Very-Broad-Band Feedback Seismometers

STS-1V/VBB / STS-1H/VBB

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The STS-1V/VBB and STS-1H/VBB seismometers are highly sensitive, remotely controlled seismic sensors for observatory use. Their extremely high dynamic range and their stable transfer characteristics make them ideal for a wide range of applications. The basic response of the instrument is flat to ground velocity from 0.1 to 360 sec period. The whole spectrum of teleseismic signals, from 0.1 sec to about 1 hour period, is resolved in the output signal and can be recorded in a single digital data stream when a suitable digitizer is used.

The sensors can be converted to a free period of 20 sec with internal jumpers. Except for the upper corner frequency which is 10 Hz in place of 5 Hz, the response is then identical to that of the 20 sec STS-1V and STS-1H seismometers.

THE STS-1V/VBB / STS-1H/VBB SEISMOMETERS OFFER

- HIGHEST DYNAMIC RANGE
- RESOLUTION OF GROUND NOISE FROM SHORT PERIODS TO THE FREE-MODE BAND
- A SIMPLE AND STABLE TRANSFER FUNCTION THAT DOES NOT NEED TO BE ADJUSTED AFTER INSTALLATION
- PRECISE CALIBRATION BY THE MANUFACTURER
- INEXPENSIVE SURFACE INSTALLATION
- ELECTRONICS SEPARATE FROM THE MECHANICAL SENSOR, I. E. ALWAYS ACCESSIBLE
- REMOTE POSITION CONTROL AND MASS CENTERING
- SELF-TEST MODE (FREE ELECTRICAL OSCILLATIONS OF THE CLOSED-LOOP SYSTEM)
- SHIELDING AGAINST ENVIRONMENTAL DISTURBANCES

Principle of Operation

The STS-1V/VBB / STS-1H/VBB seismometers are force-balance seismometers. This design principle is now more or less standard in high-performance seismometers, and means that the boom is always kept close to its center position by an electrically generated restoring force. While in conventional seismometers the deviation of the boom from its center position measures the seismic signal, in a force-balance seismometer the output signal is derived from the electric voltage or current that is required to keep the boom centered. In this way problems of linearity, dynamic range and stability are transferred from the mechanical system to the electronic feedback circuit where they are much easier to solve. Only the resolution still depends on the mechanical part.

Our sensors are small but massive long-period pendulums with an inertial mass of 600 g. The boom position is sensed by a displacement traducer of the differential-transformer type (LVDT). A combination of integral, proportional and differential feedback force is generated by sending appropriate currents through two moving-coil transducers. A great variety of transfer functions can be realized in this way, but not all of them are equally favourable in terms of dynamic range. We chose a transfer function whose mathematical form is already familiar to seismologists, namely that of a 360 sec long-period seismometer combined with a 0.1sec short-period recording galvanometer or low-pass filter.

The Mechanical Design of our Sensors

As horizontals we use simple "garden-gate"pendulums of about 10 cm boom length, with an almost vertical axis of rotation defined by two pairs of crossed hinges. Due to the massive construction they are virtually free of parasitic resonances. The horizontals are centered by moving up or down one of the three legs under remote control.