1 Introduction

The VolksMeter II is a Seismometer / Tiltmeter. It is based on a unique, patented sensor technology that provides low frequency capabilities not found in *any* other seismometer, at a fraction of the price of conventional broadband force-feedback instruments. The VolksMeter requires a dedicated support computer (Windows XP, 2000 or Vista) to perform data logging, display, analysis and, optionally, networking.
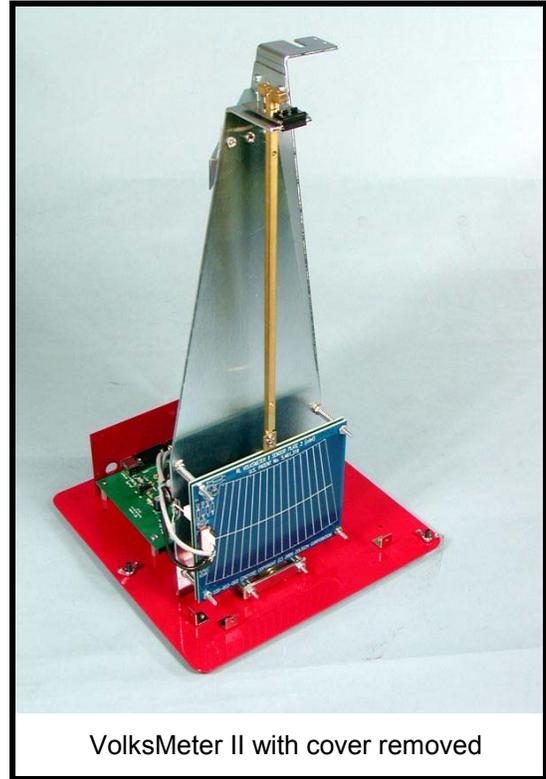
The VolksMeter is appropriate for use in geophysical research, education and by the amateur seismologist.

Performance/Capabilities
● Detects and measures local and teleseismic earthquakes
● New window on VERY-LOW-FREQUENCY earth motions
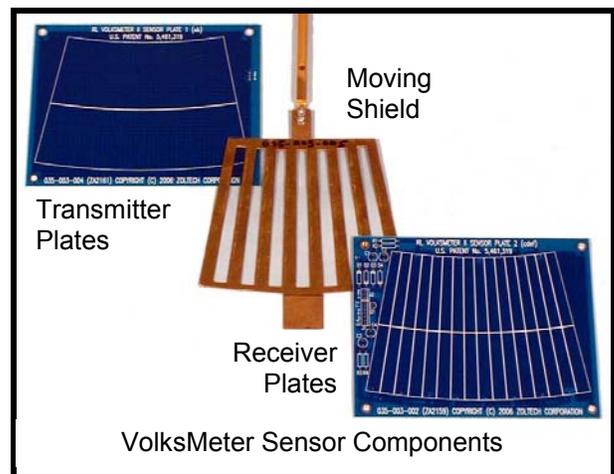● Sensitive Tiltmeter
● Optional GPS-based time standard

VolksMeter II with cover removed

Powerful, User-Friendly Software
● WinSDR for data acquisition & recording
● WinQuake for display & analysis
● Easily generate TRUE power spectral densities (2Q-2007)

Moving Shield

Transmitter Plates

Receiver Plates

VolksMeter Sensor Components

The VolksMeter uses a unique, patented[*], Symmetric Differential Capacitor (SDC) array

* U.S. Patent Number 5,461,319

VolksMeter II, RS232-C & USB I/O, with cover in place

sensor to detect and measure minute accelerations and tilts. The sensor consists of two fixed printed circuit boards holding the transmitting and receiving capacitor plates and a moving faraday shield array, mounted on the end of a pendulum. When subjected to accelerations or tilts, the shield array on the pendulum moves relative to the fixed plates and changes the amount of receiving plate that is exposed to or shielded from the transmitting plates. This, in turn, changes the overall capacitance of the sensor. A magnetic eddy damper, located below the sensor plates, damps oscillations of the pendulum. A direct Capacitance-To-Digital-Converter (CDC) chip converts the current capacitance of the sensor array to a 24-bit number. An interface board in the VolksMeter controls the CDC chip and formats the acquired data for transmission to the support computer.


Interface board

1 or 2 CHANNELS
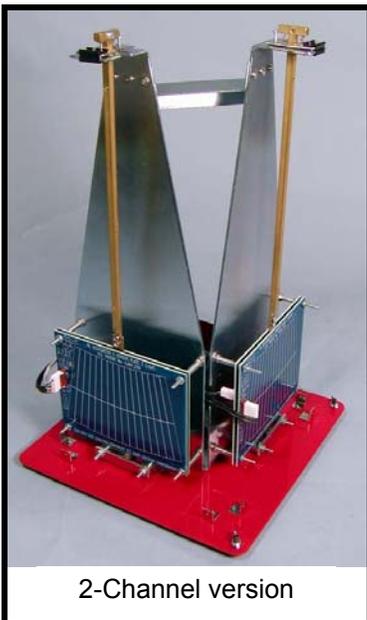
2-Channel version

The VolksMeter is available in 1 or 2-channel versions. If ordered in the 2-channel version, the two sensor arrays are mounted at a 90° angle to each other, and thus can provide useful correlation information or tilt in two dimensions.

INTERNAL AIR CURRENTS

In order to minimize convective air currents within the VolksMeter case that could cause spurious movement of the sensors, a block of insulating material is mounted above the Interface Board.
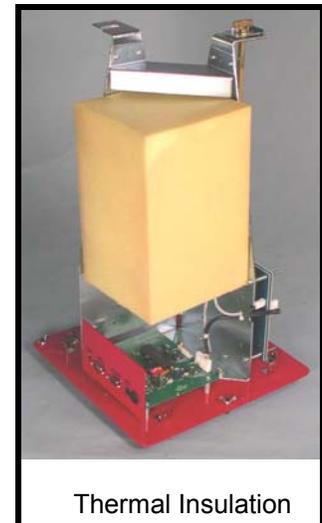
Thermal Insulation

SUPPORT COMPUTER

A user-supplied support computer is required to provide control and data logging (at a minimum) for the VolksMeter. A PC running MS Windows XP, Windows 2000 or Vista is required to run the software supplied with the VolksMeter (Windows 95, 98 and ME are reported to work but are not supported). The PC requires a CD-ROM (to load the software) and a USB or RS232-C port (to connect to the VolksMeter). Networking operations require a network interface (usually ethernet) and network connection. Normally, the PC should be dedicated to the VolksMeter, but a multi-tasking system that is capable of accepting a data packet every 200mS from the VolksMeter will work. If the PC is not ready to accept the data packet when the VolksMeter sends it, gaps in the data record will result.

INSTALLATION CONSIDERATIONS

The VolksMeter may be installed on any hard, flat surface with a good connection to the earth. While an isolated pier is ideal, the VolksMeter performs well on ordinary concrete slabs. For demonstration purposes, hardwood floors and even solidly built tables or lab benches have been used successfully. For best results, the VolksMeter should be protected from air currents, radical temperature changes, and local sources of electrical and mechanical disturbance. After the VolksMeter has been positioned, you must perform leveling by adjusting screws on the Base Plate. Leave room around the

Typical Installation

VolksMeter to access these leveling screws. Because of cable length limitations, the support computer must be located within 10 feet of the VolksMeter (a USB Booster may be used to increase this distance). The support computer may be controlled and monitored from a remote location via LAN (typically ethernet-based) and/or TCP/IP over the Internet using standard remote-access software.

ELECTRICAL POWER

Operation of the VolksMeter requires 9-24VDC. A 110VAC input power adapter is included. The VolksMeter may be run on 12V battery power but the support computer must also be powered. An optional upgrade to a universal input (90-264VAC @ 47-63 Hz) is available if 110VAC is unavailable. The part number is **VMII-UACA**.

POWERFUL, USER-FRIENDLY SOFTWARE

The software supplied with the VolksMeter consists of two primary components: WinSDR and WinQUAKE. WinSDR provides control, data display, and data storage functions. WinQUAKE provides data analysis, processing and formatting functions. The software package also includes USB drivers, if required.

The version of WinSDR that is supplied with the VolksMeter has been specially modified to control and acquire data from the VolksMeter instrument. It supports data resolutions from 16 to 24 bits per sample. One or two channels (with integrated pseudo-channels) may be collected at sample rates from 10 to 80 samples per second. RS232-C and USB connections are supported. WinSDR offers pre-processing of the data in the form of signal averaging, low and high-pass filtering and event triggering. Collected data may be displayed in real-time, either in helicord or single channel formats. Data may be time-stamped precisely using an optional GPS-based time standard (see below). Data may be saved in a variety of formats, including PSN, SAC Binary and MiniSeed with Steim 2 encoding. Data files are automatically saved to disk for post-event analysis. Data files may be automatically uploaded to an FTP server. TCP/IP Server/Client mode and MiniSeed Data Server functions are supported. Data may be sent to the USGS Earthworm Seismic Processing System.

WinQUAKE reads the data files output by WinSDR (as well as other sources of seismic data) and provides a variety of signal processing, analysis, data display and data conversion functions. These functions include calculating the event distance and magnitude. The frequency spectrum (FFT) of a data set may be calculated and displayed as well as the true Power Spectral Density (PSD). Highpass, lowpass, notch and bandpass filtering may be applied to a dataset. Data files may be converted between Public Seismic Network (PSN), Binary SAC and ASCII formats. There are many other seismic data processing functions: See www.seismicnet.com for more information.

OPTIONAL GPS TIME STANDARD

The VolksMeter is equipped to use an optional GPS-derived time standard that provides a clock that is accurate to ±5mS. This is useful in teleseismic research where knowing the precise time of a seismic wave arrival is critical. The GPS unit consists of a GPS Receiver and 16 foot (5m) long RS232-C cable that plugs into the GPS port on the VolksMeter. The cable may be extended if necessary, since the data rate is low. The GPS
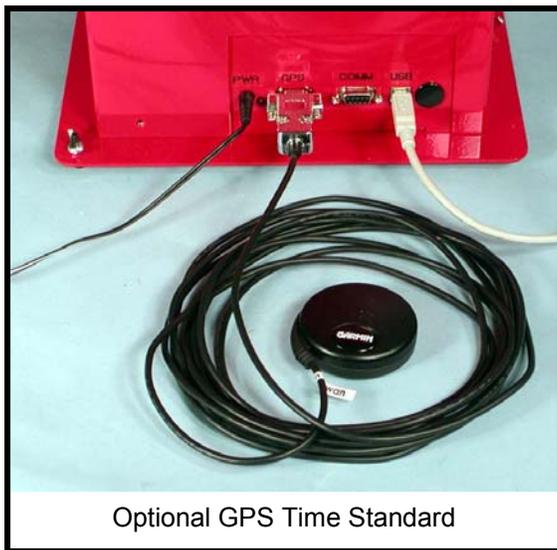

Optional GPS Time Standard

Receiver also provides a precise location (latitude, longitude and altitude) for the VolksMeter (more specifically, the GPS Receiver, which may be positioned some distance from the VolksMeter itself). In the absence of the GPS option, the time stamp for instrument data is derived from the support computer, which may be off by seconds or more, depending on how the computer clock is set. The part number of the GPS clock option is **VMII-GPS**.

PERFORMANCE

The figures in the next column compare the integrated (pseudo-velocity) output of a VolksMeter to a broadband STS-1 for the same teleseismic earthquake (Mag 6.6, >3850km from both instruments). The VolksMeter is detecting horizontal motion while the STS-1 is detecting vertical motion. The VolksMeter is somewhat less

Comparison of teleseismic response of VolksMeter II to traditional broadband instrument (STS-1). Hawaii earthquake of 15-Oct-06, Mag 6.6
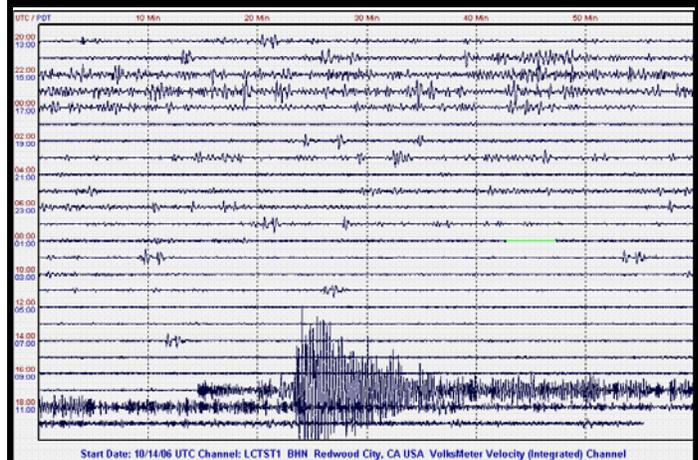
VolksMeter II (integrated) record, Redwood City, CA

STS-1 record, no filter, USGS Corvalis, OR
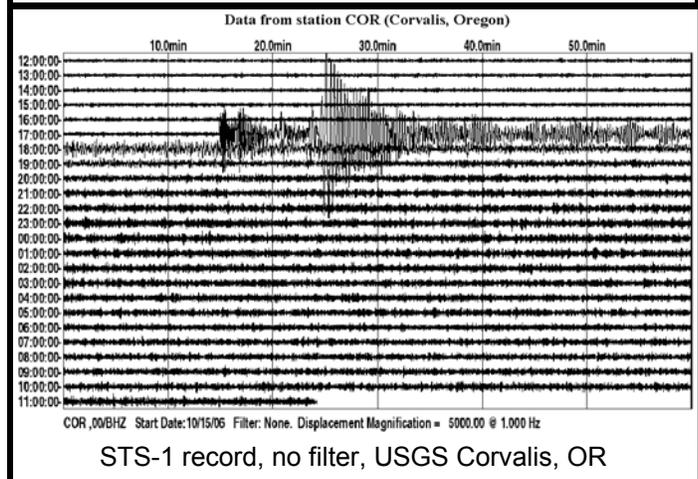
sensitive to teleseismic events than broadband force-feedback instruments such as the STS-1 or –2 (-150dB vs –180dB), but as the above records show, it can still be effective with a sufficiently strong signal in a low-noise environment.

The VolksMeter is superior to all instruments that use velocity sensors in two respects: 1) There is no loss of information associated with position or tilt offsets, and 2) Free earth oscillations.

Additional information regarding performance of the VolksMeter II is available at our website: **http://www.rllinstruments.com**

SPECIFICATIONS

Configuration: 1 or 2 horizontal channels, pendulum with Symmetric Differential Capacitive sensors

Outputs, Acceleration/Tilt/Time stamp Data
    Direct digital connection (RS232-C or USB) to support computer

   Sensitivity, Acceleration: 1 part in 16.7 million across a range of ± 0.0034g
    Sensitivity, Tilt: 1 part in 16.7 million across a range of ±3.55mRad (±2°)
    Dynamic Range: >140dB

    Bandwidth: ~40Hz to DC   Natural frequency, f_0: 0.92Hz

Note: Sensitivity (resolution) is inversely proportional to sample rate. For 40Hz max., a sample rate of 80 samples per second is required. At this sample rate, only 15 bits (1 part in 32,000) resolution is available due to noise considerations, for full 23-bit + sign resolution (1 part in 16.7million) the sample rate must be limited to 10 samples per second or less. At a 10 s/sec rate, the maximum frequency is 5Hz
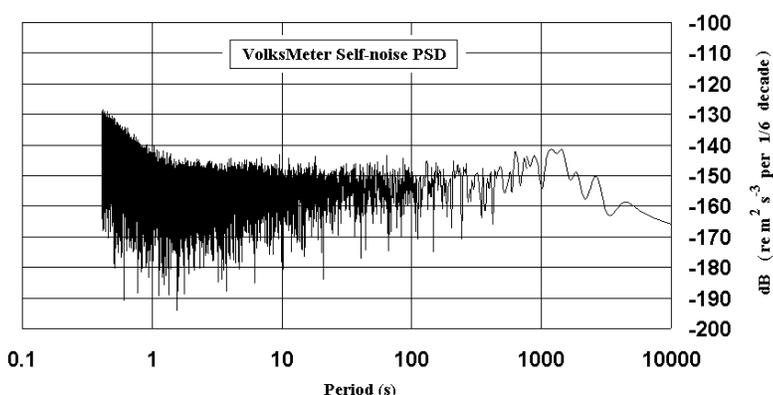
    Linearity: Due to the nature of the sensor and the limited travel of the moving plate, the output is inherently linear across the range of motion.

Power Requirements: 9-24VDC Note: Current draw is a function of supply voltage and the presence or absence of the GPS option

Supply Voltage	Current Draw Without GPS Option	With GPS Option
9 VDC	45mA	90mA
12	33mA	68mA
15	30mA	54mA
20	22mA	44mA
24	20mA	38mA

    A 110VAC input, 15VDC/500mA output, power supply is included with the VolksMeter. The user-supplied support computer will have power requirements of its' own.

Environmental Characteristics
    Operating Temperature: +5°C to +55°C (41°F to 131°F) non-condensing.
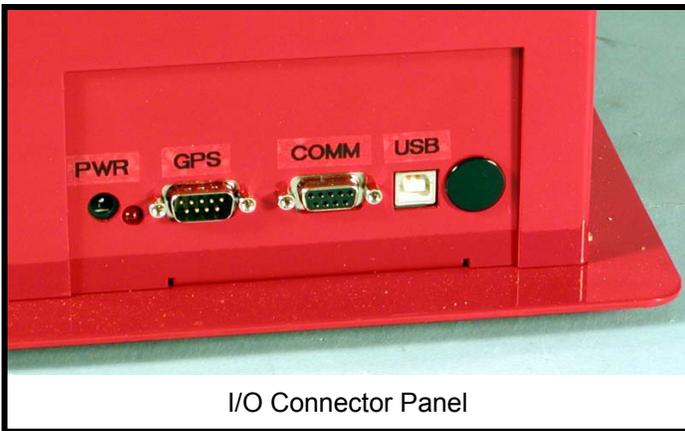   Storage Temperature: -40°C to +85°C (-40°F to 185°F) non condensing

Physical Characteristics
    Size: 10.75"W x 10.75"D x 19.5"H
    Net Weight: 23 lbs (2-channel version)
    Shipping Weight: ~30 lbs (including GPS)

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

I/O Connector Panel

WARRANTY
The VolksMeter II is warranted against defects in material or workmanship for a period of one year from the date of purchase. The customer is responsible for returning the product to the factory. RLL Instruments will pay shipping back to the customer for items repaired or replaced under the warranty.

CONNECTORS
DC POWER: 5.5mm OD x 2.1mm ID center pos.
COMM: DE-9S (RS232-C)
GPS: DE-9P
USB: USB-B(F)

INCLUDED WITH STANDARD MODELS
VolksMeter II instrument
WinSDR / WinQUAKE software on CD-ROM
110VAC Power Adapter
Installation Tools
RS232-C or USB cable (see above)
User's Manual

STANDARD MODELS
VMII-1RU   Single Channel, RS232-C & USB
VMII-2RU   Dual Channel, RS232-C & USB
(A 10ft USB-A(M) to USB-B(M) cable is normally included with USB models unless otherwise requested)

Options:
VMII-GPS   GPS Time Standard
VMII-UACA   Universal Input AC Adapter Upgrade
             Replaces standard 110VAC power
             adapter. Input: 90-264VAC @ 47-63Hz
             Includes interchangeable AC plugs.

Special Order:
VMII-1R   Single Channel, RS232-C only
VMII-2R   Dual Channel, RS232-C only
(A 10ft DE-9S to DE-9P cable is included with RS232-C models)

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RLL INSTRUMENTS
VOLKSMETER II
MAJOR COMPONENTS

LEFT SIDE VIEW

REAR VIEW

I/O PANEL

RIGHT SIDE VIEW

FRONT VIEW

TOP VIEW

INTERFACE BOARD

COVER

LEVELING SCREW 1

LEVELING SCREW 2

LEVELING SCREW 3

PIVOT PLATE

CROSSBAR

ANTI-VIBRATION BRACKET

PENDULUM ROD

MOVING PLATE

STATIC PLATES

LEVELING SCREW

BASE

EDDY DAMPER

POST

CH3 IN
9-PIN MINI DIN
USB TYPE-B RT-ANGLE
RS232 COMM
RS232 GPS
LED
POWER

CH1
CH2