

INDEX OF TEST RESULTS

<u>Exhibit #</u>	<u>Description</u>
6A	1900MHz/Part 24: RF Power
6B	1900MHz/Part 24: Modulation Characteristics
6C	1900MHz/Part 24: Occupied bandwidth
6D	1900MHz/Part 24: Spurious Emissions (conducted)
6E	1900MHz/Part 24: Spurious Emissions (radiated)
6F	1900MHz/Part 24: Frequency Stability

1900MHz GSM RF POWER OUTPUT

Para. 2.1033 (c,6,7), 2.1046

The RF power measured at the output terminals (antenna connector) is plotted against supply voltage variation and temperature variations at the highest levels.

Required for Canadian approval:

Exhibit	Voltage (V)	Temperature	TX Freq	Power Level
6A2	Varied	+25C	Mid Band	0
6A3	3.6	Varied	Mid Band	0

The measurements were made the following equipment:

HP6623A DC Power Supply	HP 8593 E Spectrum Analyzer
HP 8566 B Spectrum Analyzer	Thermotron SM-8C Temperature Chamber
HP 8922 M System Simulator	

EFFECTIVE RADIATED POWER

The following is a description of the substitution method used to obtain accurate EIRP readings at the carrier fundamental frequency:

- (1) EUT measurements are made at 3 m using calibrated antennas and equipment with known cable losses.
- (2) A maximized measurement is made by raising and lowering the antenna and rotating the EUT 360 degrees. Horizontal and vertical polarization data is recorded. The power recorded is from a maximized power measurement and not a peak of the average power.
- (3) A generator and dipole antenna are then substituted for the EUT. The dipole antenna is a half-wave dipole. If a dipole antenna cannot be used, then the designated antenna is referenced to a dipole antenna.
- (4) Measurements are made through the dipole antenna at known power levels to determine the system calibration factors at a given frequency.
- (5) At frequencies where no calibration data is taken, the value is interpolated between the closest data point above and below the transmit frequency.

Table: Power table

Mode	f (MHz)	Radiated (dBm/ w)
GSM	1850	32.3/ 1.69
	1880	30.2 /1.05
	1910	30/1.00

Exhibit 6A2

RF power across PCS band @ PL0 vs. Voltage

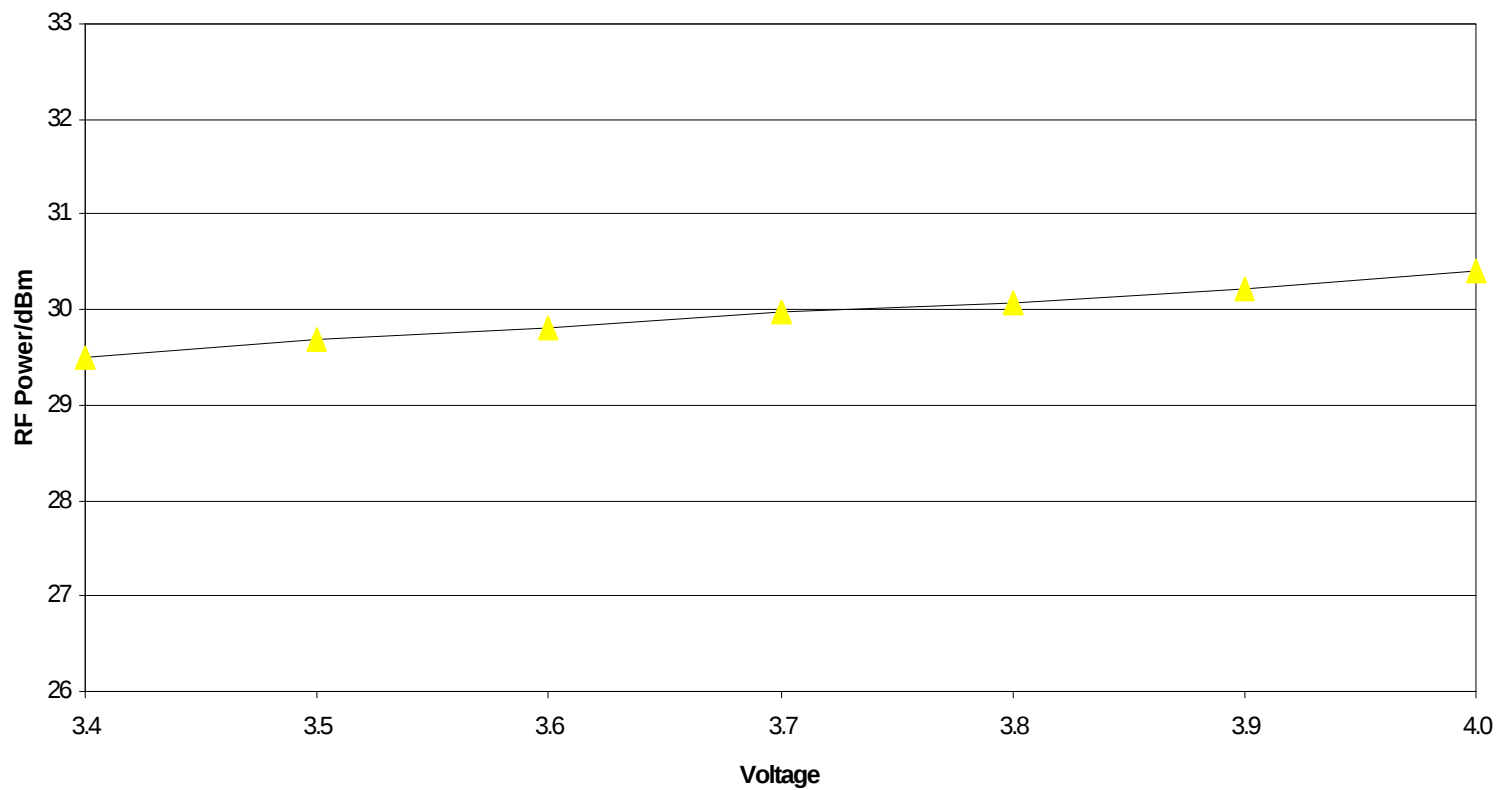
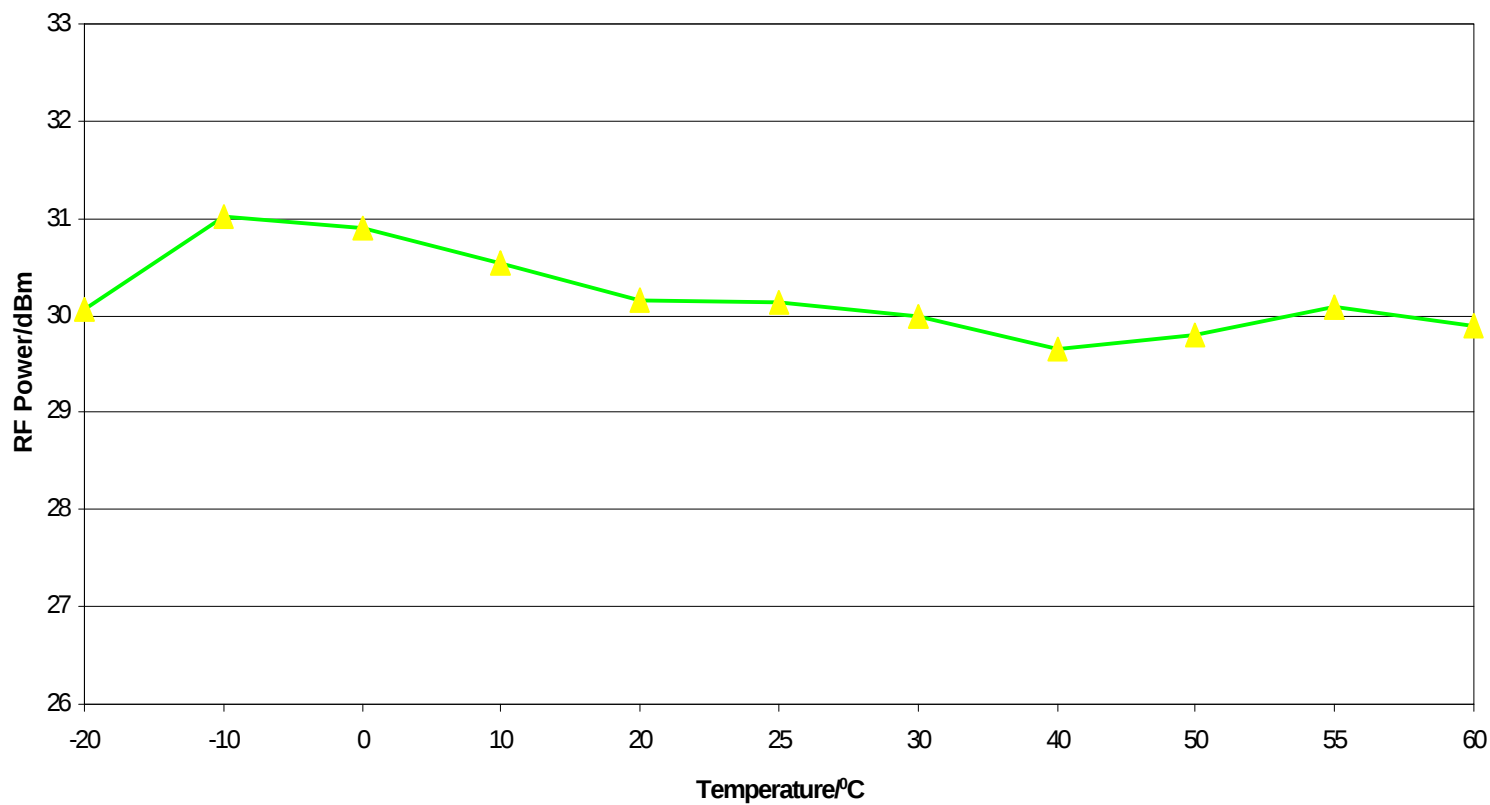


Exhibit 6A3

RF power across PCS band @ PL0 vs. Temperature



1900 MHz GSM MODULATION CHARACTERISTICS

Para: Part 2.1047 (a)(b)(d) and Part 24

4. Modulation

This chapter defines the theoretical requirements of the modulator, inclusive of the differential encoder. The modulator receives the bits from the encryption unit and produces an RF modulated signal. The information bits are first differentially encoded and then passed to the modulator. The modulation is GMSK (Gaussian Minimum Shift Keying) with a BT product of 0.3.

4.1 Modulation Format

4.1.1 Modulating Bit Rate

The modulating bit rate is $1/T = 1625/6$ kb/s (approximately 270.833 kb/s).

4.1.2 Start And Stop Of The Burst

The bits contained within a burst are defined in chapter 2. For the purpose of the modulator specification that follows, the bits entering the differential encoder prior to the first bit of the burst and following the last bit of the burst are consecutive logical ones and are denoted by the term dummy bits which define the start and end points of the useful and active parts of the burst as shown in Figure 4.1. The actual state of these bits is left to the manufacturer's implementation subject to the requirement that all performance specifications of this volume are met. Nothing is specified about the actual phase of the modulator output signal outside of the useful part of the burst. Figure 4.1 depicts the relationship between the active and useful part of the burst, the tail bits and dummy bits for a normal burst. The useful part of the burst lasts for 147 modulating bits.

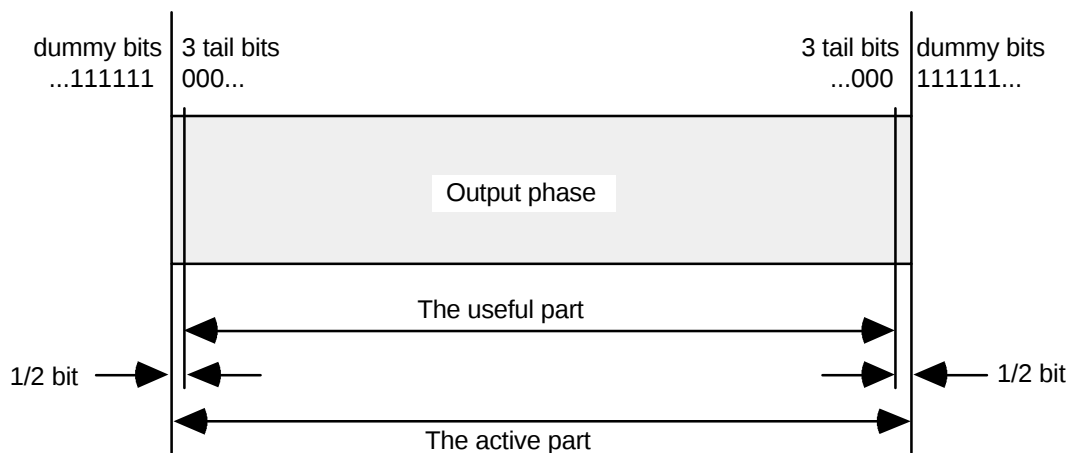


Figure 4.1: Normal Burst

4.1.3 Differential Encoding

Each data value $d_i = [0,1]$ is differentially encoded. The output of the differential encoder is:

$$\hat{d}_i = d_i \oplus d_{i-1}$$

where $\oplus$ denotes modulo 2 addition.

The modulating data value α_i input to the modulator is:

$$\alpha_i = 1 - 2\hat{d}_i$$

where $\alpha_i \in \{-1, 1\}$

4.1.4 Filtering

The modulating data values α_i as represented by Dirac pulses excite a linear filter with impulse response defined by:

$$g(t) = h(t) \otimes \text{rect}\left(\frac{t}{T}\right)$$

where the function $\text{rect}(x)$ is defined by:

$$\text{rect}\left(\frac{t}{T}\right) = \frac{1}{T} \quad \text{for } |t| < \frac{T}{2}$$

$$\text{rect}\left(\frac{t}{T}\right) = 0 \quad \text{otherwise}$$

and $\otimes$ means convolution. $h(t)$ is defined by:

$$h(t) = \frac{e^{-\left(\frac{t^2}{2\sigma^2 T^2}\right)}}{\sqrt{2\pi} \sigma T} \quad \text{where } \sigma = \frac{\sqrt{\ln(2)}}{2\pi BT} \quad \text{and } BT = 0.3$$

where B is the 3 dB bandwidth of the filter with impulse response $h(t)$, and T is the duration of one input data bit.

4.1.5 Output Phase

The phase of the modulated signal is:

$$\phi(t') = \sum_i \alpha_i \pi h \int_{-\infty}^{t' - iT} g(u) du$$

where the modulating index h is $1/2$ (maximum phase change in radians is $\pi/2$ per data interval).

The time reference $t' = 0$ is the start of the active part of the burst as shown in Figure 4.1. This is also the start of the bit period of bit number 0 (the first tail bit) as defined in chapter 2.

4.1.6 Modulation

The modulated RF carrier, except for start and stop of the TDMA burst may therefore be expressed as:

$$x(t') = \sqrt{\frac{2E_c}{T}} \cos(2\pi f_0 t' + \phi(t') + \phi_0)$$

where E_c is the energy per modulating bit, f_0 is the center frequency and ϕ_0 is a random phase and is constant during one burst.

1900 MHz: OCCUPIED BANDWIDTH

Per 2.1049 (h) and 24.238 (a)(b)(c)(d) the exhibits presented show the modulation that have to exist in a 1900 MHz Cellular System.

All the exhibits listed below are plots where the modulation condition is Psuedorandom Data (270.833 kb/s switched), operating in the GSM mode. All plots were taken while transmitting at Power Level 0. Any frequency span not covered at the exhibits below was found to be unaffected by the transmitter/modulation.

<u>EXHIBIT</u>	<u>Lower Channel (Channel 512, power level 0)</u>
6C2	Plot showing 1MHz resolution bandwidth, peak power
6C3	Plot showing emissions bandwidth, center frequency at 1.8502GHz
6C4	Plot showing 100KHz span, resolution bandwidth 1% of necessary BW.
 <u>Upper Channel (Channel 810, power level 0)</u>	
6C5	Plot showing 1MHz resolution bandwidth, peak power
6C6	Plot showing emissions bandwidth, center frequency at 1.9098GHZ
6C7	Plot showing 100KHz span, resolution bandwidth 1% of necessary BW.

The measurements were made per CFR 47, part 24 using the following equipment:

Hewlett Packard 8922 M System Simulator
Hewlett Packard 8593 E Spectrum Analyzer

Exhibit 6C2

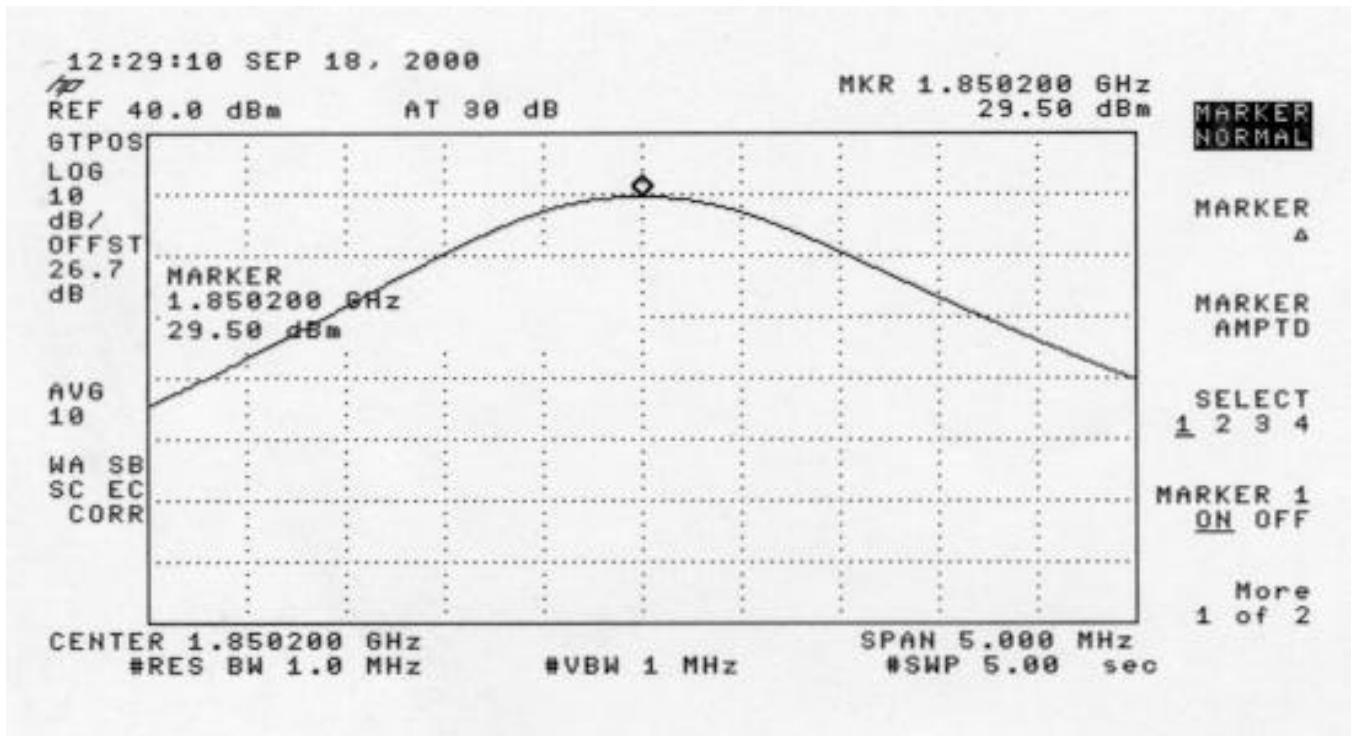


Exhibit 6C3

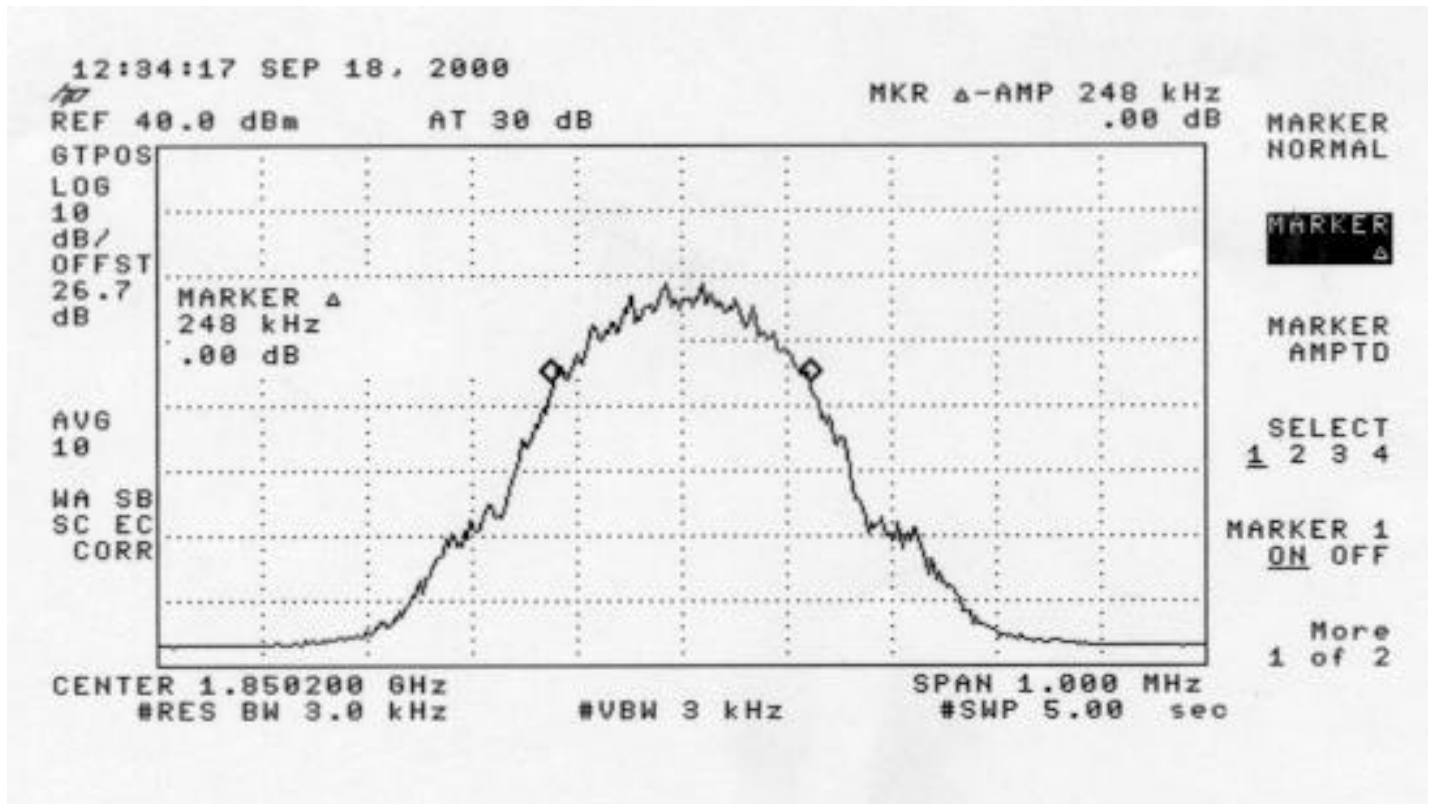


Exhibit 6C4

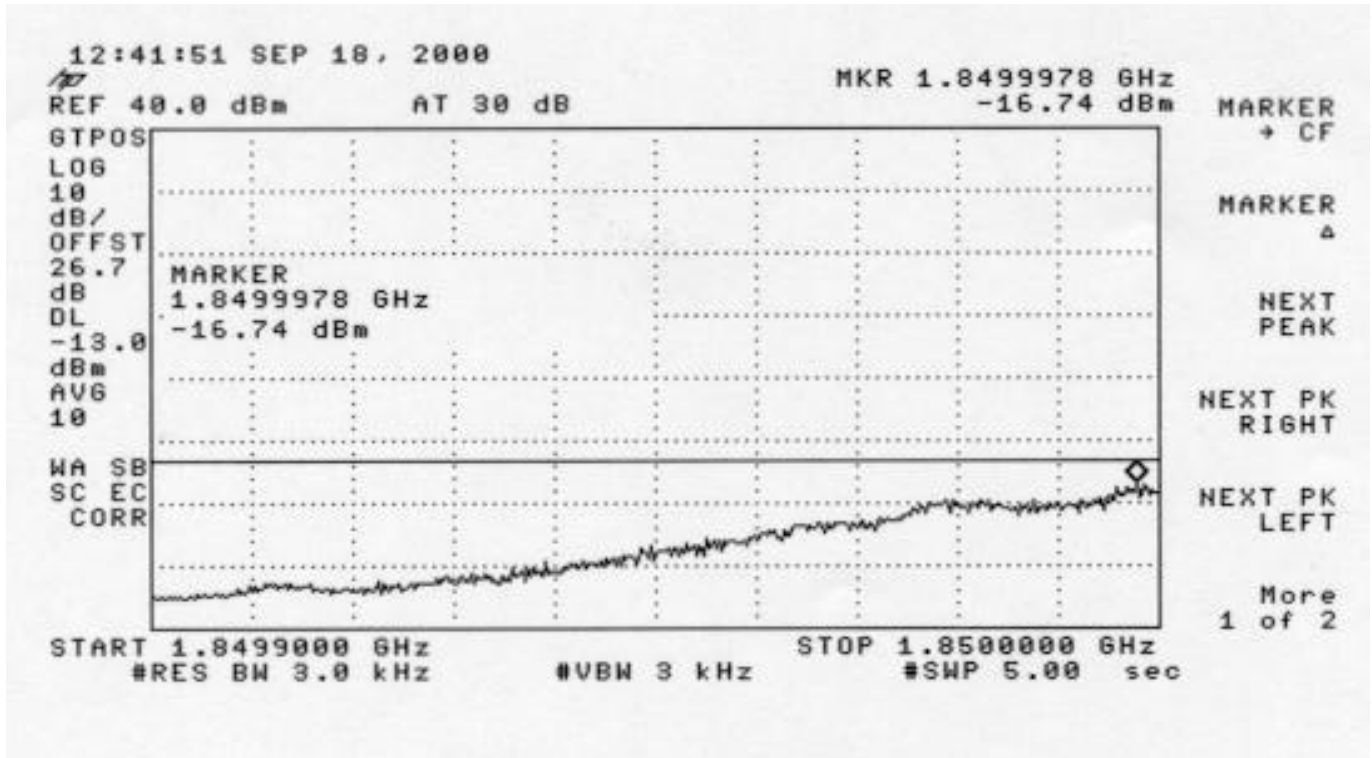


Exhibit 6C5

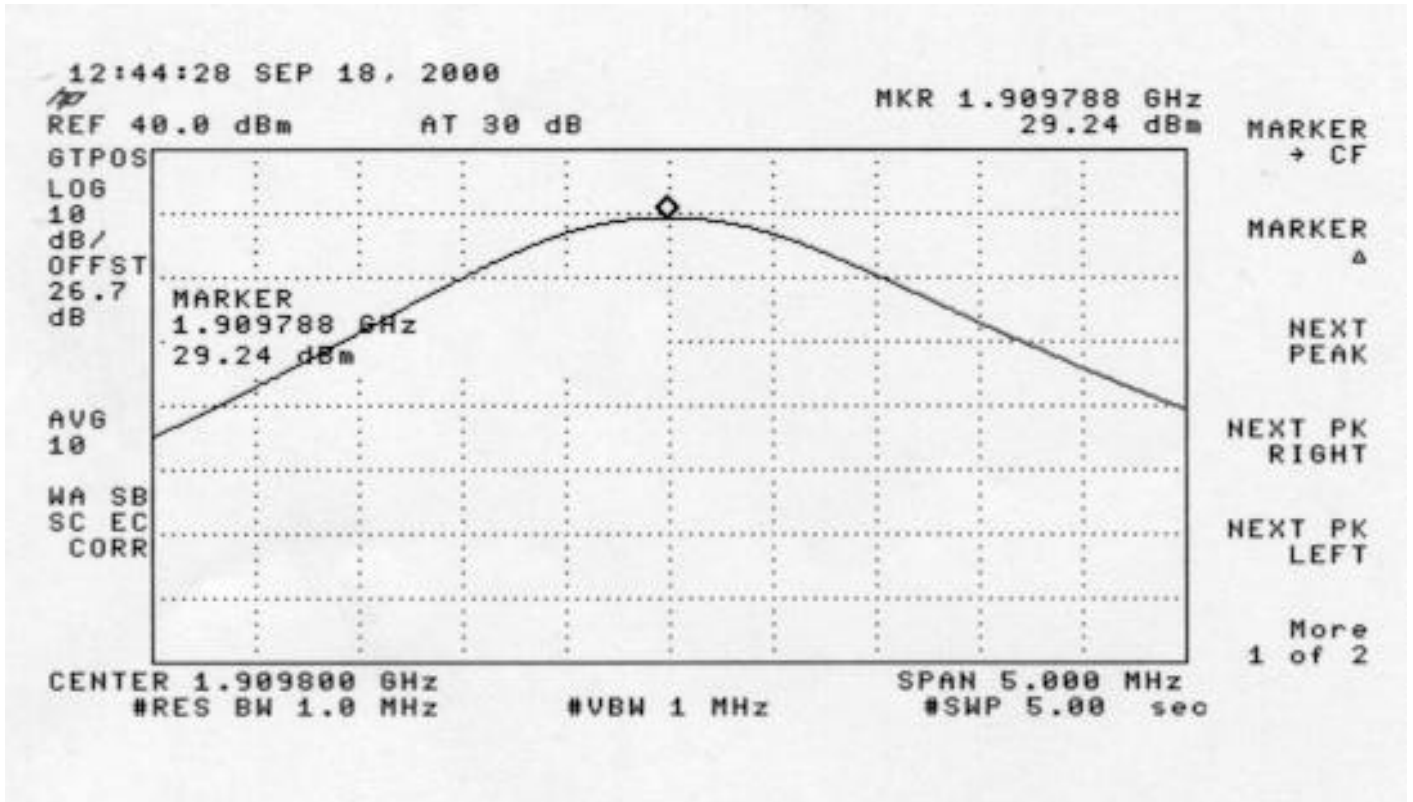


Exhibit 6C6

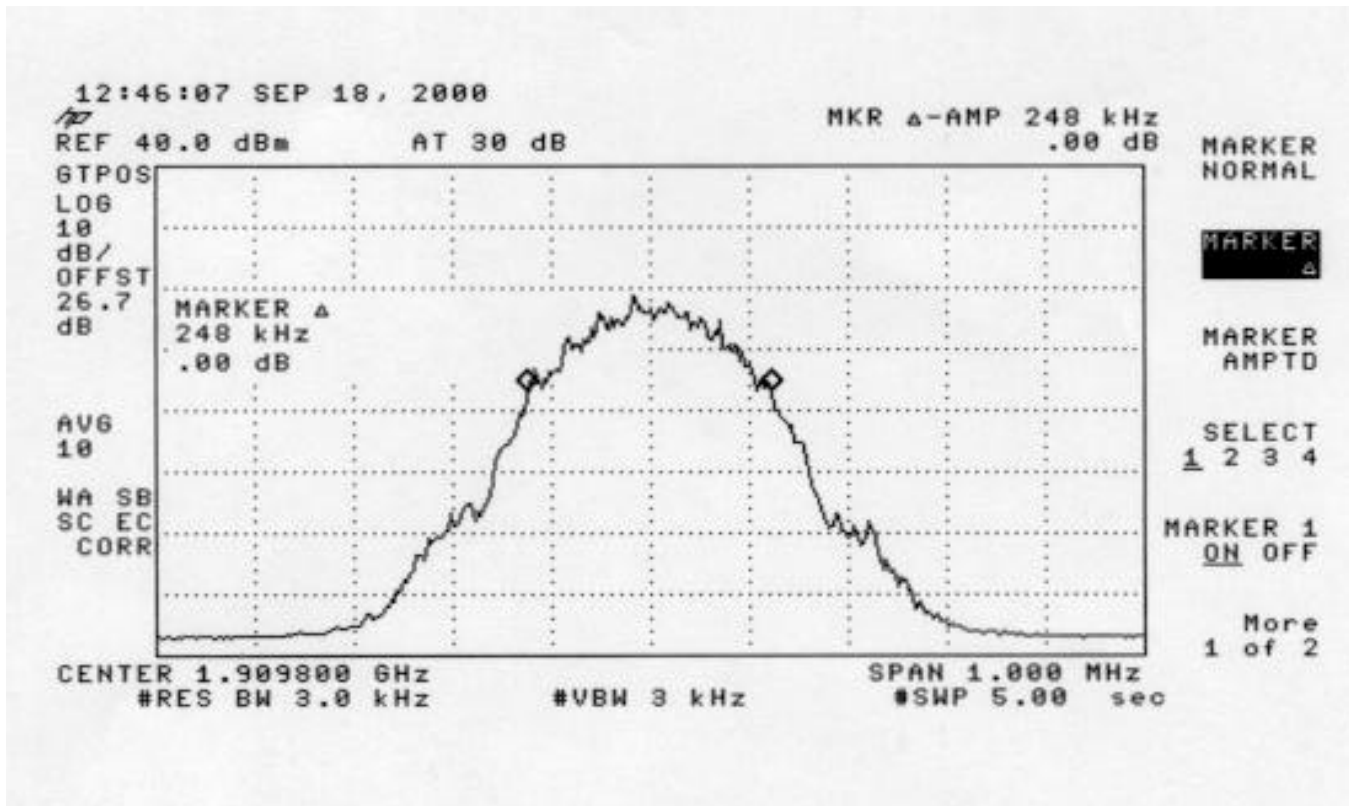
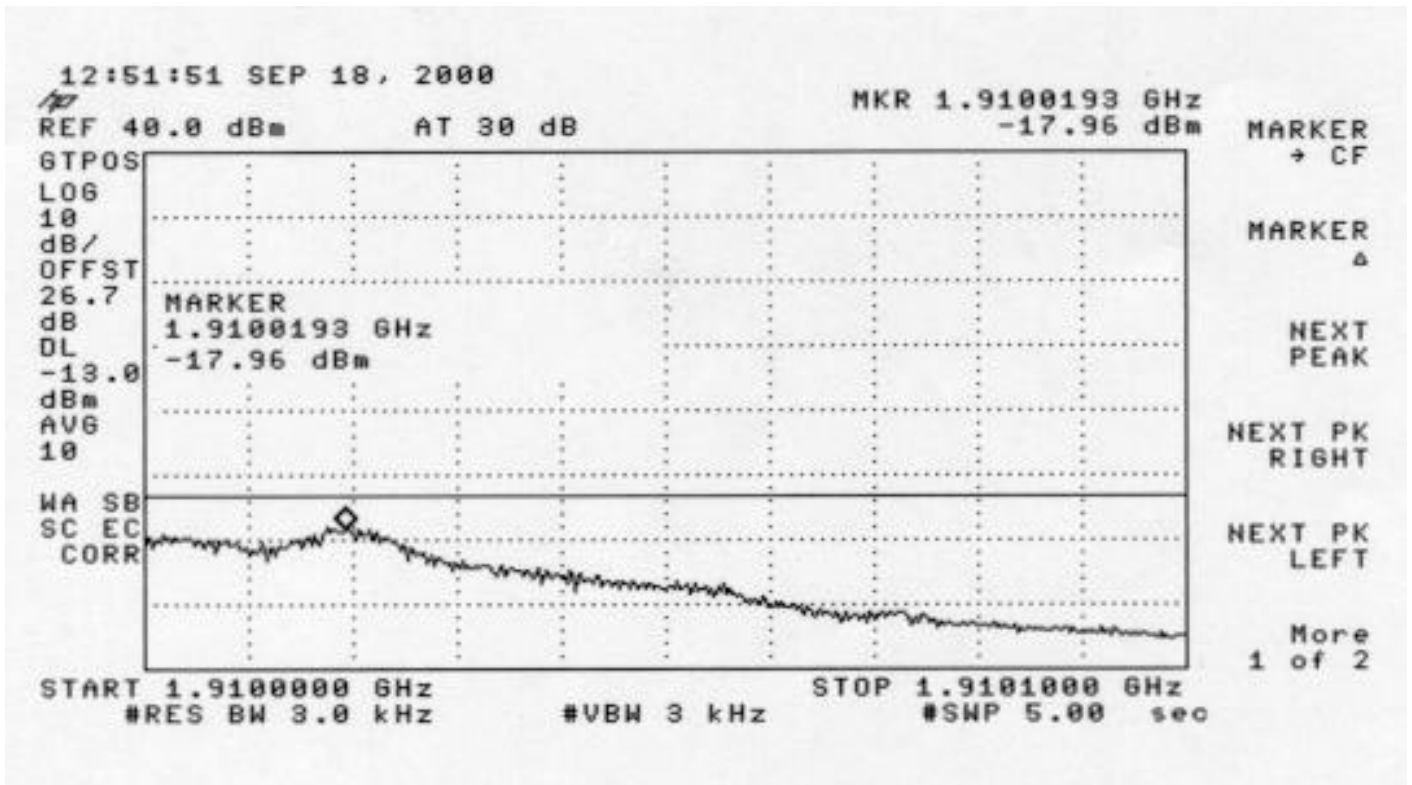


Exhibit 6C7



1900 MHz SPURIOUS EMISSIONS (CONDUCTED)

Per 2.1051 Spurious emissions at the antenna terminals (conducted) when properly loaded with an appropriate artificial antenna.

<u>EXHIBIT #</u>	<u>FREQUENCY (MHz)</u>	<u>Output Power level</u>
6D2	1879.8	15 (low)
6D3	1879.8	0 (high)

Note: The spectrum was examined through the 10th harmonic of the carrier. Measurements recorded are peak measurements.

The measurements were made using the following equipment:

HP 8958A	Cellular Interface
HP 8901B	Modulation Analyzer
HP 8559A	Spectrum Analyzer

Exhibit 6D2

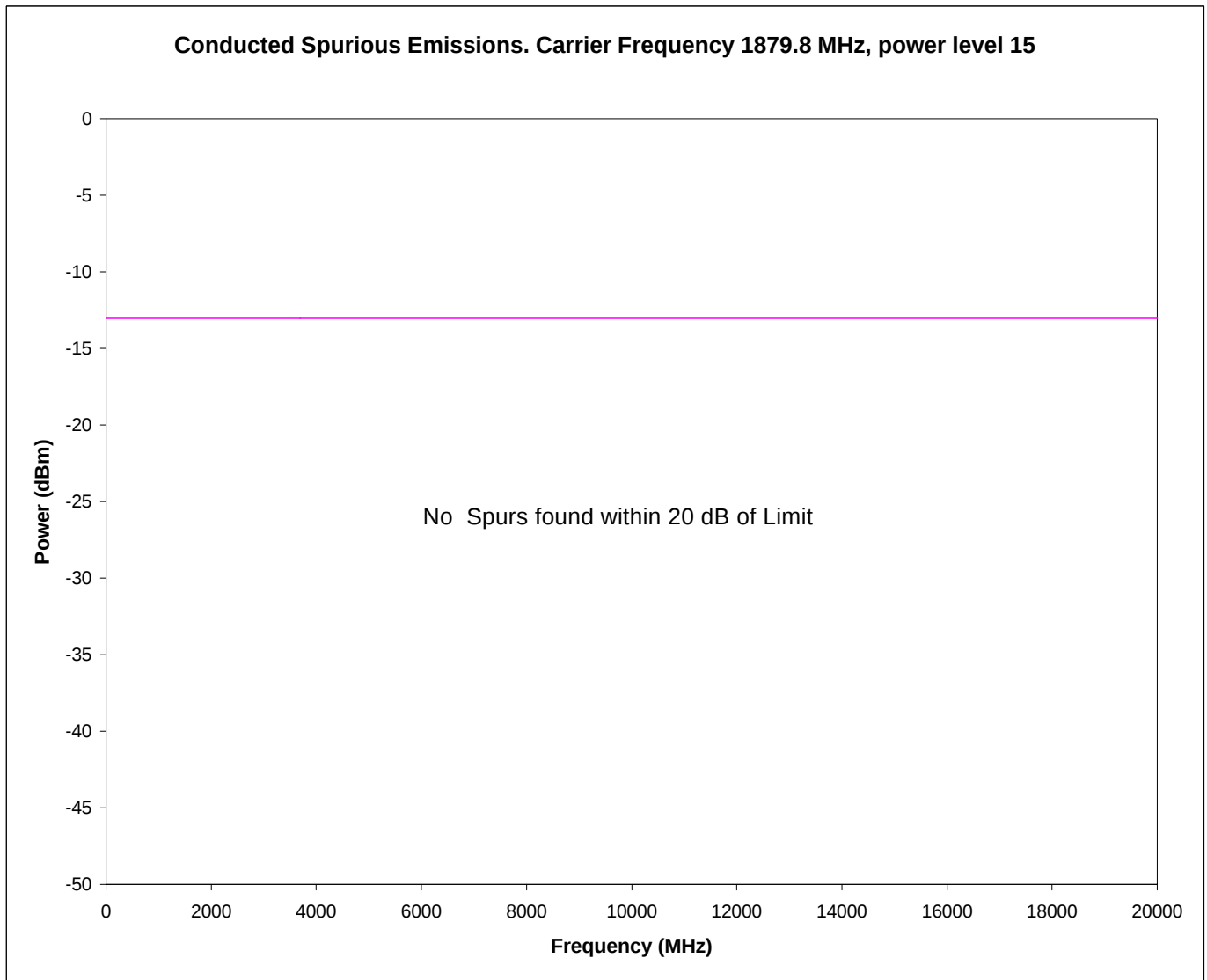
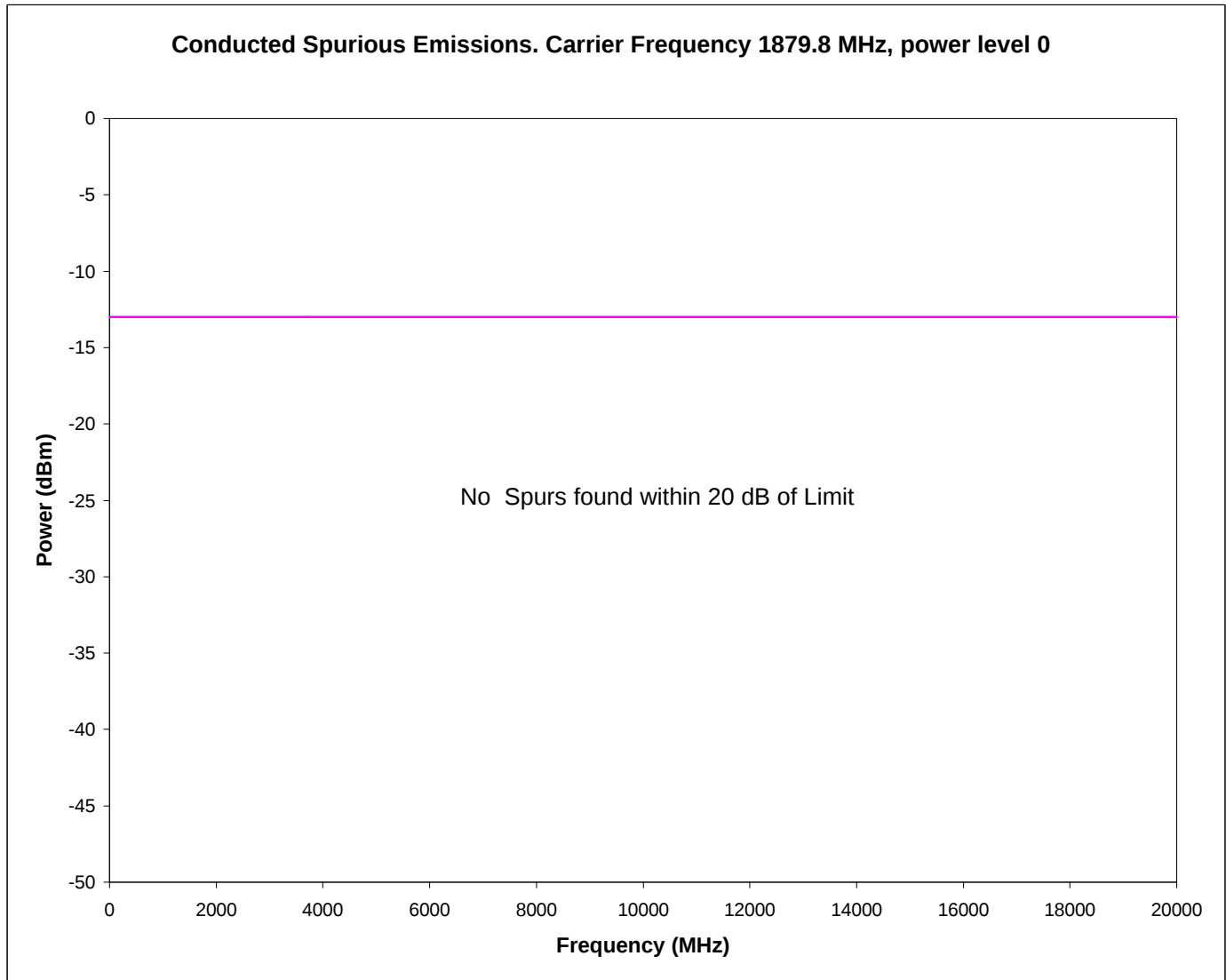


Exhibit 6D3



1900 MHz SPURIOUS EMISSIONS (Radiated)

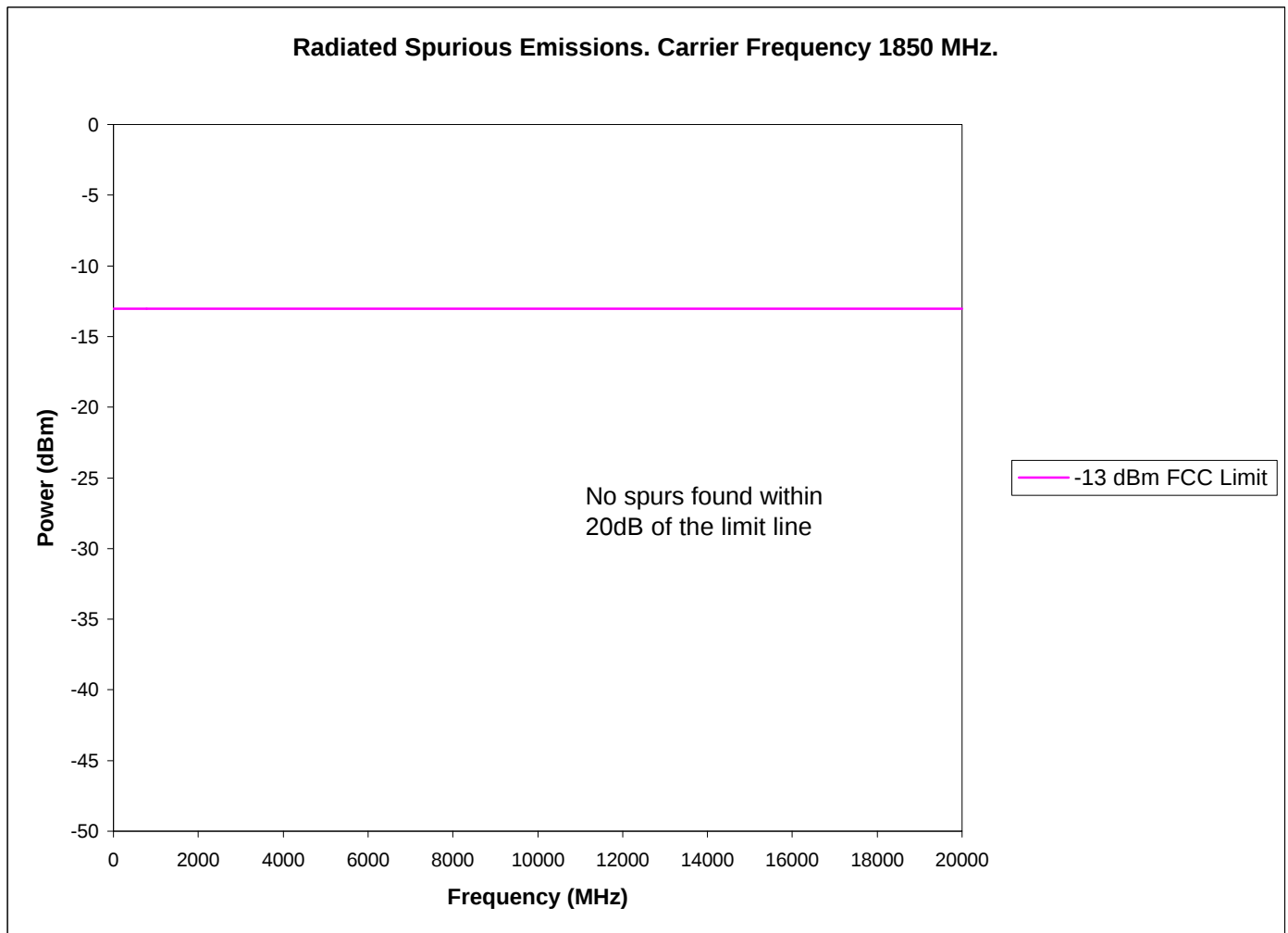
Per 2.1053 and Part 24, field strength of spurious radiation was measured at Underwriters Laboratories Inc. Research Triangle Park, NC site. The measurement procedure utilizes EIA IS-137 as guide. Measurements were made on a 3 meter test site. Results are shown on the following Exhibit.

Note: The spectrum was examined through the 10th harmonic of the carrier. Measurements recorded are peak measurements.

<u>EXHIBIT</u>	<u>FREQUENCY</u>	<u>OUTPUT POWER LEVEL</u>
6E2	1850 MHz	0 (high)

The measurements were made using the following equipment:

8566B Spectrum Analyzer
85650A Quasi Peak Detector
HP Amplifier 8449B
HP Signal Generator 8657B
Anritsu 8802A test set



1900 MHz FREQUENCY STABILITY

Per 2.1.055 (a)(1),(b),(d)(2)

Testing was conducted at mid-channel (660), 1879.8 MHz at power level 0.

<u>EXHIBIT #</u>	<u>Voltage</u>	<u>Temperature</u>
6F2	3.4 to 4.0 Volts (varied)	+25 C
6F3	3.6 Volts	Varied

Note: The manufacturers rated voltage for the battery is 3.4 VDC to 4.0 VDC.

The measurements were made the following equipment:

HP8958A Cellular Interface
HP 6623A DC Power Supply
HP 8596E Spectrum Analyzer
HP 437B RF Power Meter
HP 8901B Modulation Analyzer
HP 8903B Audio Analyzer
Thermotron SM-8C Temperature Chamber

Exhibit 6F2

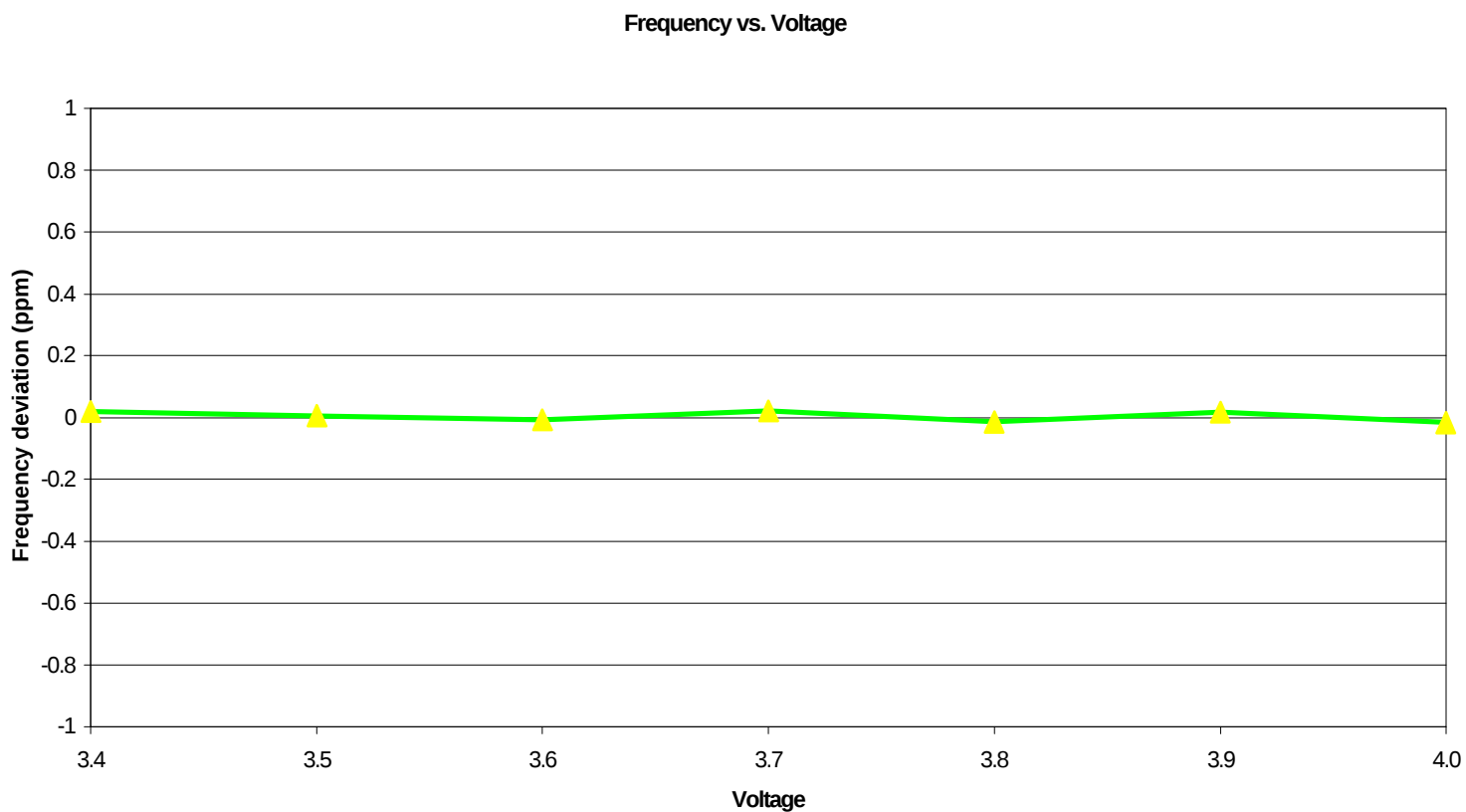


Exhibit 6F3

Frequency vs. Temperature

