



*Tactical*  
**Technologies**  
*Inc.*

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**1701 Second Ave  
PO Box 91  
Folsom, PA 19033  
FAX 610-522-9430  
TEL 610-522-0106**

**Part 2 & 90 Testing  
Synthesized FM Voice Repeater  
Model ECHO5  
FCC ID: IP9ECHO5**

**Tactical Technologies Inc.  
1701 Second Ave  
Folsom, PA 19033  
610-522-0106**

**A. INTRODUCTION**

The following data are submitted in connection with this Application for Type Certification in accordance with Part 2, Subpart J, and Part 90, Subparts B,D, and I of the FCC Rules and Regulations.

## **B. INFORMATION REQUIRED BY PART 2**

2.1003(a) See Form 731

2.1033(b) N/A

2.1003(c)

(1) The full name and address of the applicant and manufacture for certification is:

Tactical Technologies Inc.  
1701 Second Ave.  
P.O. Box 91  
Folsom, Pa. 19033

(2) The FCC Identifier of this device is IP9ECHO5

(3) Operating Instructions are included in the Exhibits.

(4) Emission: NBFM Voice – 11K2F3E

Emission Calculations are included in the Exhibits.

(5) Frequency Range 150 – 174 Mhz

(6) Output Power of the device is 1.95W @ 13.8 Volts

(7) Maximum Power Rating is 2 Watts.

(8) All of the Pre-amp sections run off of 6.0v, and RF Final transistor run off of unregulated +12 Volts.

(9) Tune up procedure is included in the Exhibits.

(10) Test Data required by Part 2.1046 through 2.1057, inclusive, is measured in accordance with the procedure in Part 2.1041.

## **C. SUBMISSION OF EQUIPMENT FOR TESTING - Paragraph 2.943**

Upon request, the test sample will promptly be made available by Tactical Technologies Inc.

#### **D. DESCRIPTION OF MEASUREMENT FACILITIES - Paragraph 2.947**

The open-field tests were performed on the 3 meter range maintained by Radiation Science Inc. Complete description and measurement data have been placed on file with the Commission.

#### **E. TEST DATA**

This section contains results of measurements required by Parts 2 and 90 of the rules. Data is presented in tabular and/or graphical form, and measurement procedures are described within the text of each reported test.

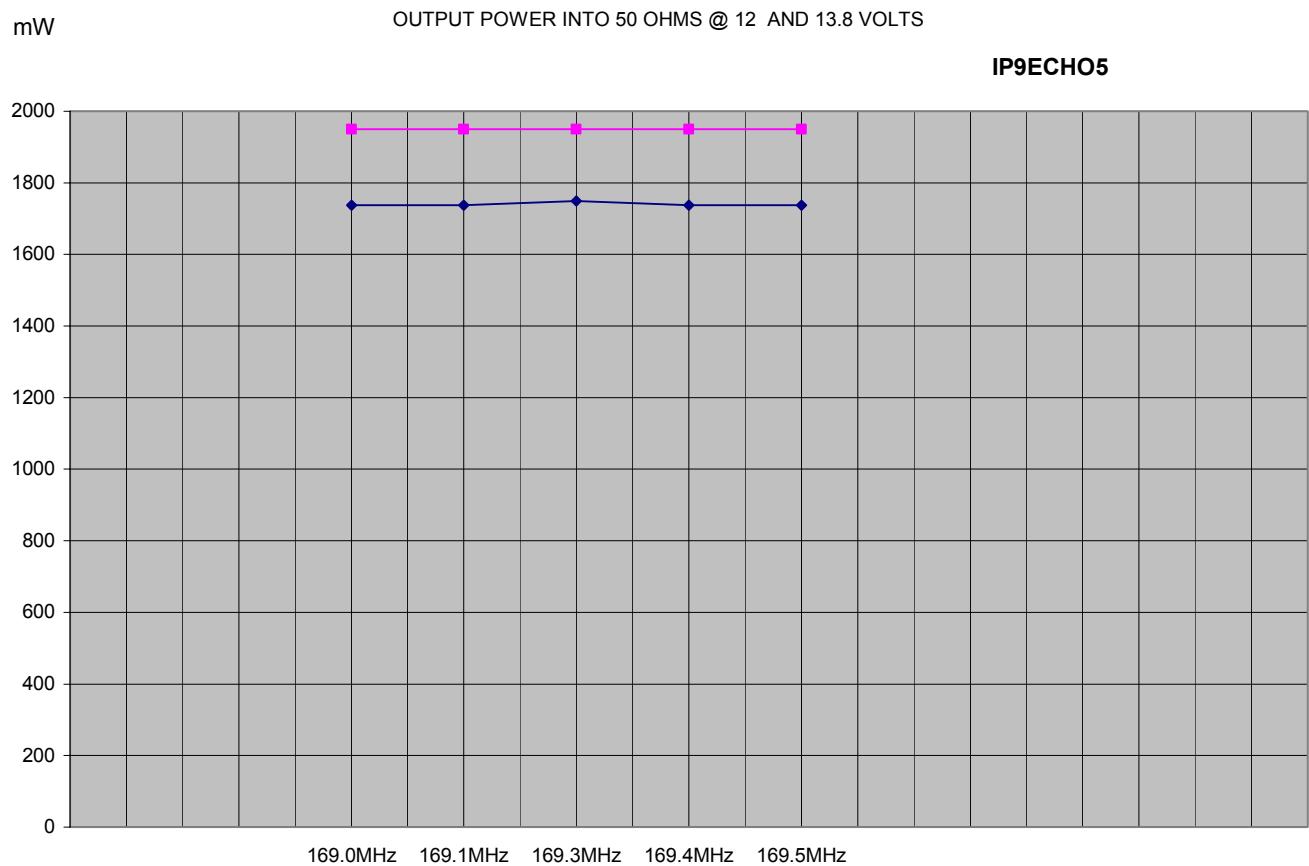
##### **1. RF POWER OUTPUT - Paragraphs [2.1046(a),2.1033(c)(8),90.205(d)]**

Power output measurements were made at the RF connector. This test was done with an unmodulated carrier in accordance with part 90.205(d)

The power output was measured with a Spectrum Analyzer with a series 30 dBm pad.

The electrical characteristics of the RF load was 50 ohms 0j.

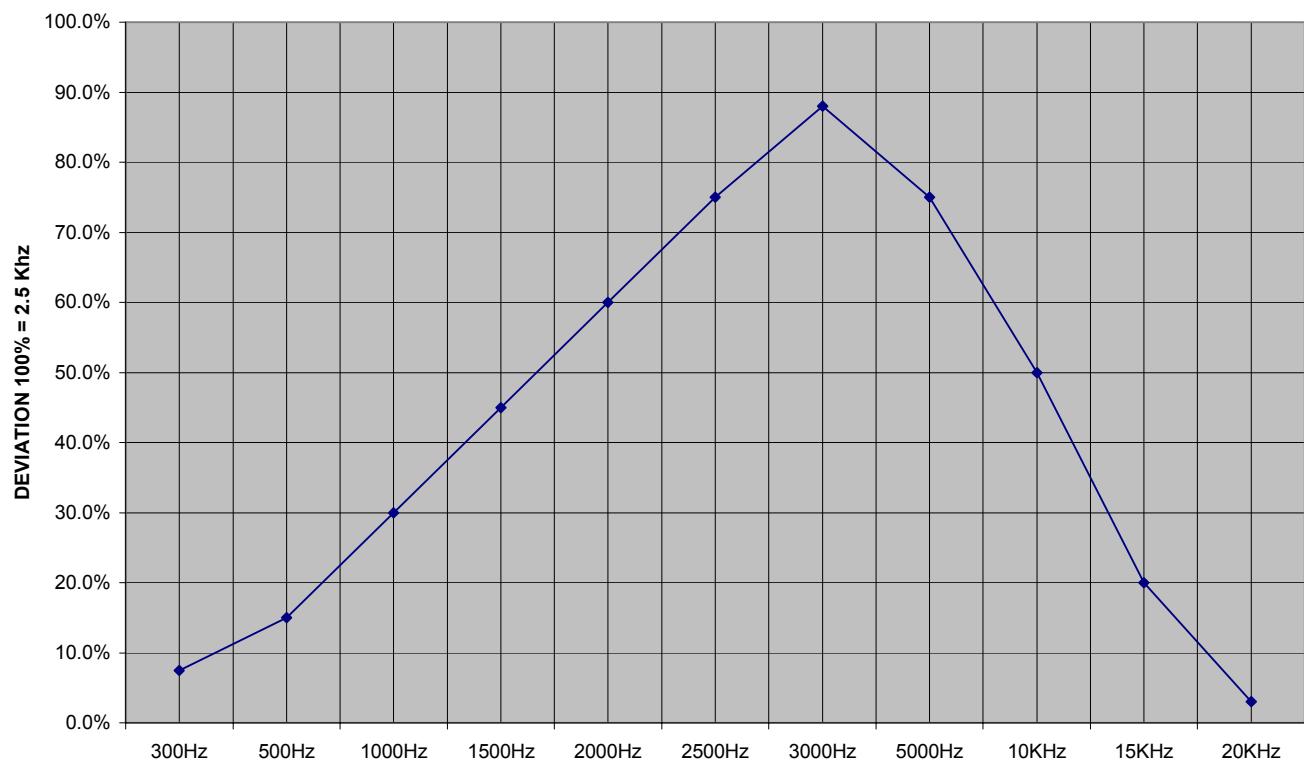
The RF power output was measured from 169.0 Mhz – 169.5 Mhz



##### **2. MODULATION CHARACTERISTICS - Paragraph [2.1047(a), TIA/EIA -603 3.2.6]**

Measurement data showing the frequency response of the transmitter is shown in the graph below. A signal generator was connected to the receivers input, and the transmitted audio deviation was measured by a communications monitor.

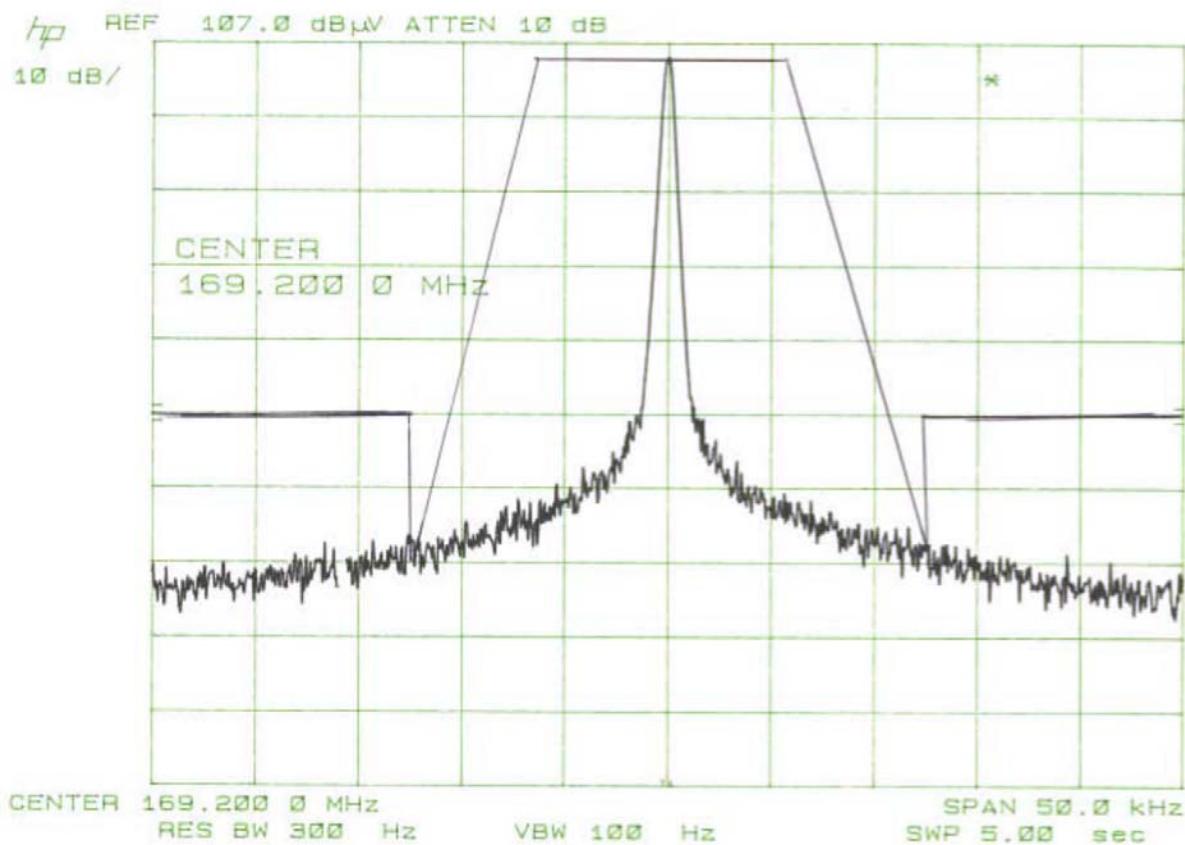
**PRE-EMPHASIZED RX AUDIO @ 1:1 MODULATION RATE VS. TX DEVIATION ECHO 5**  
**FCC ID # IP9ECHO5**



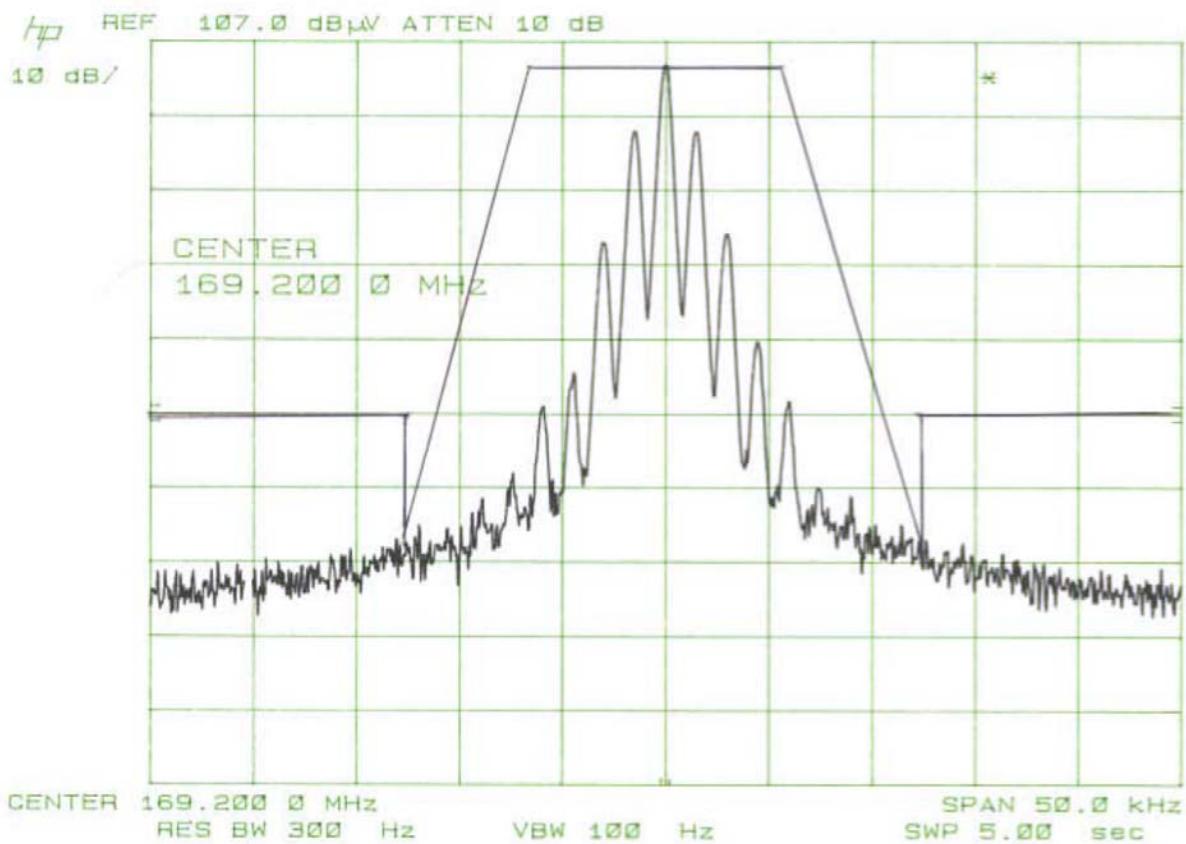
### 3. OCCUPIED BANDWIDTH - Paragraphs [2.1049, 90.210]

Figures 3 and 4 contain pictures taken from a Spectrum Analyzer. The transmitter was modulated with a sine wave tone at 2500 Hz at a level 16 dB above the required to produce 50% modulation at the frequency maximum response. Paragraph 90.210(d) requires that the mean power of emissions shall be attenuated below the mean output power of the transmitter by the following amounts:

- On any frequency removed from the center of the authorized bandwidth  $f_0$  to 5.625 khz removed from  $f_0$ ; Zero db.
- On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in khz) of more than 5.625 khz but no more than 12.5 khz. At least  $(f_d - 2.88\text{khz})\text{db}$ .
- On any frequency removed from the center of the authorized Bandwidth by a displacement frequency ( $f_d$  in khz) of no more than 12.5 khz. At least  $50 + \log(P)$  or 70db, whichever is the lesser attenuation



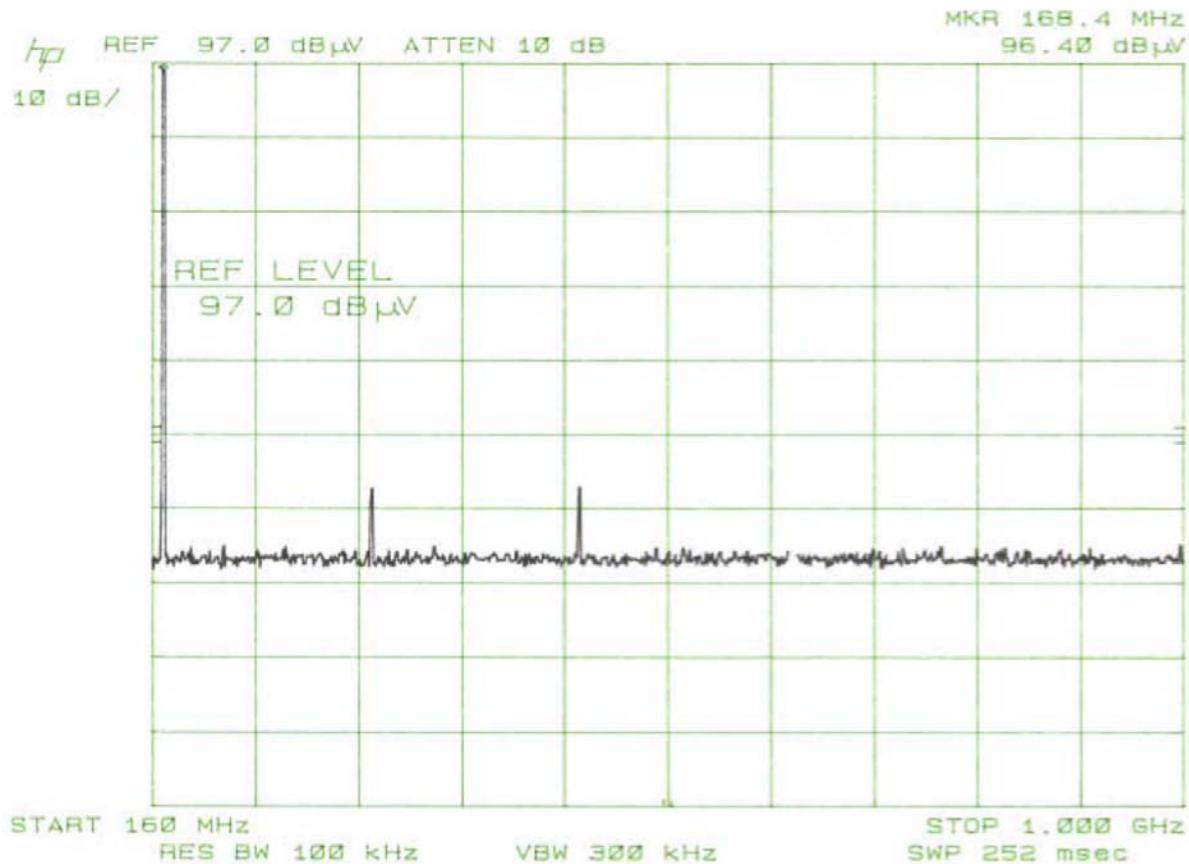
Part 90.210 Emission Mask D



Part 90.210 Emission Mask D

4. SPURIOUS EMISSIONS AT THE 50 OHM TEST POINT ON THE TRANSMITTER [2.1053, 90.210 Emission Mask D]

The transmitter was modulated per paragraph 2.1053. The spectrum was checked with the spectrum analyzer from 10 MHz to the 10th harmonic of the carrier frequency. Observed emissions not reported are attenuated more than 20 dB below the permissible value of 53 dB, i.e.,  $50 + 10\log(2W) = 53$  dB given by Section 90.210.



## 5. FIELD STRENGTH OF SPURIOUS RADIATION - Paragraphs [2.1053, 90.210]

Measurements were made on the three meter range maintained by Radiation Science Inc. to quantify spurious emission level that] are radiated directly from the cabinet, control circuits, power leads and intermediate circuit elements under normal conditions of installation and operation. Particular attenuation was paid to harmonics of the carrier frequency as well as those frequencies removed from the carrier by multiples of the oscillator frequency.

Data is submitted in Table 2 showing the magnitude of harmonics and other spurious emissions from 30 MHz through the 10th harmonic. The test sample with its external 50 ohm dummy load was placed on a non-conductive table one meter above the ground plane in order to determine the maximum level at each emission. Both horizontal and vertical site antenna polarization were employed. The antenna was raised 1 to 4 meters in height and the equipment under test was rotated 360 degrees to minimize the emission. The reference level for spurious radiation was taken as an ideal dipole excited by the measured output power according to the following relationship:

$$E = (49.2 P)^{1/2} / R \quad \text{Where:} \quad \begin{aligned} E &= \text{electric-field intensity in Volts/meter} \\ P &= \text{transmitted power in Watts } 2W \text{ or } 33 \text{ dBm} \\ R &= \text{distance in meters} \end{aligned}$$

For this case:  $E = 3.31 \text{ V/M} = \text{a field strength of } 130.41 \text{ dBuV/m @ 3 meters}$   
FCC Limit =  $P_{dBm} - [50 + 10\log(P)] = 33 - [50 + 10\log(2)] = -20 \text{ dBm or } 87 \text{ dBuV}$

The third harmonic of the IP9ECHO5 was 45.1 dBuV @ 3 meters, which is 19.8 dBm below the FCC limit and all other harmonics detected were > 20dBm below the FCC limit of 87dBuV, no other harmonics were detected after the forth harmonic. The maximum transmitted radiated power into the 50 ohm dummy load at the third harmonic frequency (507.600 MHz) was 45.1 dBuV @ 3 meters. In order to obtain this level of radiation (45.1 dBuV) using the antenna substitution method described in the TIA 603 manual a signal level of -34.2 dBm (signal generator) - 2.2 dBm (cable loss) + 3.76 dBd = -32.24 dBm = .000597 mW

The ERP @ the third harmonic = .000597 mW



RADIATION SCIENCES INC.

### Electromagnetic Emission Test

**RADIATION SCIENCES INC.****Electromagnetic Emission Test**

<b>E U T</b>	Manufacturer: Tactical Tech Model#: ECHO 5 Serial #: 101 Mode: RECEIVE			Date: 6/22/05 Test Instruments: RSI # 75, 80,391, 708,501,502,503			Test Code <b>RE</b>	
							Technician	
				Frequency Range: 30MHz – 1000MHz			Engineer	
	Temperature: 81.9°F Humidity: 24%			Additional Info:			Test Spec: FCC Part15, Class A Unintentional Radiators	
<b>Radiated</b> Distance: 3 meter Antenna: Bicon / Log			<input checked="" type="checkbox"/> HORIZ. <input type="checkbox"/> BB <input type="checkbox"/> NB <input checked="" type="checkbox"/> VERT. <input type="checkbox"/> H <input type="checkbox"/> E		<b>Conducted</b> Line: Function:			<input type="checkbox"/> BB <input type="checkbox"/> NB
<b>FREQ.</b>	<b>IND. Level</b>	<b>Correction Factors</b>		<b>Final Level</b>	<b>Antenna Height</b>	<b>EUT Azimuth</b>	<b>Remarks</b>	
		<b>ANT.</b>	<b>Cable loss</b>					
<b>MHz</b>	<b>dB<math>\mu</math>V</b>	<b>dB</b>	<b>dB</b>	<b>dB<math>\mu</math>V/m</b>	<b>Meters</b>	<b>Degree</b>		
30.0	2.1	12.9	0.8	15.8	1.0	0.0	Vertical/Bicon	
80.0	11.3	7.6	1.5	20.4	1.0	0.0		
120.0	5.1	11.2	1.9	18.1	1.0	0.0		
142.8	4.0	12.2	2.0	18.2	1.0	0.0		
200.0	2.0	14.1	2.3	18.4	1.0	0.0		
200.0	-1.7	11.0	2.3	11.6	1.0	0.0	Vertical/LogP.	
500.0	-1.6	17.9	3.0	15.6	1.0	0.0		
700.0	-1.6	21.5	4.7	25.8	1.0	0.0		
1000.0	-0.2	24.2	5.8	29.8	1.0	0.0		
30.0	1.8	13.9	0.8	16.5	1.00	0.0	Horiz./Bicon	
80.0	2.5	8.3	1.5	12.1	1.00	0.0		
120.0	1.4	10.9	1.9	14.2	1.00	0.0		
200.0	4.4	14.0	2.3	20.7	1.00	0.0		
200.0	-1.6	11.2	2.3	11.9	1.00	0.0	Horiz./LogP.	
500.0	-1.6	18.2	4.0	20.6	1.00	0.0		
700.0	-0.4	21.6	4.7	25.9	1.00	0.0		
1000.0	0.2	24.2	5.8	30.2	1.00	0.0		

## IP9ECHO5

### Frequency Stability (2.1055)

Frequency stability measurements were made over the temperature range of -30C to +60C. This test was performed at Tactical Technologies Inc. which is not a certified Lab, but was allowed to perform this test due to the lack of a temperature chamber at Radiation Science Inc. The DC voltage was varied by 30% lower and 15% higher then the rated voltage (12VDC). The Frequency measurements were made using a direct 30 dBm attenuator connected to a HP5245L Frequency Counter that has its reference connected to a JK1100T Frequency Standard.

Power variations were done with a variable regulated DC power supply, the temperature chamber was a VK1108 Associates Testing Lab and the temperature measurements were monitored with a CIE306. The temperature was lowered to -30C and soaked for 1 hour and the frequency of the transmitter was recorded 15 seconds after the unit was turned ON. Then the temperature was increased to the next temperature setting and soaked for an hour.

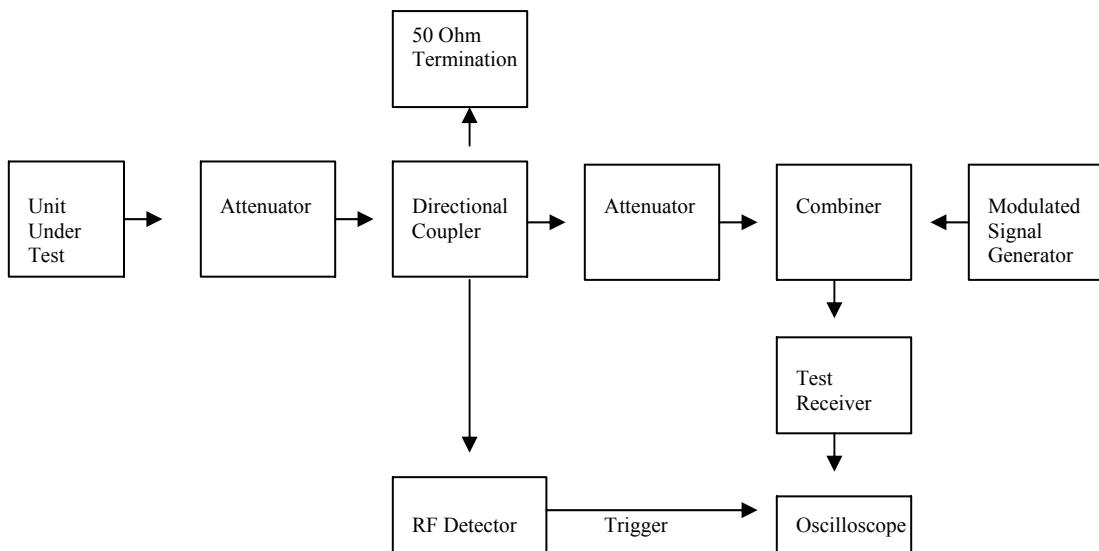
<b>Temperature</b>	<b>Frequency (Hz) @12.0V</b>
+60C	<b>169200119</b>
+50C	<b>169200110</b>
+40C	<b>169200097</b>
+30C	<b>169200083</b>
+20C	<b>169200074</b>
0C	<b>169200027</b>
-10C	<b>169199961</b>
-20C	<b>169199930</b>
-30C	<b>169199886</b>

The above results for this test was < 2.5 ppm over the temperature range of -30C to +60C.

<b>Power Supply Voltage (v)</b>	<b>Frequency (Hz)</b>
13.8	<b>169200070</b>
12.0	<b>169200077</b>
8.4	<b>169200074</b>

**BLOCK DIAGRAM**  
**FCC ID: IP9ECHO5**

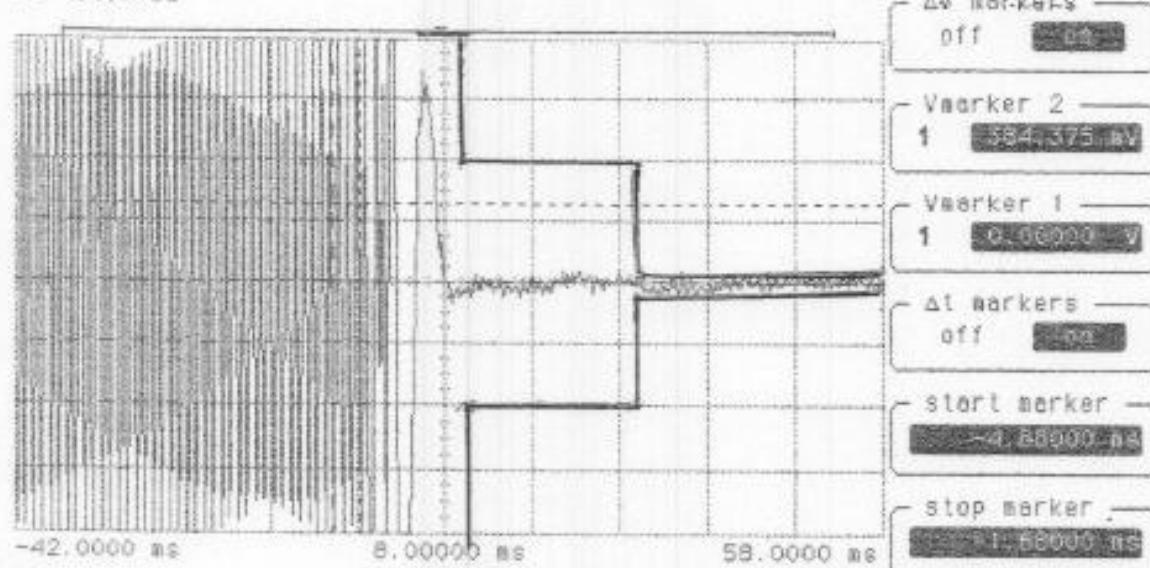
**Transient Frequency Behavior 90.214**



The unit under test (IP9ECHO5) was connected to a Directional Coupler. The two outputs from the coupler were connected to a RF Detector Diode and the other output from the coupler was combined with a 12.5kHz FM modulated test signal. The output from the combiner was connected to a test receiver, the demodulated audio from the receiver was connected to the oscilloscope input and the external trigger input on the oscilloscope was connected to the output of the RF diode detector. Power was applied to the test unit from a power supply, and the unit was turned OFF/ON manually with a test lead applied to the positive terminal of the power supply.

Three time periods were captured on the storage oscilloscope and recorded. The two pictures below (Figure 5) show the turn on and turn off points and the related frequency displacement. The t1 and t2 mask limits are superimposed on the TOP photograph (ON to OFF), and the t3 mask limit is superimposed on the BOTTOM photograph (OFF to ON).

Ac stopped



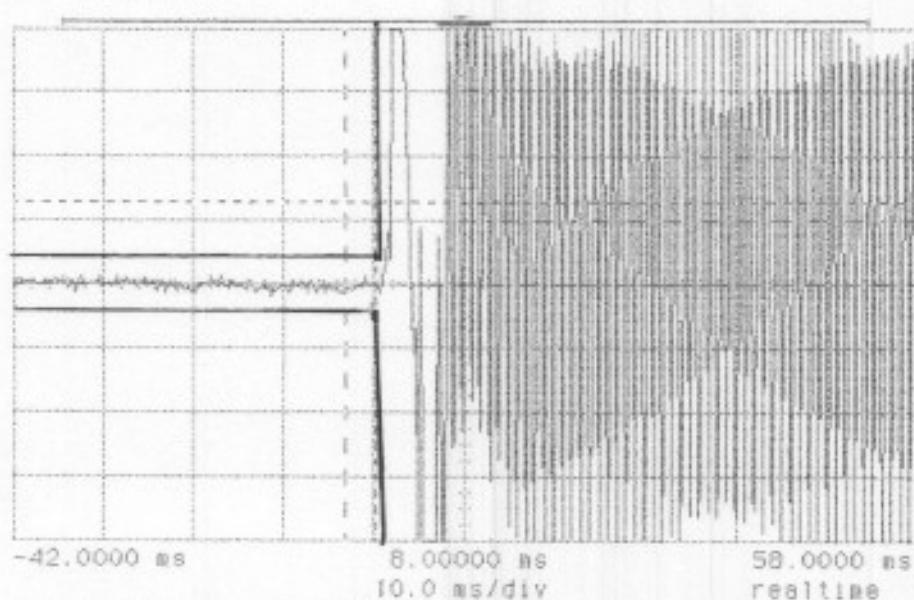
Vmarker2(1) 384.375mV stop marker: -1.68000ms  
Vmarker1(1) 0.00000 V start marker: -4.88000ms  
delta V(1) 384.375mV delta t: 3.20000ms  
1/delta t: 312.500 Hz

Channel 1	Sensitivity	Offset	Probe	Coupling	Impedance
Channel 1	300 mV/div	0.00000 V	1:1	ac	1M ohm

Trigger Mode: Edge  
On the Positive Edge of Channel 1  
Trigger Level(s)  
Channel 1 = 2.00000 V (noise reject OFF)  
HoldOff = 320.000 ms

OFF to ON

Ap stopped



ΔV markers off  on  
Vmarker 2 1 384.375mV  
Vmarker 1 1 0.00000 V  
Δt markers off  on  
start marker -5.00000 ns  
stop marker -1.68000 ns

Vmarker2(1) 384.375mV stop marker: -1.68000ns  
Vmarker1(1) 0.00000 V start marker: -5.00000ns  
delta V(1) 384.375mV delta t: 3.32000ns  
1/delta t: 301.205 Hz

	Sensitivity	Offset	Probe	Coupling	Impedance
Channel 1	300 mV/div	0.00000 V	1:1	ac	1M ohm

Trigger Mode: Edge  
On the Positive Edge of Channel 1  
Trigger Level(s)  
Channel 1 = 2.00000 V (noise reject OFF)  
HoldOff = 320.000 ms

On to OFF

**RSI**  
**INV**

<b>#</b>	<b>DESCR</b>	<b>MANUFACTURER</b>	<b>MODEL #</b>	<b>SERIAL #</b>
02	PRE_AMPLIFIER	C.M.T.	LF51104N	114
32.1	SPEC. ANALY.	H.P.	8566B	3638A08767
33.1	SPEC. ANALY. DISPLAY	H.P.		3701A22258
75	ANTENNA	TENSOR	4108	204
80	ANTENNA	AMP.RES.Assoc.	AT1000	4094-025
200	GEN, SIGNAL	H.P.	8656B	2542A03013
281	DMM	FLUKE	25	5450037
298	SCOPE, DIG.	H.P.	54510A	3209A02622
356	P/S	SORENSEN	QRD15-2	NSN
391	RECEIVER	R & S	ESVP	861744/015
501	MINI MAST	EMCO	2075-2	0002-2278
502	TURNTABLE	EMCO	2065-1.21	0001-2156
503	CONTROLLER	EMCO	2090	0001-1489
708	40ft Cable RG-223	PASTERNACK	BNC TO BNC	N/A

(If CAL DUE DATE = Blank Field, then no calibration is required for this item)