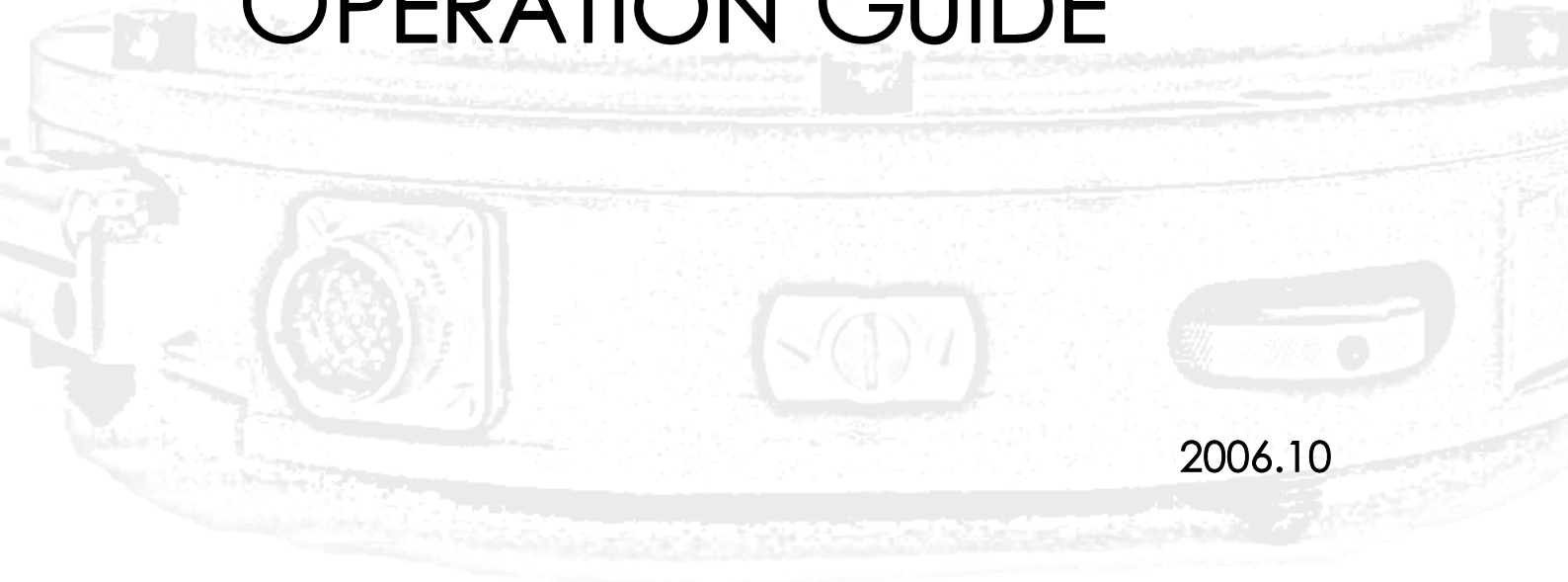
Geodevice

Beijing Gangzhen M & E Technology Co.,Ltd

BROADBAND SEISMOMETER

BBVS-60

OPERATION GUIDE



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Foreword

- Thank you for purchasing BBVS-60 Broadband Seismometer newly designed by Geodevice.
- At the beginning of using BBVS-60 Broadband Seismometer, we advice you read this Operation Guide carefully to ensure your operation is proper and efficient.
- You will not enjoy the guarantee service if the malfunctions or damages are caused because of not complying with the provisions in this Operation Guide or refiting without the permission of Geodevice in the process of using BBVS-60 Broadband Seismometer.
- Corrections of the typographical errors or inaccurate information in this Operation Guide and improvements to the instrument or its parts will not be notified specially. However, these changes will be upgraded in the new version of the Operation Guide.
- The information in this Operation Guide is proprietary to Geodevice and may not be copied or distributed outside the approved of Geodevice.

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1. Quick Use Guide

1.1 Introduction

The BBVS-60 newly designed by Beijing GangZhen M&E Technology Co., Ltd is a force-balance feedback broadband seismometer. It is integrated together with 3 independent sensors and the electronic circuit boards is built-in including control circuit, power-conversion circuit and feedback circuit. Low self-noise, large dynamic range, quick installation and easy use feature BBVS-60 Broadband Seismometer.

The main characteristics of BBVS-60 are as follows:

- Stable force-balance electronic feedback system is used;
- Frequency range is 60sec~40Hz with flat velocity response;
- Self-noise is lower than the NLNM in the range 60sec ~10Hz;
- Outer mechanisms is designed for locking/unlocking the mass;
- It owns the functions of auto-adjusting and remote-adjusting of the mass position;
- It's supplied by single +12V DC with low power consumption;
- Connector pinouts are the same as FBS-3B's and BBVS-120's (made by Geodevice).

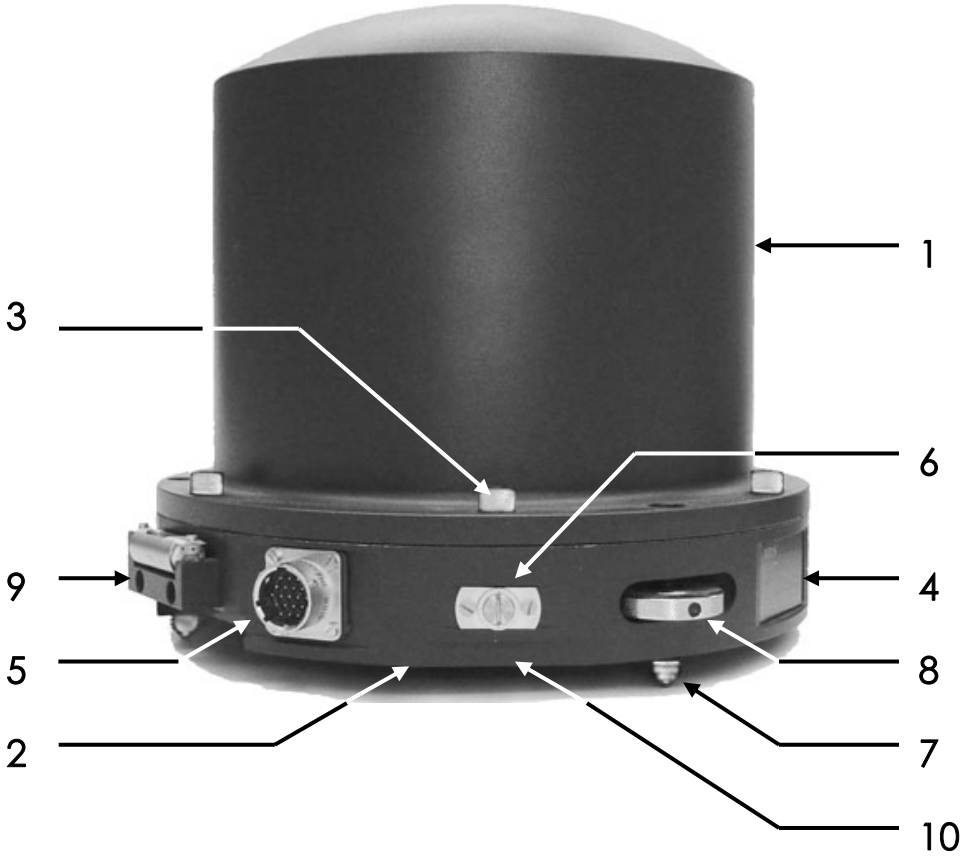


Figure 1 Appearance of BBVS-60 Broadband Seismometer

1. Cover
2. Base
3. Fixing Screw(6 in all)
4. Nameplate
5. Interface Socket
6. Locking/unlocking Screw(3 in all)
7. Adjustable Foot(3 in all)
8. Locknut Ring(3 in all)
9. Bubble Level(2 in all)
10. Orientation Plane

1.2 Transportation

After we make sure that all 3 masses of BBVS-60 have been locked accurately and put the seismometer into the special shock -absorbing package, various vehicles including plane, train, ship or truck are adopted for the transportation, but do not place the package of BBVS-60 lateral or inverse.

CAUTION: *Please be careful when moving BBVS-60, because the mechanical and electronic components are so exact that can not endure huge impact and vibration. Be sure the slots of 3 locking screws have been turned to vertical condition before movement.*

NOTE: *See details about locking the mass on Page 14.*

1.3 Environment Required

The frequency range of BBVS-60 is from 40Hz to 60sec, so the working environment should meet the requirement for observation towards short, mid and long period seismic waves.

(1) The mounting surface should be clean, near-horizontal and well coupled to the bedrock;

(2) A windtight shield outside the seismometer is recommended to protect against temperature variation and atmospheric changes. A

desiccant capsule should be trapped inside the shield in order to absorb any moisture.

(3) Avoid the influence done by human beings, such as vibration or large sound wave impact.

(4) Magnetic sources should not be placed nearby because it may cause noise and interfere the normal observation.

1.4 Installation

1.4.1 preparation

Before the installation it is recommended to prepare everything ready, such as the mounting surface, the windtight shield, the special cable, and a EDAS-24IP Digitizer (made by Geodevice) including +12V DC power supply or other data acquisition devices which support BBVS-60's remote-monitoring and remote-control functions.

Take BBVS-60 Broadband Seismometer out from the package and examine whether the outside parts such as the bubbles and the adjusting feet are all right and do the followings as long as everything is OK.

1.4.2 Orientation

Move BBVS-60 Broadband Seismometer on the mounting surface.

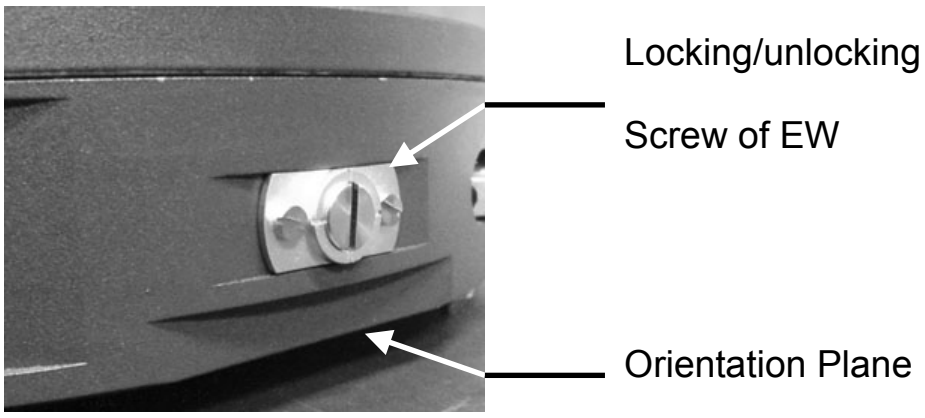
CAUTION: *Please be careful when moving BBVS-60, because the mechanical and electronic components are so exact that can not endure huge impact and vibration. Be sure the slots of 3 locking screws have been turned to vertical condition before movement.*

NOTE: *See details about locking the mass on Page 14.*

Rotate the seismometer to direct the normal of the Orientation Plane aiming to Geography East, shown as Figure 3.

NOTE: *Find the Orientation Plane of the seismometer below the Locking/unlocking Screw of EW component, shown as Figure 2.*

Make sure that BBVS-60 is mounted stably, and 3 feet will not shift any more relative to the install surface, then do the next step.



Figue 2 Location of Orientation Plane

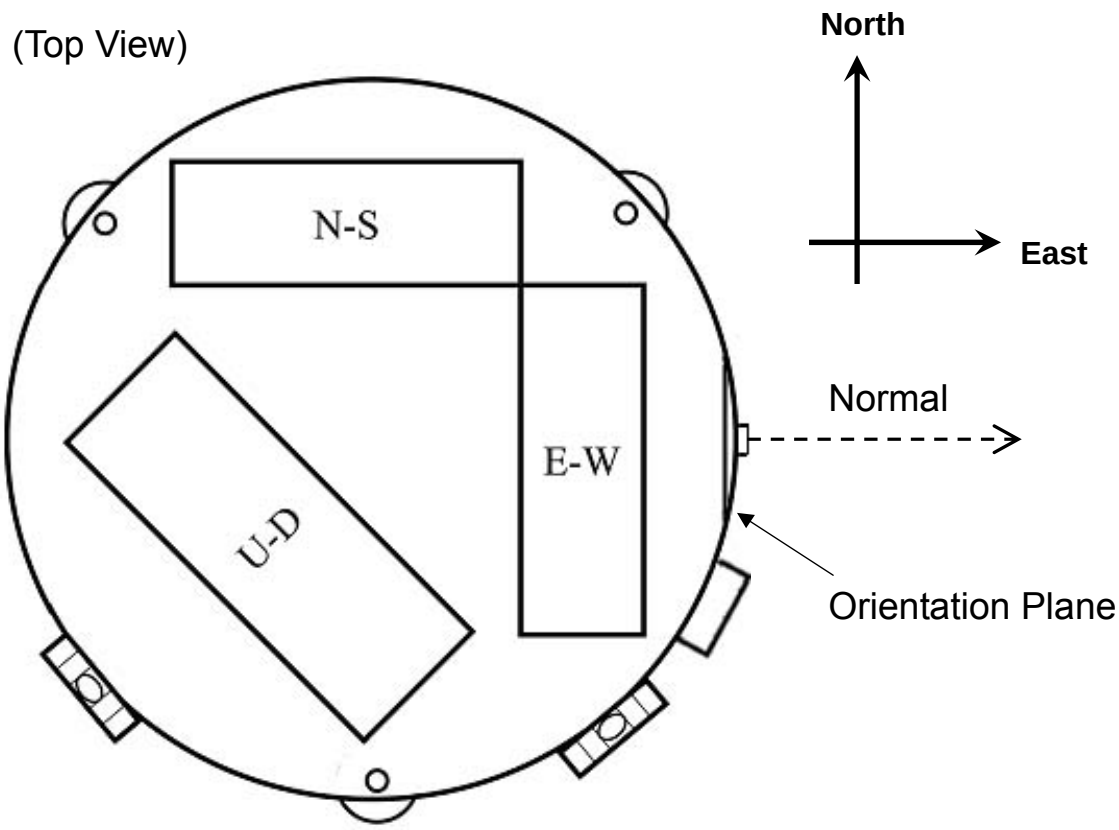


Figure 3 Orientation of BBVS-60

1.4.3 Leveling

Rotate 3 Adjustable Feet with a special screwdriver while take close look at the 2 bubble levels, and ture 3 Locknut Rings tight until both bubbles are in the middle position, shown as Figure 4.

NOTE: *Very small changes in levels will greatly affect the mass position of the horizontal components.*

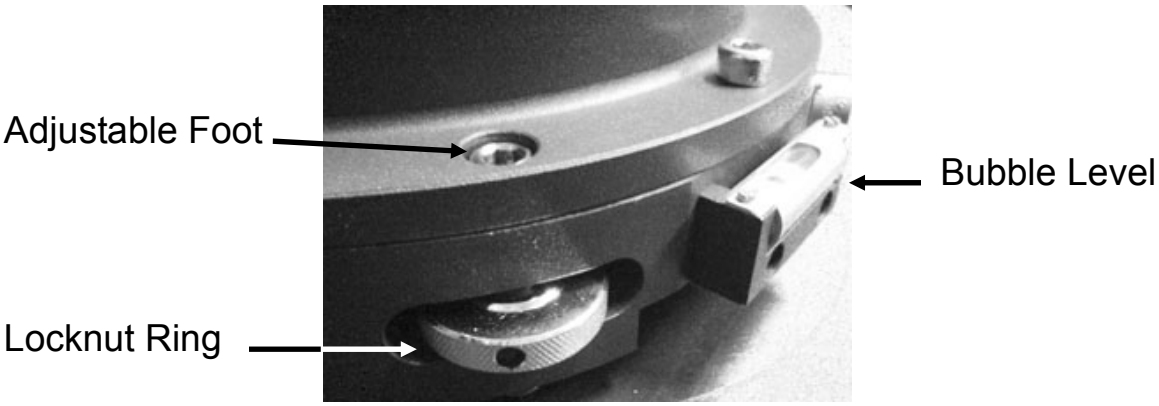


Figure 4 Leveling of BBVS-60

1.4.4 Unlocking

Turn 3 Locking/unlocking Screws clockwise or counter-clockwise 90 degrees with a flat-head screwdriver to make all 3 "▬" slots horizontal, shown as Figure 5.

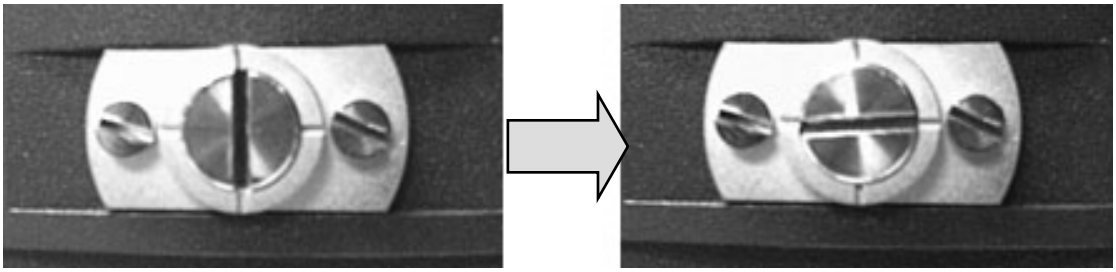


Figure 5 Unlocking the Mass

Make sure that masses of 3 components are all set free, then wait for BBVS-60 adjusting to the surrounding temperature before powering.

NOTE: *The length of waiting time lie on the difference between the temperature inside BBVS-60 and the environment temperature. A*

period longer than 5 minutes is recommended.

NOTE: *See details about locking the mass on Page 14.*

1.5 Connecting

Connect BBVS-60 to the digitizer (EDAS-24IP) with a standard 19-Pins cable.

NOTE: *The location of the Interface Socket is shown as Figure 6.*

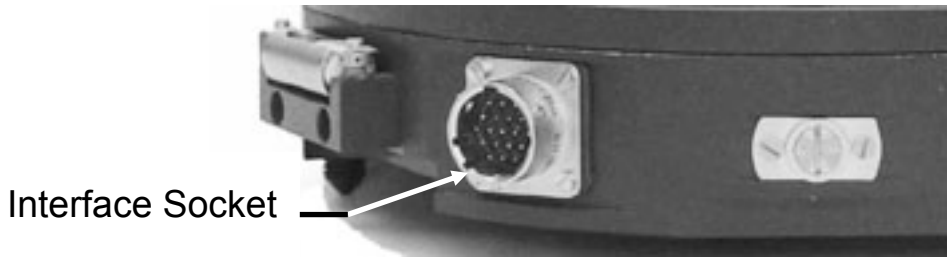


Figure 6 Location of the Interface Socket

CAUTION: *Do not connect BBVS-60 with an improper cable. Do not apply voltage beyond rated values to any inputs.*

CAUTION: *Although the connector pinouts of BBVS-60 is same as FBS-3 seismometer's, please do not use FBS-3's cable for present BBVS-60 because there are some different editions of FBS-3. If it is unavoidable, please check all lines carefully according to the Connector Assignment Table on Page 24 before use.*

Then connect power supply and portable computer to the digitizer

(EDAS-24IP). When everything is right, switch on the power of the digitizer (EDAS-24IP), at the same time BBVS-60 will also be powered and start auto-adjusting of the mass position.

1.6 Mass Position Auto-adjusting

A microprocessor circuit inside BBVS-60 afford the functions of mass position auto-adjusting. A auto-adjusting cycle is initiated by powering the seismometer, or sending a remote command from the digitizer (EDAS-24IP). 3 motors work in sequence for centering respective mass. During auto-adjusting, the seismometer's period will be switched to 1s to improve stability and reduce recentering time. After the auto-adjusting cycle ends, the period will return to 60s automatically.

NOTE: *See details of auto-adjusting flow chat on Page 18.*

NOTE: *An auto-adjusting cycle lasts about several minutes (less than 20 minutes) lie on the currenct practical mass position.*

CAUTION: *Before auto-adjusting, make sure that BBVS-60 has been leveled already and all masses have been unlocked correctly and no calibration is running.*

1.7 Calibration

Independent calibration coils of different components of BBVS-60 are used to examine or test its response.

Two kinds of calibration signals are commonly used:

(1) Step Signal (wide pulse signal in fact)

(2) Sine Signal

Generally speaking, step signal is usually used to check the self-resonant period of the seismometer, while sine signal is usually used to check its frequency characteristics.

NOTE: *Most digitizer used in earthquake observation (EDAS-24IP) can generally integrate programmable calibration signal generator for use of checking. See details of operation in relevant digitizer's manual.*

NOTE: *Setup calibration parameters practically according to the objects of examine or test, and get material data with proper processing softwares. See details of operation in relevant manuals.*

1.8 Remote Monitoring and Control

Real-time remote monitoring function is designed for BBVS-60, and the information of mass position can be acquired by user with the help of the digitizer (EDAS-24IP). The microprocessor inside BBVS-60 can receive the auto-adjusting commands from digitizer and then start a mass position auto-adjusting cycle automatically.

When the mass position of BBVS-60 occurs excursion because of temperature variation or other reasons, the functions of remote monitoring and control can self-modify the mass position, so that avoid unnecessary journeies.

NOTE: *See details of operation in relevant digitizer's manual.*

NOTE: *Some kinds of digitizer may not support this function such as EDAS-C24, EDAS-24L and other old editions.*

NOTE: *An auto-adjusting cycle lasts about several minutes (less than 20 minutes) lie on the currenct practical mass position.*

CAUTION: *Before auto-adjusting, make sure that BBVS-60 has been leveled already and all masses have been unlocked correctly and no calibration is running.*

1.9 Uninstallation

(1) Disconnect: Separate the cable from BBVS-60.

(2) Lock the mass: Turn 3 Locking/unlocking Screws clockwise or counter-clockwise 90 degrees with a flat-head screwdriver to make all 3 "—" slots vertical, shown as Figure 7. Make sure that all 3 masses are fixed.

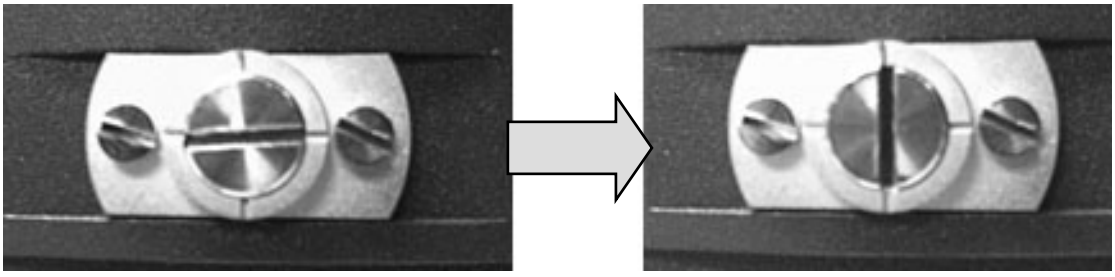


Figure 7 Locking the Mass

(3) Incasement: put BBVS-60 into the special shock-absorbing package.

2. General Information

2.1 Physical Description

3 mechanical sensors of vertical UD, horizontal EW and NS of BBVS-60 are mounted orthogonally on the circular base and the circuit boards are fixed above the masses. Special wires and sockets are used to connect the mechanical and electronic parts. The horizontal masses are garden-gate style, and the vertical one is lamina-reed style, making mechanical period up to 4 seconds. Each component has an independent mechanical organ for adjusting mass position which is driven by a motor and an independent mechanical structure which can lock or unlock the mass without opening the seismometer body. Accurate differential capacitor-displacement transducer and coil-magnet structure which produces feedback force are used on each component. 2 bubble levels, 3 adjustable feet for leveling and an orientation plane are all on the base. Waterproof seal technique is used in instrument crust and chassis as well as the output connector to prevent from humidity entering and to reduce the interference towards masses from barometric variation and air current.

2.2 Feedback System

Force-balance electronic-magnetic feedback system is used in BBVS-60. When ground motion is transmitted to seismometer frame, the relative displacement between the frame and the inertia mass will be converted into voltage signal which is proportional to the acceleration of the ground motion through a capacitor-displacement transducer after amplified. And it will be fed back to the coil-magnet structure and produce a force which is balanceable to the mass inertia force. As shown in Figure 8, the feedback network which mainly determines the closed loop transfer function of BBVS-60 is composed of capacitance differential, proportion and integral tracks. The differential output signal is proportional to the ground motion velocity. Output voltage of the integrator is positively proportional to the position excursion of the mass and can be used into auto-adjusting control circuit to modify the mass, and it is also connected to the socket of BBVS-60 to realize remote monitoring and control with the help of the digitizer.

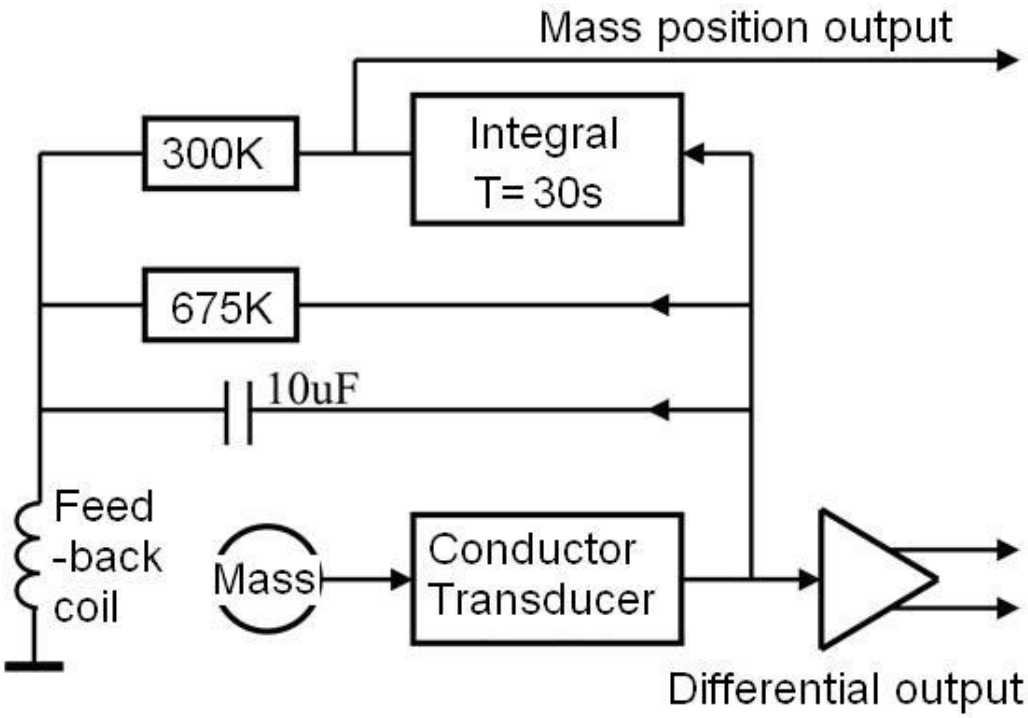


Figure 8 Feedback System of BBVS-60

2.3 Control System

2.3.1 Circuit Frame

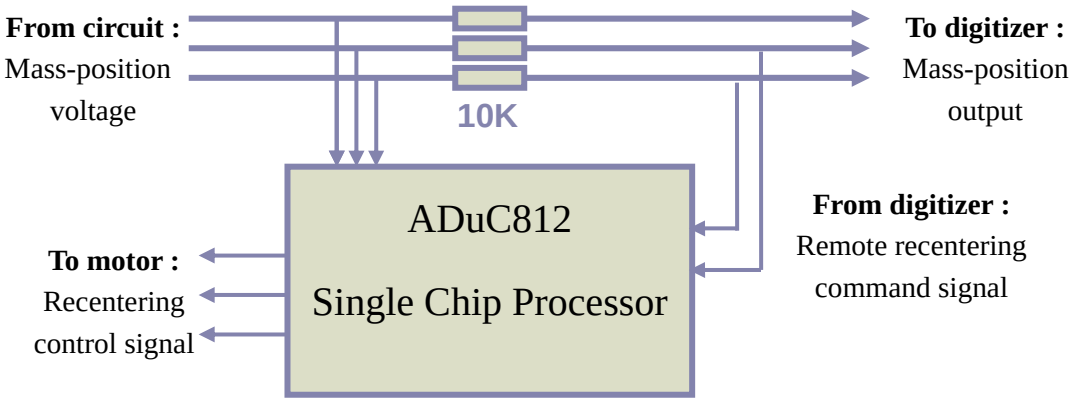


Figure 9 Circuit Frame of BBVS-60

2.3.2 Flow Chat of Auto-adjusting

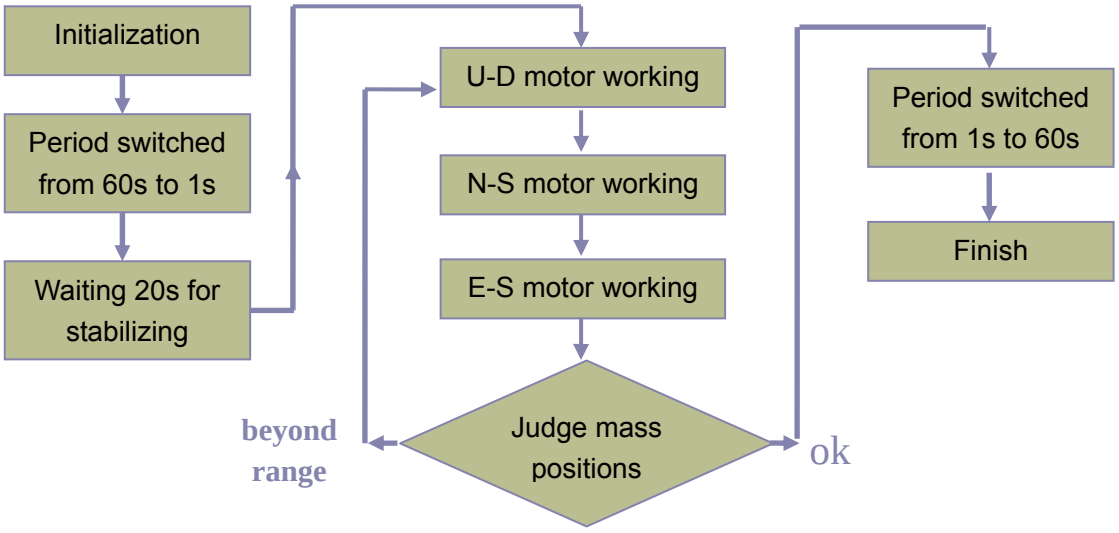


Figure 10 Flow Chat of Auto-adjusting

2.4 Transfer Function

The transfer function of BBVS-60 including its sensitivity is up to the test data attached in the product package. Whereas its nominal one is as follows:

(1) Expression:

$$H(s) = \frac{K \cdot A_0 \cdot s^2}{(s^2 + 0.14807s + 0.010966)(s^2 + 355.38s + 63165)}$$

Here：seismometer voltage sensitivity: K = 1000 V • S/m

Transfer function coefficient : A0 = 63165

(2) Zero-point and Pole-point list:

a. Zero-point number: 2

z1 = 0

z2 = 0

b. Pole-point number: 4

p1 = -0.07405 + 0.07405 i

p2 = -0.07405 - 0.07405 i

p3 = -177.72 +177.72 i

p4 = -177.72 - 177.72 i

2.5 Frequency Response

Figure 11 shows the Magnitude-frequency and Phase-frequency characteristic curves of BBVS-60, on which the horizontal axial unit is “Hz”, while the vertical ones are “dB” and “deg” respectively. Transfer Function in low frequency is consistent with that of traditional velocity-output seismometer which has 60sec natural period and 0.707 damping coefficient.

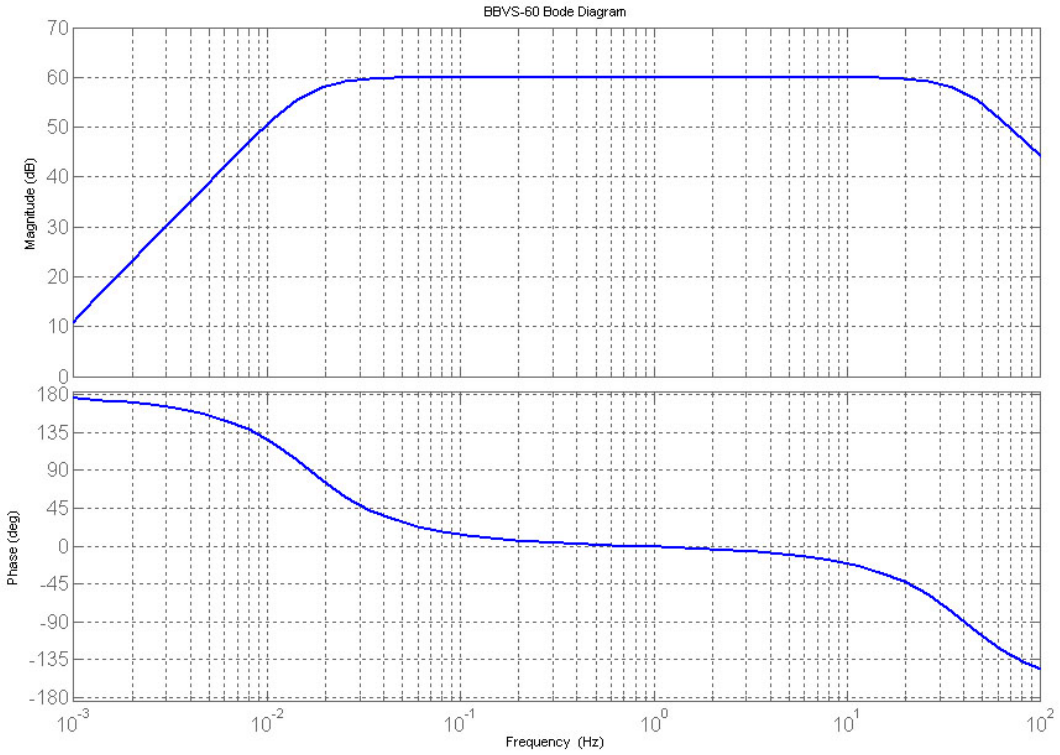


Figure 11 Frequecy Response of BBVS-60

3. Technical Specifications

3.1 Specifications

No.	Item	Specifications
1	**Sensor Type**	**3 component orthogonal, force-balance electronic-magnetic feedback**
2	**Frequency Range**	**0.0167Hz～40Hz (-3dB)**
3	**Sensitivity**	**1000V·S/m (Single end) 2000V·S/m (Differential output)**
4	**Output Signal**	**±10V (Single end) ±20V (Differential output)**
5	**Dynamic Range**	**Better than 140dB (5Hz)**
6	**Output Impedance**	**Less than 100Ω**
7	**Calibration**	**Coil resistance 70Ω, sensitivity 10V·s/m**
8	**Distortion**	**Less than -80dB**
9	**Cross Axis Coupling**	**Better than 10^{-2}**
10	**Autoeciousness Resonant Frequency**	**Higher than 100Hz**
11	**Power Supply**	**DC +12V（9V～18V）**
12	**Temperature**	**-20°C~+50°C**
13	**Encapsulation**	**Waterproof seal to ensure the normal work of relative humidity higher than 98%**
14	**Transportation packaging**	**Aluminum Alloy case with multi-layer anti-shake inner liners**
15	**Dimensions**	**Max Diameter ϕ240mm, Max height 270mm**
16	**Weight**	**Net 12kg, Gross 16kg (including packaging)**

3.2 Self-noise & Clip Level

Figure 12 shows the noise power spectrum of BBVS-60 and at the same time gives the BBVS-60 clip level as well as the New Earth Low Noise Model (NLNM).

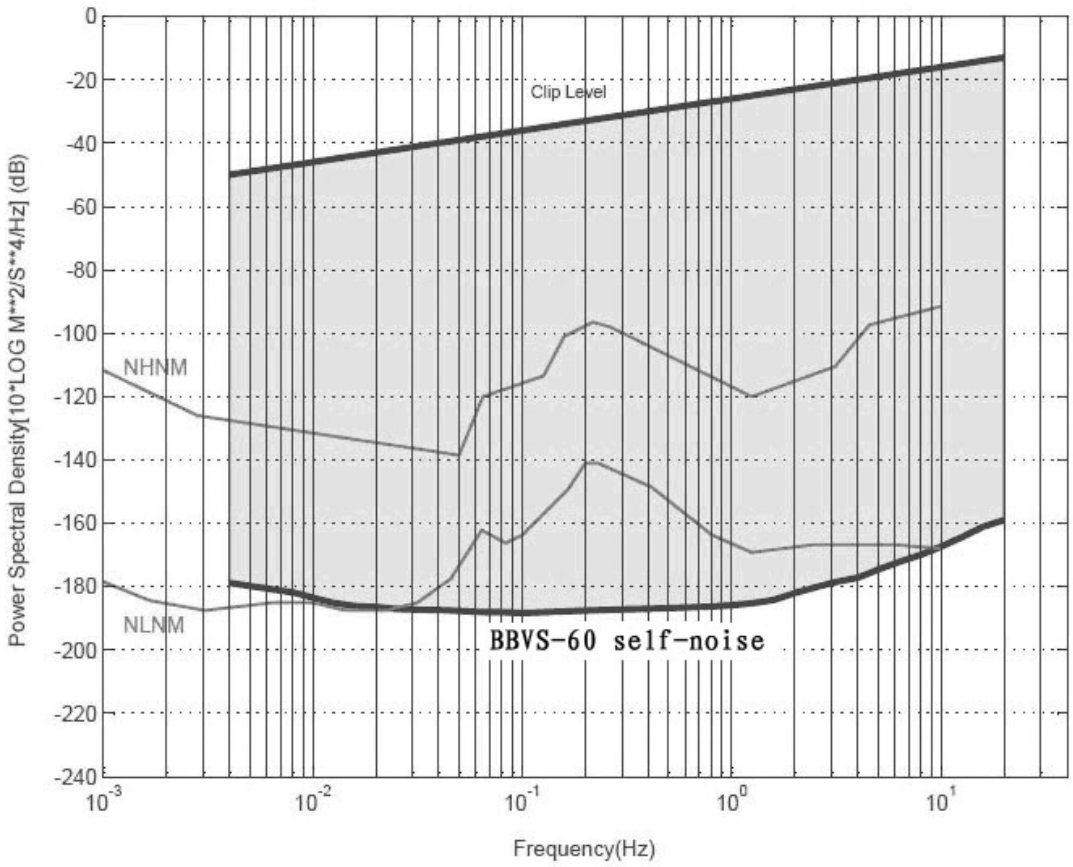


Figure 12 Noise Power Spectrum of BBVS-60

Connector Assignment

The assignment of BBVS-60's output connector is basically in accordance with the requirements of relative chapter and section of Seismological Industry Standard DB/T 13-2000《Seismometer Connection》, and also basically compatible with FBS-3B, the former product made by Geodevice.

The connector pin locations are shown as Figure 13.

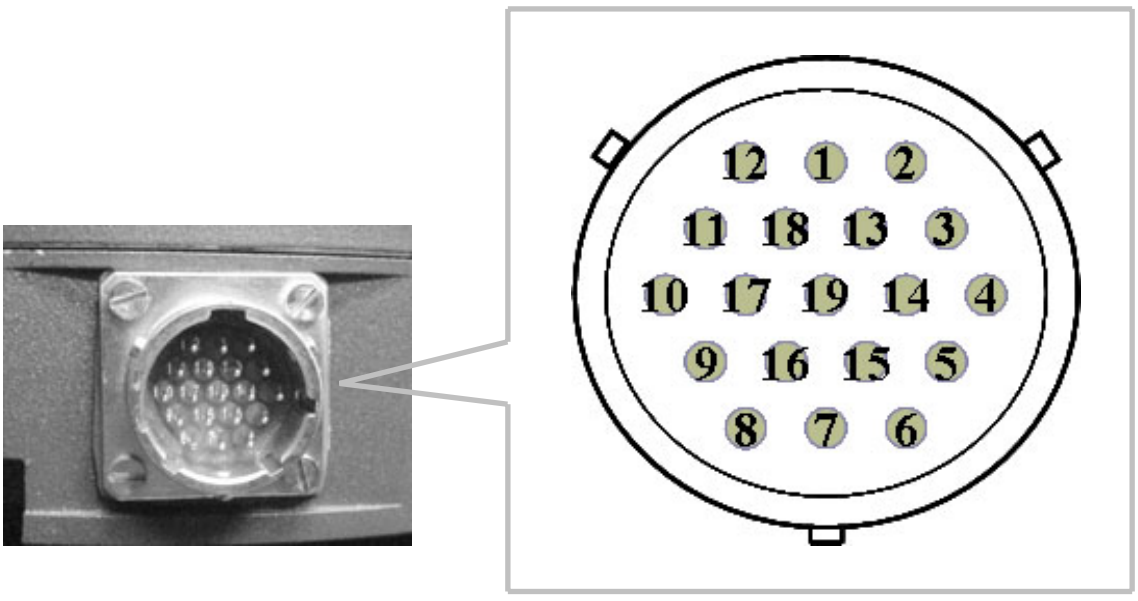


Figure 13 Pin Location Map

The assignment of BBVS-60's output connector is as the following:

Connector Assignment Table

No.	Contents	Pin No.
1	E-W positive signal output (+)	18
2	E-W negative signal output (-)	13
3	N-S positive signal output (+)	16
4	N-S negative signal output (-)	15
5	U-D positive signal output (+)	12
6	U-D negative signal output (-)	2
7	E-W calibration coil positive end (+)	11
8	E-W calibration coil negative end (-)	3
9	N-S calibration coil positive end (+)	9
10	N-S calibration coil negative end (-)	5
11	U-D calibration coil positive end (+)	6
12	U-D calibration coil negative end (-)	8
13	Power supply (+)	10
14	Power Ground	4
15	Signal Ground	1
16	EW mass position output/Command TST input *	17
17	NS mass position output/Command CMD input *	14
18	UD mass position output/Command WST input *	19
19	Shield Ground(connected to chassis)	7

* Note： The output impedance is 10K Ohm so that the digitizer can be driven in opposite direction in order to deliver the control command towards seismometer