

Electronic Voice Phenomena Project

David M. Rountree M.S.E.E.
Audio Engineering Society
American Association for the Advancement of Science
Scientific Paranormal Investigative Research Information and Technology
Rhine Research Center
International Paranormal Research Association
April 25th, 2008

Introduction

I have been studying the EVP (Electronic Voice Phenomenon) area of paranormal research since 1976. Over the course of these many years I have compiled and analyzed an incredible amount of evidence, both audio and environmental in relationship to the individual events. I have come to some findings that appear to indicate what an EVP is.

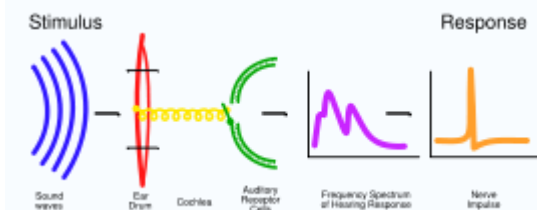
Rarely during an investigation are voices actually “heard” by the human ear, and when they are, they are not considered EVP but AVP or Audible Voice Phenomena. EVPs are recorded on a medium, and discovered during the playback sequence of the device used, be it a tape recorder, digital recorder, video cam or VCR/DVR set up. The question that has haunted me for years is “why”? To explain this you have to understand how sound is recorded in the first place. First, let me define a few things.

Some Definitions

Audio engineering is a part of audio science dealing with the recording and reproduction of sound through mechanical and electronic means as well as the design of the systems that reproduce sound electronically. The field of audio engineering draws on many disciplines, including electrical engineering, acoustics, psychoacoustics, and music. Unlike acoustical engineering, audio engineering generally does not deal with noise control or acoustical design, although these play key roles in the environment, as well as system design to produce optimum performance within that environment. Audio engineering is used for public address system design, live performance mixing and presentation, recording, and is also used in broadcast engineering.

Sound is a disturbance of mechanical energy that propagates through matter as a wave. Sound is characterized by the properties of sound waves which are frequency, wavelength, period, amplitude and velocity or speed.

Perception of sound



Above is a schematic representation of hearing. (Blue: sound waves. Red: eardrum. Yellow: cochlea. Green: auditory receptor cells. Purple: frequency spectrum of hearing response. Orange: nerve impulse.)

Sound is perceived through the sense of hearing. Humans and many animals use their ears to hear sound, but due to its mechanical nature, loud sounds and low frequency sounds can be perceived by other parts of the body through the sense of touch. Sounds are used in several ways, most notably for communication through speech or, for example, music. Sound can also be used to acquire information about properties of the surrounding environment such as spatial characteristics and presence of other animals or objects. For example, bats use echolocation, ships and submarines use sonar, and humans can determine spatial information by the way in which they perceive sounds. Sound can also be used as a weapon, such as in psychological warfare, or to cause injury.

The range of frequencies that humans can hear falls approximately between 20 Hz and 20,000 Hz. This range is by definition the audible spectrum, but some people (particularly women and young people) can hear above 20,000 Hz. This range varies by individual and generally shrinks with age, mostly in the upper part of the spectrum. The ear is most sensitive to frequencies around 3,500 Hz. Sound above 20,000 Hz is known as ultrasound; sound below 20 Hz as infrasound.

The amplitude of a sound wave is specified in terms of its pressure. The human ear can detect sounds with a very wide range of amplitudes and a logarithmic decibel amplitude scale is used. The quietest sounds that humans can hear have an amplitude of approximately 20 μPa (micropascals) or a sound pressure level (SPL) of 0 dB re 20 μPa (often incorrectly abbreviated as 0 dB SPL). Prolonged exposure to a sound pressure level exceeding 85 dB can permanently damage the ear, sometimes resulting in tinnitus and hearing impairment. Sound levels in excess of 130 dB are considered above of what the human ear can withstand and may result in serious pain and permanent damage. At very high amplitudes, sound waves exhibit non-linear effects including shock.

Speed of sound

The speed at which sound travels depends on the medium through which the sound waves pass, and is often quoted as a fundamental property of the material. In general, the speed of sound is proportional to the square root of the ratio of the stiffness of the medium and its density. Those physical properties and the speed of sound change with ambient conditions. For example, the speed of sound in air and other gases depends on temperature. In air, the speed of sound is approximately 345 ms^{-1} , in water 1500 ms^{-1} and in a bar of steel 5000 ms^{-1} .

Sound pressure

Sound pressure is the pressure deviation from the local ambient pressure caused by a **sound** wave. Sound pressure can be measured using a microphone in air and a hydrophone in water. The SI unit for sound pressure is the pascal

(symbol: Pa). The instantaneous sound pressure is the deviation from the local ambient pressure caused by a sound wave at a given location and given instant in time. The effective sound pressure is the root mean square of the instantaneous sound pressure over a given interval of time. In a sound wave, the complementary variable to sound pressure is the acoustic particle velocity. For small amplitudes, sound pressure and particle velocity are linearly related and their ratio is the acoustic impedance. The acoustic impedance depends on both the characteristics of the wave and the medium. The local instantaneous sound intensity is the product of the sound pressure and the acoustic particle velocity and is, therefore, a vector quantity.

Sound pressure level

As the human ear can detect sounds with a very wide range of amplitudes, sound pressure is often measured as a level on a logarithmic decibel scale.

The **sound pressure level** (SPL) or L_p is defined as

$$L_p = 10 \log_{10} \left(\frac{p^2}{p_0^2} \right) = 20 \log_{10} \left(\frac{p}{p_0} \right) \text{ dB}$$

where p is the root-mean-square sound pressure and p_0 is a reference sound pressure. (When using sound pressure levels, it is important to always quote the reference sound pressure used.) Commonly used reference sound pressures, defined in the standard ANSI S1.1-1994, are 20 μPa in air and 1 μPa in water.

Since the human ear does not have a flat spectral response, sound pressure levels are often frequency weighted so that the measured level will match perceived sound level. The International Electrotechnical Commission (IEC) has defined several weighting schemes. A-weighting attempts to match the response of the human ear to noise and A-weighted sound pressure levels are labeled dBA. C-weighting is used to measure peak sound levels. A-weighting is the scale commonly used by O.S.H.A. to measure noise levels for safety purposes

Examples of sound pressure and sound pressure levels

Source of sound	sound pressure	sound pressure level
	pascal	dB re 20 μ Pa
Threshold of pain	100	134
Hearing damage during short term effect	20	approx. 120
Jet, 100 m distant	6 - 200	110 - 140
Jack hammer, 1 m distant / night club	2	approx. 100
Hearing damage during long-term effect	6×10^{-1}	approx. 90
Major road, 10 m distant	2×10^{-1} - 6×10^{-1}	80 - 90
Passenger car, 10 m distant	2×10^{-2} - 2×10^{-1}	60 - 80
TV set at home level, 1 m distant	2×10^{-2}	ca. 60
Normal talking, 1 m distant	2×10^{-3} - 2×10^{-2}	40 - 60
Very calm room	2×10^{-4} - 6×10^{-4}	20 - 30
Leaves noise, calm breathing	6×10^{-5}	10
Auditory threshold at 2 kHz	2×10^{-5}	0

References

Beranek, Leo L, "Acoustics" (1993) Acoustical Society of America.

ISBN 0-88318-494-X

Magnetic storage is a term from engineering referring to the storage of data on a magnetised medium. Magnetic storage was first suggested by Obeline Smith in 1888. The first magnetic recorder was invented by Valdemar Poulsen in 1895.

The read/write heads in magnetic storage record data in the form of magnetized spots on iron oxide coatings.

Media types that exploit magnetic storage include hard disk and floppy disk drives, zip drives and various tape drives, video cassettes and audio cassettes, magnetic core memory, thin film memory and drum memory.

A new type of magnetic storage, called MRAM, is being produced that stores data in terms of polarity rather than electric charge. The advantage to this is that it will require far less electricity and will still remain intact in case of a crash.

Remember, sound recording is magnetic in nature.

A **microphone**, sometimes referred to as a **mike** or **mic** (pronounced "mike"), is an acoustic to electric transducer that converts sound into an electrical signal. Microphones are used in many applications such as telephones, tape recorders, hearing aids, motion picture production, live and recorded audio engineering, in radio and television broadcasting and in computers for recording voice, VoIP and numerous other computer applications.

All microphones capture sound waves with a thin, flexible diaphragm (or ribbon in the case of ribbon microphones). The vibrations of this element are then converted by various methods into an electrical signal that is an analog of the original sound. Most microphones in use today use electromagnetic generation (dynamic microphones), capacitance change (condenser microphones) or piezoelectric generation to produce the signal from mechanical vibration.

Microphone Types

Capacitor or condenser microphones

In a capacitor microphone, also known as a condenser microphone, the diaphragm acts as one plate of a capacitor, and the vibrations produce changes in the distance between the plates. Since the plates are biased with a fixed charge (Q), the voltage maintained across the capacitor plates changes with the vibrations in the air, according to the capacitance equation:

$$Q = C \cdot V$$

where Q = charge in coulombs, C = capacitance in farads and V = potential difference in volts. The capacitance of the plates is inversely proportional to the distance between them for a parallel-plate capacitor.

$$C \propto \frac{A}{d}$$

Capacitor microphones can be expensive and require a power supply, commonly provided from mic inputs as phantom power, but give a high-quality sound signal and are now the preferred choice in laboratory and studio recording applications.

Electret capacitor microphones

An electret microphone is a relatively new type of condenser microphone invented at Bell laboratories in 1962 by Gerhard Sessler and Jim West, and often simply called an **electret** microphone. An electret is a dielectric material that has been permanently electrically charged or *polarized*. The name comes from *electrostatic* and *magnet*; a static charge is embedded in an electret by alignment of the static charges in the material, much the way a magnet is made by aligning the magnetic domains in a piece of iron. They are used in many applications, from high-quality recording and lavalier use to built-in microphones in small sound recording devices and telephones. Though electret mikes were once considered low-cost and low quality, the best ones can now rival capacitor mikes in every respect (apart from low noise) and can even have the long-term stability and ultra-flat response needed for a measuring microphone. Unlike other condenser microphones, they require no polarising voltage, but normally contain an integrated preamplifier which does require power (often incorrectly called polarizing power or bias). This preamp is frequently phantom powered in sound reinforcement and studio applications. While few electret microphones rival the best DC-polarized units in terms of noise level, this is not due to any inherent limitation of the electret. Rather, mass production techniques needed to produce electrets cheaply don't lend themselves to the precision needed to produce the highest quality microphones.

Dynamic microphones

In a dynamic microphone a small movable induction coil, positioned in the magnetic field of a permanent magnet, is attached to the diaphragm. When sound enters through the windscreen of the microphone, the sound wave vibrations move the diaphragm. When the diaphragm vibrates, the coil moves in the magnetic field, producing a varying current in the coil through electromagnetic induction. The principle is exactly the same as in a loudspeaker, only reversed. Dynamic microphones are robust, relatively inexpensive, and resistant to moisture, and for this reason they are widely used on-stage by singers. They tend to have a poor low-frequency response, which is advantageous for reducing handling noise as a vocal mic, but tends to exclude them from other uses.

Ribbon microphones

In ribbon microphones a thin, usually corrugated metal ribbon is suspended in a magnetic field. The ribbon is electrically connected to the microphone's output, and its vibration within the magnetic field generates the electrical signal. Basic ribbon microphones detect sound in a bidirectional (also called figure-eight) pattern because the ribbon, which is open to sound both front and back, responds to the pressure gradient rather than the sound pressure. Though the symmetrical front and rear pickup can be a nuisance in normal stereo recording, the high side rejection can be used to advantage by positioning a ribbon mic horizontally, for example above cymbals, so that the rear lobe picks up only sound from the ceiling. Other directional patterns are produced by enclosing one side of the ribbon in an acoustic trap or baffle, allowing sound to reach only one side. Ribbon mics give very high quality sound reproduction, and were once valued for this reason, but a good low-frequency response can be obtained only if the ribbon is suspended very loosely, and this makes them fragile. Protective wind screens can reduce the danger of damaging the ribbon, but will somewhat reduce the bass response at large miking distances.

Ribbon microphones don't require phantom power; in fact, this voltage can damage these microphones.

Carbon microphones

A carbon microphone, formerly used in telephone handsets, is a capsule containing carbon granules pressed between two metal plates. A voltage is applied across the metal plates, causing a small current to flow through the carbon. One of the plates, the diaphragm, vibrates in sympathy with incident sound waves, applying a varying pressure to the carbon. The changing pressure deforms the granules, causing the contact area between each pair of adjacent granules to change, and this causes the electrical resistance of the mass of granules to change. The changes in resistance cause a corresponding change in

the voltage across the two plates, and hence in the current flowing through the microphone, producing the electrical signal. Carbon microphones were once commonly used in telephones; they have extremely low-quality sound reproduction and a very limited frequency response range, but are very robust devices. Unlike other microphone types, the carbon microphone can also be used as a type of amplifier, using a small amount of sound energy to produce a larger amount of electrical energy. Carbon microphones found use as early telephone repeaters, making long distance phone calls possible in the era before vacuum tubes. These repeaters worked by mechanically coupling a magnetic telephone receiver to a carbon microphone: the faint signal from the receiver was transferred to the microphone, with a resulting stronger electrical signal to send down the line.

Piezo microphones

A piezo (pronounced "*pee-ay-zo*" or "*pie-ee-zo*") microphone uses the phenomenon of piezoelectricity—the ability of some materials to produce a voltage when subjected to pressure—to convert vibrations into an electrical signal. Piezo transducers are often used as **contact microphones** to amplify acoustic instruments for live performance, or to record sounds in unusual environments (underwater, for instance).

An example of this is Rochelle salt (potassium sodium tartrate), which is a piezoelectric crystal that works as a transducer both ways; it is also commonly used as a slimline loudspeaker component.

Laser microphones

A laser microphone is an exotic application of laser technology. It consists of a laser beam that must be reflected off a glass window or another rigid surface that vibrates in sympathy with nearby sounds. This device essentially turns any vibrating surface near the source of sound into a microphone. It does this by measuring the distance between itself and the surface extremely accurately; the tiny fluctuations in this distance become the electrical signal of the sounds picked up. Laser microphones are new, very rare and expensive, and are most commonly portrayed in the movies as spying devices.

Speakers as microphones

A loudspeaker is the exact opposite of a microphone, since it's a transducer that turns an electrical signal into sound waves. However, because a conventional speaker is constructed much like a dynamic microphone (with a diaphragm, coil and magnet), speakers can actually work "in reverse" as microphones. The result, though, is a microphone with poor quality, limited frequency response (particularly at the high end), and poor sensitivity.

In practical use, speakers are sometimes used as microphones in such applications as intercoms or walkie-talkies, where high quality and sensitivity are not needed. However, there is at least one other novel application of this principle; using a medium-size woofer placed closely in front of a "kick" (bass drum) in a drum set to act as a microphone. This has been commercialized with the Yamaha "Subkick".

Operational Microphone Data

After compiling the data from hundreds of recordings and analyzing all the data, the following findings have become evident:

Microphone Selection

Capacitor or Condenser – I have never captured an EVP using a capacitor microphone. Capacitor microphones respond to changes in capacitance. I would like to continue this research if I ever capture an EVP, with capacitance field readings during the event. So far I have not been able to develop a device to measure any significant capacitance fluctuations during a paranormal event.

Electret – Many EVPs have been captured by both the community at large as well as verified by my own research. Extensive testing has shown that Electret microphones are deaf to EMF. Due to the supply voltage, the interconnecting wiring will pick up EMF only if it is higher in amplitude than the supply voltage. This means that EVP captured with electrets microphones are either Audio Voice Phenomena, or intentionally recorded data (Hoax), or simply pareidolia.

Dynamic – By far the most common method historically of capturing EVPs. These microphones respond to vibration as well as magnetic fields.

Ribbon – I have captured several EVPs while using ribbon microphones. However, due to their delicate nature, I do not recommend them for field use. Ribbon microphones respond to sound pressure variations as well as magnetic field fluctuations.

Carbon – I have never used a carbon microphone in field study, but there are reports from the past of "ghost voices" being heard over the telephone. I suspect this is due to induction effects in the wiring, and not the device itself.

Piezo – I have never been able to capture an EVP with a piezo microphone. They respond to vibrations, but because of their crystal nature, it may be possible for them to respond to magnetic fluctuation, if they are extraordinarily strong.

Laser – I have not been able to test a laser microphone in this application.

Investigation Data

In 1976 I caught my first EVP using two standard Shure Brothers PE 56 UNISPHERE 1 high impedance Microphones, a TEAC A7300RX, and a cheap pair of headphones that I can't remember the name of.



The recorder weighed over 30 pounds and it was not exactly portable. However, I was able to capture several crystal clear EVPs at an old farm house in North Carolina. While I had read about “Raudive Voices” (named after Dr. Konstantin Raudive) I had never actually heard one before. After hearing them, I was

hooked. I had to find out what was causing these disembodied voices to be captured on recording devices.



Shortly after this my career focused on audio and I became certified as an audio engineer. In 1979 a group of us were talking one night while we were drinking beer and the conversation turned to my “discoveries” of Raudive Voices. We theorized long into the night as to what they could be, and we struck up the idea of putting a microphone in a vacuum to eliminate sound or demodulated audio (audio that has demodulated from an RF carrier wave) as a source. We secured a Bell Jar rig from Edmund Scientific, (complete with evacuator pump, pressure gauge and vacuum pad) and proceeded to wire the connector to the microphone cable after sliding it through a hole in a rubber stopper. We turned on the pump, and discovered that while the cable/stopper hole fit was snug, it was not airtight. The experiment would have died right then has my friend Mike not suffered from an addiction to Bazooka bubblegum. You guessed it, the ABC gum was fitted around the cable to seal the hole and we were off to the local haunted house for some extending testing.

We arrived on the scene at about 7:30 P.M. and set up the jar. The microphone was our old reliable Shure PE 56. We added a Shure four channel microphone mixer to increase the gain of the potential signal we hoped to pickup before feeding it to our brand new Sony TC-K60 Stereo Cassette Deck with Liquid Crystal Display (state of the art back then, at a cost of about \$569.00).



We evacuated the chamber and set to work recording for the next two hours. The next day after reviewing the tapes, we found we had captured three very distinct EVPs! We discovered something else as well; the vacuum pump had not only evacuated the air from the Bell Jar, it also evacuated the microphone's diaphragm from the voice coil. We had somehow managed to record voices in a vacuum without a diaphragm! In our minds we had sufficient proof that whatever was causing EVPs, it was not a sound phenomenon. Just for mention, I read last year where Vince Wilson was going to experiment with a Bell Jar in conjunction with his own EVP research. I sincerely hope he used a cheap microphone in his experiments!

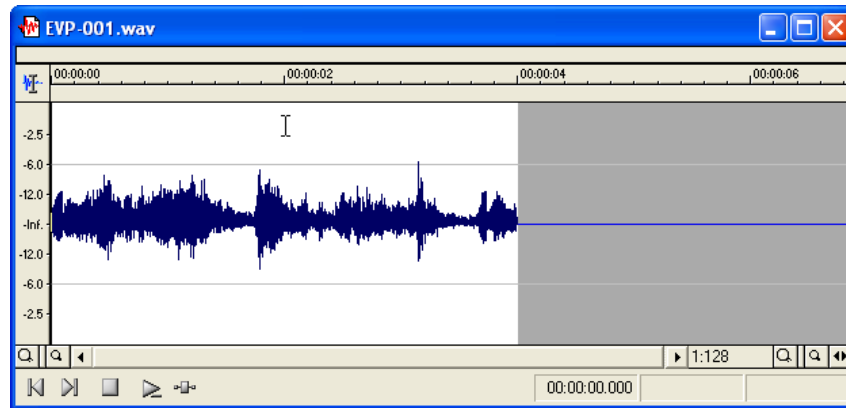
In the 1980s I found myself working at the University of Florida. I was in charge of the technical aspects of live performance and worked not only with sound reinforcement, but also with lighting. Technology had taken another quantum leap with affordable compact cassette recorders, and for around \$39.95 you could buy one at your local Radio Shack. We of course acquired several of these units and used them on investigations. Much to our dismay, we couldn't capture

any EVPs with these devices using the built in condenser microphone, and were appalled at the amount of machine noise we were recording as a result of the mechanics of the recorder's tape transport. To resolve this we began using inexpensive dynamic microphones and running them a few feet from the recorder. Not only did we stop getting machine noise interference, we immediately began to capture EVPs!

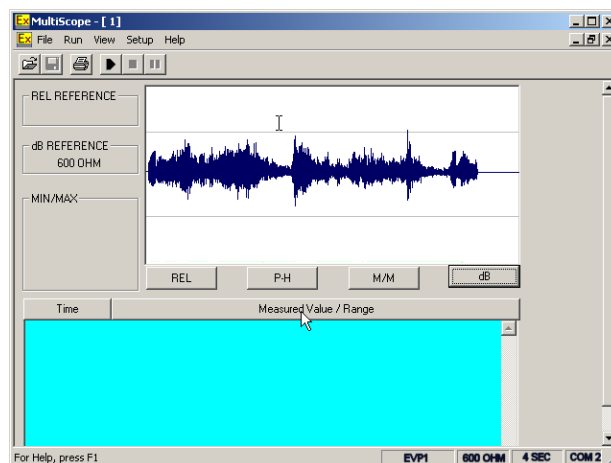
Now it seemed we were getting some pretty substantial clues that the nature of EVPs may be electromagnetic in nature. Still, the definitive proof was lacking. My own research was put on the back burner for a while as I went through a series of life altering experiences and it wasn't until the late 1990's that I resumed my EVP work. Of course our equipment inventory had grown significantly with the advance of technology. The laptop computer was quickly become the mainstay platform of our fieldwork, and we had added additional specialized software to the mix. Also, with the advent of the hand held oscilloscope, we were able to observe wave files in real time. It was at this point we captured the first definitive evidence that EVPs were electromagnetic fields. We did this by using a B&K bench oscilloscope and a very large detection coil.



The results were amazing. We recorded several EVPs and actually watched the waveform appear on the oscilloscope as the coil detected it. We could not, however, verify the waveform was the same as it was of lower amplitude, and we could not save the image for comparison. It would not be until 2005 that the final evidence would be collected. That year I purchased a Magnetic Sciences International Mag Check 95 EMF sensor, designed to work specifically in the voice range of the EMF spectrum. Additionally we coupled the device to a small, hand held oscilloscope with a computer interface (RS-232 serial port) and were able to collect an EVP with a correlating EMF.

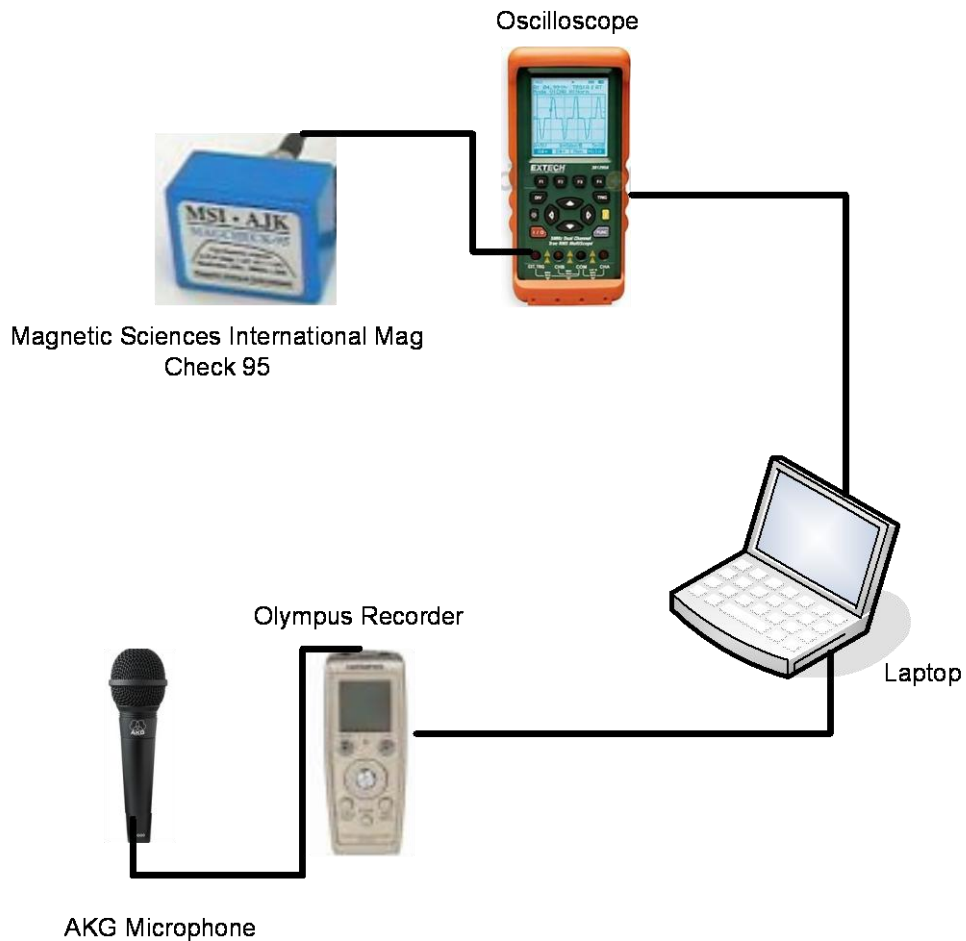


- **Audio Wave Form as recorded Audio with Olympus DS330 Digital Voice Recorder and AKG dynamic microphone**
- **Audio level Peaks at - 6dB**



- **Magnetic field measured with Magnetic Sciences International MagCheck 95 Probe coupled with EXTECH 381275 portable Oscilloscope**
- **Peaks @ -32dB**

- **Wave Form is an exact match – analyzed with Sony Sound Forge software**



Clearly this demonstrates a correlation between EVPs and EMF. Unfortunately, for every answer we find in this or any field of science, the answer often poses a new set of questions. Recent efforts using RF spectrum analyzers, scanners and Field Strength meters have eliminated RF as a potential source for some of these EMFs captured. I am currently performing additional research on locating the point source for EMF/EVP at a reported paranormal event horizon, as the EMF spontaneously appears from point inside the investigated building and or space. Using direction finding triangulation coils, the source of entry has been located on three occasions, and this research will be published as more data becomes available.