

Geostuff Wall-Lock Borehole Geophones

including

BHG-2 Borehole Geophone
BHG-3 Borehole Geophone
BHGC-1 Geophone Controller
BHGC-4 Geophone Controller
BHGC Rechargeable Battery Option

Operation Manual

Geostuff

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Important Notices

- The clamping mechanism is very strong. Do not continue to apply power after the current approaches 1 amp. You can bend the spring or damage the mechanical parts of the Big Hole Adapter.
- The borehole geophones normally require **at least 24 volts** for efficient operation. If you try and operate the system on 12 volts, the clamp mechanism will operate very slowly or not at all.
- The BHG-3 compass mechanism must be correctly positioned for proper operation— Read the directions:

If the mark on the compass housing is aligned with the clamp spring, the longitudinal compass will point towards magnetic North. If the housing is rotated, the geophone can be adjusted to point to a different direction.

- Do not apply more than 36 volts to the BHG-3 orientation mechanism.
- Geostuff has a tutorial paper on conducting borehole shear wave surveys. If you do not have a copy, request one.

The Geostuff family of borehole instruments includes several products.

- The BHG-2 is a 3-component borehole geophone with a motor-driven clamp mechanism.
- The BHG-3 is a 3-component borehole geophone with a motor-driven clamp mechanism and a flux-gate compass and servo mechanism to orient the horizontal geophones along any particular azimuth.
- The BHGC-1 is an optional controller which controls power to the clamp and orientation mechanisms, and selects seismograph channels.
- The BHGC-4 is an optional controller for use with up to four geophones simultaneously.
- The Big Hole kit allows either BHG to operate in very large boreholes.
- The cable includes a waterproof connector on the wet end, high strength copperweld conductors, and a Kevlar braid for additional strength beneath a Polyurethane jacket. The cable is also available as an extension cable with waterproof connectors on each end to provide a temporarily longer cable.
- A multi-takeout cable is available to create "strings" of borehole geophones for simultaneous multi-level recording.



A tutorial paper, *Borehole Shear-Wave Surveys for Engineering Site Investigations*, is available by mail or download from Geostuff's Borehole Geophone web page. It is highly recommended that anyone using this instrument review that paper for useful hints and procedures.

This manual describes the operation of all these products.

BHG-2 Borehole Geophone

The BHG-2 is a 3-component, borehole geophone with a motor-driven clamp to hold the geophone in place against the wall of a borehole. The BHG-2 can be used for a variety of borehole seismic surveys, including down hole and cross hole. The geophone elements are oriented in an X-Y-Z pattern. The Longitudinal geophone points toward the clamp spring. The geophone is slightly less than 2 inches (50 mm) diameter and can operate in holes of at least that diameter. The BHG-2 will fit inside a Schedule 40, 2-inch PVC pipe, but not Schedule 80, 2-inch pipe.

The spring and geophone expand to slightly over six inches (15 cm) wide. An optional big hole adaptor is available for use in larger diameter boreholes.

The clamping mechanism is a steel spring which is compressed and expanded by a piston actuated by a DC motor. The motor and the vertical geophone element share a common pair of wires. A voltage high enough to overcome the resistance of the cable is applied to the appropriate conductors and the motor retracts a piston, expanding the spring. Reversing the voltage reverses the motor, collapsing the spring. The current drain provides the operator with a measurement of how much work the motor is doing, and indicates when the spring is pushing against the wall. This can be confirmed by pulling up on the cable when it is in a hole.

The cable may be supplied with bare wires or a Cannon NK-27-21C which will mate with either BHGC controller. If your seismograph also features Cannon NK-27 connectors, you may connect the cable directly to your seismograph. In that case, the Vertical component will be connected to pins 1 & 2 (usually channel 1 on a 12-channel seismograph, or channel 12 or 13 on a 24-channel seismograph). The Longitudinal geophone will be connected to pins 3 & 4, and the Transverse

geophone will be connected to pins 5 & 6. The Longitudinal geophone points toward the clamp spring.

To operate the clamp mechanism without a controller, apply a DC voltage directly to pins 1 & 2 of the connector. If the positive terminal is connected to pin 1 and the negative to pin 2, the spring will expand against the borehole and clamp the geophone in place. Reverse the connection to collapse the spring and release the geophone. Verify proper operation before putting the geophone in a hole.



The supply can be any convenient DC source, including standard flashlight batteries connected in series. The power supply voltage needs to be high enough to drive 1 amp through the motor and the cable resistance (24 volts is usually sufficient and a good choice for most cable lengths).

With the geophone disconnected, and pins 1 and 2 shorted on one end of the cable, measure the resistance between pins 1 and 2 on the other end to find the round-trip total resistance. Using Ohm's Law, calculate the voltage required to push 1 amp down the cable¹. The voltage required will vary from 18 to 48 volts (or even more for long cables) depending on the cable length (see the discussion in the BHGC instructions).

A schematic for a suitable controller is included in this manual, or it may be operated with the Geostuff Model BHGC-1 or BHGC-4 controller.

The motor will draw 1/3 to 1/2 amp when moving the spring. As the spring presses against the wall, the current will increase, usually to about 1 amp depending on the voltage and cable resistance. Practice at the top of the borehole to determine how much current is required to clamp the geophone in the borehole.

¹ Use Ohms Law, $E = I \cdot R$. If the resistance equals 18 ohms, Then 18 volts will be needed to push 1 amp down the cable. Round up to 24 volts.

The slot in the geophone housing limits the piston travel. If the piston runs against either end, the current will increase rapidly. The system may become "stuck" at either end, just as a screw becomes tight at the end of its travel. To get the system "unstuck", try cycling the power a few times. If that doesn't work, try temporarily increasing the voltage or connect the battery directly to the geophone (eliminating the drop in the cable).

Do not leave the power switched on after the spring is in position.

When connecting the waterproof connectors between the cable and geophone, it is necessary to lubricate the connector. Be careful not to get too much lubricant on the pins or the excess will become trapped inside the connection and might cause a leak. Use a silicone spray lubricant or a very small amount of silicone grease. **Do not use petroleum based lubricants, they will eventually damage the rubber.** Please see the Geophone Cable section of this manual for further instructions.

For large diameter boreholes, an optional "big-hole" kit is available. This kit replaces the spring with a set of arms (available in different lengths in the kit). The foot is designed for soft-wall uncased holes, and it can be omitted in cased holes. See the illustration in this manual for the proper installation of the kit.

The standard geophone elements are OYO Geospace type GSC-20DM Omni, 15-Hz natural frequency, with a 2400 ohm coil. 10, 14, 28 and 40 Hz elements are also available. Specifications for the geophone elements are included in this manual.

The geophone elements can be field replaced by any reasonably skilled electronics technician.

To service the geophone elements, just follow these simple steps:

1. Remove the clamp spring by removing the screw at the bottom of the spring.
2. Remove the four screws around the perimeter on the connector end of the geophone
3. Using firm but controlled force, pull the geophone block out. Once the O-rings clear the housing, the part will move freely.

To service the motor/clamp assembly, you must first follow the directions above and then follow these steps:

4. Disconnect the two wires connecting the upper assembly from the lower. Use the provided connectors (they may be encased in tape or shrink).
5. Remove the four screws near the bottom end.
6. Remove the Spring Guide Pin (it is often easiest to do this with the piston nearly fully retracted into the tool).
7. Pull the lower assembly out of the bottom the tool.

See the drawing for the interior view.

Feel free to consult the factory for assistance with repairs, troubleshooting, or replacement parts.

BHG-3 Borehole Geophone with Orientation Mechanism

The BHG-3 is similar to the BHG-2, except that it includes a servo mechanism which will rotate the geophone elements until the horizontal geophones are aligned with an azimuth selected by the user. Normally, that means that the longitudinal geophone will be aligned with a plank positioned on the surface, but other survey configurations are possible, such as pointing towards another borehole.

The lower portion of the BHG-3 contains a flux-gate compass and a servo amplifier. The compass senses the magnetic azimuth and the amplifier rotates the geophone assembly inside the tube to align it. Since a magnetic compass is used as the sensing device, the orientation system will not work in steel-cased boreholes. The compass housing can be rotated to select a particular azimuth.

The wiring is as follows:

<u>Wire Color</u>	<u>Connector Pin No.</u>	<u>Function</u>
White	1	Vertical geophone + and clamp motor
Yellow	2	Vertical geophone - and clamp motor
Red	3	Longitudinal geophone + and servo mechanism positive power (on BHG-3)
Black	4	Longitudinal geophone - and servo mechanism negative power (on BHG-3)
Brown	5	Transverse geophone +
Orange	6	Transverse geophone -
Green	7	spare wire (no connection)

The clamping mechanism operates just like that on the BHG-2, and you should read that portion of this manual before proceeding. The BHGC-1 and BHGC-4 controllers can operate the orientation system, or a controller can be built using the schematic in this manual.

The orientation servo operates when DC power is applied to pins 3 (red) and 4 (black). The

process is automatic— just position the geophone at its desired depth and clamp the geophone in the hole. Then, apply power to pins 3 and 4. The positive voltage must go to pin 3, and should be between 15 and 36 volts DC. The mechanism will draw some current for a few seconds while the geophone is rotated, then the current will drop off (sometimes, the current will fluctuate as the servo moves the geophone back-and-forth). The compass power must be disconnected to record seismic data.

The compass block at the bottom can be rotated by loosening the four set screws and turning it by hand. Unless you wish to orient the geophone at a different azimuth, ***make sure that the mark on the side of the compass is aligned with the clamp spring***. In that position, the Longitudinal geophone will always point towards magnetic North. The Transverse geophone will point to magnetic East.

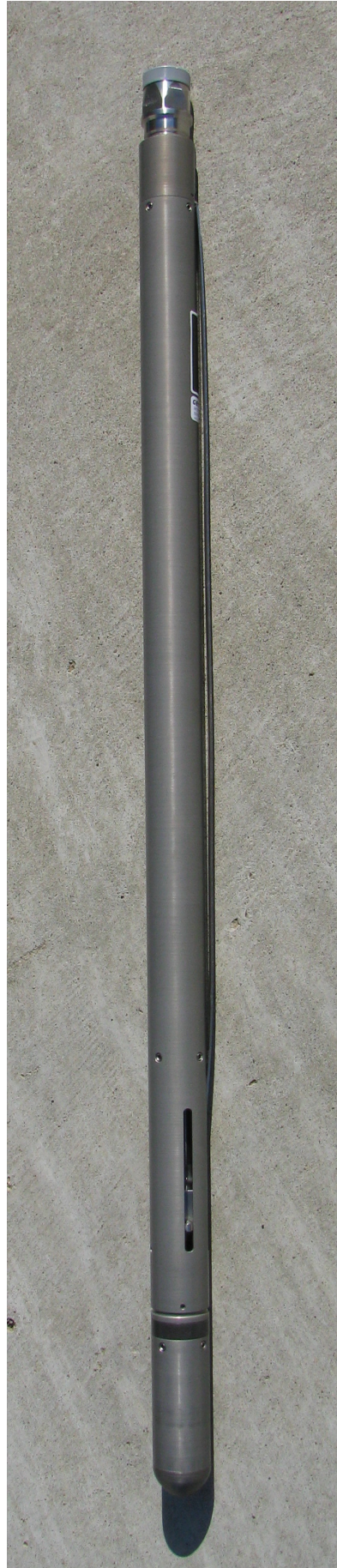
If convenient, align the survey and the shear wave energy source so that the impact is parallel to magnetic North (or East). One of the horizontal geophones will be then aligned with the plank (if the mark is pointed toward the clamp spring). See the last paragraph on locating magnetic North.

If you need to point the geophones in a different direction, this is easily done by adjusting the housing holding the compass mechanism.

1. Loosen the four small set screws holding the compass housing to the long tube.
2. Turn the body of the geophone so that the clamp spring is pointed in the direction of the survey (generally along the plank).
3. Turn the compass housing so that the orientation dot points to magnetic North (while still pointing the spring in the direction you wish to align the geophone).
4. Tighten the set screws.

To check the orientation, tap on the side of the BHG-3 near the top. Tap around the cylinder and observe which geophone is most sensitive to horizontal motion. Once the BHG-3 has been oriented, just put it in the hole and conduct the survey. Whenever the geophone is positioned or re-positioned, apply power to the compass leads for a few seconds to allow the orientation mechanism to rotate the geophone elements.

The internal mechanism of the BHG-3 rotates the geophone one revolution. When the body of the geophone is rotated, a point is reached where the mechanism stops tracking the compass and instead reverses itself, makes a full turn in the other direction, and re-synchronizes with the compass. If you turn the geophone assembly slowly, and listen, you can hear this happen as the motor will run for several seconds. This event happens just when the flux-gate compass (and the dot marker) is pointed towards magnetic North. You can use this to locate magnetic North without a separate compass.



BHGC-1 and BHGC-4 Geophone Controller

The BHGC-1 is a control box used to operate the BHG-2 and BHG-3 Borehole Geophones.

Operation is simple and intuitive as will be seen in the control panel illustration: There is a single control to operate the geophone, plus three switches which direct the outputs to selected channels on the seismograph.

The control has four positions:

RELEASE Switches power to the clamp motor which will collapse the spring and loosen the geophone in the borehole.

CLAMP Switches power to the clamp motor, which will expand the spring, clamping the geophone against the wall of the borehole.

RECORD This position is used to record seismic data. This is also the "off" position, since it is the only position which does not power the geophone motors. **Always keep this switch in the RECORD position, except when intentionally operating one of the motors.**

ORIENT Switches power to the orientation mechanism on the BHG-3 geophone. It has no function with the BHG-2 geophone.



The three channel-selector knobs will select which channel is used for each of the geophone elements. By combining this capability with judicious use of the seismograph "memory freeze" function, you can record multiple levels of the survey side-by-side on a single 12-channel seismograph record. This can help with arrival identification. **Do not select the same channel with more than one switch, as this will connect the geophones in parallel and produce spurious results.**

Note that the channel numbers on the selector switches may not match the channel numbers on your seismograph. This is because 12-channel seismographs may use a different input connector wiring than 24-channel seismographs.

To operate the system, connect the borehole geophone to the geophone connector, and the seismograph to its connector using the cables provided.

If you do not have the internal rechargeable battery pack, then connect a suitable battery to the EXTERNAL POWER binding posts, with the positive terminal to the + (Red) post and the negative terminal to the - (black) post. There is a protective diode in series, so reversing the connections will not damage the system, but it will not work. Suitable choices include 12-volt lantern batteries or several flashlight D-cells connected together in series to generate the required voltage. The nominal current drain is about ¼ to ½ amp, with short duration increases to one amp, so D-cells will operate the system for a long time.

Test the system on the surface. Turn the control switch to the CLAMP position. The spring should start to expand as the piston pulls into the geophone body.

The motor current meter will enable you to monitor the events taking place in the borehole. When there is no load on the spring, the current will be 1/3 to 1/2 amp, depending on brand of motor used. You may see pulsations as the motor turns, indicating the revolution rate. As the spring starts to compress against the side of the borehole, the current will increase, to perhaps 1

amp. This will be your clue that the geophone is clamped in the borehole. Stop the motor at this point (by putting the switch in the RECORD position), and pull lightly on the cable to confirm that the geophone is clamped in place. Run the system in the clamp mode again to tighten the spring if necessary.

Leave the control switch turned to the RECORD position after the spring is positioned so the motor is not powered.

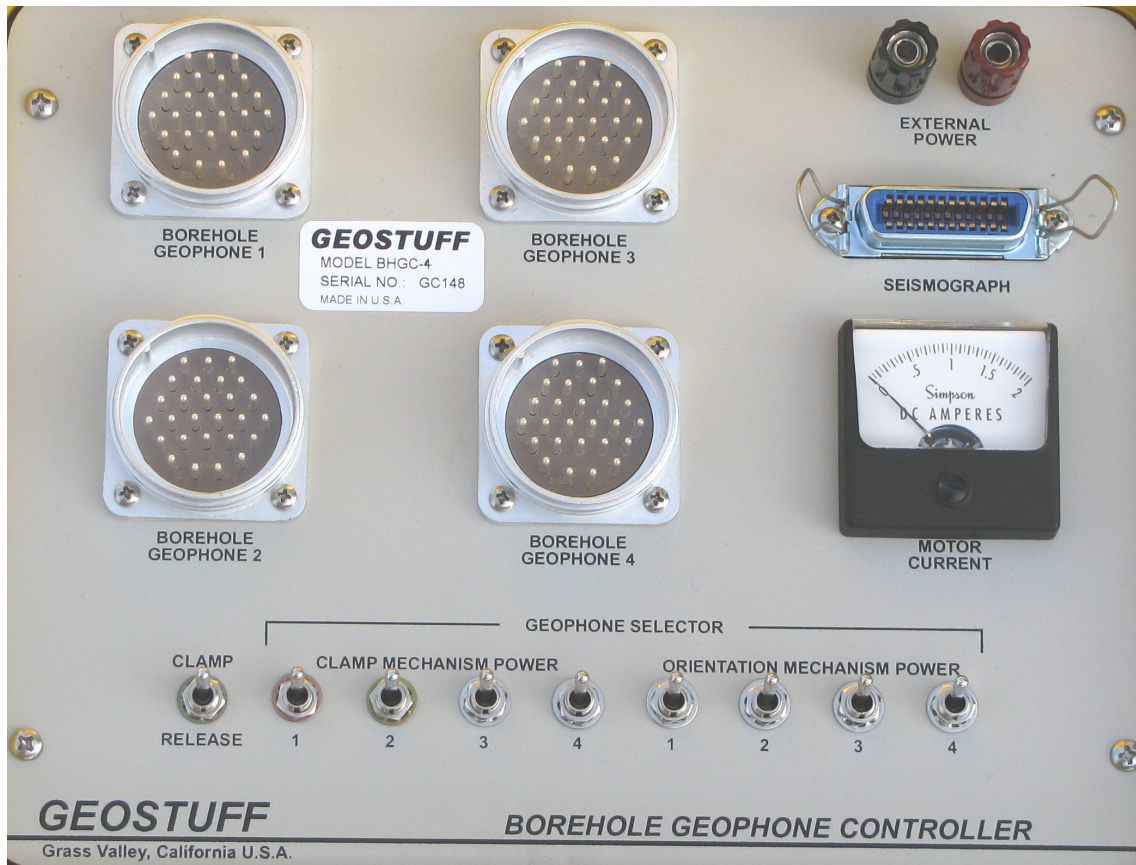
If the piston moves all the way open or closed, the motor will stall, and the current increases to 1 amp or more. After a few seconds, the current may drop again as the protective thermistor heats up and lowers the current to protect the motor. If the piston has been moved to the stall position, extra voltage may be required temporarily to get the motor started.

Experiment on the surface (or very top of the borehole) to familiarize yourself with the meaning of the current meter in various conditions of operation.

To orient a BHG-3, just turn the switch in the ORIENT position after clamping the geophone in place. Watch the current until it drops to a small value or starts fluctuating as the servo hunts the proper orientation, then place the switch in the RECORD position.

Once the geophone is clamped in the hole and oriented, the controller may be removed from the circuit, and the geophone connected directly to the seismograph. Thus, one controller may be used with two geophones if you have a 24-channel seismograph with two input connectors.

When not operating the CLAMP, RELEASE, or ORIENT functions, always leave the controller in the RECORD position



BHGC-4 Multiple Geophone Controller

The BHGC-4 is a controller with clamp and orientation switches for up to four geophones. There are nine toggle switches to control operation of the geophones. Operation is obvious from the panel. This unit does not have the channel selection feature.

Rechargeable Battery Option

The rechargeable battery option consists of a pair of 12-volt 5-amp-hour rechargeable sealed, lead-acid batteries installed inside the BHGC controller case. Also included is a 24-volt battery charger powered from 110 or 220 volts AC.

To charge the internal battery, plug the charger into the power source before connecting the output leads to the controller. The green LED light indicates that the power is on. Then, connect the charger leads to the External Power binding posts, matching the colors between the clips and the binding posts.

After the battery has been connected to the charger the red LED will light up and the green LED will go off. This indicates that the charger has gone into **Fast Charge** mode.

The green LED will light up again when the charger has switched to **Float** voltage indicating that the battery is close to being fully charged.

The charger may be left on the unit indefinitely. Units in storage should be charged every three months. Do not apply more than 26 volts to the terminals on a system with internal batteries (or disconnect the internal battery).

Geophone Cable

The geophone cable contains two copper conductors and five conductors of copperweld, a high-strength wire. There is a Kevlar braid inside the polyurethane jacket for additional strength. The cable is connected to the borehole geophone with an underwater connector, allowing the cable and geophone to be disconnected for transit or storage.

The wet end of the cable has a Reed Products type SU-8F connector. The dry end is normally supplied with a Cannon NK-27-21C (if the optional BHGC is purchased) or un-terminated for user-fabricated controllers.


The same type cable is also available with male and female underwater connectors, and this cable can be used as an extension cable to temporarily increase the total depth capacity.

The connector should be lubricated with silicone or other lubricant which will not damage the plastic. The stainless steel threads should have a small amount of anti-seize compound applied to prevent the connectors from "galling" together.

The system is normally wired as follows:

Wire Color	BHG Pin No.	Function
White	1	Vertical geophone + and motor power
Yellow	2	Vertical geophone - and motor power
Red	3	Longitudinal geophone + and orientation mechanism power
Black	4	Longitudinal geophone - and orientation mechanism power
Brown	5	Transverse geophone +
Orange	6	Transverse geophone -
Green	7	spare wire (no connection)

Prior to 1997, the geophone cables had seven conductors of copperweld, with a higher resistance. This meant that supply voltages needed to be higher to drive the clamp motor. If you have a system with the older cables, take this into account when selecting batteries.



A-G Geophysical Products, Inc.
(281) 373-5952 fax (281) 373-3632

IMPORTANT INFORMATION


**Underwater Electrical Connectors
MATING**


BEFORE SHIPMENT
A-G connectors are lightly sprayed with an AEROSOL non-water-soluble silicon lubricant, in preparation for the first connection.

FOR SUBSEQUENT MATINGS
the connectors should be cleaned to remove any contamination and silicon buildup, then re-lubricated. This procedure will insure correct mating as well as prolonged connector life.

Only use SILICON SPRAY approved for POLYURETHANE application.

DO NOT use WD40, CRC or any other organic-based solvent spray.






DO NOT use heavy silicon greases like DC 111.


Mating of Locking Rings should be done BY HAND only.

USE OF A WRENCH OR PLIERS
can cause thread damage and can lead to failure of the locking rings.

X Do not BEND or TWIST.




✓ Pull STRAIGHT across connectors, or anchor with foot and pull STRAIGHT up.



FOR TROUBLE-FREE SERVICE
use a light machine oil or anti-seize DIELECTRIC product to lubricate the **THREADED** portion of the stainless steel locking rings.

PULLING APART



A special cable is also available with several connectors molded on to provide multiple takeouts. Up to 8 geophones can be attached to one downhole cable. The cable is 1/2-inch diameter and is routed down the side of the geophone adjacent to the spring. The minimum borehole diameter increases by 1/2 inch.

Installation of the "Big Hole" Kit

Big Hole Kit Parts List

Locking Arm Pair, PN 940410
Actuator Arm, 2 ea, PN 940411
Foot, 1 ea, PN 940412
Locking Arm Hook, 1 ea, PN 940413A
Locking Arm Retainer, PN 940413B
Screw, 6-32 x 1/4, Pan Head Phillips, SS, 1 ea
Spacer, threaded, 8-32, 1/4" round x 1.75", 2ea
Spacer, 1/2" round x 5/8", nylon, 2 ea
Screw, shoulder, 8-32, 3/16 ht, SS, Berg PL-7, 4 ea
Roll pin, 1/4-inch

1.
Retract the piston into the geophone a few cm, compressing the spring. Remove the screw and pin that holds the bottom end of the spring. Remove the spring by tilting it up until it comes free of the small roll pin at the top.

2.
Choose the long or short arm, depending on the hole diameter. Attach the foot to the arm with the large roll pin. Position the foot so that long side hangs down.

4.
Attach locking arm to geophone. Attach spring clip and retainer to end of arm with loose screw. Hook clip under roll pin. Tighten screw.

5.
Attach actuating arms to locking arm. Insert threaded spacer in hole. Attach arms with shoulder screws. Put a 5/8-inch nylon spacer on each side to centralize the arm.

3.
Attach the actuating arms to the piston. Insert threaded spacer into piston hole. Attach arms with shoulder screws.

The Big Hole Adapter is very strong. Do not leave the clamping motor engaged beyond the force required to clamp the geophone. Excessive force can damage the mechanical parts.

Trouble-shooting

Clamp Mechanism

If the clamp mechanism fails to operate, isolate the problem by eliminating major parts of the system as follows.

Remember that a geophone with a cable attached will need 24 volts or more to operate properly.

The controller is protected against reverse polarity. If the clamp mechanism doesn't work, check the polarity of the battery connection.

Next, test the basic geophone. Disconnect the cable from the borehole geophone and connect a battery directly to pins 1 and 2² to see if the clamp mechanism operates. Reverse the wires to see if it moves in the other direction. If it operates properly, then the problem is in the cable or the controller.

If you can hear the motor run but the spring doesn't operate, then there is a mechanical problem inside the tool. Disassemble the tool and look for the cause. Consult the factory if you need parts or if you would like to return it for repair. If you don't hear the motor run, then the problem can be electrical or mechanical, but still internal to the tool.

If the clamp mechanism operates normally, then the problem is in the cable or the controller. To check the cable, connect it to the BHG but disconnect it from the controller. Apply DC power to pins 1 and 2 on the dry end of the cable to see if the clamp mechanism operates properly. If it does, then look for a problem with the controller.

You may also check the cable with an ohmmeter. Be sure and flex the cable while you check it to test for intermittent problems. If the cable is defective, it is not field repairable. However, there is a spare wire in the cable (except in the BHG-2C) which can be used to

patch around a defective conductor. To use it, it is necessary to re-wire the dry end connector and the inside of the tool. The spare wire is green, and can be connected in parallel with the defective conductor.

Geophone Signal Problems

If one or more of the geophone signals is missing or noisy, they can usually be checked with a common ohmmeter. The standard 15-Hz geophones have a coil resistance of 2400 ohms, and any optional geophone will have some resistance between 100 and 500 ohms. Start by checking continuity at the geophone itself. Pins 1-2 are the vertical, 3-4 the longitudinal, and 5-6 the transverse geophones. Remember that too low a resistance suggests a short circuit. The motor, which is in parallel with the vertical geophone, will not affect the reading on most ohmmeters because there are diodes in series with the motor that will not turn on for small voltages.

Continue the process by adding the cable, then the controller to isolate the problem. Put the selector switches in the 1-2-3 positions and the pinout will be the same all the way to the connector to the seismograph. The BHGC output connector uses pins 1-13, 2-14 and 3-15 for outputs 1, 2 and 3.

If you have continuity through the system and there is still no signal, it is possible but rare for a geophone to be defective but still connected.

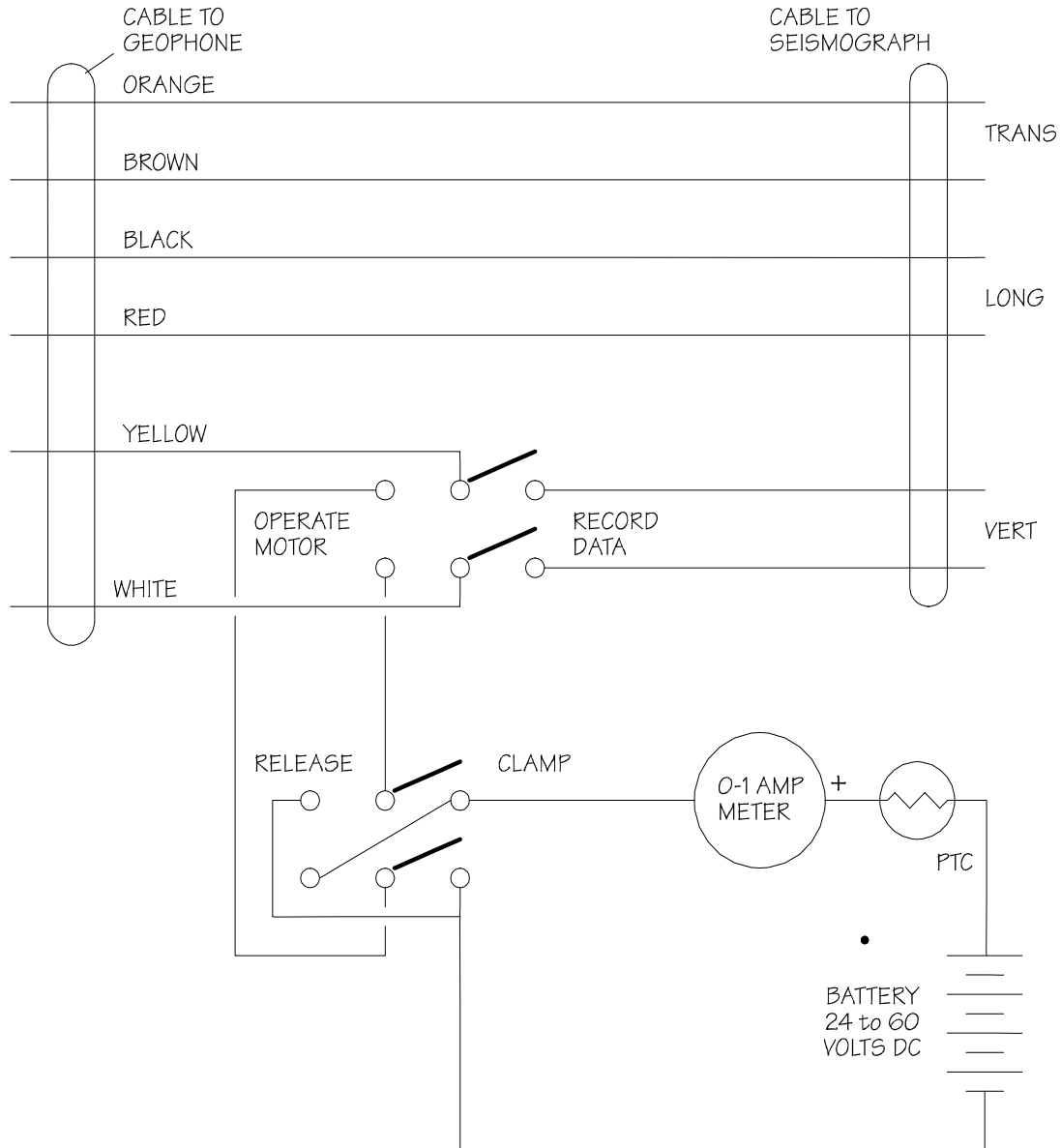
Orientation System

The orientation system is normally operating properly if you can hear the servo operating as you turn the BHG-3. You should hear the transition when rotating through North and the motor recycles all the way around. Note carefully the position of the orientation mark on the compass housing, and tap on the side to check the orientation. If necessary, remove the top of the BHG-3 and look for the mark on the geophone block. Trouble-shoot the system as described above.

The following section includes a number of useful drawings provided for repair purposes

² The pin numbers are molded into the connector. Pin 1 is slightly larger than the other pins.

Schematic for a user-constructed controller for a BHG-2 geophone

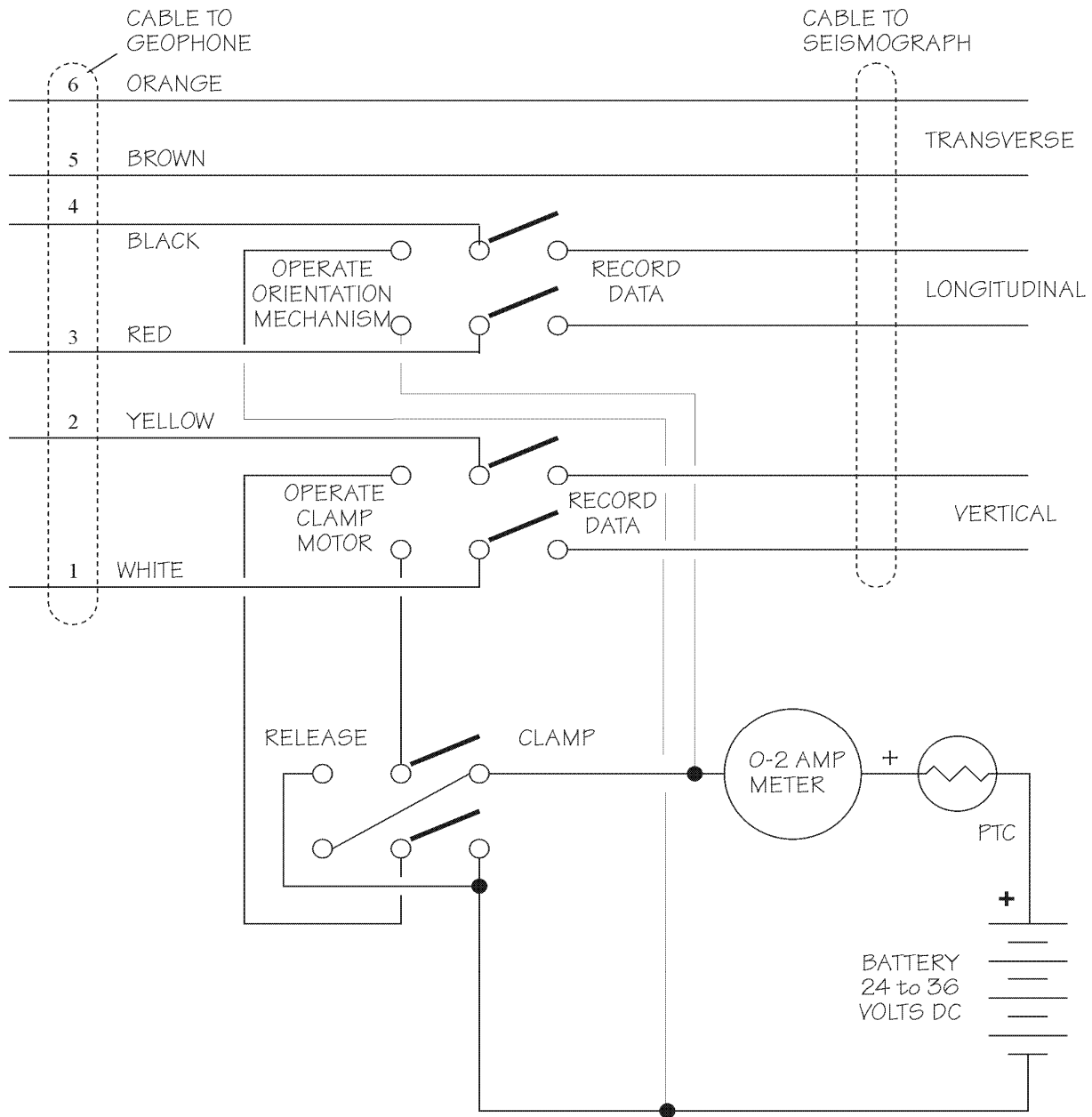


Circuit diagram for a typical clamp motor control for BHG-2 borehole geophone.

Requires two DPDT switches, 0-1 amp meter, and battery. Battery can be series of D-cells, 12-volt lantern batteries, or gel cells. Use 24 volts for 100 meters, add 6 volts/100 meters additional length.

PTC supplied with BHG on request.

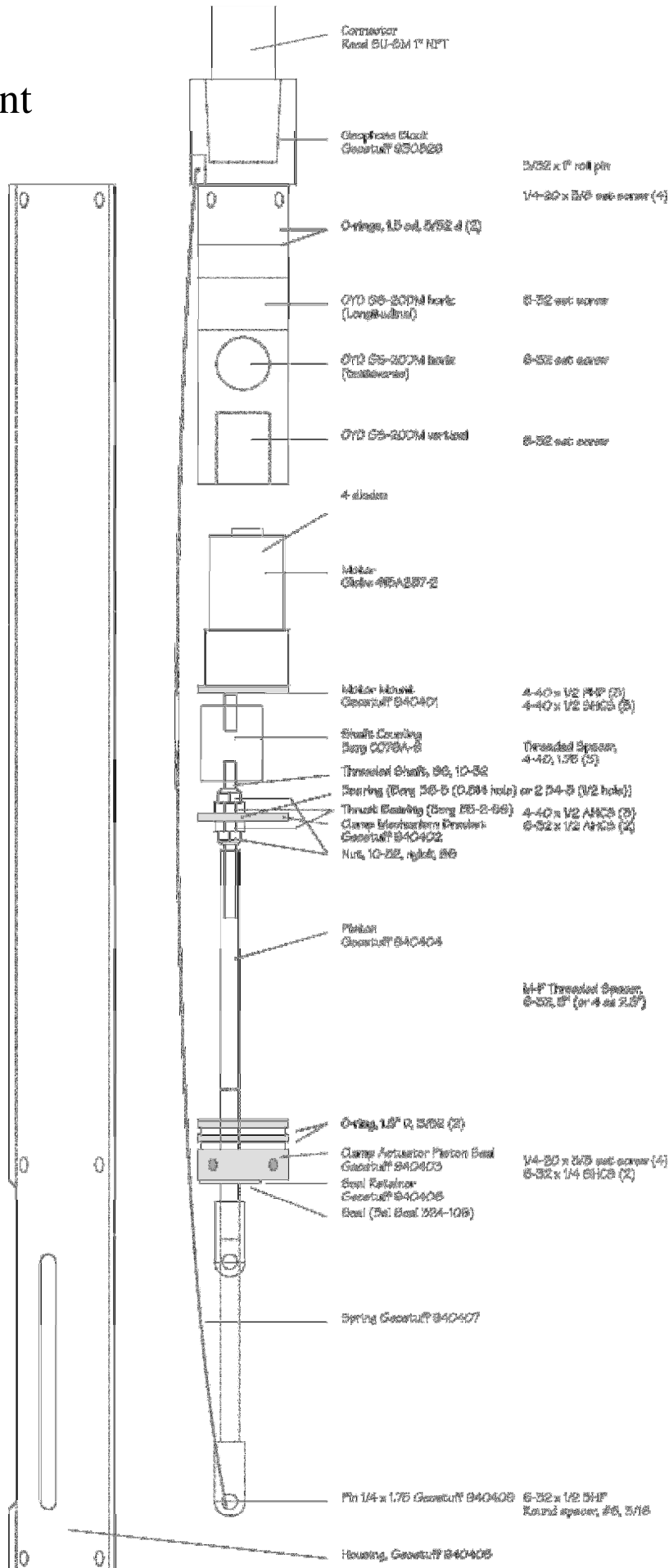
Schematic for a user-constructed controller for a BHG-3 geophone.



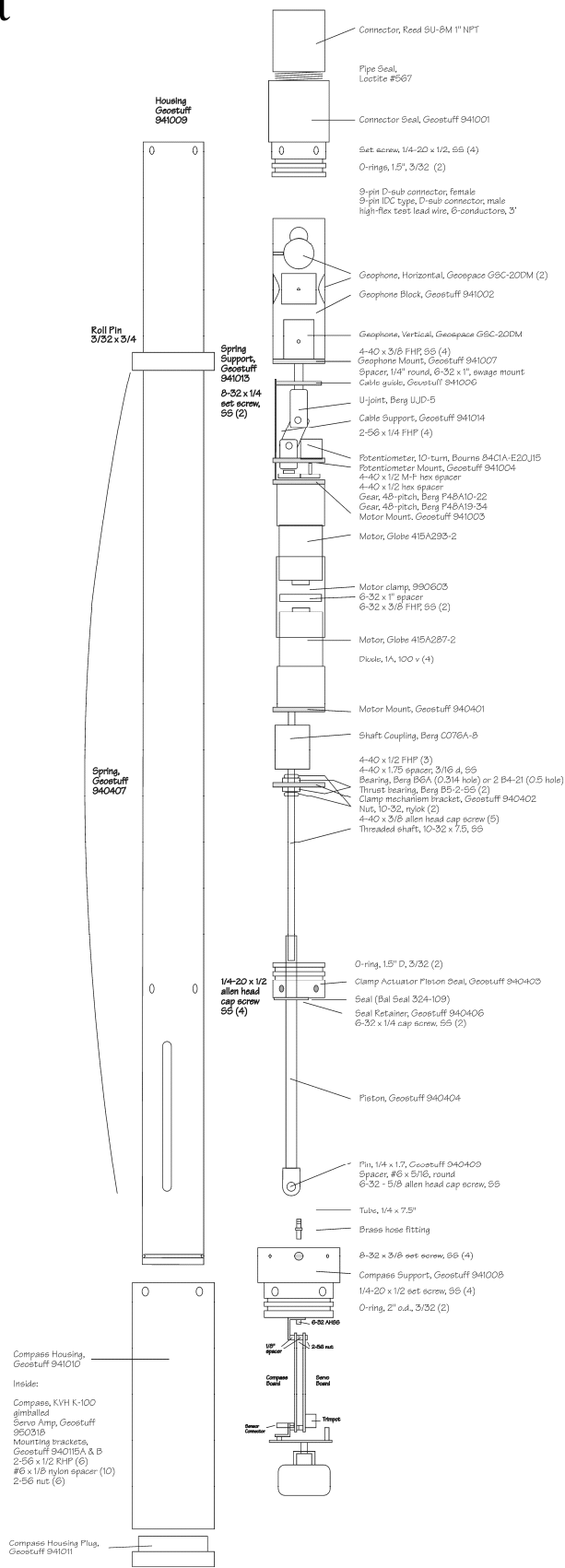
Circuit Diagram for a Typical Clamp Motor and Orientation Mechanism Controller for BHG-3 Borehole Geophone.

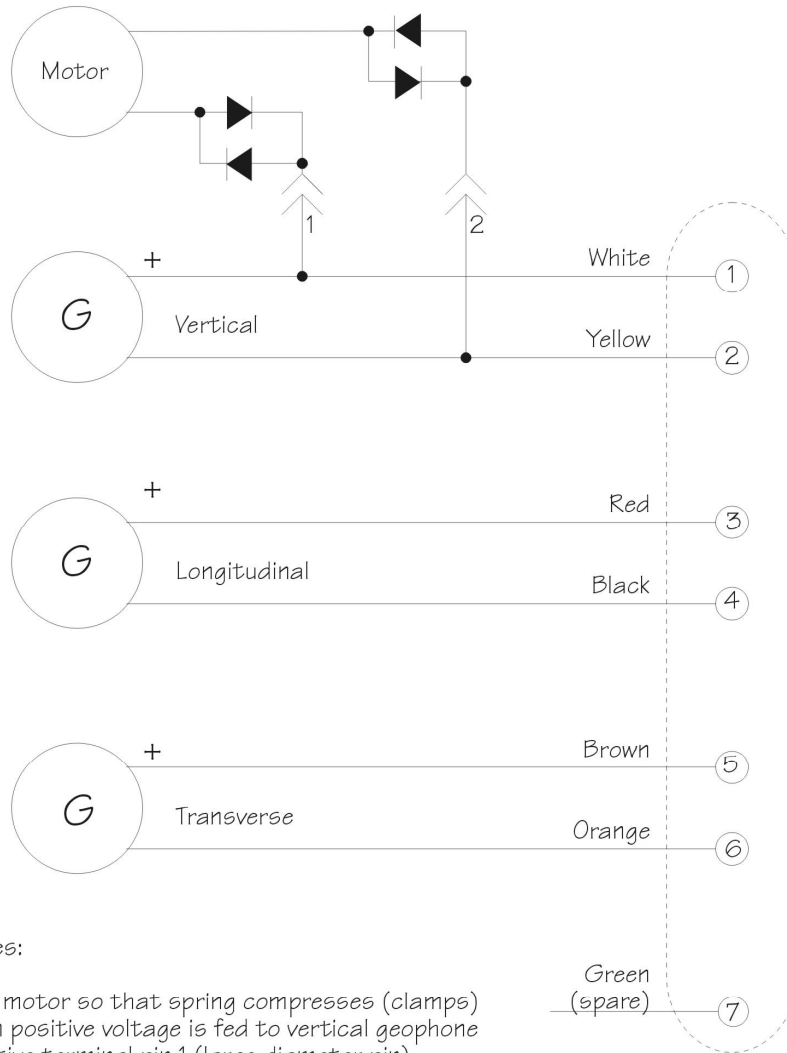
Requires three DPDT toggle switches, 0-2 amp meter, and battery power. The two operate switches should be spring return. Battery can be 12-volt lantern batteries or rechargeable batteries. Use 24 volts for 50-150 meters, add 12 volts/100 meters additional. Use separate battery for Orientation Mechanism if Clamp Mechanism requires more than 36 volts. PTC thermistor available free on request with borehole geophone.

BHG-2 Component View



BHG-3 Component View





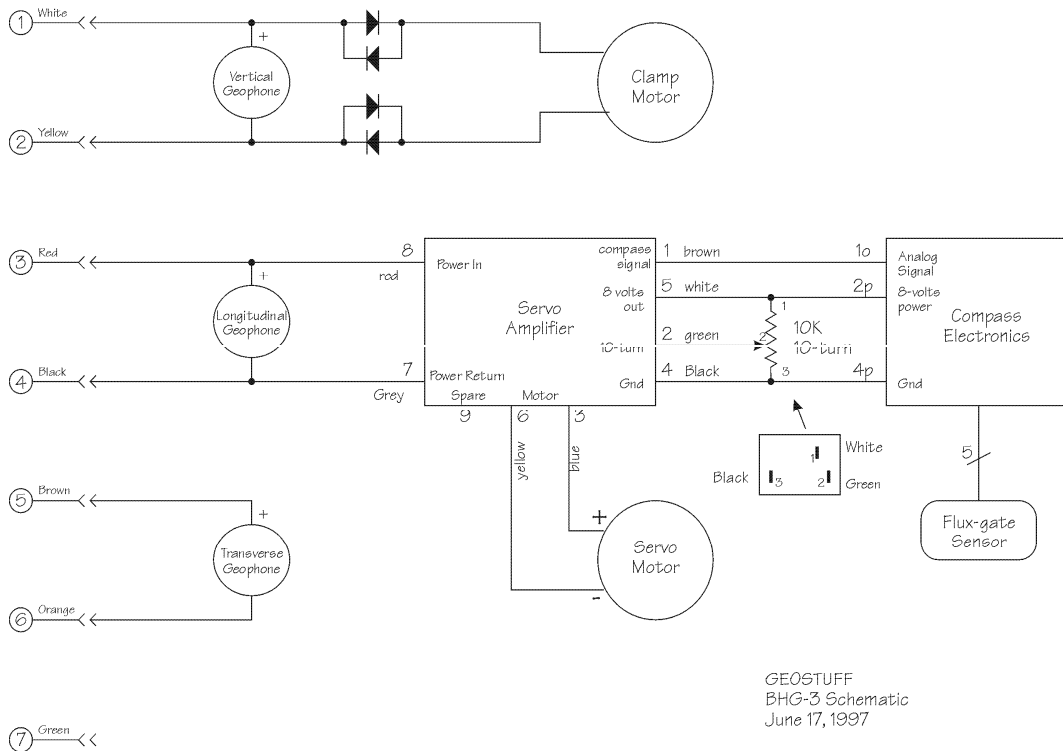
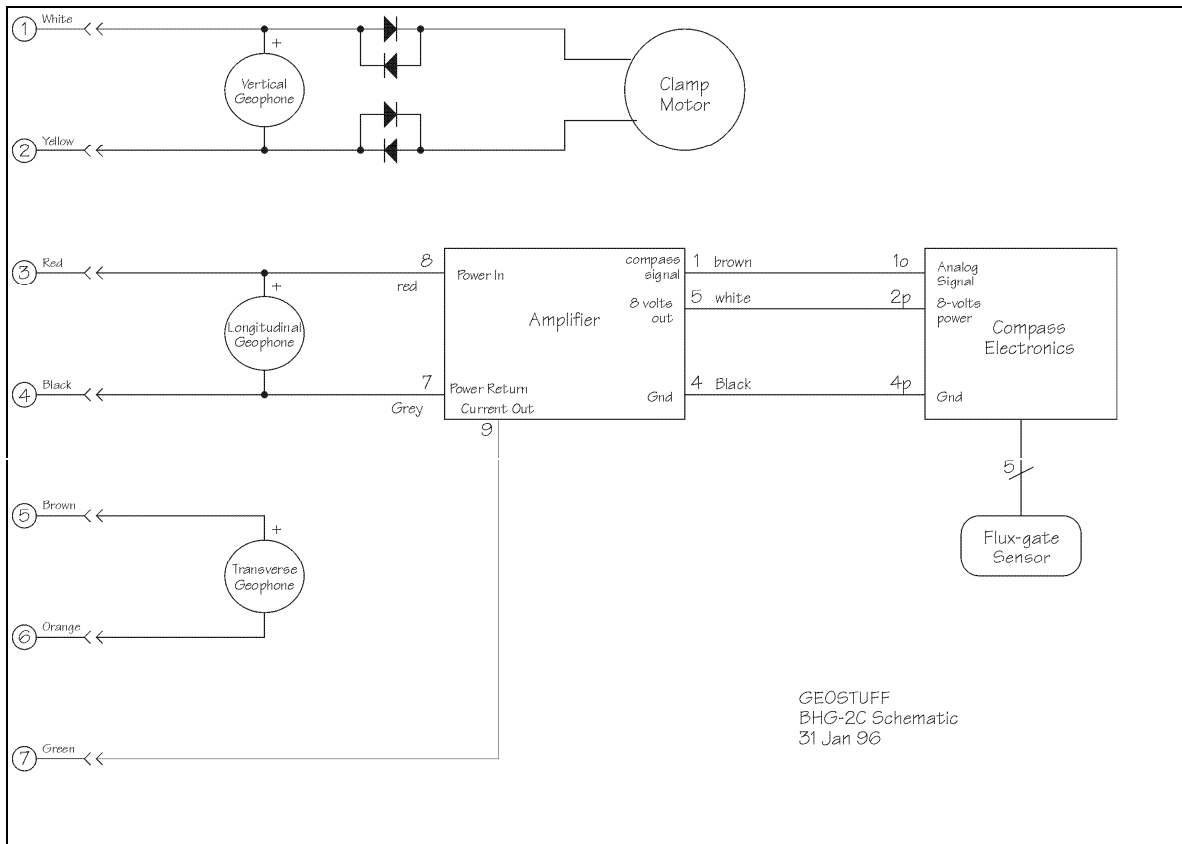
Notes:

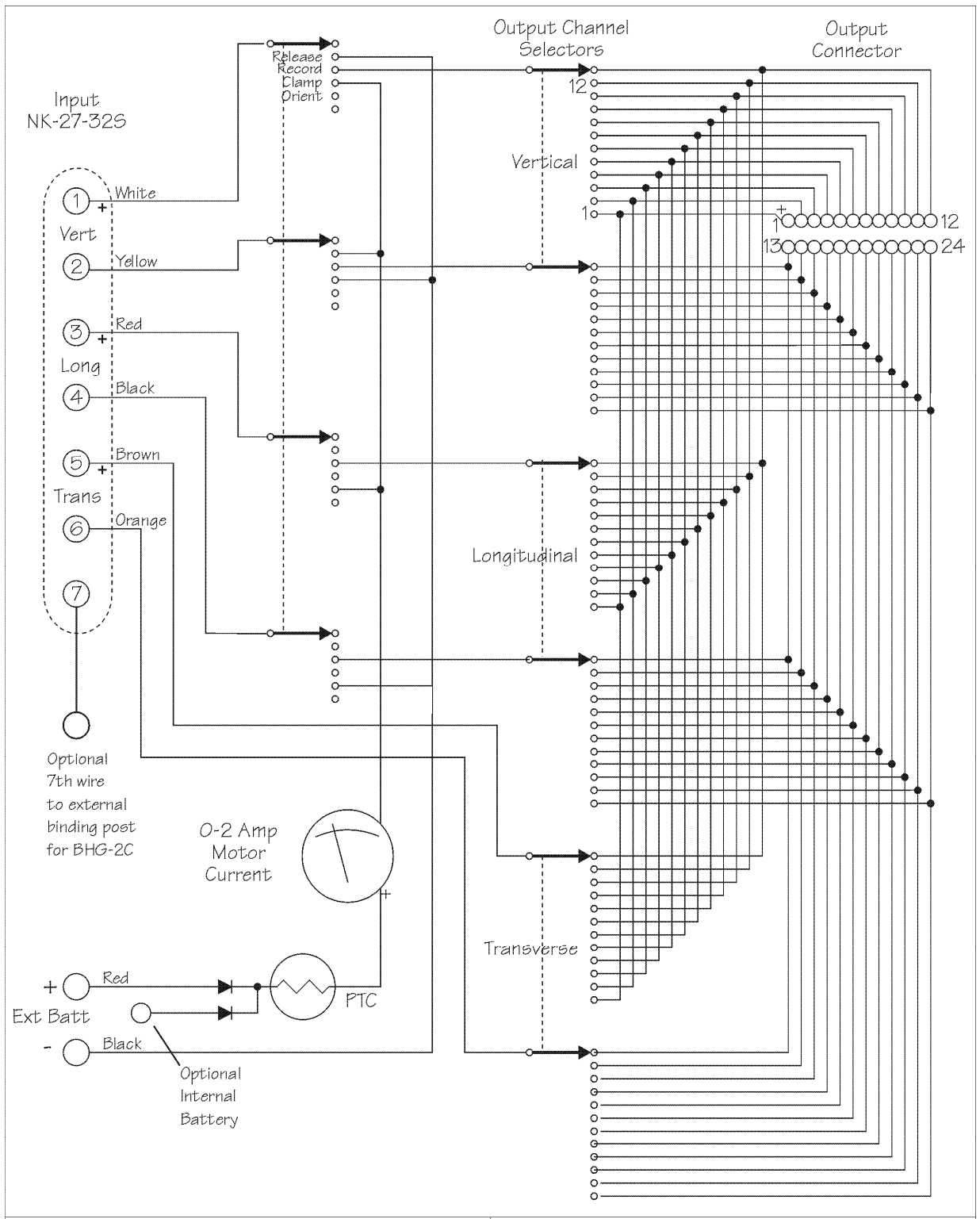
Wire motor so that spring compresses (clamps) when positive voltage is fed to vertical geophone positive terminal pin 1 (large diameter pin).

Axis of longitudinal sensor points toward spring

Mating connector, Reed Products SU-8F. Pin numbers on Reed connector are same as pin numbers on NK-27-21C connector used on cable.

Part	BHG-2 Schematic Diagram	GEOSTUFF		
Where Used	BHG-2	Part No.	Rev	Date 7/28/94





Part BHGC-1 Schematic Diagram

GEOSTUFF

Where Used Borehole Geophone Controller

Part No.

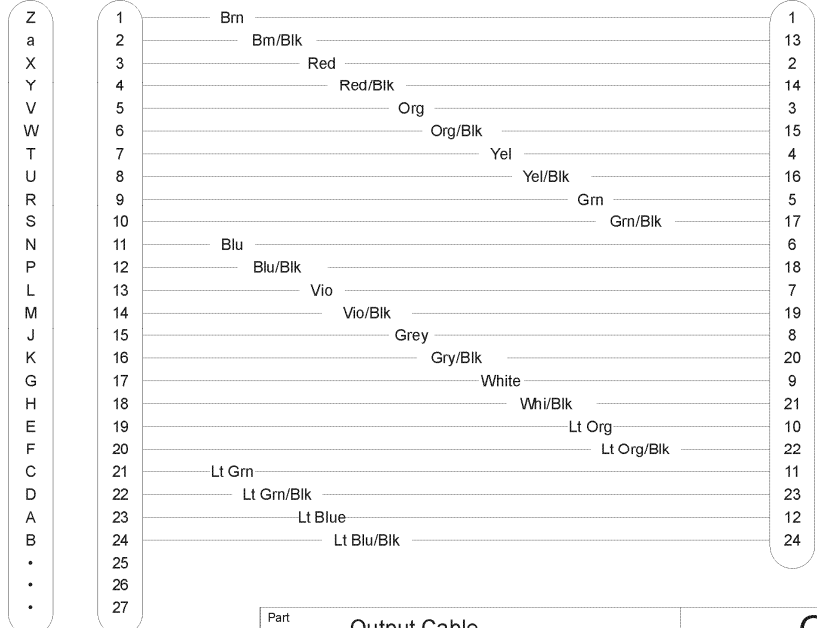
Rev

Date 7/25/94

Bendix
PT06A-
22-55S or
24-61S

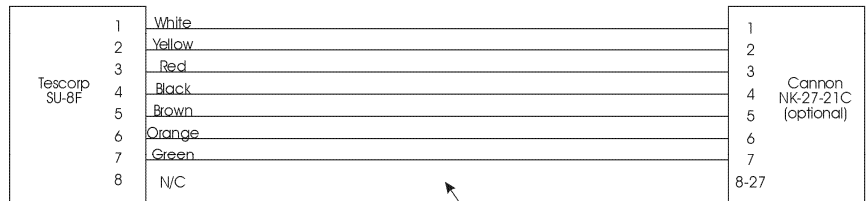
Cannon
NK-27-21C

Amphenol
57--30240



- Notes:
1. Length approximately 6 feet
 2. If available wire colors do not match drawing, use any logical substitution.
 3. Place shrink tubing or hose around cable to expand to cable clamp size and to provide strain relief.
 4. Alternately built with Cannon NK-27-21C (for 12 or 24-channel seismograph), For 48-channel seismograph, use Bendix PT06A-22-55S, or Bendix PT06A-24-61S output connector.
 5. Do not connect spare wire or ground lead.

Part	Output Cable	GEOSTUFF		
Where Used	Borehole Geophone Controller	Part No.	Rev	Date
		970221	B	05/30/01



Tescorp PN	Length	Weight	Resistance Cu/CW
RCA-1438-1	110 m		
RCA-1438-2	100 m		
RCA-1438-3	300 m	17 lbs	4.1/10.5 ohms
RCA-1438-4	3 m		
RCA-1438-5	500 m		
RCA-1438-6	400 m		
RCA-1438-7	200 m	33 lbs	9.5/23 ohms
RCA-1438-8	50 m	8 lbs	3/6.5 ohms
RCA-1438-9	150 m	25 lbs	7/17 ohms
RCA-1438-10	60 m		
RCA-1438-11	35 m		
RCA-1438-12	1 m		
RCA-1438-13	305'		
RCA-1438-14	105'		
RCA-1438-15	65 m		
RCA-1438-16	120 m	19 lb	6/15 ohms
RCA-1438-17	80 m		
RCA-1438-18	70 m		
RCA-1438-19	160 m		
RCA-1438-20	75 m		
RCA-1438-21	250 m		

TL7-1002 (TL7-70-KB-31D Leader Cable)
White and Yellow wires are 22 ga copper
Remaining wires are 70 lb copperweld

Tescorp PN Length Weight Resistance Cu/CW
RCA-1721-4 50 m 8 lbs 3/6.5 ohms
RCA-1721-3100M

Tescorp RCA 1721-X cable is an extension with an SU-8F on one end and an SU-8M on the other end.

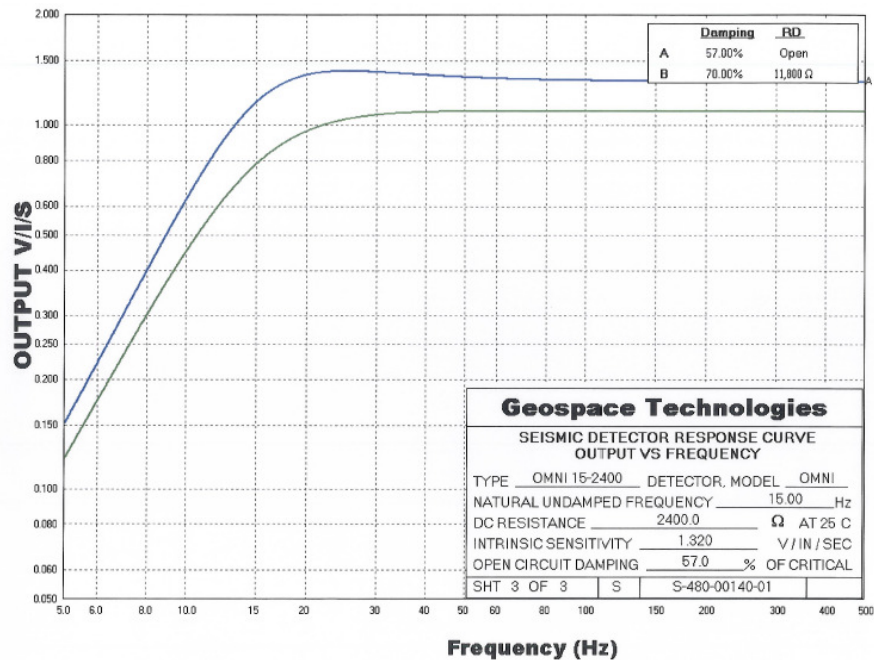
Tescorp assembly does not include Cannon NK-27-21C on dry end.

Part	Cable	GEOSTUFF		
Where Used	Borehole Geophone	Part No.	Rev	Date
		see table		7/1/95

Standard Geophone Element Specifications

PRODUCT/CUSTOMER SPECIFICATION		
GEPHONE MODEL: <u>OMNI 15-2400</u>	PART NUMBER: <u>480-00140-01</u>	
DESCRIPTION	SPECIFICATION @ 25°C	TOL
OPTIMUM ORIENTATION	<u>HORIZ.</u>	
OPERATIONAL RANGE	<u>0° TO 180° (OMNI)</u>	
NATURAL FREQUENCY (Fn)		
@ OPTIMUM ORIENTATION	<u>15 Hz</u>	<u>± 5 %</u>
@ OPERATIONAL RANGE	<u>15 Hz</u>	<u>-5% to +15%</u>
COIL EXCURSION P-P		
@ OPTIMUM ORIENTATION	<u>>.120 in., >.305 cm</u>	
@ OPERATIONAL RANGE	<u>>.020 in., >.051 cm</u>	
CLEAN BAND PASS (SPURIOUS RESPONSE)	<u>> 365 Hz</u>	
DC RESISTANCE	<u>2400 Ω</u>	<u>± 5 %</u>
INTRINSIC VOLTAGE SENSITIVITY (G)		
@ OPTIMUM ORIENTATION	<u>1.32 V/in./sec., 0.520 V/cm/sec</u>	<u>± 5 %</u>
@ OPERATIONAL RANGE	<u>1.32 V/in./sec., 0.520 V/cm/sec</u>	<u>-15% to + 5%</u>
NORMALIZED TRANSDUCTION CONSTANT	<u>.02694 √R_c V/in./sec</u>	
Coil Resistance (R _c) <u>2400 Ω</u>		
OPEN CIRCUIT DAMPING (B _o)		
@ OPTIMUM ORIENTATION	<u>.57</u>	<u>± 15 %</u>
@ OPERATIONAL RANGE	<u>.57</u>	<u>-20% to +10%</u>
MOVING MASS (M)	<u>7.8 gr.</u>	<u>± 5 %</u>
HARMONIC DISTORTION @ <u>15 Hz</u> WITH DRIVING VELOCITY OF <u>.7 in/sec (1.8 cm/sec) P-P</u>		
@ OPTIMUM ORIENTATION	<u>< .20 %</u>	
@ OPERATIONAL RANGE	<u>< .75 %</u>	
DAMPING CONSTANT (B _r)	<u>1837</u>	
STORAGE TEMPERATURE	<u>-40 to +100 °C</u>	
OPERATING TEMPERATURE	<u>-40 to +100 °C</u>	
DIMENSIONS		
WEIGHT	<u>1.52 oz., .44 gr.</u>	
DIAMETER	<u>0.875 in., 2.22 cm</u>	
HEIGHT	<u>1.035 in., 2.63 cm</u>	

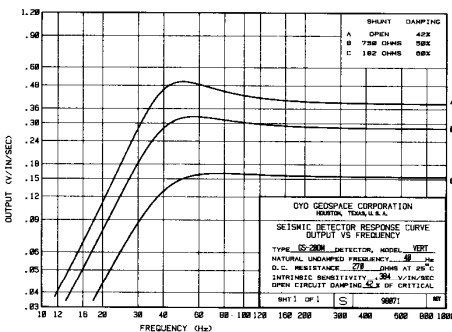
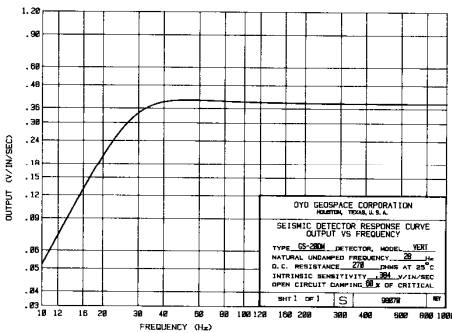
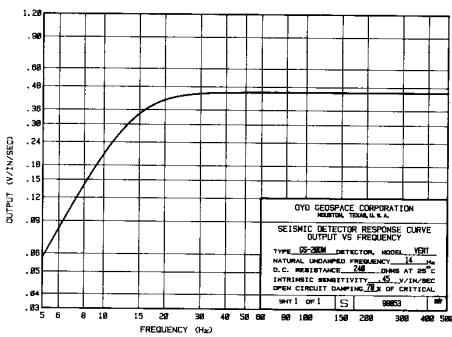
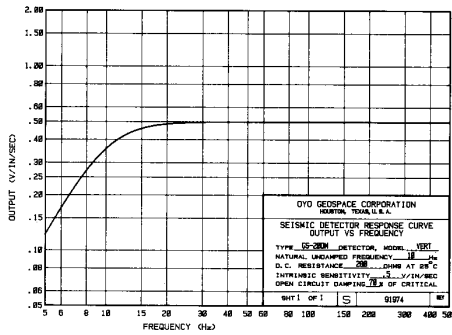
GEO SPACE		
SHEET 2 OF 3	S-480-00140-01	*



Optional Geophone Element Specifications

FREQUENCY RESPONSE CURVES

SPECIFICATIONS



(At 25° C)

	10 Hz	14 Hz	28 Hz	40 Hz
Natural Frequency (Fn) ± 5%	10 Hz	14 Hz	28 Hz	40 Hz
Maintains Fn Specifications to Tilt Angle of	20°	20°	90°	90°
Typical Spurious Frequency	>300 Hz	>400 Hz	>600 Hz	>850 Hz
Harmonic Distortion with driving velocity of 0.7 in/sec (1.8 cm/sec) P-P	<.2%	<.2%	<.2%	<.2%
Distortion Measured at	12 Hz	14 Hz	28 Hz	40 Hz
Maintains Specifications to Tilt Angle of	20°	20°	90°	90°
Open Circuit Damping (Bo) (for all coil resistances)	.70	.70	.60	.42
Standard Coil Resistance (Rc) ± 5%	280 ohms	240 ohms	270 ohms	270 ohms
Intrinsic Voltage Sensitivity ± 7%				
V/in/sec	.500	.450	.384	.384
V/cm/sec	.197	.177	.151	.151
Optional Coil Resistances (Rc) ± 5%	65 / 435	56	110	110
Damping Constant	1.37 Rc	.95 Rc	.43 Rc	.30 Rc
Normalized Transduction Constant				
V/in/sec	.030 √Rc	.029 √Rc	.023 √Rc	.023 √Rc
V/cm/sec	.012 √Rc	.011 √Rc	.009 √Rc	.009 √Rc
Moving Mass ± 5%	8.0g (.28oz)	7.8g (.28 oz)	5.6g (.20 oz)	5.6g (.20 oz)
Case to Coil Motion P-P				
Min	_____ 1 mm (.04 in) _____			
Max	_____ 2 mm (.08 in) _____			
Operating Temperature Range (°C)	_____ -45° to + 100° _____			
Dimensions				
Height	_____ 2.64 cm (1.04 in) _____			
Diameter	_____ 2.22 cm (.875 in) _____			
Weight	_____ 43 g (1.5 oz) _____			

KEY

Natural Frequency Fn
 Open Circuit Damping Bo
 Coil Resistance Rc
 Shunt Resistance Rs
 Sensitivity G
 Total Damping Bt = $\frac{\text{Damping Constant}}{Rs + Rc} + Bo$

Specifications are subject to change without notice.

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