



LS Research Inc.

Quartex Synchronization Transmitter

Question 2 and 4

Part 90 Type Acceptance, Conducted Measurements

V1.1

prepared for

Quartex, Division of Primex, Inc.



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Surveillance Transmitter

I. Project Information

Project: Surveillance Transmitter

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Revision:
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Job Number:

Signatures:

Technical Approval



II. FCC Conducted Tests

A. Part 90 Subpart I

1. 90.207 (a) (1) Types of Emissions (Device Classification)

Classified as an ***FID*** emitter (Frequency Modulation, Digital Modulation, Data). Power level: 1W.

2. 90.209 (a) (5) Bandwidth Limitations (Device Classification, Test Condition).

20 kHz Nominal Channel Bandwidth



3. Part 2.1046 Output Power, Part 2.1051 Spurious Emissions at Antenna terminals and Part 2.1049 Occupied bandwidth using 90.210 (c) Emission Mask for F1D Transmitter.

a) **Test Requirement:**

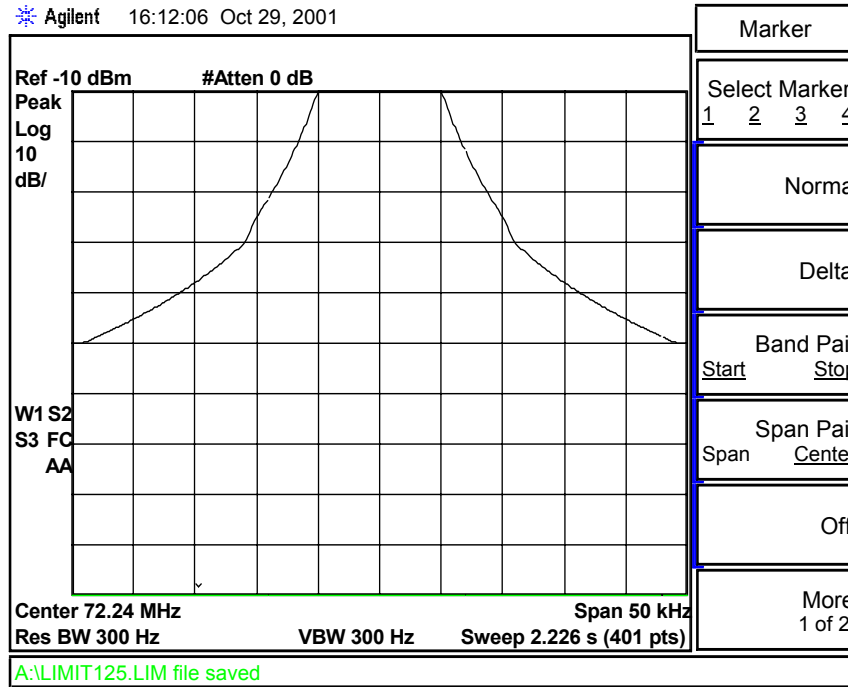
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5kHz but not more than 10kHz: At least $83 \log (f_{d/5})$ dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz but no more than 250 percent of the authorized bandwidth: At least $29 \log (f_d^2/11)$ dB or 50 dB, whichever is the lesser attenuation.

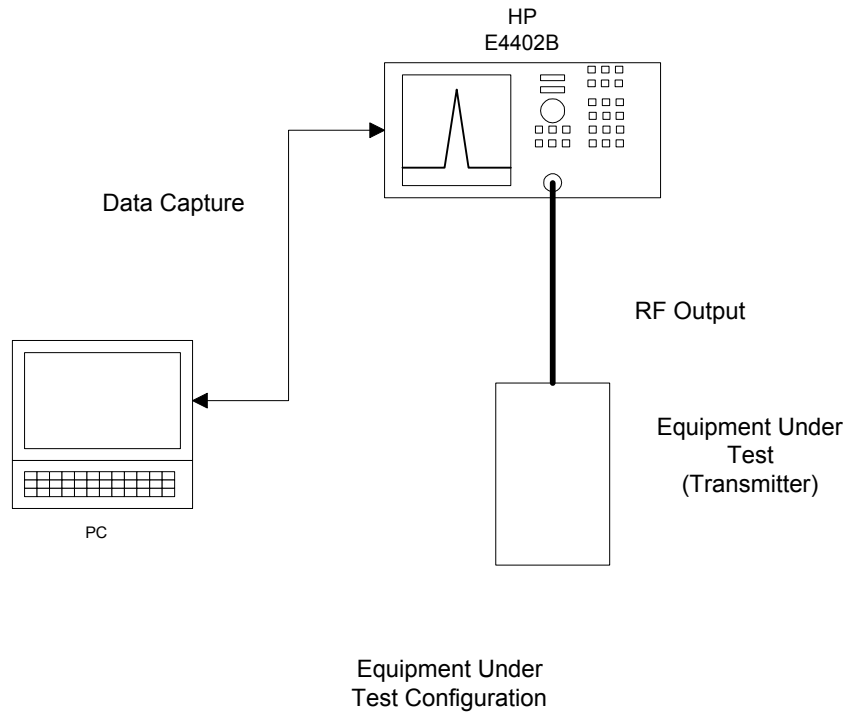
(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log (P)$ dB. P is output power in Watts.

The test condition is presented in Tabular form below. The definition of the spectrum mask as indicated on the spectrum analyzer is also presented.

90.210 (c)	Absolute Frequency Offset Range: $ f_d $	Attenuation relative to Carrier power P.
(1)	0 to 5 kHz	0 dB
(1)	5 kHz to 10 kHz	$83 \log (f_{d/5})$ dB
(2)	10 kHz to 70 kHz	$29 \log (f_d^2/11)$ dB or 50 dB, whichever is the lesser attenuation.
(3)	Greater than 70 kHz	$43 + 10 \log (P)$ dB



b) Test Configuration



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c) Equipment Under Test Conditions, Instrument Conditions and Indicated Numerical Data for Part 2.1046 Output Power.

Presented below is a table that summarizes the equipment under test conditions, instrument conditions and numerical data. Numerical Data for the Transmitter Power under each of the test conditions is indicated in the Table. The source of the numerical data is presented in sub-sections(e),and (f), Test Indications. Demonstration of compliance is presented in sub-sections (e) and (f).

	Set f (MHz)	Maximum Power Output Allowed (dBm)	Measured Power Out (dBm)	2 nd Harmonic (dBc)	fcenter (MHz)	fspan (kHz)	fstart (MHz)	fstop (MHz)	RBW (kHz)	VBW (kHz)
Conductd Emission-Harmonic Output	72.24	+30	+27.64	-57.84			60	150	30	30
	72.24						10	1000	10	10
Conducted Emission – Occupied Bandwidth	72.24	+30			72.24	50			0.100	0.100

NOTES: Po measured on the Gigatronics 8542C; all cable losses measured and accounted for.

Set f: E.U.T Carrier frequency Setting .

Po: Measured Absolute Output Power (HP 8920B)

2nd : Second Harmonic Level in dB relative to the fundamental power

fcenter: Spectrum Analyzer Center Frequency Setting

span: Spectrum Analyzer Frequency Span Setting.

fstart: Spectrum Analyzer Start Frequency

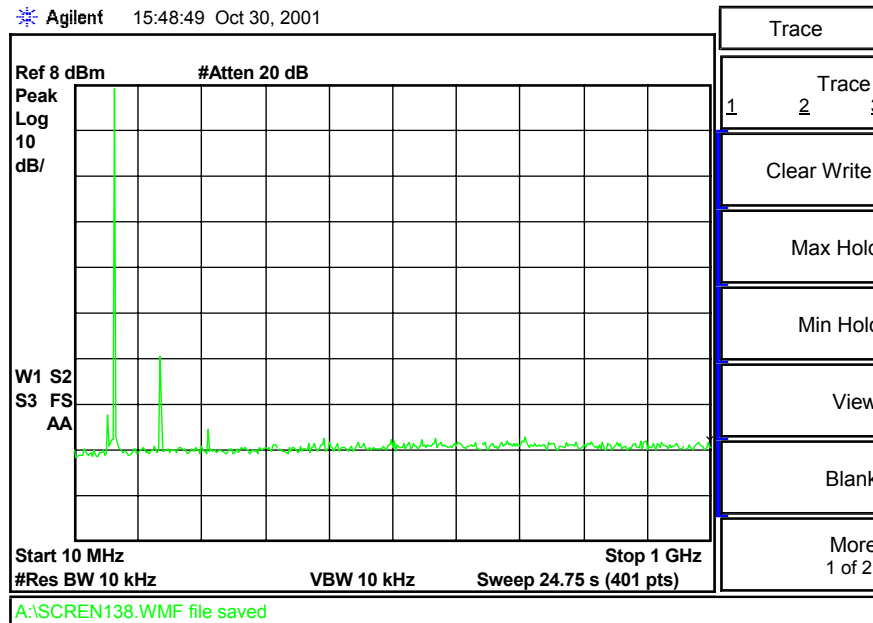
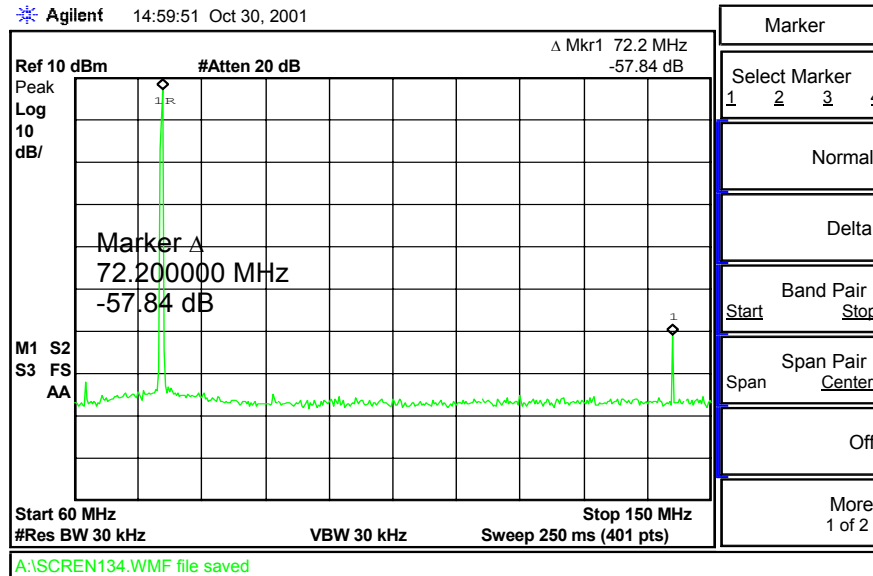
fstop: Spectrum Analyzer Stop Frequency

RBW: Spectrum Analyzer Resolution Bandwidth.

VBW: Spectrum Analyzer Video Bandwidth.



d) Test Indications Part 2. 1046 Conducted Spurious Emissions at Antenna Terminals



Test Condition: 72.24 MHz, 27.5 dBm

Test Limit: $10 \log (1 \text{ W}) + 43 \text{ dB} = 43$

Test Indication: 57.84

Test Outcome: 57.84 dBc > 43 dBc → PASS

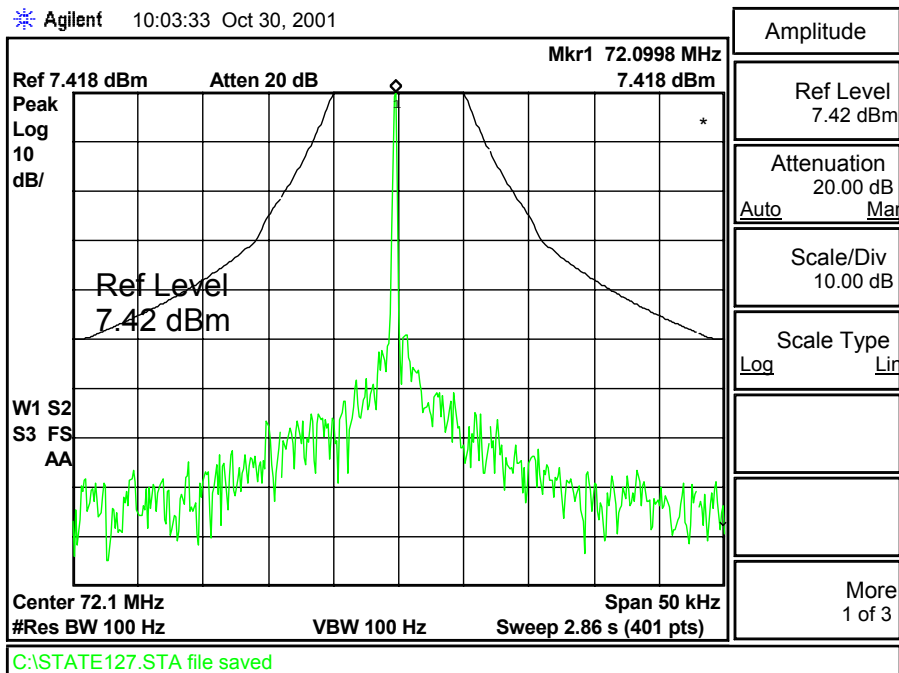
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e) Test Indications Part 2. 1049 Occupied Bandwidth

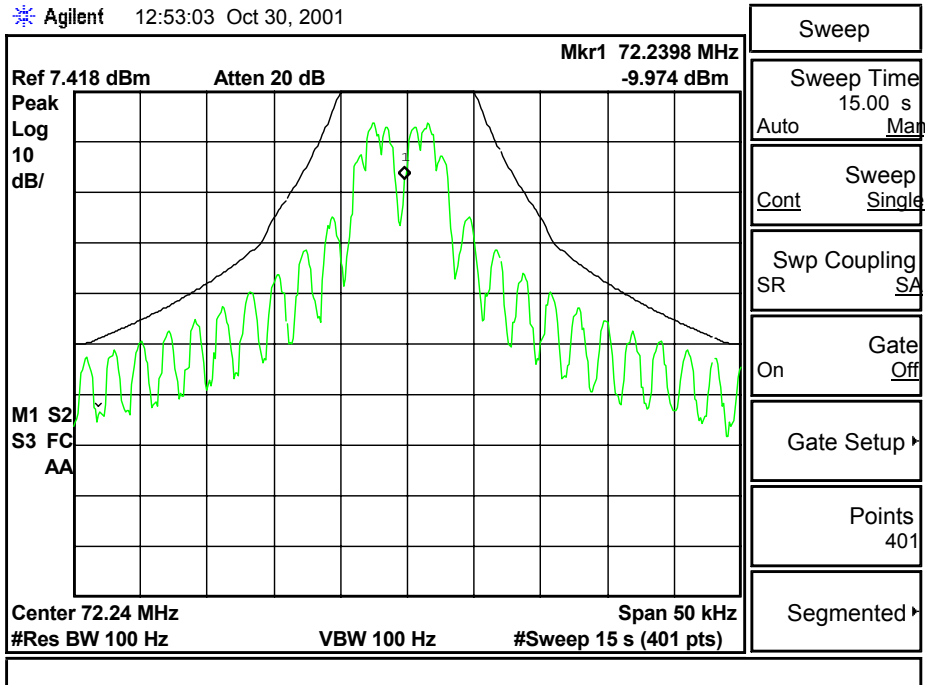
3. Reference Level setting under these conditions:

- (a) Span = 50 kHz.
- (b) Resolution Bandwidth = 100 Hz.
- (c) Video Bandwidth = 100 Hz.
- (d) Set Reference Level to the peak of the unmodulated carrier



4. Measurement Indication under these conditions:

- (a) Span =50 kHz
- (b) Resolution Bandwidth = 100 Hz.
- (c) Video Bandwidth = 100 Hz.
- (d) Peak Hold for > 10 Sweeps



Test Condition: 72.24 MHz, 27.5dBm

Test Limit: Indicated Mask (see sub-section (a))

Test Indication: Indicated Spectrum falls below Indicated Mask

Test Outcome: Spectrum falls below Indicated Mask → PASS



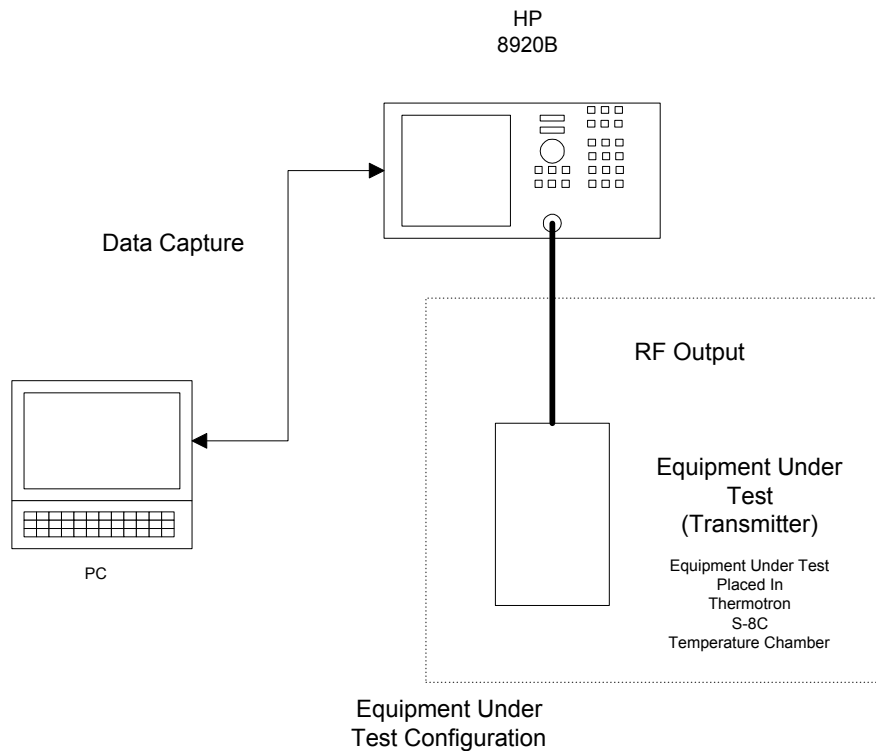
4. Part 2.1055 and 90.213 (a) Frequency Stability

a) Test Requirement

Mobile stations operating in the 72 to 76 MHz frequency range below 2W output power must have an absolute frequency stability of **50 ppm**.

Test in accordance to conditions called out in Part 2.1055 (a) (1):
Frequency stability must be measured from **-30 to 50 degrees centigrade for (b) steps of 10 degrees** allowing for thermal equilibrium.

b) Test Configuration



c) Test Conditions, Numerical Test Indications



Set Temperature (C)	Frequency Measured (MHz)	Frequency Error (ppm)
-30	72.240172	2.34
-20	72.240110	1.53
-10	72.240111	1.53
0	72.240089	1.23
10	72.240091	1.26
20	72.240091	1.26
30	72.240100	1.39
40	72.240094	1.30
50	72.240077	1.07

Test Condition: 72.24 MHz, 27.5dBm (-30 deg. C to 50 deg C, 10 degree steps)

Test Limit: 50 ppm Maximum Frequency Offset

Test Indication: Frequency Display on the HP 8920B

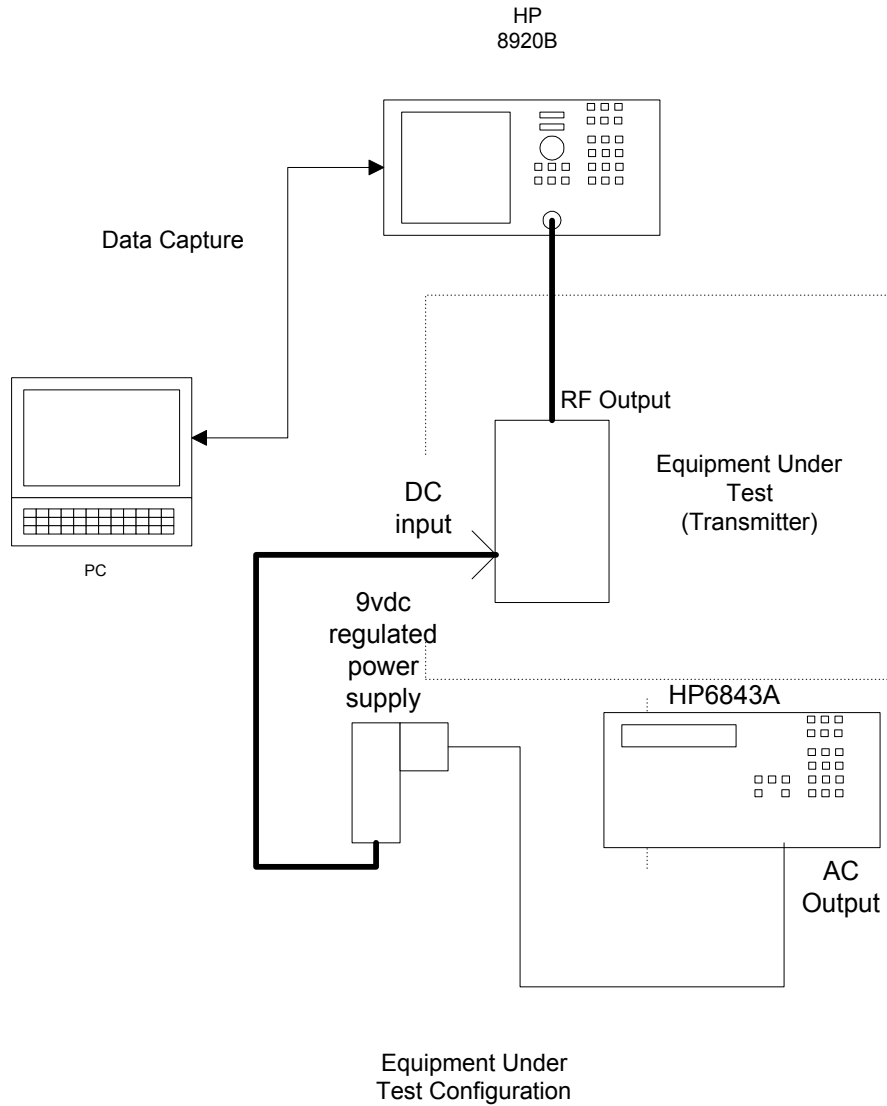
Maximum Frequency Offset is 2.34

Test Outcome: and 2.34 ppm < 50 ppm → PASS

5. Part 2.1055(d)(1) Frequency stability with respect to voltage.

a. Vary the supply voltage from 85% to 115% of the nominal value

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Voltage	Frequency Measured	Voltage measured (HP6843A)
138 VAC (115% of nominal)	72.240105 MHz	138.12VAC

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120VAC (Nominal)	72.240101 MHz	120.08VAC
102VAC (85% of nominal)	72.240109 MHz	102.11VAC

Test Condition: 72.24 MHz, 27.5dBm

Test Limit: 50 ppm Maximum Frequency Offset

Test Indication: Frequency Display on the HP 8920B

Maximum Frequency Offset is 1.51ppm

Test Outcome: and 1.51 ppm < 50 ppm → PASS

6. 2.1033(c)(8) Provide an exhibit showing the DC currents and voltages supplied to the final amplifier stage.

Total measured current into the final amplifier is 375mA at 4.96Vdc



III. Equipment List

Equipment	LSR Serial No.	Serial Number	Calibration
HP E4402B Spectrum Analyzer	-	US39010240	4/30/01
HP 8920B Communication Test Set		3820A10282	1/5/99
Thermotron S-8C Temp Chamber	CC000210C	On Record	6/5/98
Gigatronics 8542C		1831450	8/15/01

IV. Equipment Uncertainties

Specified Characteristic	Specified Probability Density	Specified Uncertainty
HP8591E Spectrum Analyzer		
Reference Level Accuracy	Uniform	+/-0.3 dB +0.01 X dB from -20 dbm
Calibrator Output	Uniform	+/-0.4 dB
Absolute Amplitude Calibration Uncertainty	Uniform	+/-0.15 dB
Gigatronics 86301A Sensor Calibration Factor	Uniform	1.33%
HP8920A Communication Test Set		
RF Frequency Measurement	Uniform	+/-1ppm
Thermotron S-8C Temp. Chamber		
Temperature Accuracy	Uniform	+/- 0.3 deg C

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V. Uncertainty Analysis

HP Spectrum Analyzer Total Uncertainty (-60 dBm level):

Perform Root-Sum-Square of three uncertainties to find total uncertainty for a 95% confidence level:

Uniform uncertainties specify the probability density interval $\pm a$. The variance of the uniform density is $a^2/3$.

Sum the uncorrelated variances to find the total variance:

$$\text{Total variance} = [(0.3 \text{ dB} + 0.01 \cdot 40 \text{ dB})^2/3 + (0.4)^2/3 + (0.15)^2/3] = 1.25/3 = 0.416$$

The uncertainty for a 95% confidence interval is 1.96 times the standard deviation:

$$\text{Total Uncertainty} = \pm 1.96 \cdot \sqrt{0.416} = 1.96 \cdot 0.644 = \pm 1.26 \text{ dB}$$