TEST REPORT FOR

FCC PART 15 COMPLIANCE

FOR KNOWLES ELECTRONICS, INC.

Prepared by
Daniel C. Swann
August 28, 1998

Knowles Electronics, Inc.
Model Number RF-3296

Analog Inductive Intentional Radiator

FCC Part 15.209

FCC ID N293296

GEL Report File PE9806

GLEN ELLEN LABORATORIES
1876 London Ranch Road
Glen Ellen, CA 95442

MEASUREMENT/TECHNICAL REPORT

KNOWLES ELECTRONICS, INC.

FCC ID N293296

This report concerns:	An Original Grant
Equipment type:	FCC Part 15, Subpart C, Paragraph 15.209(a) Analog Inductive Intentional Radiator, and Receiver for FCC Part 90.265, Wireless Microphone
Deferred grant requested:	no
Transition rules per 15.37:	no
Report prepared by:	Daniel C. Swann Glen Ellen Laboratories 1876 London Ranch Road Glen Ellen, CA 95442 (707) 996-8533 (707) 996-2803 fax
Report Certified By:	Daniel C. Swann

Date August 28, 1998

GEL Report File: PE9806

TABLE OF CONTENTS

1 GENERAL INFORMATION

1.1 Product Description

The Knowles Electronics, Inc. High Performance Radio Frequency Wireless Headset Model Number RF-3296 is a headset/base station combination utilizing a pulse modulated magnetic induction loop operating at 200 kHz or 400 kHz to transmit from the base station to the headset (FCC Part 15, Subpart C, Paragraph 15.209(a), intentional radiator), and a receiver for wireless microphone signals from a headset transmitter operating at 169.445 / 171.905 MHz.

The product consists of a headset, a base station, a magnetic transmit antenna connected to the base station with a non-removable shielded cable, a computer monitor sensor (to sense nearby computer display frequencies to reduce interference,) an audio cable, and a wall mount power supply to power the base station.

The base station provides a 7 mA charger position for the headset when the EUT is not in use.

All plastic parts in the base station are un-plated.

1.2 Related Submittal or Grant

There are no related submittals or grants.

1.3 Tested System Details

EUT

Knowles Electronics, Inc. Model Number RF-3296.

Made by:

Knowles Electronics, Inc.
2800 West Golf Road
Rolling Meadows, IL 60143

See the Block Diagram/Operational Description for more information.

1.4 Test Methodology

The conducted and radiated tests were performed in accordance with the ANSI C63.4-1992 standard. See Figure 3.1 and the photographs for details of the test setup. The base station unit was tested with a laptop computer, a serial device (mouse) and a parallel device (printer.)

1.5 Test Facility

The Glen Ellen Laboratories open area test site and conducted measurement facility is located in Glen Ellen, California, at the street address of 1876 London Ranch Road. This site has been fully described in a report dated September 16, 1996, submitted to the FCC, and accepted in a letter dated December 4, 1996 (31040/SIT/1300F2.)

Test equipment used was:

1. Hewlett Packard 8560A opt 002 spectrum analyzer, cal due 6-06-99.

2. Sonoma Instruments 330 opt 38 preamplifier, 10 kHz to 2.5 GHz, cal due 3-06-99.

3. GEL BIC9414 biconical antenna, 30 MHz to 300 MHz, cal due 6-13-99.

4. GEL LPA-3 log periodic antenna, 275 MHz to 2 GHz, cal due 6-13-99.

5. GEL ML9411 passive magnetic loop antenna, 10 kHz to 30 MHz, cal due 2-22-99.

6. EMCO LISN, model number 3825/2, cal due 4-25-99.

7. EMCO LISN, model number 3825/2, cal due 7-29-99.

2 PRODUCT LABELING AND MANUAL STATEMENTS

2.1 Product Labeling

The following appears on the label:

Note: FCC Rules Part 15, Subpart A, 15.19(a)(1). This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

2.2 FCC Statement in User Manual

The following statements appear in a prominent location in the text of the user manual:

Note: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesirable operation.

3 SYSTEM TEST CONFIGURATION

3.1 Justification

The EUT was tested in accordance with the standard ANSI C63.4-1992, 47 CFR Part 15, Subpart C, and 47 CFR Part 90.265. The base station magnetic transmitter was tested at the two available transmit frequencies, 200 kHz and 400 kHz, changed by moving a jumper on the magnetic transmitter board.

The base station receiver was tested at the lowest frequency available for Part 90.265 wireless microphones, 169.445 MHz, and the highest frequency available, 171.905 MHz. These frequencies correspond to a LO frequency of 158.745 MHz, and of 161.205 MHz, respectively. The receiver frequency was changed by changing the crystal in the unit.

3.2 EUT Exercise Equipment and Software

The base station was tested with the following system:

Laptop computer: Dell Inspiron 3200 D266XT, Model Number TS30H, SN 8240246BY49147A, with a Dell Power Supply, Model Number PA-3, SN P3818108931T, with unshielded cable.

Serial mouse: Logitech Mouse, Model Number M-M28-9F, SN LCA44812450, FCC ID DZL210365, with shielded cable.

Parallel Port Printer: Hewlett Packard Deskjet 500 printer, Model Number C2106A, Serial Number 3328S04462, FCC ID B94C2106X, with shielded parallel printer cable.

3.3 Special Accessories

No special accessories were used.

3.4 Equipment Modifications

Two 22 pF capacitors were added on the base station receiver PC board to bypass the ground plane cutout at high frequencies. Two Fair-Rite bead-on-lead ferrites were loaded on the base station receiver board at the power input connector, in existing plated through holes. Four 5.6 nF caps were added to the base station magnetic transmitter output transistors.

3.5 Configuration of Tested System

The base station was configured with the back of the base station at the rear of the tabletop, to the right of the laptop computer, the induction loop laid out on the right side of the base station, and the monitor sense cable laid out on the right side. The serial device was placed in front of the laptop computer, and the printer was placed to the left of the laptop computer. The audio cable was connected to the audio input of the laptop computer.

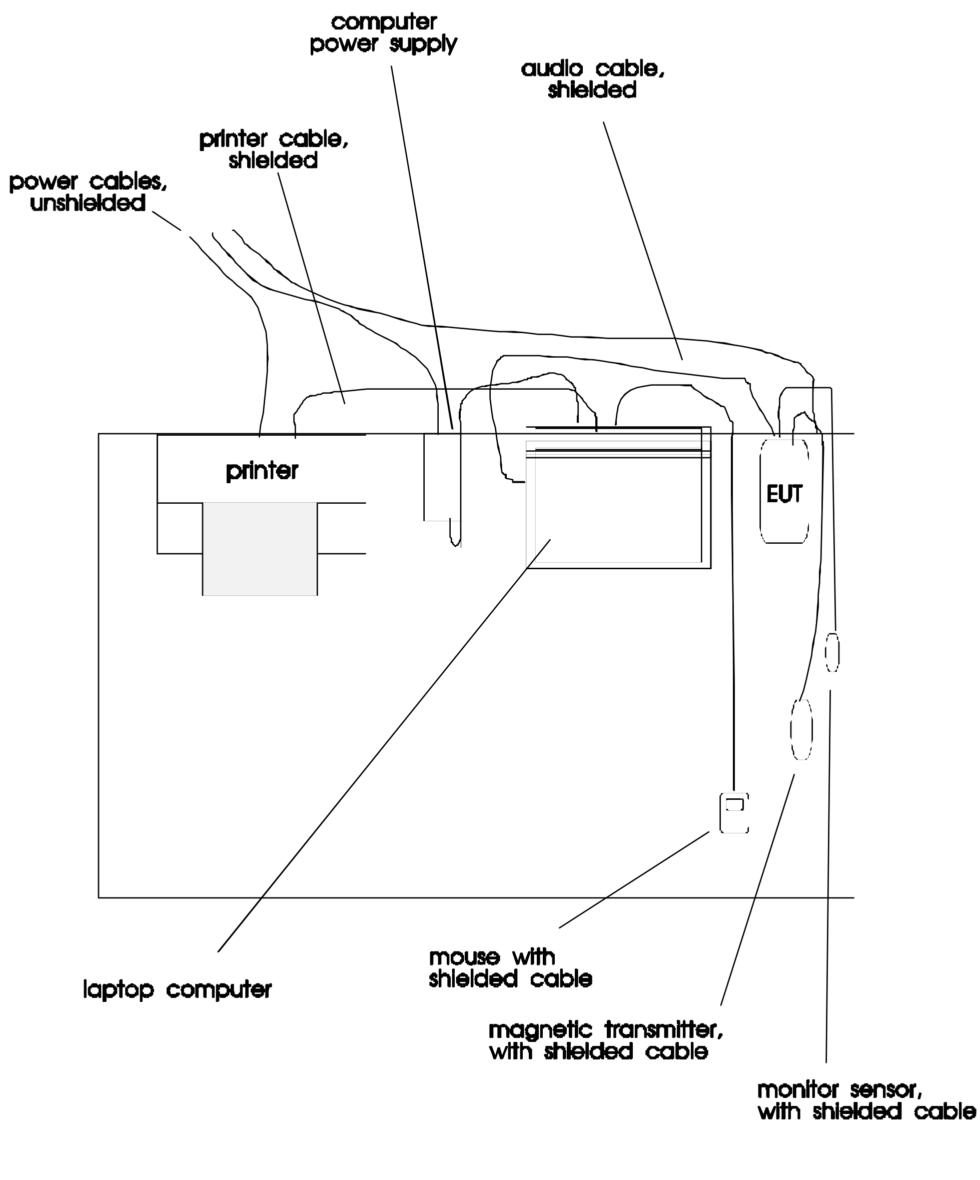
The radiated test site tabletop and turntable were rotated 360 degrees, and the antenna height was scanned from 1 meter to 4 meters height, 3 meters spacing, in both vertical and horizontal polarization. The magnetic loop tests were performed with the loop rotated between 0 and 180 degrees, at 1 meter height, 10 meters spacing, and the tabletop rotated 360 degrees.

This condition put the EUT in the highest emissions state.

See Figure 3.1 and the photographs for the configuration of the tested system.

3 SYSTEM TEST CONFIGURATION (continued)

Figure 3.1 Configuration of Tested System, Base Station



4 CONDUCTED EMISSIONS DATA

The following data lists the significant emissions frequencies, measured quasi-peak levels and FCC Class B margins, of the base station using 9 KHz RBW at 6 dB. These measurements were made on August 28, 1998, by Daniel Swann and Roger Davis.

Frequency MHz	Measured Amplitude dBuV	Corrected Measured Amplitude dBuV	FCC B Limit dBuV	FCC B Margin dB
Line				
0.451	28.6	38.6	48.0	-9.4
0.500	28.8	38.8	48.0	-9.2
0.600	32.7	42.7	48.0	-5.3
1.000	30.7	40.8	48.0	-7.2
1.400	28.5	38.6	48.0	-9.4
3.100	23.8	34.0	48.0	-14.0
8.000	25.6	36.0	48.0	-12.0
14.714	28.5	39.1	48.0	-8.9
15.032	29.7	40.3	48.0	-7.7
15.353	30.5	41.1	48.0	-6.9
Neutral				
0.451	27.7	37.7	48.0	-10.3
0.600	25.2	35.2	48.0	-12.8
0.800	26.0	36.0	48.0	-12.0
1.000	24.2	34.3	48.0	-13.7
1.400	21.3	31.4	48.0	-16.6
15.535	25.5	36.1	48.0	-11.9
15.739	27.1	37.7	48.0	-10.3
16.488	25.5	36.2	48.0	-11.8

Test Personnel:

Tester Name Daniel C. Swann

5 RADIATED EMISSIONS DATA

5.1 Intentional Radiated Emissions, Base Station

The following data lists the intentional emissions frequencies, measured levels and FCC Part 15.209 limits for measurements made on July 6, 1998, by Daniel Swann and Roger Davis.

The FCC Part 15.209 limit is calculated from the formulas:

Limit (.009 to 490 kHz) = 2400/F(kHz) microVolts/meter, at 300 meters distance.
Limit (490 to 1705 kHz) = 24000/F(kHz) microVolts/meter, at 30 meters distance.
Limit (1.705 to 30 MHz) = 30 microVolts/meter, at 30 meters distance.

Converting the Limit to dBuV/meter yields:

Limit (.009 to 490 kHz) = 20*LOG(2400/F(kHz)) dBuV/m, at 300 meters distance.
Limit (490 to 1705 kHz) = 20*LOG(24000/F(kHz)) dBuV/m, at 30 meters distance.
Limit (1.705 to 30 MHz) = 20*LOG(30) dBuV/m, at 30 meters distance.

At other measurement distances, , in accordance with 47CFR15.31(f), item 2, below 30 MHz, the limit can be scaled by using the square of an inverse linear distance extrapolation factor (40 dB/decade)

Limit (distance d meters) = Limit (specified distance) + 40*LOG(specified distance) /d meters).

5.1 Intentional Radiated Emissions, Base Station (continued)

The following data was taken using an average detector below 490 kHz, and quasi-peak detector above 490 kHz. The EUT to antenna spacing was 10 meters. The turntable was rotated 360 degrees, and the magnetic loop receive antenna was rotated 180 degrees to maximize the signal for each measurement. These measurements were made on August 28, 1998, by Daniel Swann and Roger Davis.

200 kHz transmit frequency

Frequency MHz	Measured Amplitude dBuV	Antenna Factor dB/m	Cable Loss dB	Amplifier Gain dB	Field Strength dBuV/m	15.209 10m Average Limit	15.209 10m Margin dB
0.2000	51.8	61.3	0.0	38.5	74.6	80.7	-6.1
0.4000	36.8	55.6	0.0	38.5	53.9	74.6	-20.7
0.6000	32.1	52.3	0.0	38.5	45.9	51.1	-5.3
0.8000	27.0	49.9	0.0	38.5	38.4	48.6	-10.2
1.0002	33.6	48.1	0.0	38.5	43.1	46.7	-3.5
1.2002	30.2	46.6	0.0	38.5	38.3	45.1	-6.9
1.4002	27.3	45.3	0.0	38.5	34.1	43.8	-9.7

400 kHz transmit frequency

Frequency MHz	Measured Amplitude dBuV	Antenna Factor dB/m	Cable Loss dB	Amplifier Gain dB	Field Strength dBuV/m	15.209 10m Average Limit	15.209 10m Margin dB
0.4000	52.1	55.6	0.0	38.5	69.2	74.6	-5.4
0.8003	30.9	49.9	0.0	38.5	42.3	48.6	-6.3
1.2001	33.2	46.6	0.0	38.5	41.2	45.1	-3.9
1.9999	27.2	42.8	0.0	38.5	31.4	40.7	-9.2
1.6000	29.6	44.2	0.0	38.5	35.2	42.6	-7.4

Test Personnel:

Tester Name Daniel C. Swann

5 RADIATED EMISSIONS DATA (continued)

5.2 Unintentional Radiated Emissions, Base Station

The following data lists the significant emissions frequencies, measured quasi-peak averaged levels and FCC Class B margins. The spectrum analyzer RBW was 120 KHz at 6 dB. These measurements were made on August 28, 1998, by Daniel Swann and Roger Davis. The emissions were measured with the receiver LO for the lowest available frequency for Part 90.265 wireless microphones, 169.445 MHz, and the highest frequency available, 171.905 MHz, corresponding to a LO frequency of 158.745 MHz, and of 161.205 MHz, respectively.

Receive freq 171.905, IF freq 10.7

Frequency MHz	Measured Amplitude dBuV	Antenna Factor dB/m	Cable Loss dB	Amplifier Gain dB	Field Strength dBuV/m	FCC B 3 m Limit dBuV/m	FCC B 3 m Margin dB
Vertical Polarization							
33.018	55.1	16.6	1.4	38.5	34.6	40.0	-5.4
66.414	65.2	7.3	2.0	38.5	36.0	40.0	-4.0
132.855	52.8	13.9	2.7	38.5	31.0	43.5	-12.5
161.192	50.6	15.4	3.0	38.5	30.6	43.5	-12.9
199.262	53.4	17.0	3.3	38.4	35.2	43.5	-8.3
232.492	49.0	17.2	3.6	38.5	31.3	46.0	-14.7
240.000	45.6	17.0	3.6	38.5	27.8	46.0	-18.2
265.718	53.0	18.1	3.9	38.5	36.5	46.0	-9.5
322.390	52.7	15.2	4.3	38.4	33.8	46.0	-12.2
644.800	50.5	21.0	6.1	38.4	39.1	46.0	-6.9
806.005	49.4	23.1	6.9	38.5	41.1	46.0	-4.9
Horizontal Polarization							
66.414	62.0	7.3	2.0	38.5	32.8	40.0	-7.2
132.848	52.8	13.9	2.7	38.5	31.0	43.5	-12.5
161.192	55.0	15.4	3.0	38.5	34.9	43.5	-8.6
199.262	56.0	17.0	3.3	38.4	37.8	43.5	-5.7
322.393	53.1	15.2	4.3	38.4	34.1	46.0	-11.9
644.800	51.9	21.0	6.1	38.4	40.5	46.0	-5.5
806.005	51.0	23.1	6.9	38.5	42.6	46.0	-3.4

Test Personnel:

Daniel C. Swann

Tester Name Daniel C. Swann

5.2 Unintentional Radiated Emissions, Base Station (continued)

Receive freq 169.445, IF freq 10.7

Frequency MHz	Measured Amplitude dBuV	Antenna Factor dB/m	Cable Loss dB	Amplifier Gain dB	Field Strength dBuV/m	FCC B 3 m Limit dBuV/m	FCC B 3 m Margin dB
Vertical Polarization							
32.730	55.7	17.0	1.4	38.5	35.6	40.0	-4.4
66.414	64.4	7.3	2.0	38.5	35.3	40.0	-4.7
132.828	49.8	13.9	2.7	38.5	28.0	43.5	-15.5
158.748	52.9	15.1	3.0	38.5	32.5	43.5	-11.0
199.242	54.2	17.0	3.3	38.4	36.0	43.5	-7.5
265.656	50.4	18.1	3.9	38.5	33.9	46.0	-12.1
317.503	54.6	15.0	4.3	38.4	35.4	46.0	-10.6
634.987	53.0	20.8	6.1	38.4	41.5	46.0	-4.5
793.729	48.6	22.7	6.9	38.4	39.8	46.0	-6.2
Horizontal Polarization							
66.448	60.7	7.3	2.0	38.5	31.5	40.0	-8.5
132.862	53.3	13.9	2.7	38.5	31.5	43.5	-12.0
158.758	51.7	15.1	3.0	38.5	31.3	43.5	-12.2
199.276	55.1	17.0	3.3	38.4	37.0	43.5	-6.5
317.448	50.8	15.0	4.3	38.4	31.6	46.0	-14.4
317.485	53.1	15.0	4.3	38.4	33.9	46.0	-12.1
634.969	53.0	20.8	6.1	38.4	41.5	46.0	-4.5
793.711	51.5	22.7	6.9	38.4	42.7	46.0	-3.3

Test Personnel:

Daniel C. Swann

Tester Name Daniel C. Swann

5 RADIATED EMISSIONS DATA (continued)

5.6 Field Strength Calculations

The field strength was calculated from the following formula:

FIELD STRENGTH = MEASURED SIGNAL + CORRECTION FACTOR

Where MEASURED SIGNAL = Spectrum Analyzer amplitude, in dBuV

CORRECTION FACTOR = AF + CF - GAIN, in dB/m

AF = antenna factor, in dB/m

CF = cable attenuation factor, in dB

GAIN = pre-amplifier gain, in dB

For example, with the receiver LO frequency of 161.205, at 644.800 MHz, in vertical polarization, an quasi-peak reading of 50.5 dBuV was measured, and the antenna factor is 21.0 dB/m, the cable loss is 6.1 dB, and the pre-amplifier gain is 38.4 dB.

FS (dBuV/m) = 50.5 + 21.0 + 6.1 – 38.4

FS (dBuV/m) = 39.1 dBuV/m

FCC Class B 3 meter Radiated Emissions Limit = 46.0 dBuV/m