Texas Components - Data Sheet

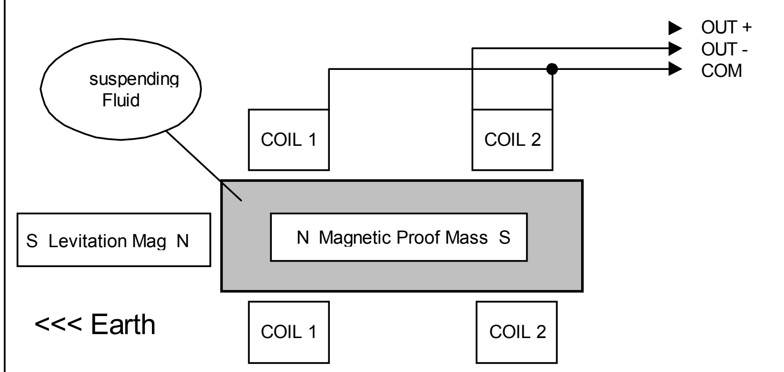
REV A
08/30/99

AN004

DESCRIPTION and CHARACTERISTICS of the TX53G1 HIGH PERFORMANCE GEOPHONE

The TX53G1 is an extremely rugged, low distortion, wide dynamic range sensor.

The proof, or moving, mass of the TX53G1 is a rod magnet positioned within a cylindrical cavity filled with a suspending fluid. In addition, a rod magnet installed within an external mounting provides an opposing force to that of gravity and centers the proof mass within the housing cavity.



TX53G1 Geophone Schematic - U.S. Patent 5756896

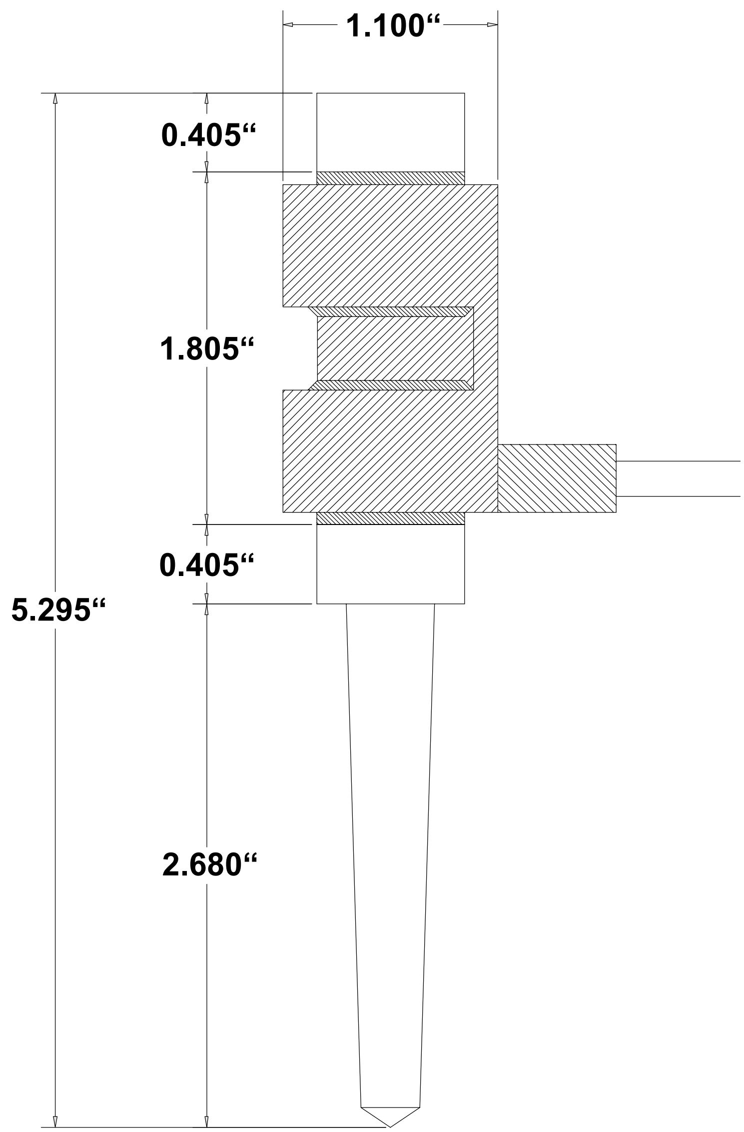
The combination of the magnetic fields sets the mechanical sensitivity and spring rate constant of the sensor. This arrangement overcomes all of the problems associated with mechanical springs as well as enhancing the survivability of the unit during high shock loads. Additionally, the mechanical dimensions of the internal components were selected so as to reduce brownian noise to an absolute minimum. Motion of the proof mass is sensed by an external, center tapped, coil around the cavity and is designed to be interfaced to a high common mode rejection, differential, amplifier with the center tap providing bias current return for the amplifier inputs. What follows will describe the performance characteristics of this device and the test procedures employed.

TX53G1 Specifications :

Resonance Frequency	5 Hz ± 10.0%
Damping	+ 3dB peak at Resonance (± 0.5 dB)
Response	4 Hz to Greater than 1KHz
Distortion	< 0.0012%
Sensitivity	14.0 V/M/S
Spurious Frequencies	None with lateral inputs < 0.4 In / Sec
Moving Mass	3.5 G
Excursion	± 4.2 MM
Operating Temp	-45 C° to +85 C°
Coil DC Resistance	10K Ω (5K / 5K)
Shock Survival	> 3000 G in any Axis
Weight	130 grams (assembled with spike)

The TX53G1 geophone is an extremely rugged device which can actually be hammered into the ground. The coil is molded of high impact ABS and is vacuum impregnated to resist moisture absorption. The transducer core and spike are fabricated of high strength, corrosion resistant, stainless steel.

All elements of the TX53G1, from one TX53G1 to another, are interchangeable allowing easy repair in the field or shop.



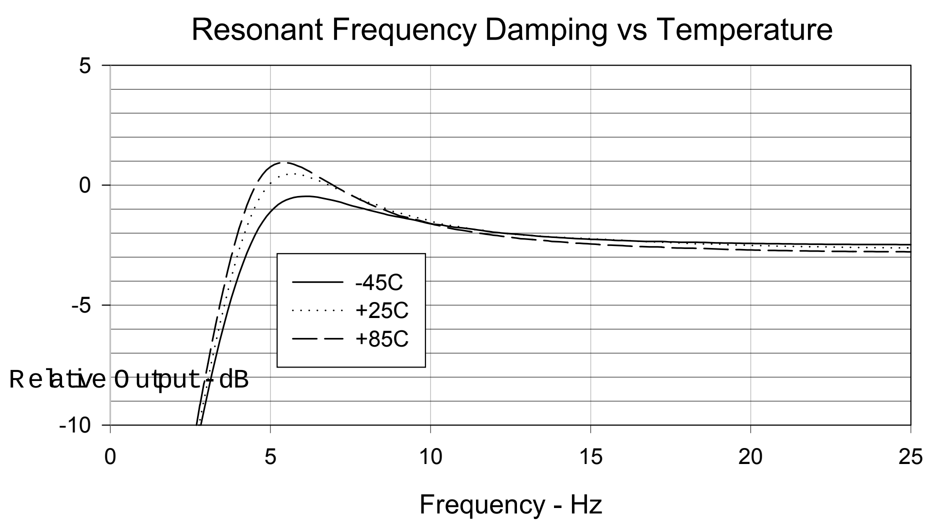
TX53G1 Geophone Assembly

Resonant (Natural) Frequency, ‘Q’ and Damping Considerations

Resonant frequency is that frequency at which a mechanical system prefers to absorb periodic energy. In general, it is a function of moving mass Vs restraining spring rate. ‘Q’ is generally a measure of the ratio of response at resonance Vs the response at frequencies several octaves away from resonance. The larger the ‘Q’ , the larger the amplitude peak at resonance due to the more efficient transduction of energy at this frequency. Damping is a measure of forced, or artificial, amplitude reduction Vs frequency to achieve specific device frequency or transient response characteristics.

A common, and effective, technique to reduce the amplitude response at resonance of low impedance, moving coil or moving mass transducers is to shunt the sensing coil with an external resistance. This is effective because it forces the transducer to input more energy, at resonance, to energy levels more consistent with other frequencies. The downside to this technique is that it requires that the transducer deliver increased power to a load which can increase the total harmonic distortion of the device.

The TX53G1 is a ‘springless’ implementation of a moving magnetic mass transducer. It was designed to be transduced by a high impedance sensing coil such that under no conditions would the device be required to deliver any significant power to a load. This keeps the distortion of the device to an absolute minimum regardless of resistive load. However, this means that damping must be achieved solely by the kinematic viscosity of the suspending fluid. Considering the large number of variables affected by the fluid, the best damping compromise results in a 3 dB to 4 dB peak at resonance.



Distortion Performance and Measurement Procedures

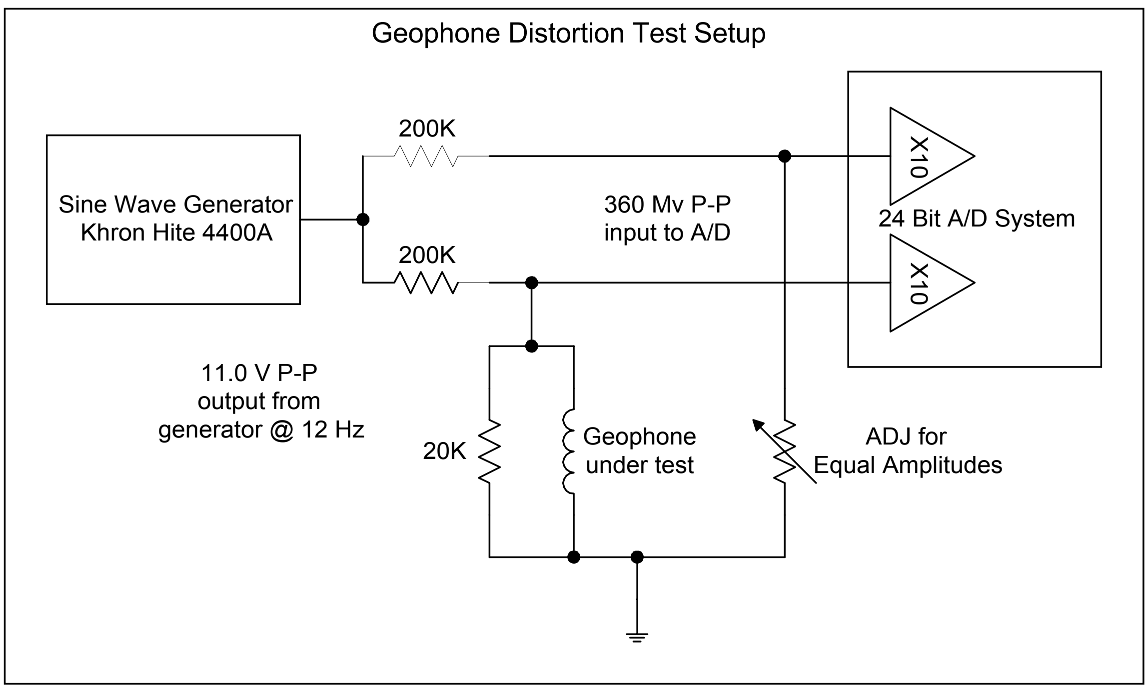
In general, the best technique for measuring distortion in moving coil, or moving mass, transducers is to apply a steady-state sine wave to the device under test through a high value resistor. The voltage impressed across the device causes the coil, or mass, to deflect above and below it's nominal at rest position and any non-linearity of movement by the proof mass will modify the voltage across the device. This voltage can be digitized by a high resolution data acquisition system and a resultant FFT plot can be examined for harmonic distortion.

Since all elements of this test setup can generate distortion, it is best to acquire data from two identical channels :

One channel will digitize data from the generator + device under test + digitizer and the other will digitize data only from the generator + digitizer.

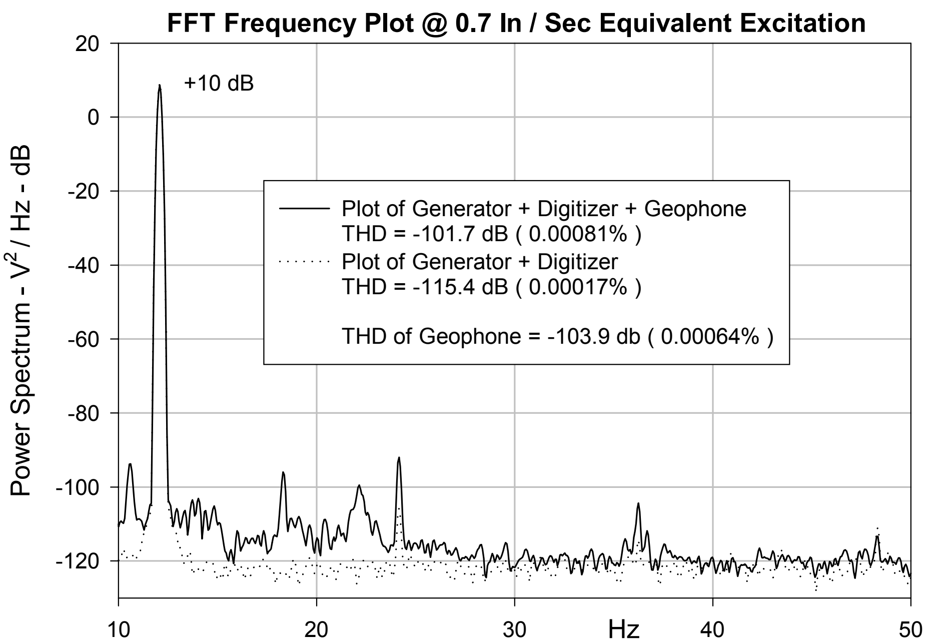
Differential analysis of the two plots will eliminate distortion components from the generator + digitizer, what remains is the distortion of the geophone under test.

Such a test setup is shown below. Amplitudes shown are equivalent to outputs generated by the TX53G1 at 0.7 In / Sec @ 12 Hz

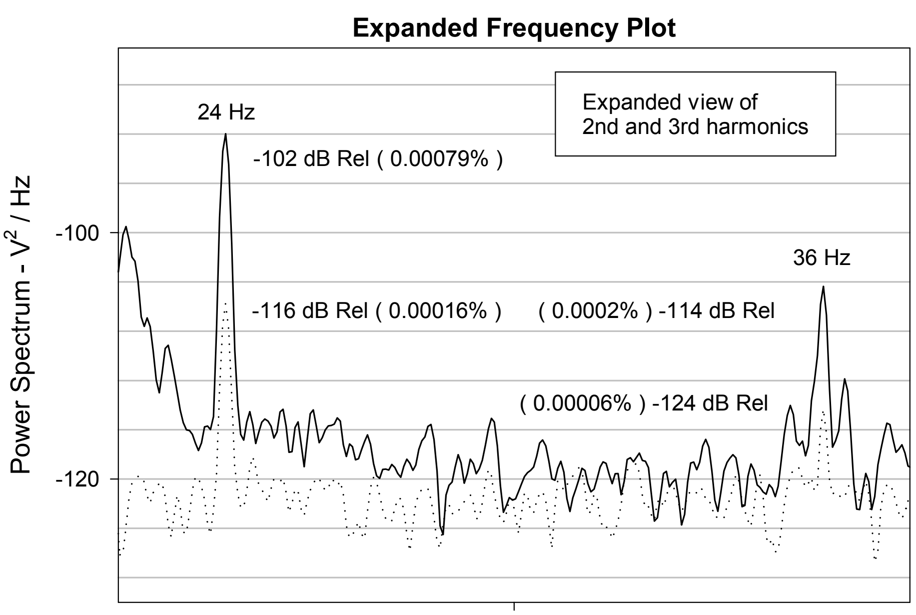


The FFT plots on the following page illustrate the results of such a test. Data was taken at night to minimize the effect of traffic and human activity on ground noise.

The TX53G1 is installed in a bucket of sand, using it's spike, and isolated from ambient ground noise by suspending the bucket using two springs (of different rates) and a bungy cord in series. The total deflection of the suspension system at 10 lb mass is 38"

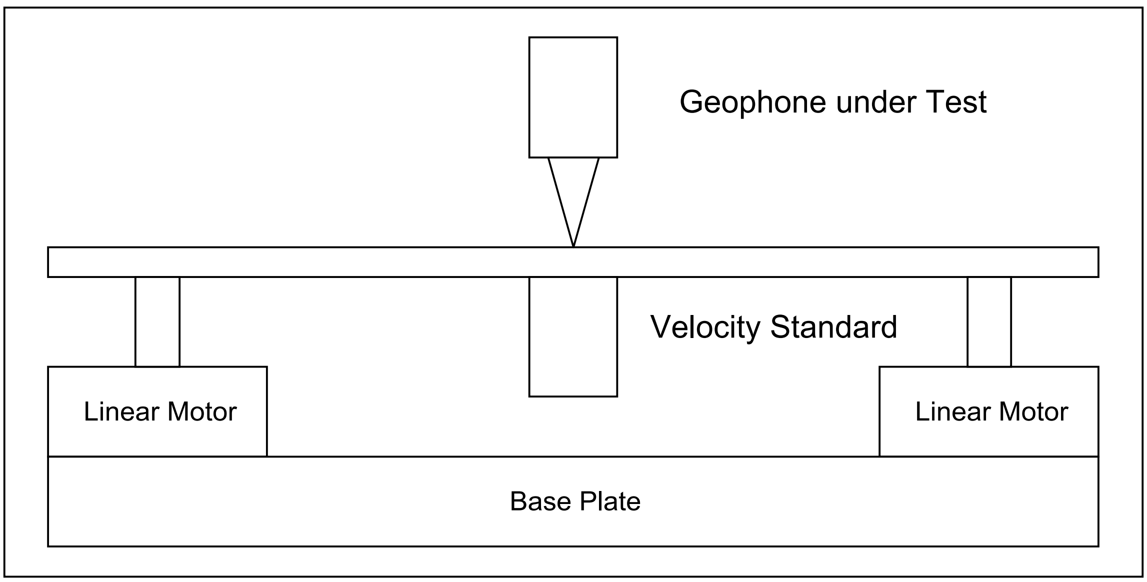


The isolation system appears to be fairly effective, although not perfect. However, notice that the noise floor of both plots > 30 Hz is about the same, indicating low device self noise.



Sensitivity

Sensitivity is measured with the test fixture shown below. The basic layout consists of 4 linear motors driven by an audio amplifier. These motors are coupled to a moving plate on which the device under test and the velocity standard are mounted. This amplifier input is generated by a calibration card within a 24 bit data acquisition system and is usually a random binary signal of appropriate amplitude. Data from both the device under test and the velocity standard are digitized simultaneously and a coherence plot generated to determine both sensitivity and frequency response. Sensitivity of the velocity standard is 18 V / m / sec and is flat to approximately 0.5 Hz.



Spurious Frequency Generation and Sensitivity

Spurious frequency generation is generally the result of failure of the suspension system to reject motion inputs in the non-sensitive axis. Because the radial springs used in modern geophones are stiff in the lateral axis, any component not completely rejected is translated into a vertical component at a fairly high frequency. The TX53G1 utilizes a suspending fluid to center the proof mass inside the device housing. Lateral force inputs are completely rejected up to a specific lateral velocity input. This force is not linear and becomes stronger as the proof mass approaches the wall and as such is difficult to characterize in theory.[1] However, preliminary tests indicate that lateral velocity inputs in the range of 0.4 In / Sec should be completely rejected.

[1] Texas Components is, as of 08/30/99, in the process of constructing a test fixture to determine actual lateral rejection velocity.