EMISSIONS TEST REPORT

Report Number: 3147251BOX-005e
Project Number: 3147251

Testing performed on the

Wireless Relay

Model: FA-04

To

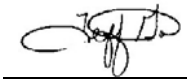
CFR47 "Telecommunications"
FCC Part 15 Subpart C "Unintentional Radiators" 15.225

For

Freelinc

Test Performed by:	Test Authorized by:
Intertek – ETL SEMKO	Freelinc
70 Codman Hill Road	266 West Center Street
Boxborough, MA 01719	Orem, UT 84057

Prepared by:  Date: 07/09/2008
Nicholas Abbondante

Reviewed by:  for: Date: 07/10/08
Michael F. Murphy

1.0 Job Description

1.1 Client Information

This EUT has been tested at the request of:

Company:	Freelinc 266 West Center Street Orem, UT 84057
Contact:	Mr. Michael Wheeler
Telephone:	801-494-3995
Fax:	N/A
Email:	mwheeler@freelinc.com

1.2 Equipment Under Test

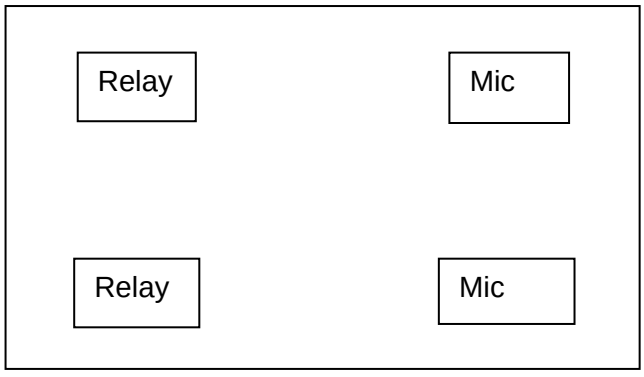
Equipment Type:	Wireless Relay
Model Number(s):	FA-04
Serial number(s):	A, B
Manufacturer:	Freelinc
EUT receive date:	03/07/2008
EUT received condition:	Prototypes in Good Condition
Test start date:	04/17/2008
Test end date:	07/09/2008

1.3 Test Plan Reference: Tested according to the guidelines of ANSI C63.4:2003 and the standards listed.

1.4 Test Configuration

1.4.1 Block Diagram

The EUT set must be in the proximity of another EUT set in order to trigger transmission at 13.956 MHz in addition to the normal 13.56 MHz transmission. The Mic and Relay must be ~1.1 meters apart maximum, and the two systems must be ~0.5 meters apart.



Turntable

1.4.2. Cables:

Cable	Shielding	Connector	Length (m)	Qty.
None				

1.4.3. Support Equipment:

Name: Freemic
Model No.: FMC-200
Serial No.: A, B

1.5 Mode(s) of Operation:

The EUT was activated from a fresh, 9 Volt battery in transmit mode and was transmitting repetitively on both channels, 13.56 MHz and 13.956 MHz, throughout testing. In order for the EUT to operate at 13.956 MHz, two EUTs were placed in proximity with each other. The EUT software disables transmission while in charge mode, so this mode was not tested to the transmitter requirements. The EUT was manipulated in three orthogonal axes.

2.0 Test Summary

TEST STANDARD	RESULTS	
CFR47 Telecommunications FCC Part 15 Subpart C 15.225		
SUB-TEST	**TEST PARAMETER**	**COMMENT**
Radiated Fundamental Field Strength and Spurious Emissions FCC 15.205, 15.209, 15.225	The field strength of emissions must not exceed the limits of 15.209 and 15.225.	Pass
Frequency Stability FCC 15.225	The frequency tolerance of the 13.56 MHz fundamental must not deviate by more than 0.01% (100 ppm) over a temperature range from -20 to +50 degrees Celsius.	Pass

REVISION SUMMARY – The following changes have been made to this Report:

Date	Project No.	Project Handler	Page(s)	Item	Description of Change

3.0 Sample Calculations

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

Level in μV/m = [10(32 dBμV/m)/20] = 39.8 μV/m

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBμV
RF = Reading from receiver in dBμV
LF = LISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV

Example:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBμV
$UF = 10^{(48.1\ dB\mu V / 20)}$ = 254 μV/m

3.1 Measurement Uncertainty

Compliance of the product is based on the measured value. However, the measurement uncertainty is included for informational purposes.
The expanded uncertainty (k = 2) for radiated emissions from 30 to 1000 MHz has been determined to be:

±3.5 dB at 10m, ±3.8 dB at 3m

The expanded uncertainty (k = 2) for mains conducted emissions from 150 kHz to 30 MHz has been determined to be:

±2.6 dB

The expanded uncertainty (k = 2) for telecom port conducted emissions from 150 kHz to 30 MHz has been determined to be:

±3.2 for ISN and voltage probe measurements
±3.1 for current probe measurements

3.2 Site Description

Test Site(s): 2 and Littleton

Our OATS are 3m and 10m sheltered emissions measurement ranges located in a light commercial environment in Boxborough, Massachusetts. They meet the technical requirements of ANSI C63.4-2003 and CISPR 22:1993/EN 55022:1994 for radiated and conducted emission measurements. The shelter structure is entirely fiberglass and plastic, with outside dimensions of 33 ft x 57 ft. The structure resembles a quonset hut with a center ceiling height of 16.5 ft.

The testing floor is covered by a galvanized sheet metal groundplane that is earth-grounded via copper rods around the perimeter of the site. The joints between individual metal sheets are bridged with a 2 inch wide metal strips to provide low RF impedance contact throughout. The sheets are screwed in place with stainless steel, round-head screws every three inches. Site illumination and HVAC are provided from beneath the ground reference plane through flush entry ports, the port covers are electrically bonded to the ground plane.

A flush metal turntable with 12 ft. diameter and 5000 lb. load capacity (12,000 lb. in Site 3) is provided for floor-standing equipment. A wooden table 80 cm high is used for table-top equipment. The turntable is electrically connected to the ground plane with three copper straps. The straps are connected to the turntable at the center of it with ground braid. The copper strap is directly connected to the groundplane at the edges of the turntable. The turntable is located on the south end of the structure and the antennas are mounted 3 and 10 meters away to the north. The antenna mast is a non-conductive with remote control of antenna height and polarization. The antenna height is adjustable from 1 to 4 meters.

All final radiated emission measurements are performed with the testing personnel and measurement equipment located below the ground reference plane. The site has a full basement underneath the turntable where support equipment may be remotely located. Operation of the antenna, turntable and equipment under test is controlled by remote controls that manipulate the antenna height and polarization and with a turntable control. Test personnel are located below the ellipse when measurements are performed, however the site maintains the ability of having personnel manipulate cables while monitoring test equipment. Ambient radiated emissions are 6 dB or more below the relevant FCC emission limits.

AC mains power is brought to the equipment under test through a power line filter, to remove ambient conducted noise. 50 Hz (240 VAC single phase), 60 Hz power (120 VAC single phase, 208 VAC three phase), and 60 Hz (480 VAC three phase) are available. Conducted emission measurements are performed with a Line Impedance Stabilization Network (LISN) or Artificial Mains Network (AMN) bonded to the ground reference plane. A removable vertical groundplane (2 meter X 2 meter area) is used for line-conducted measurements for table top equipment. The vertical groundplane is electrically connected to the reference groundplane.

The EMC Lab has two Semi-anechoic Chambers and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference groundplanes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

Test Results: Pass

Test Standard: FCC Part 15 Subpart C

Test: Radiated Fundamental Field Strength and Spurious Emissions

Performance Criterion: The field strength of any emissions must not exceed the limits of 15.209 and 15.225:

Frequency Range (MHz)	Field Strength at 30m (dBuV/m)	Field Strength at 3m (dBuV/m)
13.553-13.567	84	124
13.410-13.553 and 13.567-13.710	50.5	90.5
13.110-13.410 and 13.710-14.010	40.5	80.5
1.705-30	29.5	69.5
30-88	-	40
88-216	-	43.5
216-960	-	46
Above 960	-	54

Test Environment:

Environmental Conditions During Testing:		Ambient (°C):	23	Humidity (%):	24	Pressure (hPa):	2008
Pretest Verification Performed		Yes		Equipment under Test:		Wireless Relay	
Test Engineer(s):	Nicholas Abbondante			EUT Serial Number:		A, B	

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	**Equipment Type**	**Make**	**Model No.**	**Serial No.**	**Next Cal. Due**
1	Digital 4 Line Barometer	Mannix	0ABA116	BAR2	05/20/2008
2	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	01/25/2009
3	ANTENNA	EMCO	3142	9711-1225	06/05/2008
4	3 Meter In floor cable for site 2	ITS	RG214B/U	S2 3M FLR	09/17/2008
5	LOOP ANTENNA	Empire	LP-105	905	09/21/2008

Software Utilized:

Name	Manufacturer	Version
EXCEL 2000	Microsoft Corporation	9.0.6926 SP-3
EMI BOXBOROUGH	Intertek	3/07/07 Revision

Test Results:

Special Radiated Emissions

Company: Freelinc
Model #: FA-04
Serial #: A, B
Engineers: Nicholas Abbondante
Project #: 3147251
Standard: FCC Part 15 Subpart C 15.225
Receiver: R&S ESCI (ROS002)
PreAmp: NONE.

Location: Site 2
Date(s): 04/17/08
Limit Distance (m): 3
Test Distance (m): 3

Antenna & Cables: LF Bands: N, LF, HF, SHF
Antenna: Loop2_E-Field_09-21-08.txt Loop2_H-Field_09-21-08.txt
Cable(s): S2 3M FLR 9-17-08.txt NONE.
Barometer: BAR2
Temp/Humidity/Pressure: 23c 24% 1050mB

PreAmp Used? (Y or N): N
Voltage/Frequency: Fresh 9V Battery
Frequency Range: 13.56-30 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	
QP	V	13.559	13.4	41.1	0.4	0.0	0.0	54.9	124.0	-69.1	9/30 kHz	FCC
QP	V	13.552	9.0	41.1	0.4	0.0	0.0	50.5	90.5	-40.0	9/30 kHz	
QP	V	13.568	4.4	41.1	0.4	0.0	0.0	45.9	90.5	-44.6	9/30 kHz	
QP	V	13.509	10.8	41.1	0.4	0.0	0.0	52.3	90.5	-38.2	9/30 kHz	
QP	V	13.610	14.3	41.1	0.4	0.0	0.0	55.8	90.5	-34.7	9/30 kHz	
QP	V	13.458	-3.1	41.1	0.4	0.0	0.0	38.4	90.5	-52.1	9/30 kHz	
QP	V	13.662	2.8	41.1	0.4	0.0	0.0	44.3	90.5	-46.2	9/30 kHz	
QP	V	13.409	-17.4	41.1	0.4	0.0	0.0	24.1	80.5	-56.4	9/30 kHz	RB
QP	V	13.711	-13.2	41.1	0.4	0.0	0.0	28.3	80.5	-52.2	9/30 kHz	
QP	V	27.120	-16.9	39.6	0.6	0.0	0.0	23.3	69.5	-46.2	9/30 kHz	
QP	V	13.908	16.0	41.1	0.4	0.0	0.0	57.5	80.5	-23.0	9/30 kHz	
QP	V	13.956	15.2	41.1	0.4	0.0	0.0	56.7	80.5	-23.8	9/30 kHz	
QP	V	14.011	12.8	41.1	0.4	0.0	0.0	54.3	69.5	-15.2	9/30 kHz	
QP	V	27.912	-16.7	39.4	0.6	0.0	0.0	23.3	69.5	-46.2	9/30 kHz	

Special Radiated Emissions

Company: Freelinc
Model #: FA-04
Serial #: A, B
Engineers: Nicholas Abbondante
Project #: 3147251
Standard: FCC Part 15 Subpart C 15.225
Receiver: R&S ESCI (ROS002)
PreAmp: NONE.

Location: Site 2
Date(s): 04/17/08
Limit Distance (m): 3
Test Distance (m): 3

Antenna & Cables: N
Antenna: LOG4 06-05-08 V3.txt
Cable(s): S2 3M FLR 9-17-08.txt
Barometer: BAR2

Bands: N, LF, HF, SHF
LOG4 06-05-08 H3.txt
NONE.

Temp/Humidity/Pressure: 23c 24% 1050mB

PreAmp Used? (Y or N): N
Voltage/Frequency: Fresh 9V Battery
Frequency Range: 30-1000 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth	FCC
QP	V	40.680	13.4	11.4	0.7	0.0	0.0	25.5	40.0	-14.5	120/300 kHz	
QP	V	41.868	11.8	11.0	0.7	0.0	0.0	23.6	40.0	-16.4	120/300 kHz	
QP	V	54.032	14.1	8.9	0.9	0.0	0.0	23.9	40.0	-16.1	120/300 kHz	
QP	V	108.876	13.9	8.1	1.3	0.0	0.0	23.3	43.5	-20.2	120/300 kHz	RB
QP	V	111.273	8.7	7.9	1.3	0.0	0.0	17.9	43.5	-25.6	120/300 kHz	RB
QP	V	112.092	7.9	7.9	1.3	0.0	0.0	17.0	43.5	-26.5	120/300 kHz	RB
QP	V	121.580	10.5	6.9	1.4	0.0	0.0	18.7	43.5	-24.8	120/300 kHz	RB
QP	V	122.500	11.5	6.8	1.4	0.0	0.0	19.7	43.5	-23.8	120/300 kHz	
QP	V	125.176	16.8	6.7	1.4	0.0	0.0	24.9	43.5	-18.6	120/300 kHz	RB
QP	V	126.088	16.3	6.7	1.4	0.0	0.0	24.4	43.5	-19.1	120/300 kHz	RB
QP	V	135.084	18.5	6.9	1.4	0.0	0.0	26.8	43.5	-16.7	120/300 kHz	RB
QP	V	136.100	16.9	6.9	1.4	0.0	0.0	25.3	43.5	-18.2	120/300 kHz	RB
QP	V	139.092	14.1	7.1	1.4	0.0	0.0	22.7	43.5	-20.8	120/300 kHz	
QP	V	140.092	14.0	7.2	1.4	0.0	0.0	22.6	43.5	-20.9	120/300 kHz	
QP	V	148.576	13.6	8.1	1.5	0.0	0.0	23.2	43.5	-20.3	120/300 kHz	
QP	V	149.726	14.3	8.2	1.5	0.0	0.0	24.0	43.5	-19.5	120/300 kHz	
QP	V	152.990	20.3	8.3	1.6	0.0	0.0	30.2	43.5	-13.3	120/300 kHz	
QP	V	154.110	20.2	8.4	1.6	0.0	0.0	30.1	43.5	-13.4	120/300 kHz	
QP	V	166.890	20.2	8.5	1.6	0.0	0.0	30.3	43.5	-13.2	120/300 kHz	RB
QP	V	168.121	20.2	8.5	1.6	0.0	0.0	30.3	43.5	-13.2	120/300 kHz	RB
QP	H	180.810	23.5	9.8	1.7	0.0	0.0	35.0	43.5	-8.5	120/300 kHz	
QP	H	182.140	21.3	9.9	1.7	0.0	0.0	32.9	43.5	-10.6	120/300 kHz	
QP	H	189.120	9.9	10.2	1.7	0.0	0.0	21.9	43.5	-21.6	120/300 kHz	
QP	H	190.548	11.7	10.3	1.8	0.0	0.0	23.7	43.5	-19.8	120/300 kHz	
QP	H	194.717	10.2	10.3	1.8	0.0	0.0	22.2	43.5	-21.3	120/300 kHz	
QP	H	196.144	10.0	10.3	1.8	0.0	0.0	22.0	43.5	-21.5	120/300 kHz	
QP	H	202.585	8.5	10.4	1.9	0.0	0.0	20.7	43.5	-22.8	120/300 kHz	
QP	H	204.160	15.9	10.5	1.9	0.0	0.0	28.3	43.5	-15.2	120/300 kHz	
QP	H	208.610	8.3	10.7	1.9	0.0	0.0	20.8	43.5	-22.7	120/300 kHz	
QP	H	216.120	6.1	11.0	1.9	0.0	0.0	19.1	46.0	-26.9	120/300 kHz	
QP	H	217.775	4.9	11.1	1.9	0.0	0.0	18.0	46.0	-28.0	120/300 kHz	
QP	H	222.529	8.7	11.4	1.9	0.0	0.0	22.0	46.0	-24.0	120/300 kHz	
QP	H	224.163	8.4	11.4	1.9	0.0	0.0	21.7	46.0	-24.3	120/300 kHz	
QP	H	236.416	2.1	11.9	2.0	0.0	0.0	16.0	46.0	-30.0	120/300 kHz	
QP	H	238.166	2.0	12.0	2.0	0.0	0.0	15.9	46.0	-30.1	120/300 kHz	
QP	H	243.130	2.2	12.2	2.0	0.0	0.0	16.4	46.0	-29.6	120/300 kHz	RB
QP	H	244.990	0.2	12.2	2.0	0.0	0.0	14.4	46.0	-31.6	120/300 kHz	RB
QP	H	250.342	5.1	12.4	2.0	0.0	0.0	19.5	46.0	-26.5	120/300 kHz	RB
QP	H	252.192	4.9	12.4	2.0	0.0	0.0	19.4	46.0	-26.6	120/300 kHz	RB
QP	H	258.600	4.6	12.6	2.1	0.0	0.0	19.3	46.0	-26.7	120/300 kHz	RB
QP	H	264.200	-0.6	12.7	2.1	0.0	0.0	14.2	46.0	-31.8	120/300 kHz	RB
QP	H	266.200	-0.3	12.7	2.1	0.0	0.0	14.5	46.0	-31.5	120/300 kHz	RB
QP	H	272.200	-0.7	12.8	2.1	0.0	0.0	14.2	46.0	-31.8	120/300 kHz	RB
QP	H	375.508	1.6	16.2	2.6	0.0	0.0	20.4	46.0	-25.6	120/300 kHz	
QP	H	378.194	-0.1	16.3	2.6	0.0	0.0	18.7	46.0	-27.3	120/300 kHz	
QP	H	389.428	0.7	16.3	2.6	0.0	0.0	19.6	46.0	-26.4	120/300 kHz	
QP	H	392.300	1.3	16.3	2.6	0.0	0.0	20.2	46.0	-25.8	120/300 kHz	
QP	V	396.828	2.2	15.4	2.6	0.0	0.0	20.2	46.0	-25.8	120/300 kHz	
QP	H	403.300	4.8	16.4	2.6	0.0	0.0	23.8	46.0	-22.2	120/300 kHz	RB
QP	H	406.300	5.1	16.4	2.6	0.0	0.0	24.1	46.0	-21.9	120/300 kHz	RB
QP	H	420.304	6.6	16.3	2.7	0.0	0.0	25.7	46.0	-20.3	120/300 kHz	
QP	H	421.888	1.6	16.3	2.8	0.0	0.0	20.7	46.0	-25.3	120/300 kHz	
QP	H	431.162	8.9	16.5	2.8	0.0	0.0	28.2	46.0	-17.8	120/300 kHz	
QP	H	434.300	8.7	16.6	2.8	0.0	0.0	28.2	46.0	-17.8	120/300 kHz	
QP	H	445.042	9.4	17.0	2.9	0.0	0.0	29.3	46.0	-16.7	120/300 kHz	
QP	H	448.322	9.5	17.1	2.9	0.0	0.0	29.5	46.0	-16.5	120/300 kHz	
QP	H	459.242	3.5	17.5	2.9	0.0	0.0	23.8	46.0	-22.2	120/300 kHz	
QP	H	462.700	2.5	17.6	2.9	0.0	0.0	22.9	46.0	-23.1	120/300 kHz	
QP	H	472.868	2.6	17.9	2.9	0.0	0.0	23.4	46.0	-22.6	120/300 kHz	
QP	H	476.348	1.0	18.0	2.9	0.0	0.0	21.9	46.0	-24.1	120/300 kHz	
QP	H	486.766	2.7	18.0	3.0	0.0	0.0	23.6	46.0	-22.4	120/300 kHz	
QP	H	490.362	4.0	18.0	3.0	0.0	0.0	25.0	46.0	-21.0	120/300 kHz	

Radiated Emissions Setup Photos

Radiated Emissions Setup Photos

Radiated Emissions Setup Photos

Radiated Emissions Setup Photos

Test Results: Pass

Test Standard: FCC Part 15 Subpart C 15.225

Test: Frequency Stability

Performance Criterion: The frequency tolerance of the 13.56 MHz fundamental must not deviate by more than 0.01% (100 ppm) over a temperature range from -20 to +50 degrees Celsius.

Test Environment:

Environmental Conditions During Testing:		Ambient (°C):	N/A	Humidity (%):	N/A	Pressure (hPa):	N/A
Pretest Verification Performed		Yes		Equipment under Test:		Wireless Relay	
Test Engineer(s):	Nicholas Abbondante			EUT Serial Number:		A	

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	**Equipment Type**	**Make**	**Model No.**	**Serial No.**	**Next Cal. Due**
1	Spectrum Analyzer	Hewlett Packard	8591E	3308A01445	02/15/2009
2	LOOP ANTENNA	Empire	LP-105	905	09/21/2008
3	Temp/Humidity Chamber	Envirotronics	SH27C	08015563S11 263	03/18/2009

Software Utilized:

Name	Manufacturer	Version
EXCEL 2000	Microsoft Corporation	9.0.6926 SP-3
EMI BOXBOROUGH	Intertek	3/07/07 Revision

Test Details:

Frequency Stability

Company: Freelinc
Model #: FA-04
Serial #: A
Engineer(s): Nicholas Abbondante
Project #: 3147251
Standard: FCC Part 15 Subpart C 15.225

Date(s): 07/09/08
Location: Littleton

Limit: 100 PPM

Nominal f: 13.56 MHz

Test Equipment Used:
SA0001 LOOP2 148012

Voltage: 9 VDC Fresh Battery

Temp Celsius	Frequency MHz	Deviation kHz	Limit kHz
-20	13.558750	0.25	1.36
-10	13.558630	0.13	1.36
0	13.558630	0.13	1.36
10	13.558250	-0.25	1.36
20	13.558500	0	1.36
30	13.557880	-0.62	1.36
40	13.557500	-1	1.36
50	13.557250	-1.25	1.36