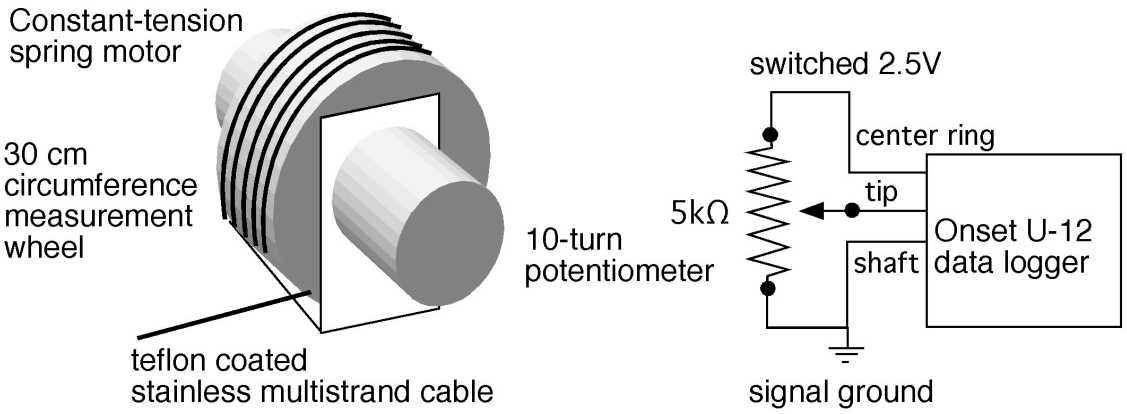
A micropower fault-slip meter using an *Onset U12* data-logger or an *Onset Micro station* data logger

This instrument is designed to measure the absolute surface slip on a fault during an earthquake*. It has a range of 3 m and a resolution of 1 mm. It can operate for a year unattended recording 1 sample per 10 minutes, or at 1 sample per second for 12 hours, simultaneously recording temperature. It costs approximately $300. When coupled to a *Micro station* data logger it can record 1 sample/second indefinitely with a "wrap round" memory of 2 days recording slip and temperature.

A 30-cm-circumference, polycarbonate drum is fastened to the 1/4" shaft of a low-friction, low torque, ten-turn, wire-wound, potentiometer. The drum is connected to a constant-tension spring motor removed from a commercial 30-foot, flexible-steel, tape-measure. Ten turns of Teflon-coated, braided stainless steel wire are wound on the drum. The inner end of the wire is fastened firmly to drum and each turn lays parallel to the next. The free end of the wire is guided through a 1/8" tube and is crimped to a loop outside the box such that the spring motor holds the assembled wire in tension.



The 5kΩ potentiometer is attached to the three wires from the voltage port of a *U12* data logger to exploit the switching capability of the unit. Prior to data acquisition a 2.5 volt port is activated that drives 0.5 mA through the wire-wound potentiometer for approximately 15 ms. Towards the end of this time interval the voltage produced at the slider of the potentiometer is recorded and the system resumes a sleep-mode.

The *U12* data logger has sufficient memory to record a data point once every 10 minutes for a year. At its fastest sampling rate, 1 sample per second, the memory is sufficient for 12 hours of data *.

*** Continuous sampling at 1 sample per second!**

If instead of using the *U12* data logger, a *Micro station* data logger is used, a 1s sample rate can be obtained on this unit indefinitely. The Micro-station *wraps excess data* such that when the memory is full it will write over the earliest previously recorded data. This,

in principle means that the system *can be left for many years recording at 1 sample per second,* with the understanding that the data will be collected within two days of a large earthquake on the fault. A slower sampling rate provides a larger safety margin, however, data from the Microstation *can be downloaded via a telephone modem.* Hence the system has important application as a 1 sample per second slip meter with daily phone downloads.

With a duty cycle of 20 ms per 10 minutes the mean power consumption is reduced from 7.5 mW to 0.25 μW. The cumulative power consumption over a year is thus 0.1AH and the internal lithium battery of the data logger is adequate to power the system. At a wrap-round sampling rate of 1 per second alkaline D-cells permit multiyear operation.

The spring-motor/drum/potentiometer assembly is mounted inside a water-tight box which contains the data logger and a jar of dessicant. The stainless wire is lead through a port with a latex rubber "cot" that is filled with plumbers grease to prevent water entry. The box is fixed firmly to one side of the fault and the wire is fixed to an invar or carbon fiber rod that crosses the fault obliquely underground.

The 12-bit precision of the U12 data logger affords a least count resolution of 0.7 mm over a range of 3 m. The accuracy over this range is ±2.5% equivalent to 7.5 mm. Temperature effects on the system in its coiled mode are negligible. At full extension the wire has a thermal coefficient that results in a thermal sensitivity of 30μm/°C.

Nylon pulleys permit the recording package to be placed almost anywhere in a creepmeter vault, or even above ground. The stainless steel wire can be strung around several pulleys before final attachment to the creepmeter rod.

High resolution (70 μm), large range (> 3 m) slip meter

A modified version of the system using the same 30 cm circumference drum connected to a continuous rotation potentiometer, (instead of the ten-turn potentiometer) yields a displacement resolution of 0.07 mm, but with the same range. In fact, the range may be doubled by adding additional turns of wire, or the resolution can be increased by decreasing the size of the drum. Although the additional resolution is advantageous, single-turn potentiometers have a small dead-zone at the transition from maximum to minimum slider position, and the measured offset, if fast and non-linear, can be ambiguous.