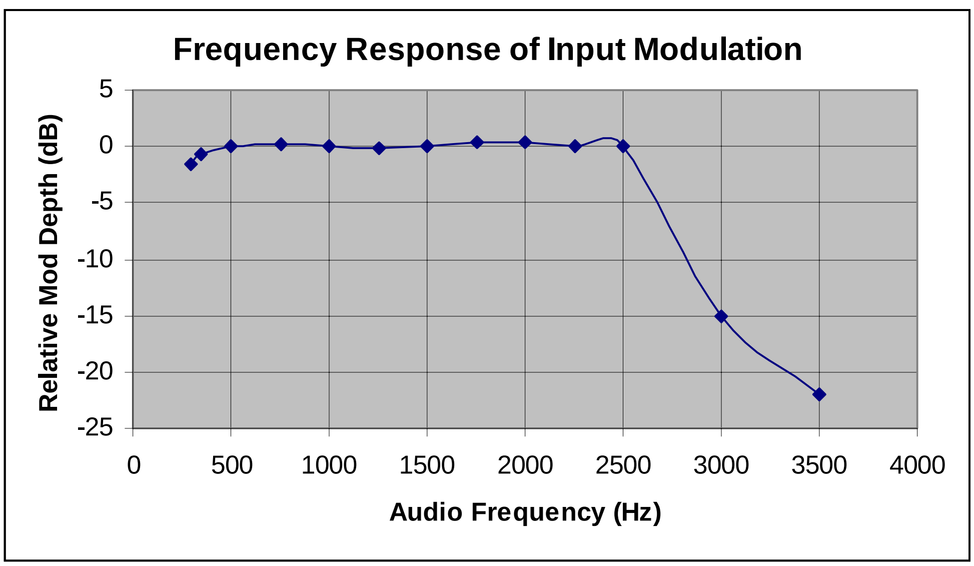


Figure 8: 716 Mode Frequency Response of Modulation

5.3.1.4.2 Modulation limitation response:

UUT: SN5460
SW: 998-2887-5Q0
Date: 3/9/2002

Input Voltage (Vrms)	Modulation Depth
0.01	5.3%
0.02	16.3%
0.05	43.0%
0.1	82.0%
0.15	94.4%
0.2	95.0%
0.25	94.9%
0.5	93.6%
0.75	94.7%
1	93.8%
2	93.2%
3	94.5%
4	93.6%

Table 4: 716 Mode Modulation Limitation Response

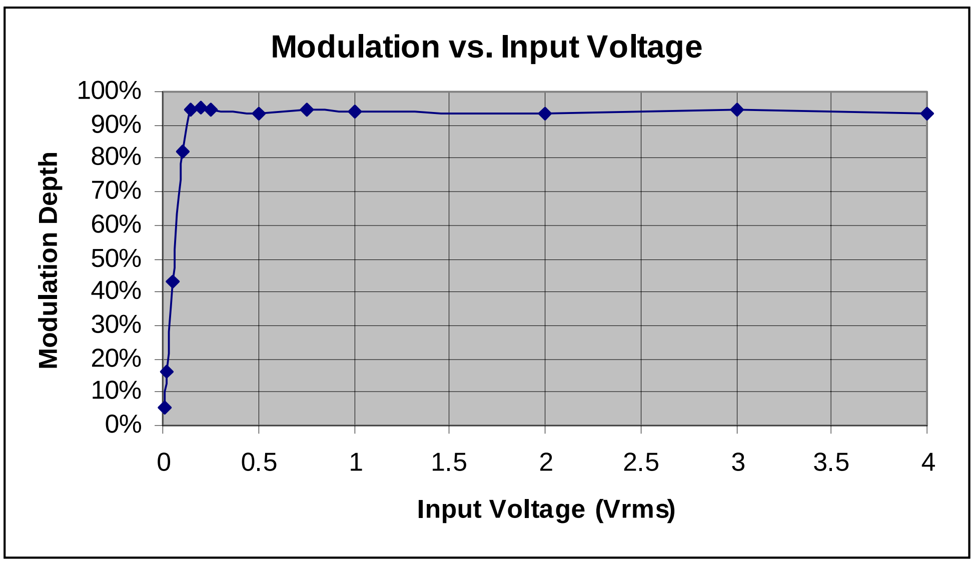


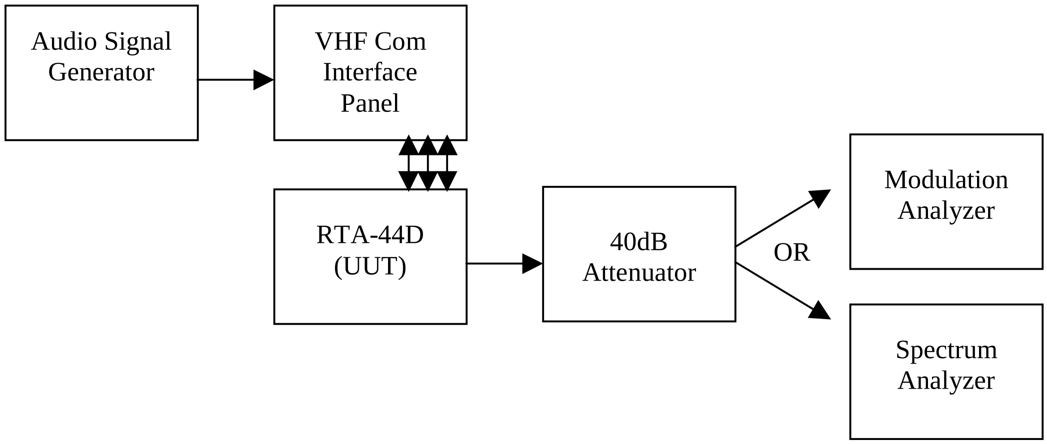
Figure 9: 716 Mode Modulation Limitation Response

5.3.1.5 NOTE: 750 Mode A and 750 Mode 2 do not use analog audio inputs, but rather an internal modem, and therefore there are no modulation response measurements.

5.4 Occupied Bandwidth (paragraph 2.1049 of Reference Document 2.1)

5.4.1 716 Mode

5.4.1.1 Test Setup



5.4.1.2 Test Procedure

5.4.1.2.1 Connect UUT to VHF Com interface panel and connect RF Antenna through attenuator to modulation analyzer as shown.

5.4.1.2.2 Connect Audio Signal Generator to audio/microphone input.

5.4.1.2.3 Configure the Audio Signal Generator to produce a 1kHz tone.

5.4.1.2.4 Power up UUT in 716 Mode with Voice/Data discrete set to VOICE and D8PSK Test Enable discrete open.

5.4.1.2.5 Tune UUT to 118MHz.

5.4.1.2.6 Key transmitter (switch PTT) and adjust audio voltage until modulation depth measures 50%.

5.4.1.2.7 Unkey transmitter, set audio signal generator tone to 2.5kHz and increase voltage by 16dB.

5.4.1.2.8 Disconnect attenuator output from modulation analyzer and connect to spectrum analyzer.

5.4.1.2.9 Rekey Transmitter and measure occupied bandwidth.

5.4.1.2.10 Repeat for 127MHz and 136.975MHz.

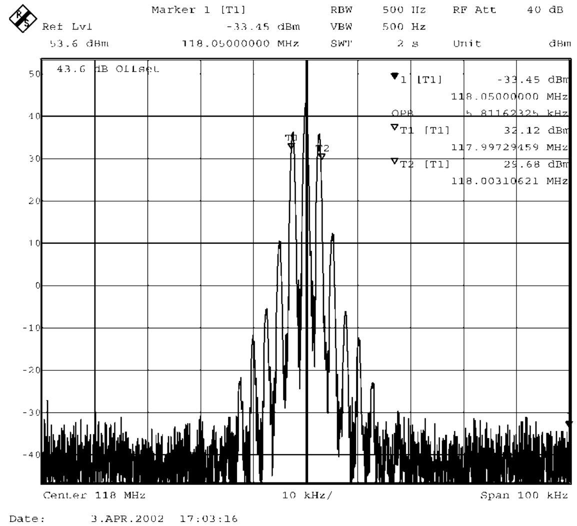
5.4.1.3 Test Requirement

5.4.1.3.1 Maximum Occupied bandwidth for a VHF A3E transmitter is 25kHz (section 87.135 and 87.137)

5.4.1.4 Test Results

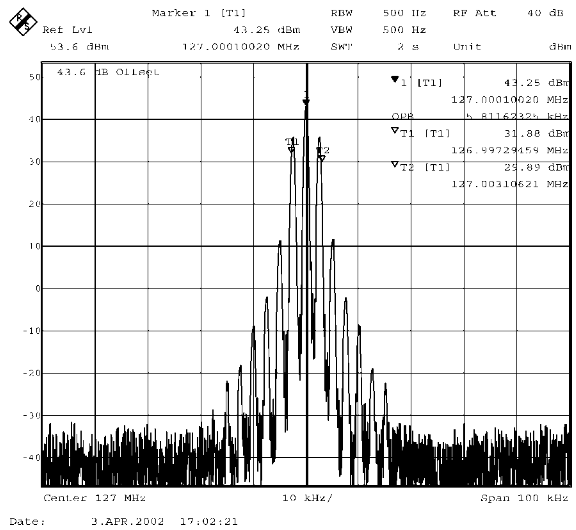
UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

716 Mode
118MHz:
BW_{occ} = 5.81kHz



UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

716 Mode
127MHz:
BW_{occ} = 5.81kHz



UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

716 Mode
136.975MHz
BW_{occ} = 5.81kHz

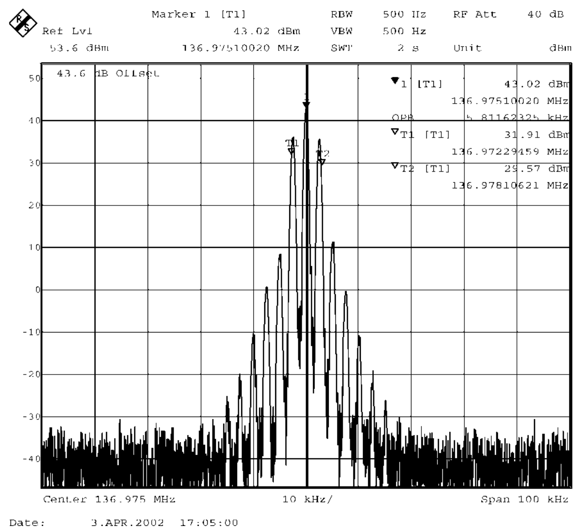
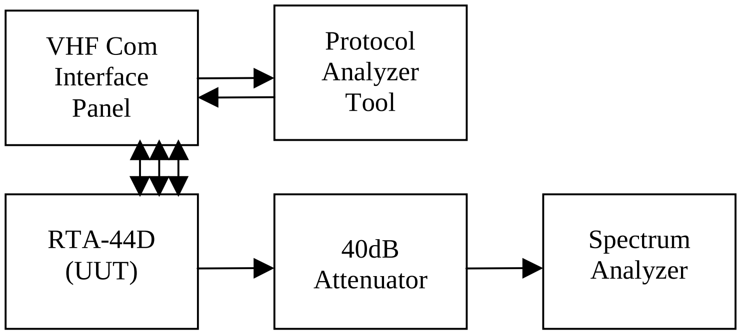


Figure 10: 716 Mode Occupied Bandwidth Data

5.4.2 750 Mode A

5.4.2.1 Test Setup



5.4.2.2 Test Procedure

5.4.2.2.1 Connect UUT to VHF Com interface panel and connect RF Antenna through attenuator to spectrum analyzer as shown.

5.4.2.2.2 Power up UUT in Data Mode with Voice/Data discrete set to DATA and D8PSK Test Enable discrete open (disabled).

5.4.2.2.3 Put UUT into Mode A with Protocol Analyzer Tool and set frequency for 118MHz.

5.4.2.2.4 Initiate a maximum length Mode A transmission and measure occupied bandwidth.

5.4.2.2.5 Repeat for 118MHz and 136.975MHz.

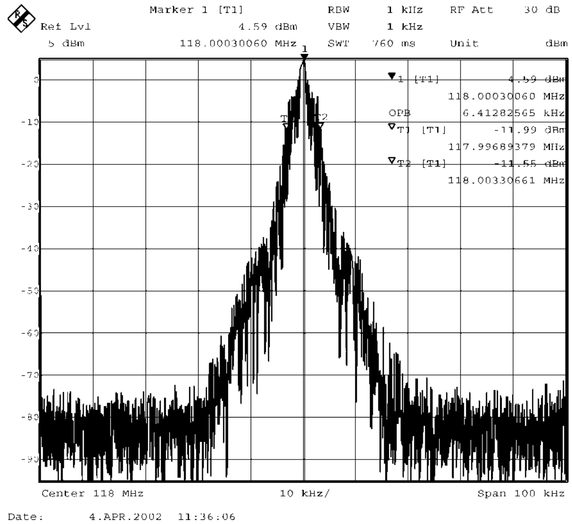
5.4.2.3 Test Requirement

5.4.2.3.1 Maximum Occupied bandwidth for a VHF A9W transmitter is 25kHz (section 87.135 and 87.137)

5.4.2.4 Test Results

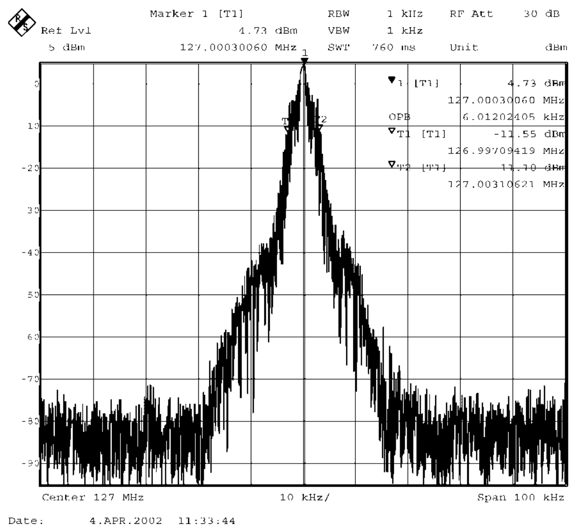
UUT: SN5460
SW: 998-2887-5Q0
Date: 4/4/2002

750 Mode A
118MHz:
BW_{occ} = 6.41kHz



UUT: SN5460
SW: 998-2887-5Q0
Date: 4/4/2002

750 Mode A
127MHz:
BW_{occ} = 6.01kHz



UUT: SN5460
SW: 998-2887-5Q0
Date: 4/4/2002

750 Mode A
136.975MHz
BW_{occ} = 6.41kHz

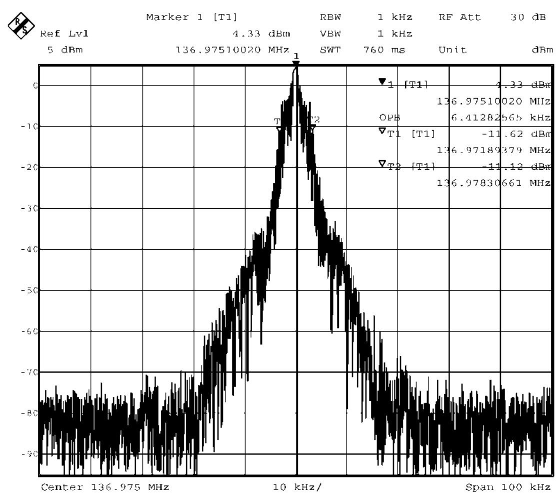
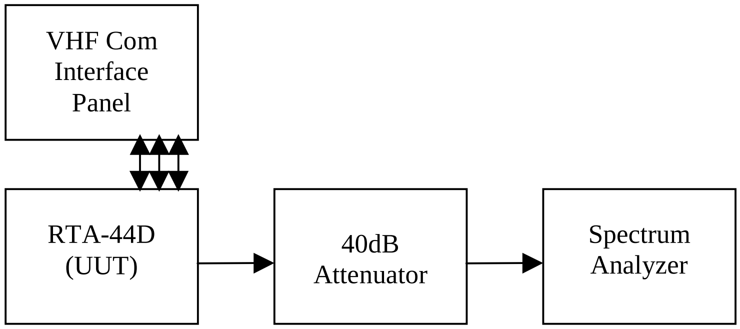


Figure 11: 750 Mode A Occupied Bandwidth Data

5.4.3 750 Mode 2

5.4.3.1 Test Setup



5.4.3.2 Test Procedure

5.4.3.2.1 Connect UUT to VHF Com interface panel and connect RF Antenna through attenuator to spectrum analyzer as shown.

5.4.3.2.2 Power up UUT in D8PSK Test Mode with Voice/Data discrete set to DATA and D8PSK Test Enable discrete grounded (enabled).

5.4.3.2.3 Tune UUT to 118MHz.

5.4.3.2.4 Key transmitter (switch Data Key) and measure occupied bandwidth.

5.4.3.2.5 Repeat for 127MHz and 136.975MHz.

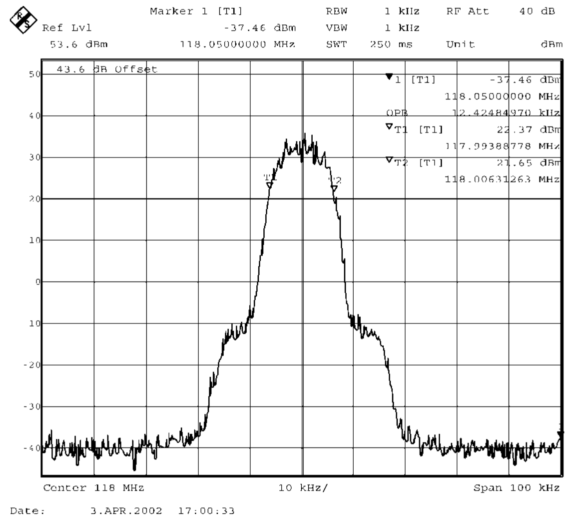
5.4.3.3 Test Requirement

5.4.3.3.1 Maximum Occupied bandwidth for a VHF G1D transmitter is 25kHz (section 87.135 and 87.137)

5.4.3.4 Test Results

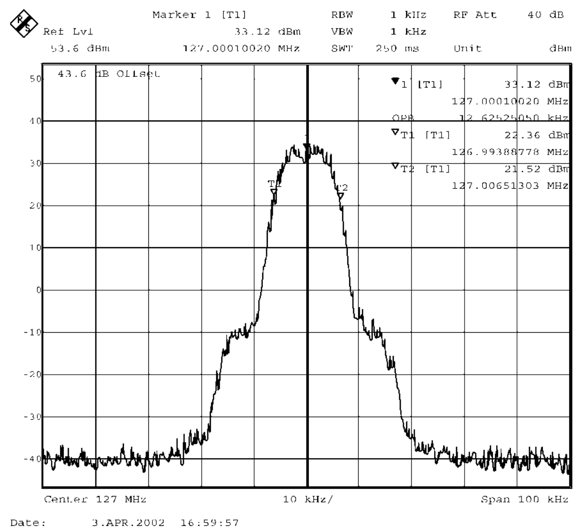
UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

750 Mode 2
118MHz:
BW_{occ} = 12.43kHz



UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

750 Mode 2
127MHz:
BW_{occ} = 12.63kHz



UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

750 Mode 2
136.975MHz
BW_{occ} = 12.83kHz

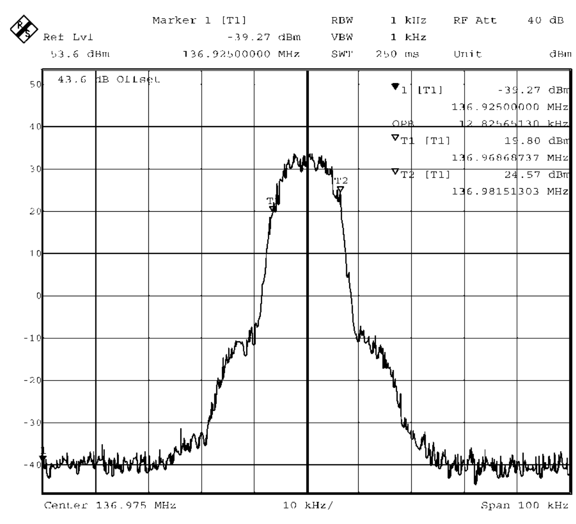
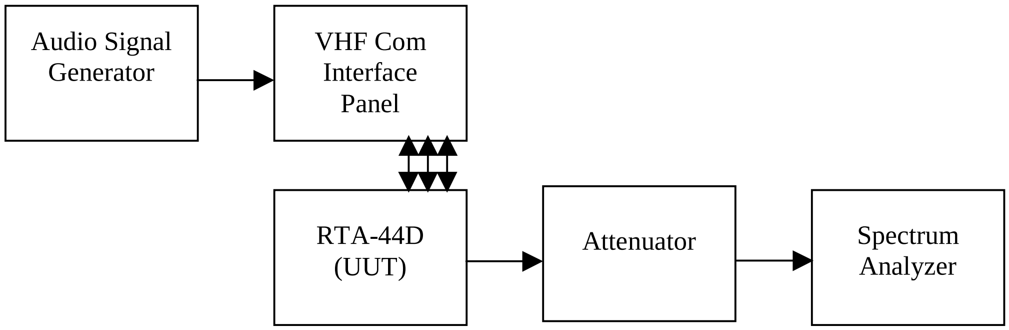


Figure 12: 750 Mode 2 Occupied Bandwidth Data

5.5 Spurious Emissions at Antenna Terminal (paragraph 2.1051 of Reference Document 2.1)

5.5.1 716 Mode

5.5.1.1 Test Setup



5.5.1.2 Test Procedure

5.5.1.2.1 Connect UUT to test equipment as shown.

5.5.1.2.2 Connect Audio Signal Generator to audio/microphone input.

5.5.1.2.3 Configure the Audio Signal Generator to produce a 2.5kHz tone with voltage as determined in paragraph 5.4.1.2.7 (16dB higher than that required for 50% modulation at 1kHz).

5.5.1.2.4 Power up UUT in 716 Mode with Voice/Data discrete set to VOICE and D8PSK Test Enable discrete open.

5.5.1.2.5 Tune UUT to 127MHz. (Make sure Cavity Bandstop Filter is tuned to 127MHz)

5.5.1.2.6 Key transmitter (switch PTT) and measure spurious emissions from 150kHz through 2GHz, noting any frequencies which are within 20dB of the requirement as well as the transmitter harmonics.

5.5.1.2.7 Couplers and filters may be used between the antenna output and spectrum analyzer to increase the dynamic range of the measurement but losses need to be taken into account to determine actual spurious emission levels.

5.5.1.3 Test Requirement

5.5.1.3.1 Per section 87.139 (a) of Reference Document 1:

5.5.1.3.1.1 –25dBc in band 12.5 to 25kHz away from center frequency.

5.5.1.3.1.2 –35dBc in band 25 to 62.5kHz away from center frequency.

5.5.1.3.1.3 –57dBc for frequencies >62.5kHz away from center.

NOTE: _-57dBc comes from the calculation of:
43 + 10*log(pY) dB
where pY is average power of the transmitter (or 25W, in this case)

5.5.1.4 Test Results

UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

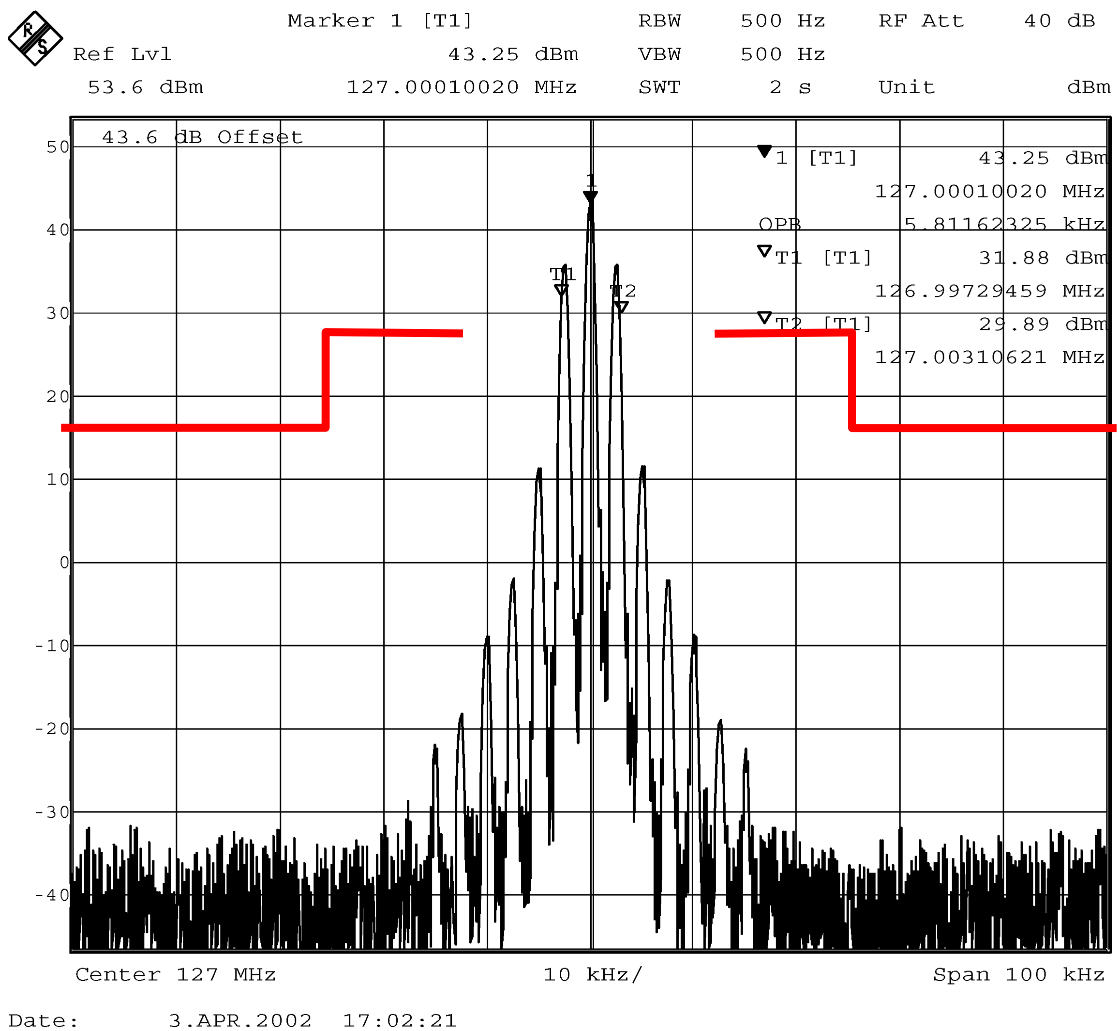


Figure 13: 716 Mode Spurious Emissions at Antenna Terminal – near output frequency

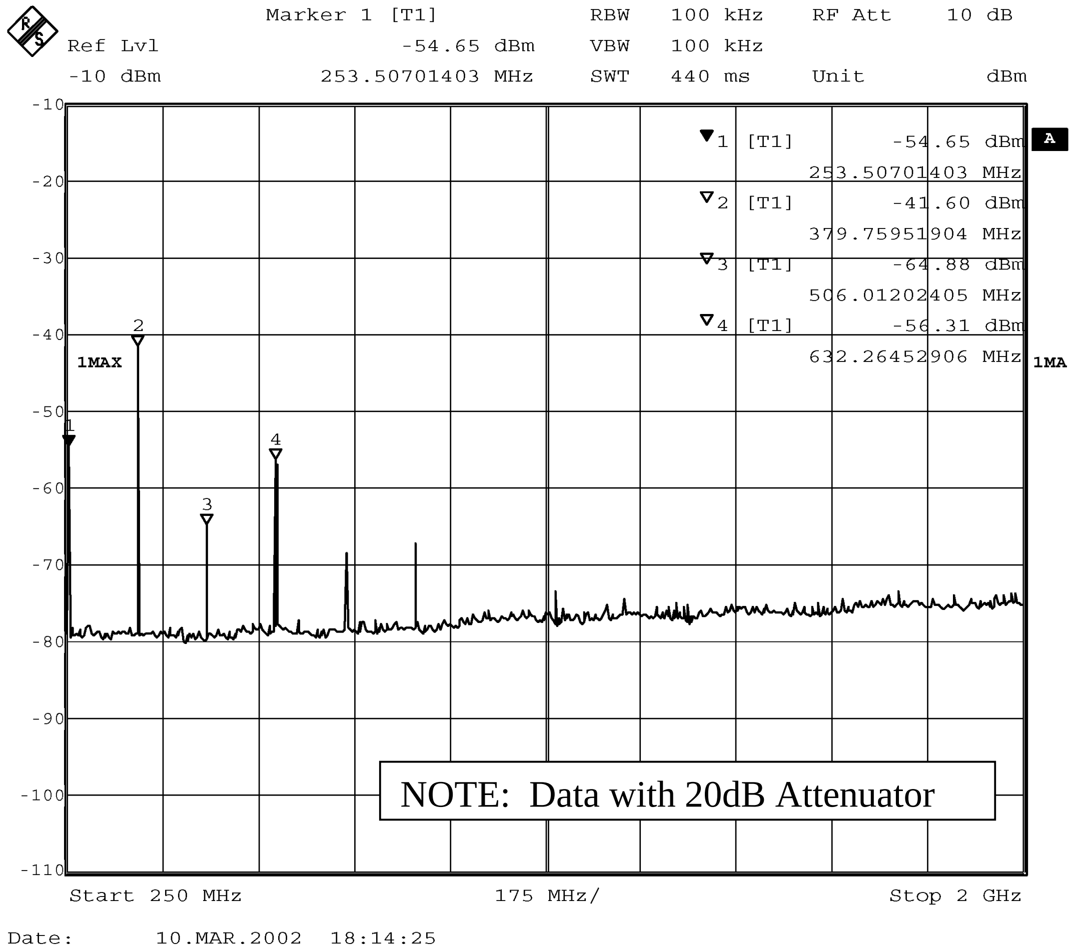


Figure 14: 716 Mode Harmonic Spurious Emissions at Antenna Terminal

Harmonic Order	Frequency (MHz)	Measured Spurious Level (dBm)
2nd	254	-34.6
3rd	381	-21.6
4th	508	-44.8
5th	635	-36.3
6th	762	-48
7th	889	-47

Table 5: 716 Mode Harmonic Spurious Emissions at Antenna Terminal

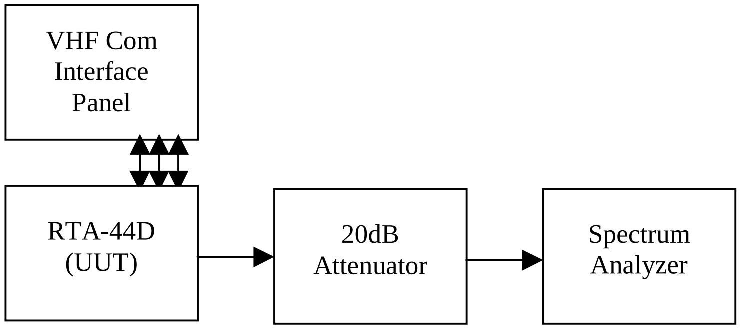
There was no other spurious response detected between 9kHz and 2Ghz within –77dBc of carrier.

5.5.2 750 Mode A

Since all RF generation and power control circuitry for 750 Mode A is identical to that of 716 Mode operation, the spurious emissions will not be tested specifically for 750 Mode A. The only difference between the modes is that in 750 Mode A, the modulation is internally generated. Therefore, the emissions data for 716 mode shall be acceptable for 750 Mode A operation.

5.5.3 750 Mode 2

5.5.3.1 Test Setup



5.5.3.2 Test Procedure

5.5.3.2.1 Connect UUT to test equipment as shown.

5.5.3.2.2 Power up UUT in 716 Mode with Voice/Data discrete set to DATA and D8PSK Test Enable discrete grounded (BER Test Mode enabled).

5.5.3.2.3 Tune UUT to 118MHz.

5.5.3.2.4 Key transmitter (switch Data Key) and measure 1st Adjacent Channel Power in 25kHz and 16kHz BWs.

5.5.3.2.5 Insert Cavity Bandstop Filter tuned to channel frequency between attenuator and Spectrum Analyzer.

5.5.3.2.6 Rekey transmitter and measure 2nd and 4th Adjacent Channel Power in 25kHz and 16kHz BWs. Be sure to account for additional losses.

5.5.3.2.7 Rekey transmitter as required to measure emissions as noted in the table below, recording all spurious frequencies and levels.

NOTE: Couplers and filters may be used between the antenna output and spectrum analyzer to increase the dynamic range of the measurement but losses need to be taken into account to determine actual spurious emission levels.

5.5.3.3 Test Requirement

5.5.3.3.1 Per requirements of Reference Documents 2.6 and 2.7, the total power emitted into a 50 Ohms resistive load when measured over the specified bandwidth centered at offset 25 kHz channels within the 118-137 MHz band shall be:

Adjacent Channel #	**Channel Offset**	**Maximum Emitted Power in 25 kHz BW**	**Maximum Emitted Power in 16 kHz BW**
1	± 25 kHz	2 dBm	-18 dBm
2	± 50 kHz	-28 dBm	N/A
4	± 100 kHz	-38 dBm	N/A
8	± 200 kHz	-43 dBm	N/A
16	± 400 kHz	-48 dBm	N/A
32 or higher	± 800 kHz	-53 dBm	N/A

5.5.3.3.2 Per requirements of Reference Documents 2.6 and 2.7, the total power emitted into a 50 Ohms resistive load and measured in the specified bandwidth shall not exceed the following levels

	Frequency Band	Bandwidth of Measurement	Maximum Emitted Power
Harmonic Spurious Emissions	1.0-1.525GHz	Discrete Spur	-60dBm
	<1.0GHz and >1.7GHz	Discrete Spur	-18dBm
	1.525-1.610GHz	Discrete Spur	-80dBm
	1.610-1.7GHz	Discrete Spur	-60dBm
Non-harmonic Discrete Spurious Emissions	47-68MHz	Discrete Spur	-54dBm
	88-108MHz	Discrete Spur	-54dBm
	162-244MHz	Discrete Spur	-54dBm
	328-336MHz	Discrete Spur	-54dBm
	470-863MHz	Discrete Spur	-54dBm
	1000-1525MHz	Discrete Spur	-60dBm
	1525-1610MHz	Discrete Spur	-80dBm
	1610-1700MHz	Discrete Spur	-60dBm
Broadband Spurious Emissions	9-150kHz	1kHz	-36dBm
	0.15-30MHz	10kHz	-36dBm
	30-117.5MHz	100kHz	-36dBm
	117.5-117.8MHz	10kHz	-36dBm
	137.175-137.475MHz	10kHz	-36dBm
	137.475-1000MHz	100kHz	-36dBm
	1000-1525MHz	100kHz	-60dBm
	1525-1610MHz	1000kHz	-80dBm
	1610-1700MHz	100kHz	-60dBm
Idle-Transmitter Spurious Emissions	9-150kHz	1kHz	-57dBm
	0.15-30MHz	10kHz	-57dBm
	30-108MHz	100kHz	-57dBm
	108-137MHz	100kHz	-64dBm
	137-1000MHz	100kHz	-57dBm
	1000-1525MHz	100kHz	-60dBm
	1525-1610MHz	1000kHz	-80dBm
	1610-1700MHz	100kHz	-60dBm

5.5.3.4 Test Results

UUT: SN5460
SW: 998-2887-5Q0
Date: 4/3/2002

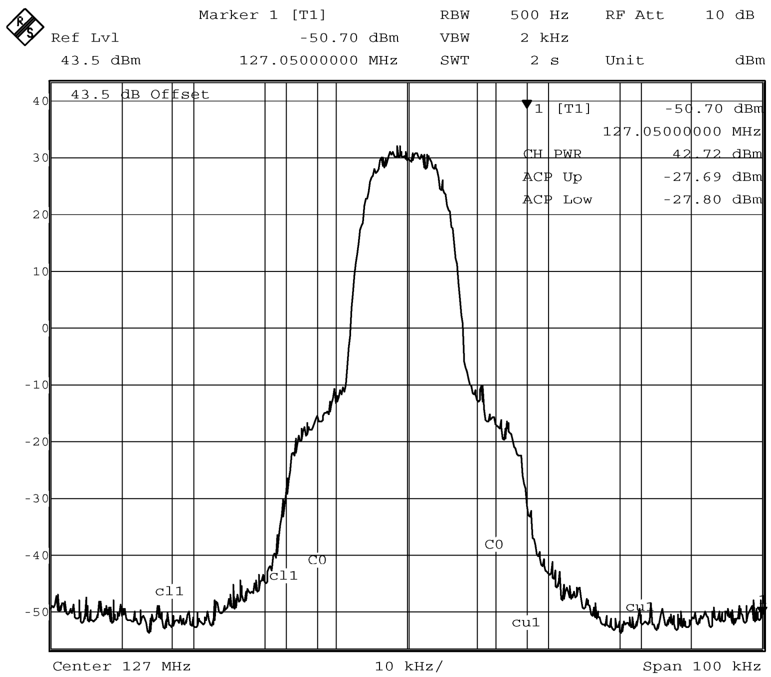


Figure 15: 750 Mode 2 Spurious Emissions at Antenna Terminal – Adjacent Channel Power 1

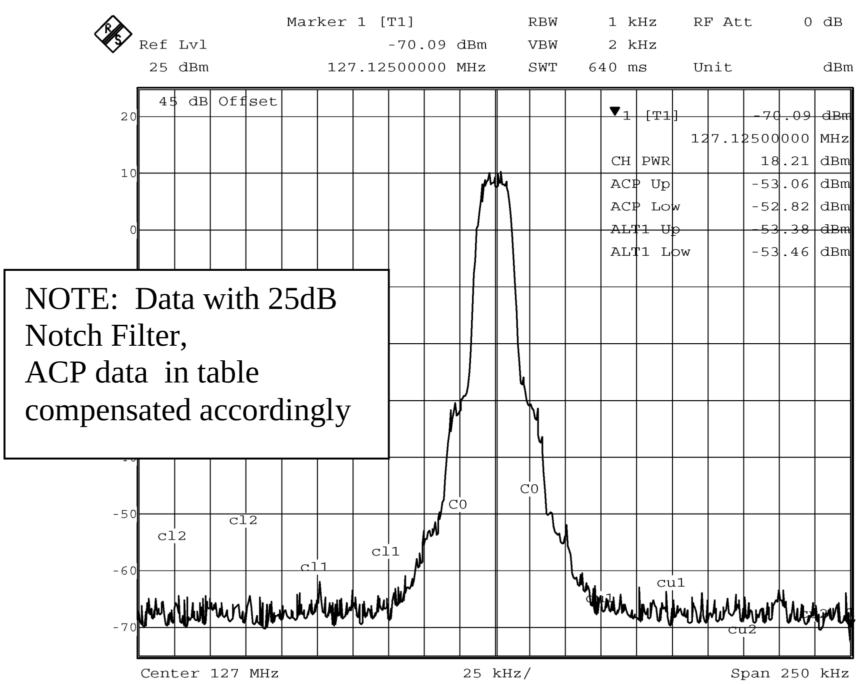


Figure 16: 750 Mode 2 Spurious Emissions at Antenna Terminal – Adjacent Channel Power 2 and 4

Measurement	BW	Units	Requirement	Measured Data at:		
				118MHz	127MHz	136.975MHz
Pout	25kHz	W	>15W	19.19	18.7	18.1
1st ACP (-25kHz)	25kHz	dBm	< +2	-6.8	-9.5	-8.6
1st ACP (+25kHz)	25kHz	dBm	< +2	-6.5	-9.5	-8
1st ACP (-25kHz)	16kHz	dBm	< -18	-25.3	-27.7	-26.5
1st ACP (+25kHz)	16kHz	dBm	< -18	-25.6	-27.8	-26.7
2nd ACP (-50kHz)	25kHz	dBm	< -28	-48.3	-49.8	-52.1
2nd ACP (-+50kHz)	25kHz	dBm	< -28	-48.1	-50	-51.8
4th ACP(-100kHz)	25kHz	dBm	< -38	-55.1	-53.4	-55
4th ACP(+100kHz)	25kHz	dBm	< -38	-54.7	-53.3	-55.2
8th ACP (-200kHz)	25kHz	dBm	< -43	-50.3	-52.3	-52.9
8th ACP(+200kHz)	25kHz	dBm	< -43	-49.9	-54.4	-53.3
16th ACP (-400kHz)	25kHz	dBm	< -48	-54.7	-55.7	-56.2
16th ACP (+400kHz)	25kHz	dBm	< -48	-54.6	-55.7	-55.7
32nd ACP (-800kHz)	25kHz	dBm	< -53	-58	-57.8	-58
32nd ACP(+800kHz)	25kHz	dBm	< -53	-58	-57.9	-58

Table 6 : 750 Mode 2 Spurious Emissions at Antenna Terminal - Adjacent Channel Power

Type of Emission	At 118MHz Freq. (MHz)	Level (dBm)	Meas BW (kHz)	At 127MHz Freq. (MHz)	Level (dBm)	Meas BW (kHz)	At 136.975MHz Freq. (MHz)	Level (dBm)	Meas BW (kHz)
Broadband Spurious	15.288	-44.6	10	15.288	-43.4	10	15.288	-42.9	10
	30.576	-38.6	100	30.576	-38.6	100	30.576	-38.4	100
	59	-44.2	100	63.5	-44.1	100	106.399	-44.6	100
	87.5	-41.5	100	96.5	-41.4	100	117.6	-51.2	100
	117.6	-37.3	10	117.6	-50.7	10	137.2	-28.1	10
	137.2	-44.6	10	137.2	-44.3	10			
	148.576	-43.7	100	157.576	-45.2	100			
	177	-43.8	100	190.5	-47.2	100			
Harmonic Discrete	236	-61.6	1	254	-69.8	1	273.95	-66.5	1
	354	-33.6	1	381	-33.9	1	410.925	-35.4	1
	472	<-70	1	508	<-70	1	547.9	<-70	1
	590	-44.3	1	635	-49.7	1	684.875	-63.1	1
	708	<-70	1	762	<-70	1	821.85	<-70	1
	826	-51.3	1	889	-62.9	1	958.825	-64.2	1
	944	<-70	1	1016	<-70	1	1095.8	<-70	1
	1062	-68.9	1	1143	-64.7	1	1232.775	-67.5	1
	1180	<-70	1	1270	<-70	1	1369.75	<-70	1
	1298	-79.4	1	1397	<-70	1	1506.725	<-70	1
	1416	<-70	1	1524	<-70	1	1643.7	<-70	1
	1534	-85.9	1000	1651	<-70	1	1780.675	<-70	1
	1652	<-70	1	1778	<-70	1	1917.65	<-70	1
	1770	<-70	1	1905	<-70	1			
	1888	<-70	1						
Non-Harmonic Discrete	59	-60.7	0.1	63.5	-55.6	0.1	91.1	-57.8	10
	98.8	-57.8	10	96.5	-57.2	0.1	106.399	-58	0.1
	102.7	-54.2	10	190.5	-58.1	1			
	177	-56.8	0.1						
Idle Spurious	153.95	-65.6	100	162.95	-66.1	100	172.925	-64.5	100

Table 7: 750 Mode 2 Spurious Emissions at Antenna Terminal

5.6 Field strength of spurious radiation (paragraph 2.1053 of Reference Document 2.1)

5.6.1 The radiated spurious emissions are measured per section 9.7 of Reference Document 2.13, the results of which, reproduced here, are part of Reference Document 2.14. The test methodology and results are in accordance with RTCA Document DO160D, Change Notice 1 and Boeing Requirements Document D6-16050-4. The emission measurements are representative of a typical airframe installation for which this equipment is intended and the emission limits are compatible with the airframe isolation characteristics to ensure interference free operation between both aircraft-installed and external-to-aircraft equipment and antennae.

Honeywell International Inc.

Redmond, Washington 98073

Unit Under Test: RTA-44D VHF Data Radio, Mode 2
Part Number: 064-50000-2051
Serial Number: 05473
Procedure Number: 076-0963-101
Operator: Paul Hoyt, Test Cell #3
Test Details: NB Radiated, Horizontal, 716 Mode Receive
Comment: 25 MHz to 6 GHz
Start of Test: 07 Mar 2002, File: VDR19

SCAN TABLE: "Rad 25-200MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
25.0 MHz	30.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	94455-1
30.0 MHz	200.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	94455-1

SCAN TABLE: "Rad 200M-1GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
200.0 MHz	400.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	96005 s/n 1032
400.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	96005 s/n 1032

SCAN TABLE: "Rad 1-6GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
1.0 GHz	6.0 GHz	500.0 kHz	MaxPeak	5.0 ms	1 MHz	96001 s/n 2041

NB Radiated, Horizontal, 716 Mode Receive

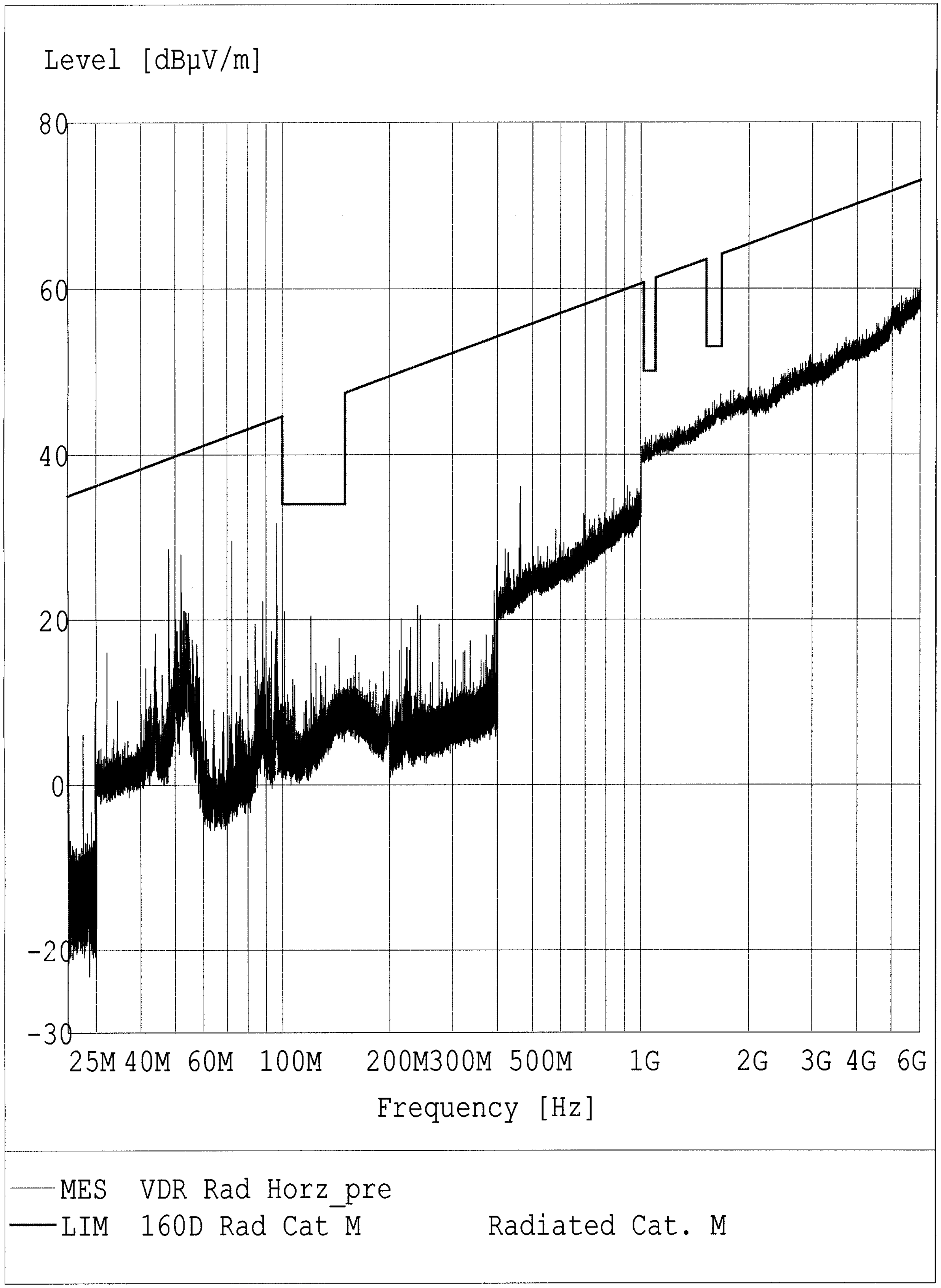


Figure 17: Narrowband Radiated Emissions in Horizontal Plane, 716 Receive Mode (TX Idle)

Honeywell International Inc.

Redmond, Washington 98073

Unit Under Test: RTA-44D VHF Data Radio, Mode 2
Part Number: 064-50000-2051
Serial Number: 05473
Procedure Number: 076-0963-101
Operator: Paul Hoyt, Test Cell #3
Test Details: NB Radiated, Vertical, 716 Mode Receive
Comment: 140 kHz to 6 GHz
Start of Test: 07 Mar 2002, File: VDR16

SCAN TABLE: "Rad 0.14-25MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
140.0 kHz	25.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	95010-1

SCAN TABLE: "Rad 25-200MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
25.0 MHz	30.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	94455-1
30.0 MHz	200.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	94455-1

SCAN TABLE: "Rad 200M-1GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
200.0 MHz	400.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	96005 s/n 1032
400.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	96005 s/n 1032

SCAN TABLE: "Rad 1-6GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
1.0 GHz	6.0 GHz	500.0 kHz	MaxPeak	5.0 ms	1 MHz	96001 s/n 2041

NB Radiated, Vertical, 716 Mode Receive

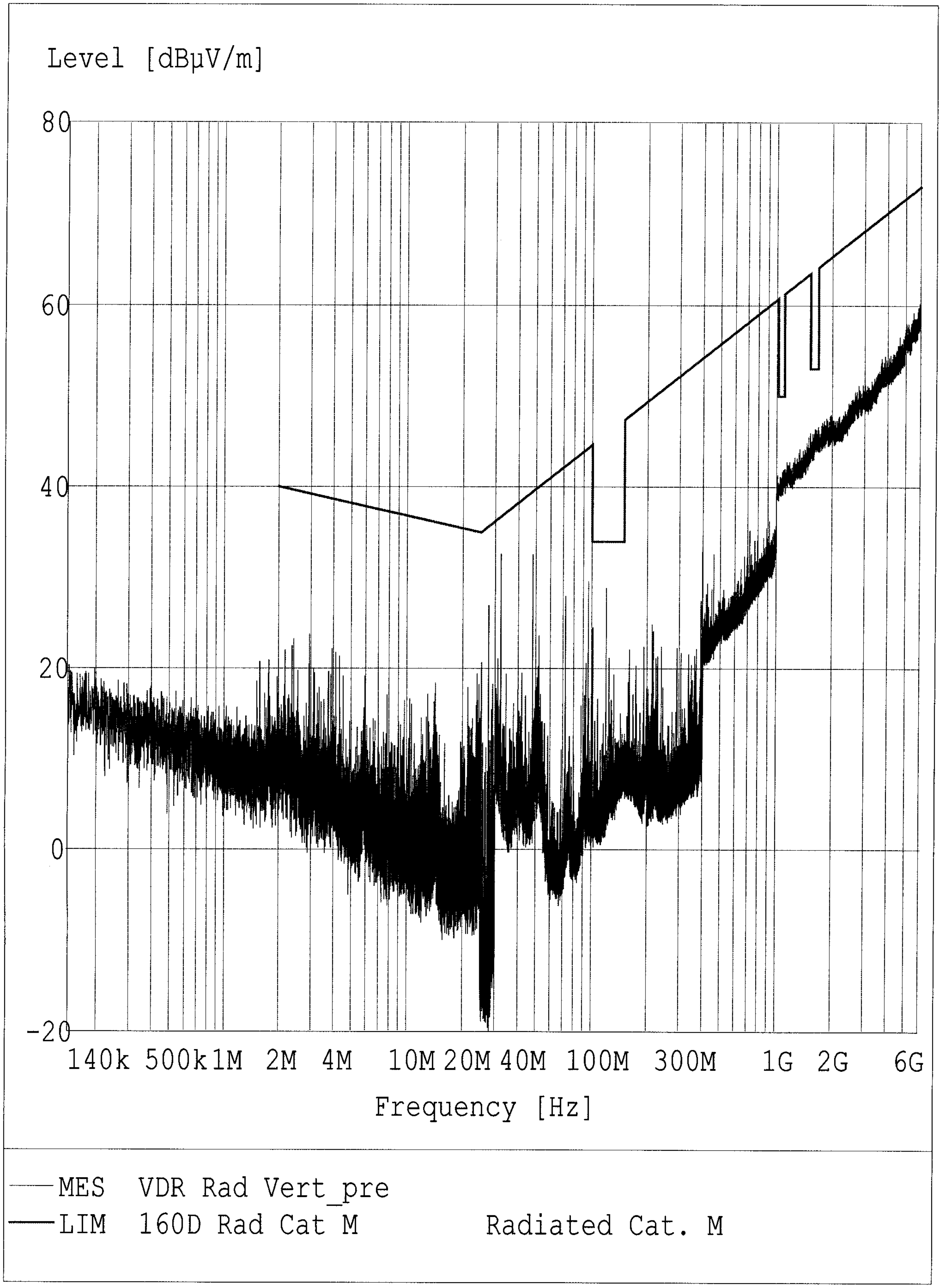


Figure 18: Narrowband Radiated Emissions in Vertical Plane, 716 Receive Mode (TX Idle)

Honeywell International Inc.

Redmond, Washington 98073

Unit Under Test: RTA-44D VHF Data Radio, Mode 2
Part Number: 064-50000-2051
Serial Number: 05473
Procedure Number: 076-0963-101
Operator: Paul Hoyt, Test Cell #3
Test Details: NB Radiated, Horizontal, 716 Mode Transmit
Comment: 25 MHz to 6 GHz
Start of Test: 07 Mar 2002, File: VDR20

SCAN TABLE: "Rad 25-200MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
25.0 MHz	30.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	94455-1
30.0 MHz	200.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	94455-1

SCAN TABLE: "Rad 200M-1GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
200.0 MHz	400.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	96005 s/n 1032
400.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	96005 s/n 1032

SCAN TABLE: "Rad 1-6GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
1.0 GHz	6.0 GHz	500.0 kHz	MaxPeak	5.0 ms	1 MHz	96001 s/n 2041

FREQUENCY LIST: "VDR Rad H716_fin"

3/7/02 2:59PM
Frequency MHz

127.650000 46.3dBuV/m

NB Radiated, Horizontal, 716 Mode Transmit

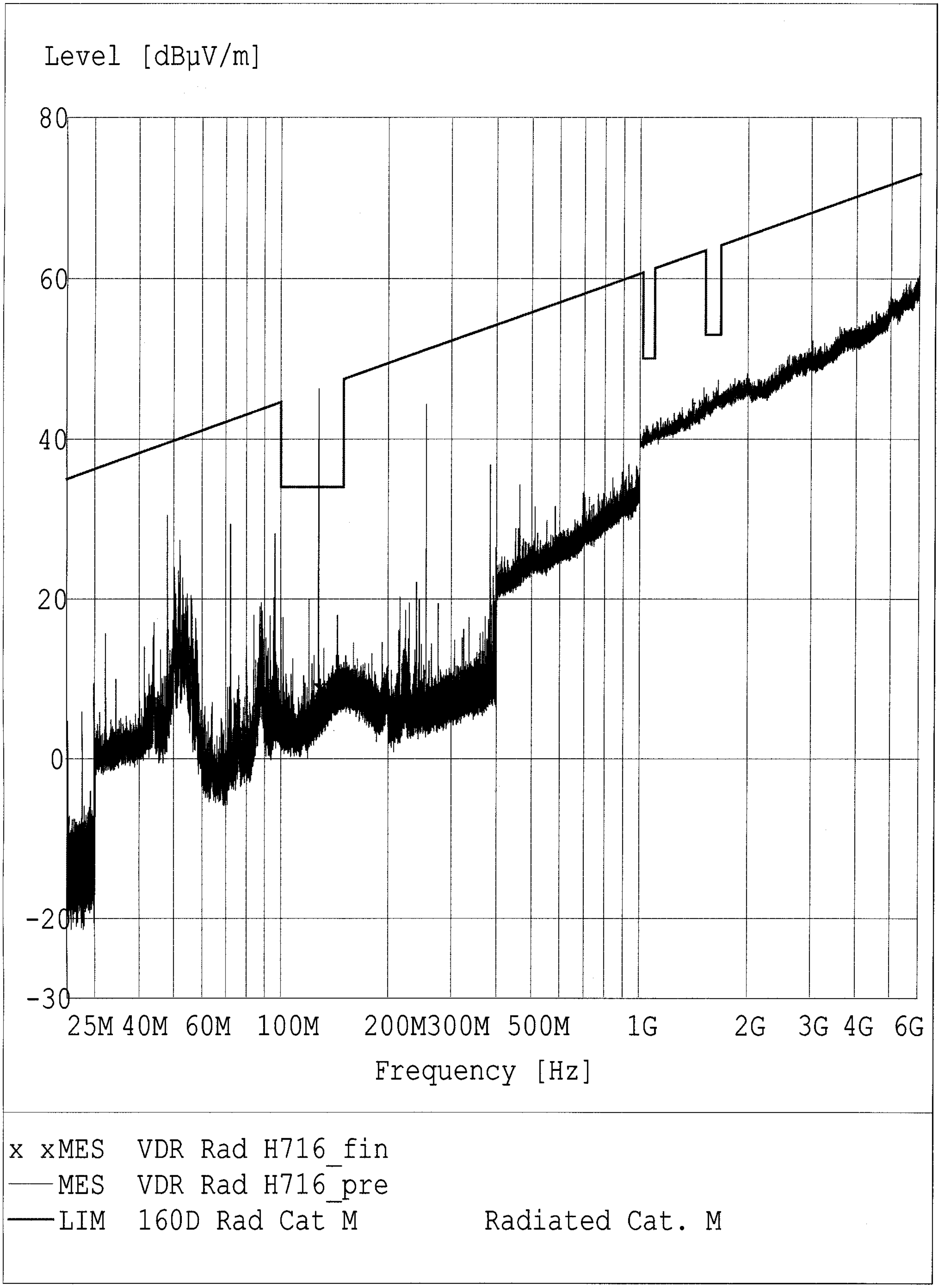


Figure 19: Narrowband Radiated Emissions in Horizontal Plane, 716 Transmit Mode

Honeywell International Inc.

Redmond, Washington 98073

Unit Under Test: RTA-44D VHF Data Radio, Mode 2
Part Number: 064-50000-2051
Serial Number: 05473
Procedure Number: 076-0963-101
Operator: Paul Hoyt, Test Cell #3
Test Details: NB Radiated, Vertical, 716 Mode Transmit
Comment: 140 kHz to 6 GHz
Start of Test: 07 Mar 2002, File: VDR17

SCAN TABLE: "Rad 0.14-25MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
140.0 kHz	25.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	95010-1

SCAN TABLE: "Rad 25-200MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
25.0 MHz	30.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	94455-1
30.0 MHz	200.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	94455-1

SCAN TABLE: "Rad 200M-1GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
200.0 MHz	400.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	96005 s/n 1032
400.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	96005 s/n 1032

SCAN TABLE: "Rad 1-6GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
1.0 GHz	6.0 GHz	500.0 kHz	MaxPeak	5.0 ms	1 MHz	96001 s/n 2041

FREQUENCY LIST: "VDR Rad V716_fin"

3/7/02 3:42PM
Frequency MHz

127.650000 57.4dBuV/m

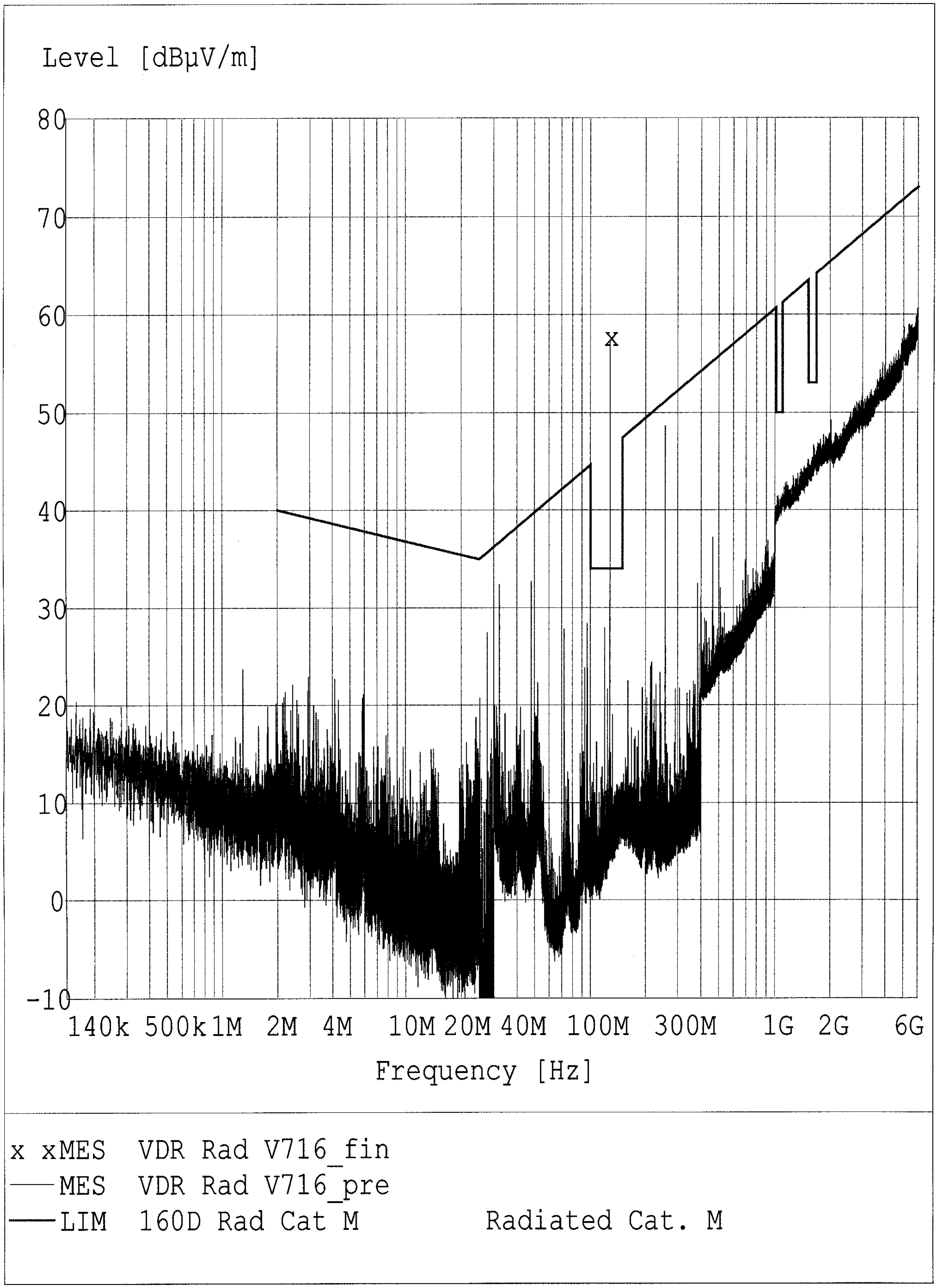


Figure 20: Narrowband Radiated Emissions in Vertical Plane, 716 Transmit Mode

Honeywell International Inc.

Redmond, Washington 98073

Unit Under Test: RTA-44D VHF Data Radio, Mode 2
Part Number: 064-50000-2051
Serial Number: 05473
Procedure Number: 076-0963-101
Operator: Paul Hoyt, Test Cell #3
Test Details: NB Radiated, Horizontal, Mode 2 Transmit
Comment: 25 MHz to 6 GHz
Start of Test: 07 Mar 2002, File: VDR21

SCAN TABLE: "Rad 25-200MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
25.0 MHz	30.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	94455-1
30.0 MHz	200.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	94455-1

SCAN TABLE: "Rad 200M-1GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
200.0 MHz	400.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	96005 s/n 1032
400.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	96005 s/n 1032

SCAN TABLE: "Rad 1-6GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
1.0 GHz	6.0 GHz	500.0 kHz	MaxPeak	5.0 ms	1 MHz	96001 s/n 2041

FREQUENCY LIST: "VDR Rad H M2_fin"

3/7/02 3:29PM

Frequency MHz	
127.650000	46.4dBuV/m

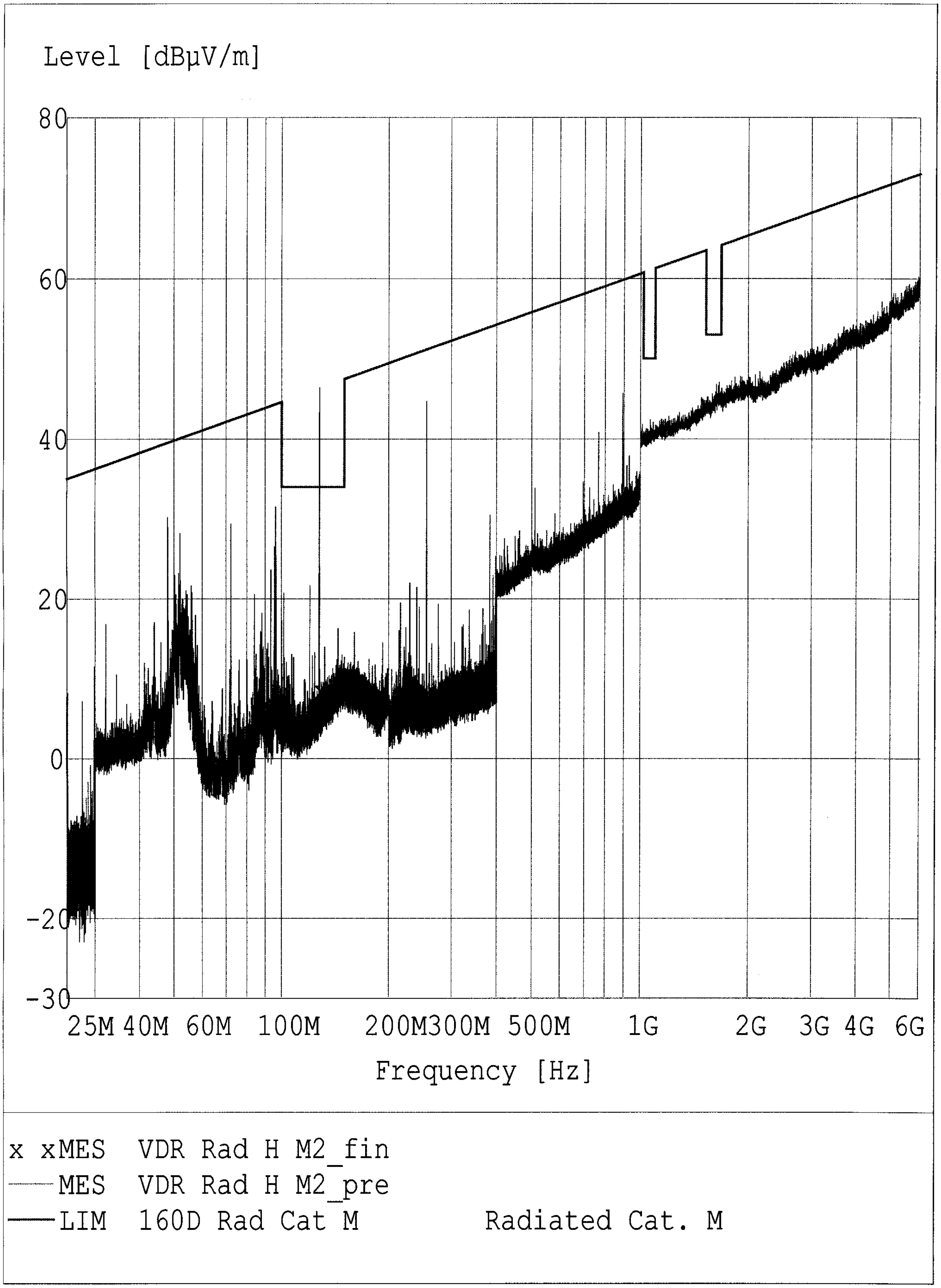


Figure 21: Narrowband Radiated Emissions in Horizontal Plane, 750 Mode 2 Transmitting

Honeywell International Inc.

Redmond, Washington 98073

Unit Under Test: RTA-44D VHF Data Radio, Mode 2
Part Number: 064-50000-2051
Serial Number: 05473
Procedure Number: 076-0963-101
Operator: Paul Hoyt, Test Cell #3
Test Details: NB Radiated, Vertical, Mode 2 Transmit
Comment: 140 kHz to 6 GHz
Start of Test: 07 Mar 2002, File: VDR18

SCAN TABLE: "Rad 0.14-25MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
140.0 kHz	25.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	95010-1

SCAN TABLE: "Rad 25-200MHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
25.0 MHz	30.0 MHz	500.0 Hz	MaxPeak	5.0 ms	1 kHz	94455-1
30.0 MHz	200.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	94455-1

SCAN TABLE: "Rad 200M-1GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
200.0 MHz	400.0 MHz	5.0 kHz	MaxPeak	5.0 ms	10 kHz	96005 s/n 1032
400.0 MHz	1.0 GHz	50.0 kHz	MaxPeak	5.0 ms	100 kHz	96005 s/n 1032

SCAN TABLE: "Rad 1-6GHz"

Short Description: DO160D Radiated Emissions

Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
1.0 GHz	6.0 GHz	500.0 kHz	MaxPeak	5.0 ms	1 MHz	96001 s/n 2041

FREQUENCY LIST: "VDR Rad V M2_fin"

3/7/02 3:38PM
Frequency MHz

127.650000	56.6dBuV/m
255.300000	52.0dBuV/m

NB Radiated, Vertical, 750 Mode 2 Transmit

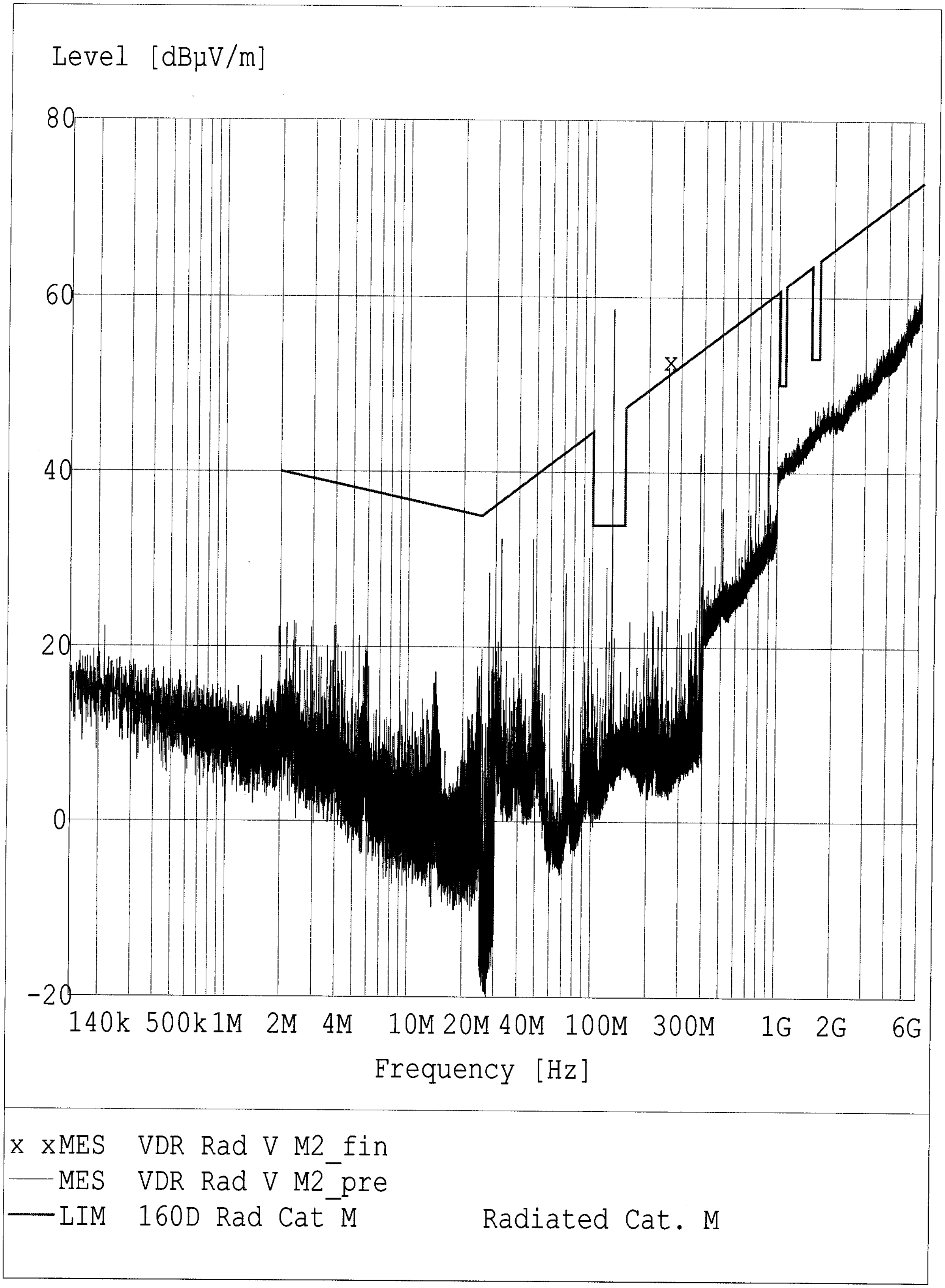


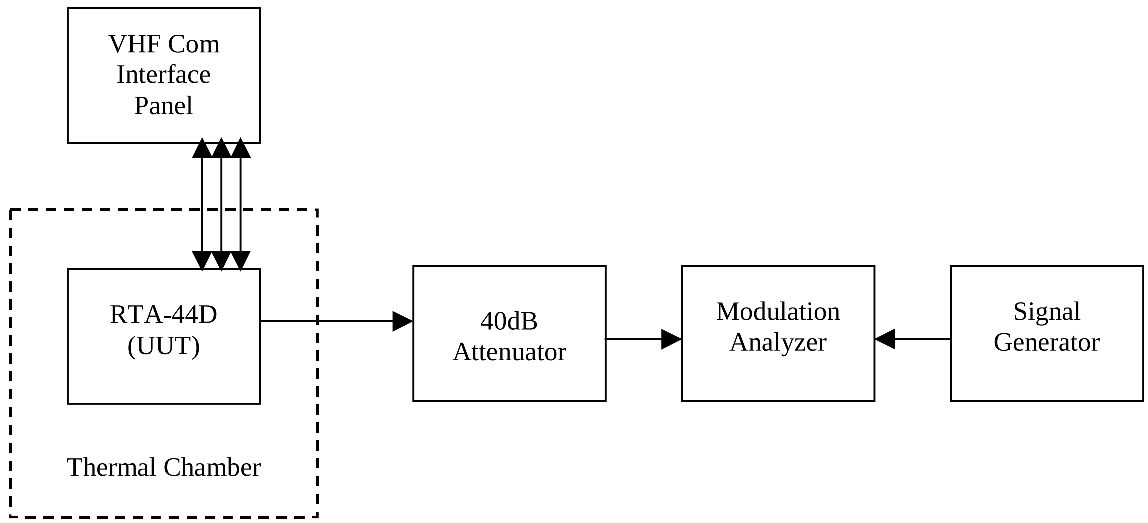
Figure 22: Narrowband Radiated Emissions in Vertical Plane, 750 Mode 2 Transmitting

5.7 Frequency Stability (per paragraph 2.1055 of Reference Document 2.1)

NOTE: Since frequency generation and control circuits are common in all modes, only one test in one particular mode for frequency stability shall be adequate.

5.7.1 716 Mode frequency stability with respect to temperature

5.7.1.1 Test Setup



5.7.1.2 Test Procedure

5.7.1.2.1 Place UUT in Test Chamber and connect to VHF Com interface panel and through attenuator to modulation analyzer as shown.

5.7.1.2.2 Power up UUT in 716 Mode with Voice/Data discrete set to VOICE and D8PSK Test Enable discrete open.

5.7.1.2.3 Tune UUT to 118MHz.

5.7.1.2.4 Key transmitter (switch PTT) and measure carrier frequency. (The RF signal generator supplies the REF OSC to the Modulation Analyzer for improved accuracy).

5.7.1.2.5 Remeasure for 127MHz and 136.975MHz.

5.7.1.2.6 Set thermal chamber to –30°C and let unit stabilize (still powered on) for 2 hours.

5.7.1.2.7 Measure carrier frequency at all 3 frequencies again.

5.7.1.2.8 Step in 10°C increments up to +50°C, allowing UUT to stabilize for 2 hours at each temperature, and remeasure carrier frequencies at all 3 channel frequencies.

5.7.1.3 Test Requirement

5.7.1.3.1 Frequency stability of 5 ppm for G1D transmitters (section 87.133 of Reference Document 1) which translates to +/-590Hz (for the lowest frequency, 118MHz)

5.7.1.4 Test Results

UUT: SN5460
SW: 998-2887-5Q0
Date: 4/2/2002 – 4/3/2002

Ambient Temperature (°C)	Frequency Deviation @118MHz (Hz)	Frequency Deviation @127MHz (Hz)	Frequency Deviation @136.975MHz (Hz)
-30	+136	+146	+160
-20	+13	+14	+16
-10	-15	-15	-16
0	-14	-15	-17
10	+43	+48	+51
20	+89	+97	+104
30	+110	+118	+128
40	+95	+103	+110
50	+71	+76	+82

Table 8: Frequency Stability Data over Temperature

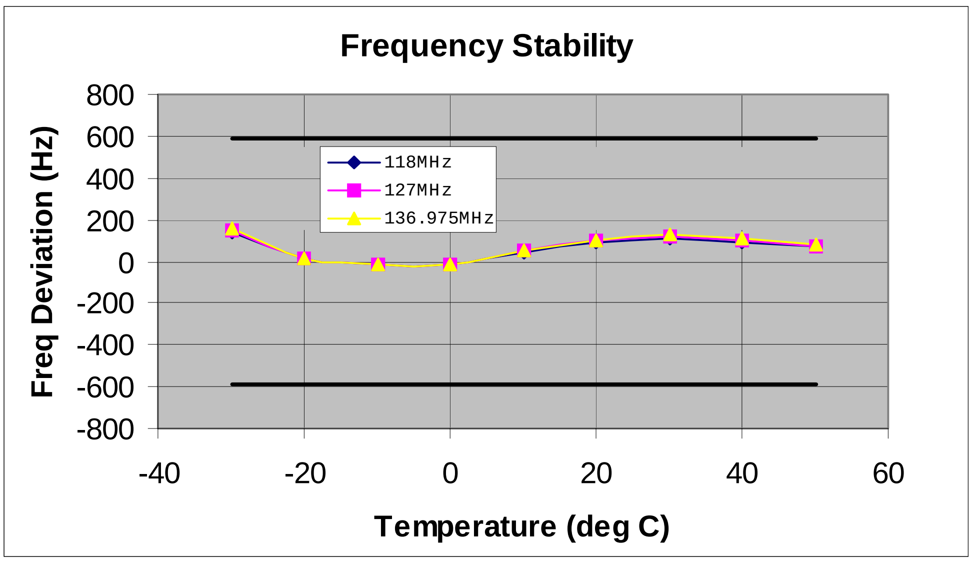
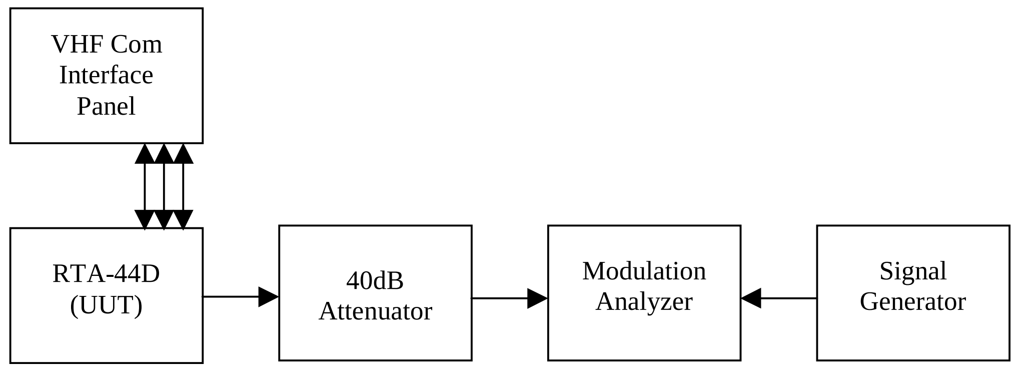


Figure 23: Frequency Stability Data over Temperature

5.7.2 716 Mode frequency stability with respect to supply voltage

5.7.2.1 Test Setup



5.7.2.2 Test Procedure

5.7.2.2.1 Connect Antenna output through attenuator to modulation analyzer as shown.

5.7.2.2.2 Power up UUT in 716 Mode with Voice/Data discrete set to VOICE and D8PSK Test Enable discrete open.

5.7.2.2.3 Tune UUT to 118MHz.

5.7.2.2.4 Key transmitter (switch PTT) and measure carrier frequency. (The RF signal generator supplies the REF OSC to the Modulation Analyzer for improved accuracy)

5.7.2.2.5 Adjust supply voltage to 23.3V (85% of nominal) and remeasure carrier frequency.

5.7.2.2.6 Adjust supply voltage to 31.6V (115% of nominal) and remeasure carrier frequency.

5.7.2.2.7 Repeat test for 127MHz and 136.975MHz.

5.7.2.3 Test Requirement

5.7.2.3.1 Frequency stability of 5 ppm for G1D transmitters (section 87.133 of Reference Document 1) which translates to +/-590Hz (for the lowest frequency, 118MHz)

5.7.2.4 Test Results

Voltage	Frequency Deviation		
	118MHz (Hz)	127MHz (Hz)	136.975MHz (Hz)
27.5V	-60	-60	-70
23.3V (85%)	-60	-60	-70
31.6V (115%)	-50	-50	-60

Table 9: Frequency Stability Data over Variation in Power Supply Voltage