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**Technical Report No. 99-086A.**

**"Measurements of the Origin Data Systems, Inc.  
'TPD 403 G' to  
FCC Radiated Emission Requirements."**

Performed: 18 November 1999 with additional sections 4.2.1 added May 18 2001

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**Origin Data Systems - Technical Report 99-086A.**

## 1. INTRODUCTION

The Origin Data Systems 'TPD 403 G' was evaluated for compliance to the FCC requirements identified in the Objective section. The results apply only to the specific items of equipment, configurations and procedures supplied to the Florida Atlantic University EMI Research Lab by Origin Data Systems as reported in this 15 page document.

## 2. OBJECTIVE

This evaluation was performed to verify conformance of the Origin Data Systems 'TPD 403 G' to the Federal Communications Commission (FCC) Code of Federal Regulations (CFR), Title 47 - Telecommunication, Part 15 - Radio Frequency Devices, Subpart C - Intentional Radiators: Section 15.231 Periodic operation in the band 40.66-40.70 MHz and above 70 MHz (b) and (c) requirements; as well 15.109(a) Radiated emission limits from unintentional radiators.

## CONCLUSION

The 'TPD 403 G' unit met the FCC radiated emission requirements of 15.231(b) and (c). Also the requirement of 15.215(b) "*...In no case shall the level of the unwanted emissions from an intentional radiator operating under these additional provisions exceed the field strength of the fundamental emission.*" was met.

The unintentional radiated emission limits of 15.109(a) were met.

## 4. TEST PROCEDURES AND RESULTS

### 4.1 TEST PROCEDURES

The measurement techniques identified in measurement procedure ANSI C63.4-1992 *"American National Standard of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"* were followed as close as practical during this evaluation. Complete details and specific procedures used are discussed in the respective Tests Results sections.

#### **4.1 UNINTENTIONAL RADIATED EMISSIONS - RECEIVE MODE.**

The 'TPD 403 G' unit was set up on a wooden turntable 80 centimeters above the ground plane of the FCC listed Semi-Anechoic test site. An EMCO 3104 Broadband Biconical antenna was installed on an EMCO pneumatically controlled Antenna Mast at a distance of 3 meters from the receiver unit. The 30 to 200 MHz frequency range was automatically scanned on the HP 8566B Spectrum Analyzer operated in the 'peak' detector mode with a bandwidth of 120 kHz obtained through the HP 85650A Quasi Peak Adapter. The turntable was rotated through 360 degrees, the antenna was scanned in height from 1 to 4 meters in both the horizontal and vertical polarizations. The 'TPD 403 G' was oriented in 3 physical positions - back, foot, and side. No emissions were detected as is shown by Figure 1.

An EMCO 3146 Log Periodic antenna was then installed and the above procedure was repeated for the 200 to 1000 MHz range, and as shown on Figure 2, no emissions were detected.

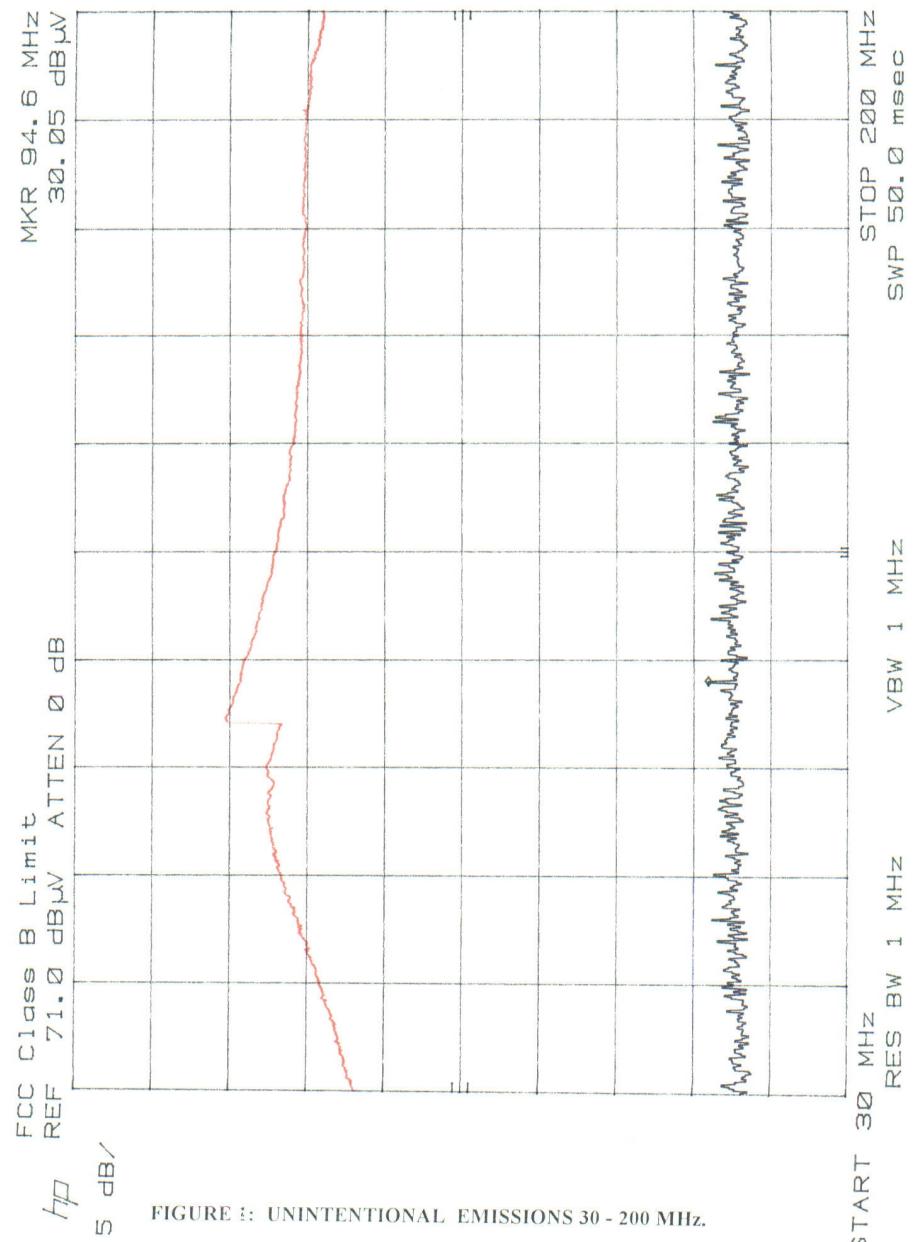
Figures 1 and 2 show the FCC unintentional radiated emission limits of 15.109(a) which have been corrected for the amplifier gain, cable loss and antenna factors such that the induced voltages at the HP 8566 Spectrum Analyzer can be compared directly to the limit.

These limit curves are equal to the following:

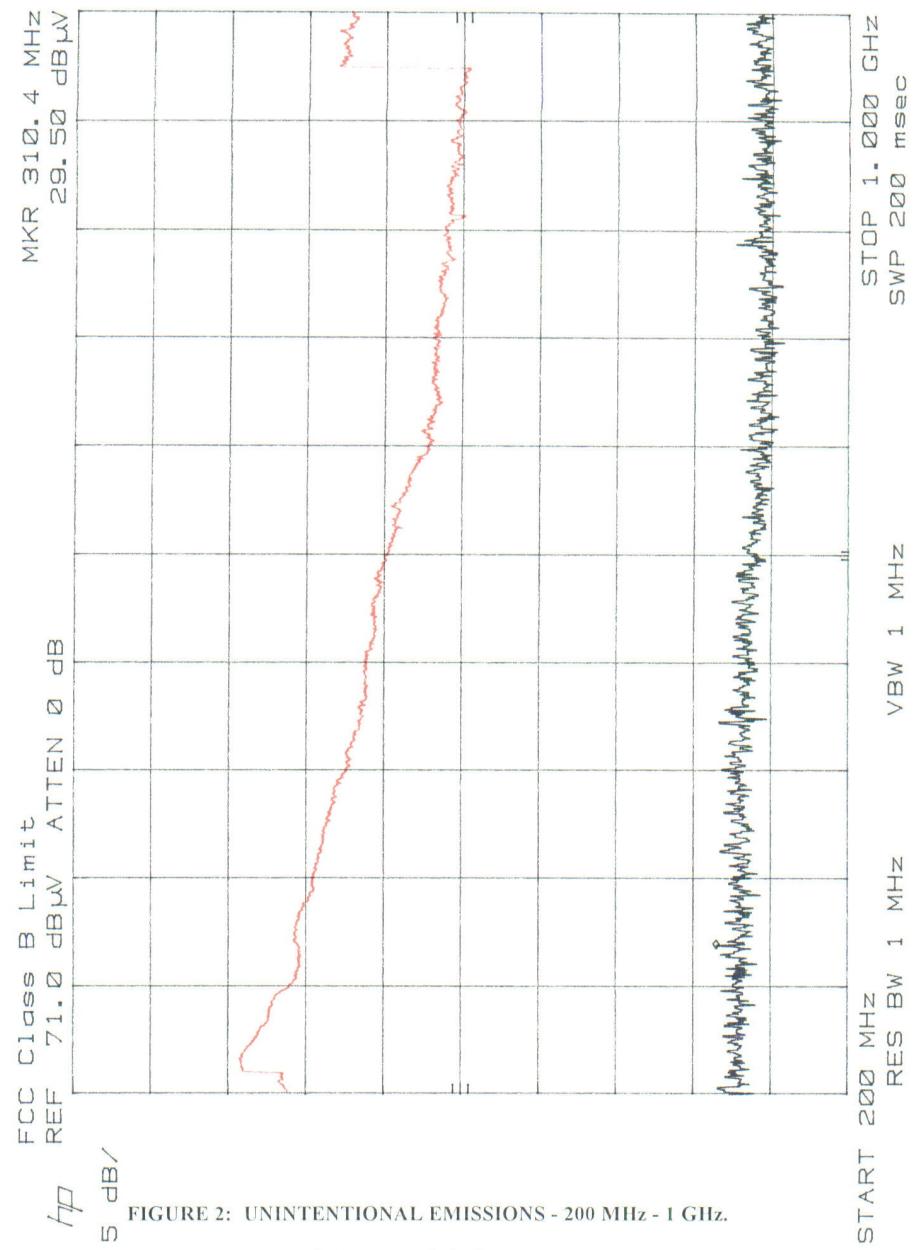
30-88 MHz = 100 uV/m (40 dBuV/m)  
88-216 MHz = 150 uV/m (43.5 dBuV/m)  
216-960 MHz = 200 uV/m (46 dBuV/m)  
> 960 MHz = 500 uV/m (54 dBuV/m)



**PHOTOGRAPH 1: SETUP FOR TESTING**



**FIGURE 1: UNINTENTIONAL EMISSIONS 30 - 200 MHz.**



**FIGURE 2: UNINTENTIONAL EMISSIONS - 200 MHz - 1 GHz.**

## 4.2 INTENTIONAL RADIATED EMISSIONS - TRANSMIT MODE.

The 'TPD 403 G' unit was set up on a wooden turntable 80 centimeters above the ground plane of the FCC listed Semi-Anechoic test site. An EMCO 3146 Log Periodic antenna was installed on an EMCO pneumatically controlled Antenna Mast at a distance of 3 meters from the transmitter unit. The HP 8566B Spectrum Analyzer, operated in the 'peak' detector mode with a bandwidth of 120 kHz obtained through the HP 85650A Quasi Peak Adapter, was tuned to the transmitter fundamental frequency of 433.9 MHz. The turntable was rotated through 360 degrees, the receiving antenna was scanned in height from 1 to 4 meters in both the horizontal and vertical polarizations, and the highest level of transmitter emission was recorded.

The limits as stated in 15.231(b) for a fundamental frequency of 260-470 MHz, the field strength of the fundamental shall be less than 3,750-12,500 uV/m and the field strength of the spurious emissions shall be less than 375-1,250 uV/m at a distance of 3 meters. These limits are determined by linear interpolation; therefore, with the 'TPD 403 G' transmitter operating at a fundamental frequency of 433.9 MHz, the limit for the fundamental is 10,998 uV/m (80.8 dBuV/m) and the limits for spurious emissions are 1,099.8 uV/m (60.8 dBuV/m).

Previous discussions with Mr. Ed Gibbons of the FCC office indicated that a relaxation for on/off transmit time or duty cycle was permitted. The data in the following tables was obtained with the transmitter on 100% of the time. The normal transmit output from this product is only when the device is interrogated by a field such as would be found in a security entry/exit alcove of a building, therefore, the duty cycle rate would be extremely low. For this report, a conservative figure of a 10% duty cycle was used. This -20 dB relaxation has been added to the limits of 15.231(b) as is reflected in the tables below; i.e., the fundamental limit of 80.8 dBuV/m has been increased to 100.8 dBuV/m and the spurious/harmonic limits have been increased to 80.8 dBuV/m.

The following tables show all emissions to be below the 15.231(b) limit, independent of unit orientation, azimuth or receiving antenna polarization. However, as indicated in 15.215(b), the level of all unwanted emissions must be lower than the fundamental emission.

It should be noted that for the frequencies, the cable loss and amplifier gain factors have been incorporated into one factor under AMP.

**RADIATED EMISSIONS - BACK - HORIZONTAL POLARITY.**

Freq MHz	Level dBuV	AF +dB	CBL +dB	AMP -dB	Total dBuV/m	Limit dBuV/m	Total uV/m	Limit uV/m
433.9	88.1	18.0		24.4	81.7	100.8	12,161.9	109,980.0
867.8	52.3	23.6		22.7	53.2	80.8	457.1	10,998.0
1,301.7	43.6	30.5		30.8	43.3	80.8	145.4	10,998.0
1,735.6	49.9	33.0		28.9	54.0	80.8	498.3	10,998.0
2,169.5	56.4	34.6		27.6	63.4	80.8	1,479.1	10,998.0
2,603.4	53.1	34.9		27.0	61.0	80.8	1,122.0	10,998.0
3,037.3	52.9	36.7		25.8	63.8	80.8	1,539.9	10,998.0
3,471.2	46.1	36.4		25.1	57.4	80.8	741.3	10,998.0
3,905.1	40.5	38.7		24.2	55.0	80.8	562.3	10,998.0
4,339.0	36.9	38.9		23.6	52.2	80.8	405.0	10,998.0

**RADIATED EMISSIONS - BACK - VERTICAL POLARITY.**

Freq MHz	Level dBuV	AF +dB	CBL +dB	AMP -dB	Total dBuV/m	Limit dBuV/m	Total uV/m	Limit uV/m
433.9	79.4	18.0		24.4	73.0	100.8	4,466.8	109,980.0
867.8	45.6	23.6		22.7	46.5	80.8	211.3	10,998.0
1,301.7	53.4	30.5		30.8	53.1	80.8	449.3	10,998.0
1,735.6	57.6	33.0		28.9	61.7	80.8	1,209.2	10,998.0
2,169.5	58.3	34.6		27.6	65.3	80.8	1,840.8	10,998.0
2,603.4	51.8	34.9		27.0	59.7	80.8	960.5	10,998.0
3,037.3	53.1	36.7		25.8	64.0	80.8	1,575.8	10,998.0
3,471.2	43.8	36.4		25.1	55.1	80.8	568.9	10,998.0
3,905.1	40.2	38.7		24.2	54.7	80.8	543.3	10,998.0
4,339.0	37.2	38.9		23.6	52.5	80.8	421.7	10,998.0

Total dBuV/m = Level dBuV + AF dB - SYS dB

Level dBuV = Max. Induced voltage @ HP-8566B Spectrum Analyzer

AF dB = Antenna Factor

AMP dB = The total system gain (cable loss + Amplifier gain)

#### RADIATED EMISSIONS - SIDE - HORIZONTAL POLARITY.

Freq MHz	Level dBuV	AF +dB	CBL +dB	AMP -dB	Total dBuV/m	Limit dBuV/m	Total uV/m	Limit uV/m
433.9	84.8	18.0		24.4	78.4	100.8	8,317.6	109,980.0
867.8	47.6	23.6		22.7	48.5	80.8	266.1	10,998.0
1,301.7	50.3	30.5		30.8	50.0	80.8	314.4	10,998.0
1,735.6	51.6	33.0		28.9	55.7	80.8	606.0	10,998.0
2,169.5	57.3	34.6		27.6	64.3	80.8	1,631.2	10,998.0
2,603.4	52.7	34.9		27.0	60.6	80.8	1,071.5	10,998.0
3,037.3	51.4	36.7		25.8	62.3	80.8	1,303.2	10,998.0
3,471.2	45.3	36.4		25.1	56.6	80.8	672.2	10,998.0
3,905.1	43.2	38.7		24.2	57.7	80.8	767.4	10,998.0
4,339.0	41.2	38.9		23.6	56.5	80.8	668.3	10,998.0

#### RADIATED EMISSIONS - SIDE - VERTICAL POLARITY.

Freq MHz	Level dBuV	AF +dB	CBL +dB	AMP -dB	Total dBuV/m	Limit dBuV/m	Total uV/m	Limit uV/m
433.9	88.5	18.0		24.4	82.1	100.8	12,735.0	109,980.0
867.8	49.6	23.6		22.7	50.5	80.8	333.0	10,998.0
1,302.7	46.2	30.5		30.8	45.9	80.8	197.2	10,998.0
1,735.6	53.8	33.0		28.9	57.9	80.8	780.7	10,998.0
2,169.5	60.0	34.6		27.6	67.0	80.8	2,238.7	10,998.0
2,603.4	52.1	34.9		27.0	60.0	80.8	994.3	10,998.0
3,037.3	50.6	36.7		25.8	61.5	80.8	1,181.7	10,998.0
3,471.2	46.0	36.4		25.1	57.3	80.8	732.8	10,998.0

3,905.1	42.4	38.7		24.2	56.9	80.8	699.8	10,998.0
4,339.0	40.2	38.9		23.6	55.5	80.8	595.7	10,998.0

Total dBuV/m = Level dBuV + AF dB - SYS dB

Level dBuV = Max. Induced voltage @ HP-8566B Spectrum Analyzer

AF dB = Antenna Factor

AMP dB = The total system gain (cable loss + Amplifier gain)

#### RADIATED EMISSIONS - END - HORIZONTAL POLARITY.

Freq MHz	Level dBuV	AF +dB	CBL +dB	AMP -dB	Total dBuV/m	Limit dBuV/m	Total uV/m	Limit uV/m
433.9	82.4	18.0		24.4	76.0	100.8	6,273.4	109,980.0
867.8	47.8	23.6		22.7	48.7	80.8	270.7	10,998.0
1,301.7	45.0	30.5		30.8	44.7	80.8	171.8	10,998.0
1,735.6	48.6	33.0		28.9	52.7	80.8	431.5	10,998.0
2,169.5	56.3	34.6		27.6	63.3	80.8	1,462.2	10,998.0
2,603.4	48.3	34.9		27.0	56.2	80.8	641.9	10,998.0
3,037.3	55.0	36.7		25.8	65.9	80.8	1,961.1	10,998.0
3,471.2	44.9	36.4		25.1	56.2	80.8	645.7	10,998.0
3,905.1	39.5	38.7		24.2	54.0	80.8	501.2	10,998.0
4,339.0	39.1	38.9		23.6	54.4	80.8	524.8	10,998.0

#### RADIATED EMISSIONS - END - VERTICAL POLARITY.

Freq MHz	Level dBuV	AF +dB	CBL +dB	AMP -dB	Total dBuV/m	Limit dBuV/m	Total uV/m	Limit uV/m
433.9	90.0	18.0		24.4	83.6	100.8	15,135.6	109,980.0
867.8	50.6	23.6		22.7	51.5	80.8	373.7	10,998.0
1,301.7	50.4	30.5		30.8	50.1	80.8	319.9	10,998.0
1,735.6	59.0	33.0		28.9	63.1	80.8	1,428.9	10,998.0
2,169.5	60.6	34.6		27.6	67.6	80.8	2,398.8	10,998.0

2,603.4	54.9	34.9		27.0	62.8	80.8	1,372.5	10,998.0
3,037.3	51.3	36.7		25.8	62.2	80.8	1,288.3	10,998.0
3,471.2	44.5	36.4		25.1	55.8	80.8	616.6	10,998.0
3,905.1	39.3	38.7		24.2	53.8	80.8	487.0	10,998.0
4,339.0	39.6	38.9		23.6	54.9	80.8	552.7	10,998.0

Total dBuV/m = Level dBuV + AF dB - SYS dB

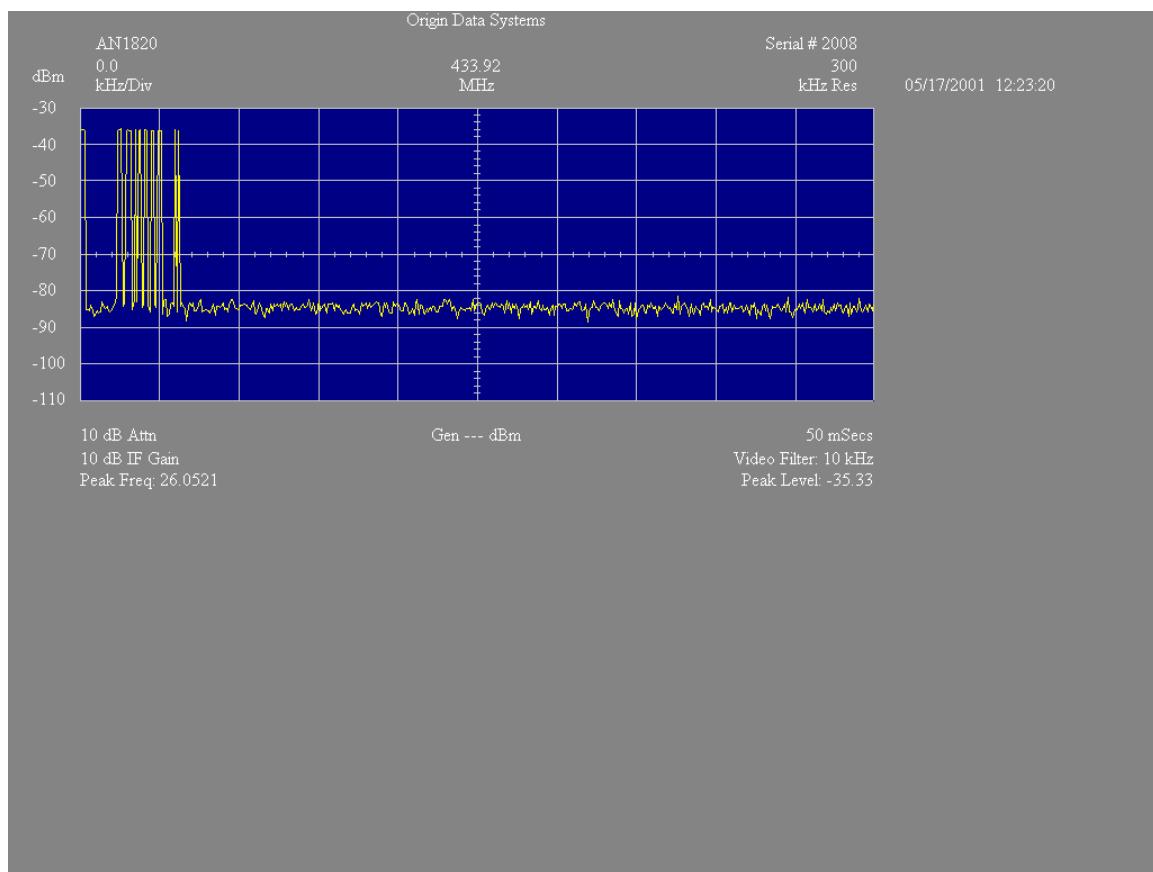
Level dBuV = Max. Induced voltage @ HP-8566B Spectrum Analyzer

AF dB = Antenna Factor

AMP dB = The total system gain (cable loss + Amplifier gain)

#### 4.2.1 Duty Cycle of Emissions

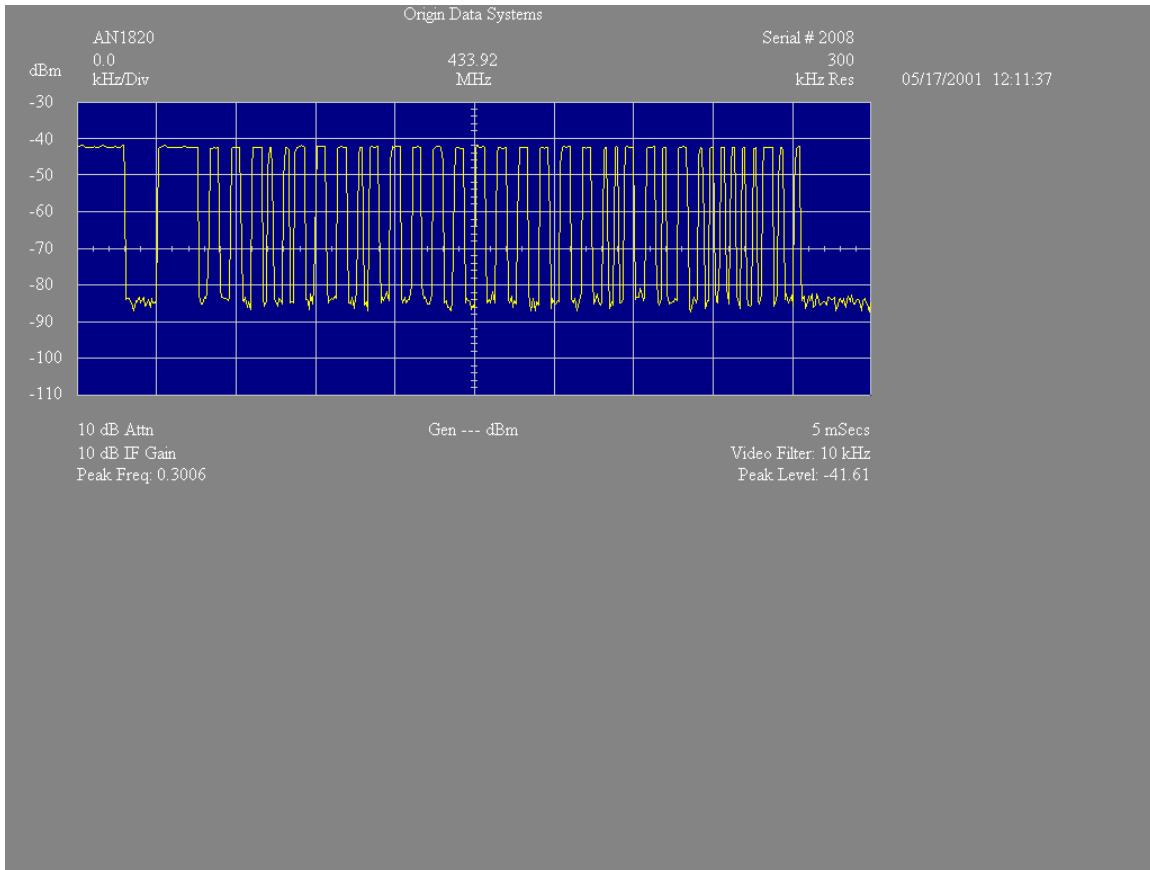
The EUT meet the provisions of 15.231 (a)(2) for ceasing transmission after automatic activation. Figure 2.1 shows the transmission emitted by the AMT-2000 tag with a message length of 75 msec.



**FIGURE 2.1 Transmitter Single Message**

#### 4.2.2 Tamper Alarm Messaging

Figure 2.2 is the Tamper alarm message. The message is less than 50msec long. This message contains the ID number of the tag as well as the alarm condition. This 50 msec message with 900 msec pause interval is repeated 4 times. The first message is emitted immediately after activation. At the end of the fourth message, the AMT-2000 ceases all transmissions. The total transmission and interval is calculated to be  $4*(900 + 50) = 3800$  sec. Hence, the complete transmission interval is less than 5 seconds.



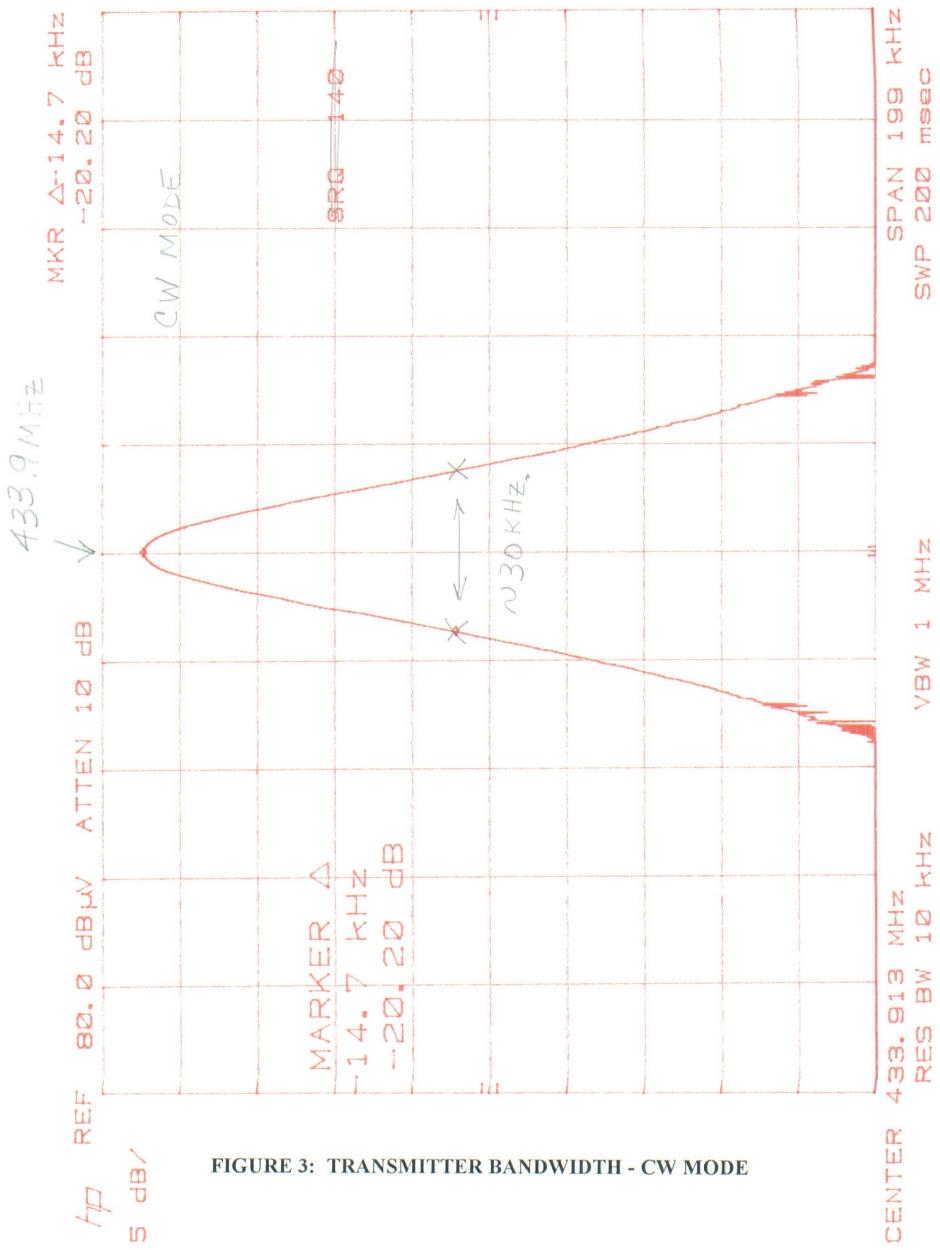
**Figure 2.2 Tamper Alarm message**

### 4.3 TRANSMITTER EMISSION BANDWIDTH

FCC requirements of 15.231(c) state "the bandwidth of emission shall be no wider than 0.25% of center frequency.... Bandwidth is determined at the points 20 dB down from the modulated carrier." At the fundamental of 433.9 MHz, the bandwidth of emission should be no wider than 108.475 kHz.

Figure 3 shows the transmitter in a cw mode of operation to have a -20 dB bandwidth of <30 kHz.

With the unit modulated with a burst mode transmission, Figure 4 shows the bandwidth to be ~75 kHz, both cases being well within that requirements stated.

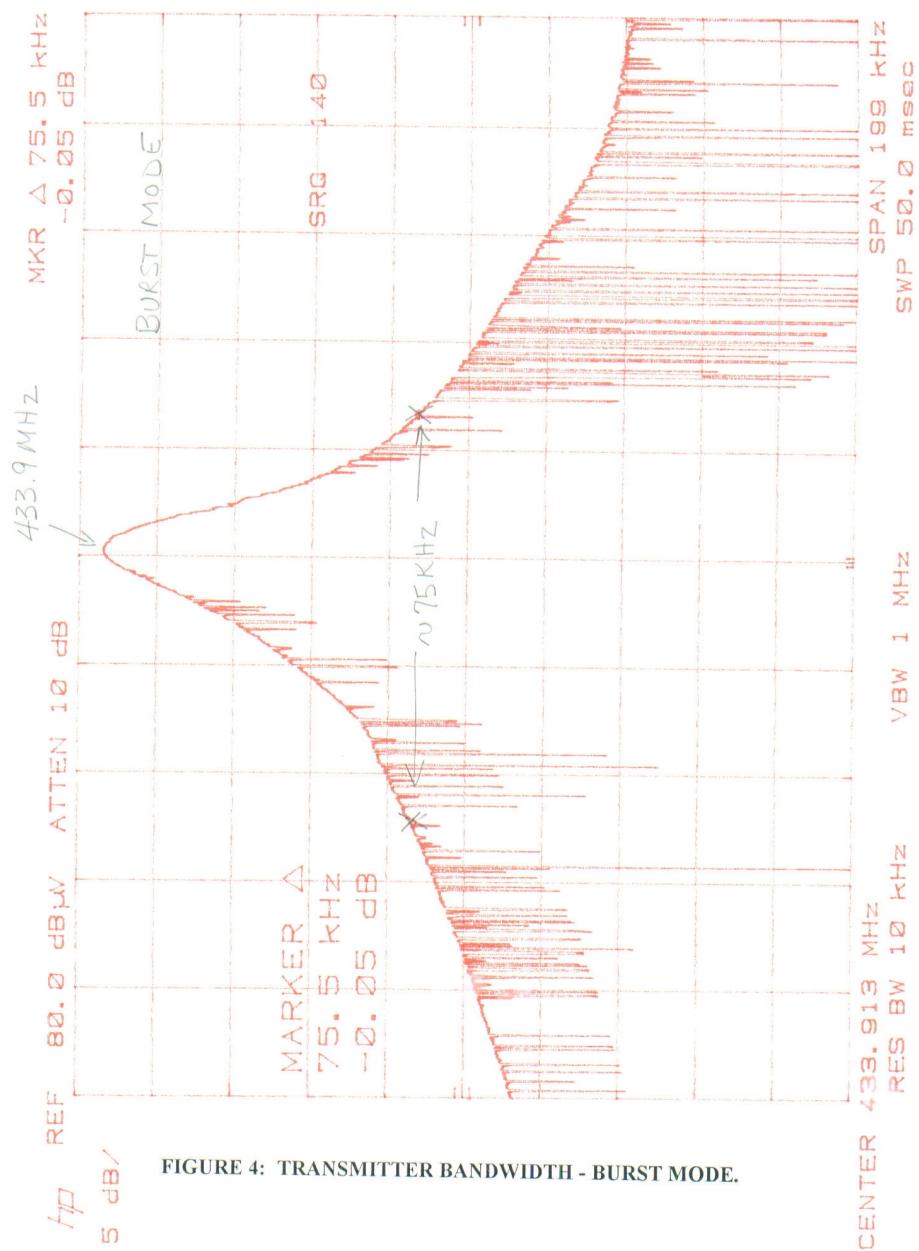


**FIGURE 3: TRANSMITTER BANDWIDTH - CW MODE**

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**FIGURE 3: TRANSMITTER BANDWIDTH - CW MODE**



**FIGURE 4: TRANSMITTER BANDWIDTH - BURST MODE.**