Proposed specifications for a new primary VBB vault seismometer for the GSN

IRIS Instrumentation Committee **November 16, 2010**

The specifications given in this document assume that the sensor is a traditional force feedback system with three analog outputs which are digitized outside of the seismometer. We will consider other technologies if the resulting sensor/system has comparable (or improved) bandwidth, dynamic range, noise performance, and physical characteristics as the sensor described below.

#	Specification Type	Specification Name	Proposed Specification	Comment
1	Operating	Components	Must produce 3 orthogonal outputs	U,V,W axis arrangement is also known as "cube-corner geometry" or "triaxial."
2	Operating	Frequency of Parasitic Resonances	>100 Hz	no comments
3	Operating	Accuracy of case alignment marks compared to sensing axes	≤0.6 degrees	no comments
4	Operating	Output Seismic Signal	If analog output, ±20 V, differential, one output for each axis, flat response to earth velocity	If sensors are U, V, W axes, outputs shall be selectable between U,V,W and Z,Y,X
5	Operating	Output Impedance of Output Seismic Signal	If analog output, ≤125 ohms, each line to system ground	no comments
6	Operating	Maximum Ouptut Current of Output Seismic Signal	Greater than ±1 mA	no comments
7	Operating	Maximum Offset of Output Seismic Signal	±100 mV	no comments
8	Operating	Offset of Output Seismic Signal vs. Temperature	≤10% full scale/°C	no comments
9	Operating	Polarity of Output Seismic Signal	Positive for earth motion UP, NORTH, EAST	Assumes that horizontal axes (or derived horizontal signals) are aligned North-South and East-West. For U, V, W outputs, all three should produce positive voltage for earth motion UP.
10	Operating	Minimum flat (within 3 dB) velocity response band	-3 dB pts: 0.00278 to 10 Hz required (50 Hz prefered)	Response to earth velocity at frequencies lower than 0.00278 Hz shall fall off at no more than 12 dB/octave.
11	Operating	Sensitivity at differential output (V/m/s)	At least 1200 required (1500 preferred)	no comments
12	Operating	Noise level	≤GSNNM 0.0005 to 2 Hz (req) 0.0005 to 10 Hz (desired) (Berger etal 2004)	no comments
13	Operating	Clip level (peak)	≥20 volts	no comments
14	Operating	Clip Recovery Time	≤ 30 minutes required (≤5 minutes desired)	This is the amount of time it takes for the output voltage to become a linear representation of input ground motion after the output gets saturated by strong ground motion.
15	Operating	Dynamic Range, 0.01 to 0.05 Hz	≥150 dB	no comments
16	Operating	Dynamic Range, 1.0 to 10 Hz	≥150 dB	no comments
17	Operating	Total Harmonic Distortion (THD)	≤-60 dB	no comments

#	Specification Type	Specification Name	Proposed Specification	Comment
18	Operating	Mass position outputs	±3 to ±10 volts Required for all three components. May be single-ended.	prefer +/- 10 V
19	Operating	Mass centering	Shall occur upon application of a mass centering signal (+5V).	no comments
20	Operating	Seismometer Module Control Inputs	Active high logic levels to enable or initiate mass lock/unlock, module leveling,calibration, and/or mass centering, as appropriate.	Logic High is defined as +5V relative to ground.
21	Operating	Calibration Input	Calibration input required, with capability to calibrate each component separately or all three simultaneously. Calibrator input sensitivity: Shall produce an equivalent ground velocity or acceleration known to within 1% and shall be sufficient to drive seismometer output to at least 75% of full scale at 0.1 Hz with a current of ≤0.4 mA peak at ≤5 V peak.	no comments
22	Operating	Calibration Enable	Calibration Enable: Separate cal enable line for each component.	When calibration is not enabled, the calibrator input shall be disconnected.
23	Operating	RFI Susceptibility	RFI performance shall be tested per IEC61326:2002, including EN55022 for emissions, EN61000-4-3 for immunity, and Annexes A, C, E, and F, which detail equipment types and usage circumstances.	no comments
24	Operating	Magnetic susceptibility	Less than 0.003 m/s^2 per T	no comments
25	Operating	Input Power Voltage Range	10 to 30 VDC unipolar	no comments
26	Operating	Common Mode on Output	if analog ≤1 volt	no comments
27	Operating	Sensor Ground	Sensor ground shall not depend upon electrical contact with a grounding point within the seismometer vault	no comments
28	Operating	Power Consumption	≤10 watts	no comments
29	Operating	Mean Time Between Failures (MTBF)	≥ 20 years	Submit evidence on how this is measured.
30	Environmental	Operational Temperature Range	-20°C to +60°C (required) -20°C to +80°C (desired)	no comments
31	Environmental	Storage Temperature Range	-55°C to + 85°C	For outdoor storage in polar and desert regions.
32	Environmental	Temperature range over which no mass centering required	±2°C change from average operating temperature	no comments
33	Environmental	Levellng capability	Seismometer modules shall be capable of being levelled when installed on pier surface up to 2° from horizontal and remain orthogonal	no comments
34	Environmental	Corrosion resistance	Will withstand exposure to typical seismic vault environments (100% humidity, condensing)	no comments
35	Physical	Case shape	Not specified	no comments
36	Physical	Maximum footprint	1m x 1m desired (smaller or more portable is better)	no comments
37	Physical	Maximum height	Not specified	no comments
38	Physical	Maximum weight	Not specified	Prefer installable by two people maximum
39	Physical	Attachment for lifting	Not specified	no comments
40	Physical	Submersion	Not specified	no comments
41	Physical	Vibration and shock	Shall survive normal international shipment, field transit, and installation. Shall survive 25g on any axis.	no comments
42	Physical	Shipping container	Sufficient to withstand normal methods of international shipment and to protect instrument from its maximum specifed shock rating.	no comments

#	Specification Type	Specification Name	Proposed Specification	Comment
43	Documentation	Documentation	Fully detailed documentation, including user's manual	Would also like to get schematics, unless these are considered to be proprietary
44	Operating	Retrievable sensor parameters	Manufacturer name, model number, serial number, and factory calibration parameters sufficient to reconstruct the sensitivity and transfer function of that particular sensor.	no comments
45	Operating	Remote lock/unlock capability	Capability to remotely command sensor to lock or unlock masses (if masses can be locked and unlocked).	no comments
46	Physical	Module Interchangeability	Electronic and mechanical modules shall be interchangeable between sensors	no comments
47	Physical	Handling equipment	Not specified	no comments
48	Physical	Orientation reference	Supply a mechanical means or flat surface on the seismometer case to orient the seismometer to a geographic reference direction	no comments
49	Diagnostic	Reporting of critical operational environmental characteristics (eg. internal pressure, temperature, humidity)	Supply a means of remotely monitoring and reporting (to the user's data logger) environmental parameters that are critical to sensor operation	May be reported in a way similar to boom position