



## Unidata installation at E. T. Aspinall's house, Windermere Road, Windermere

by R. J. Sedgman

### Abstract

Cracking of a house at Windermere indicates land movement in the area. A strain gauge and water probe were installed on the house to monitor the land movement. Details of the installation, support hardware, and software needed to service the installation are discussed.

### INTRODUCTION

The Department of Mines, in a letter of 28 April 1987 from Mr E. T. Aspinall, was requested to undertake an investigation of a cracked home 'Treetops' at Windermere, East Tamar. Preliminary investigations were carried out (Moore, 1988), and subsequent long-term automatic monitoring was requested. The purpose of further monitoring was to obtain information on whether the cracking was due to reactivation of an old landslip, expansive soils, or both.

The house is situated on the river side of Windermere Road, on a 5° slope which steepens to 9° and 12° down to the river flats. The two-storied brick-veneer house is located close to the road (fig. 1).

To monitor the cause and effect of cracking it was decided to use a strain gauge mounted between the north wall of the house and an anchored pole to the north of the house. The water table would be used to monitor the changing water table and the effect of movement of the house. Data would be recorded on a Unidata logger.

### INSTALLATION

The Unidata recorder is situated on the north-facing wall inside a grey enclosure with 'Unidata' printed in red on the cover (a detailed description of the Unidata recorder is given in Sedgman and Weldon, 1988). Next to this is another enclosure which houses the strain gauge amplifier and power supply (fig. 2). Power is supplied to this unit

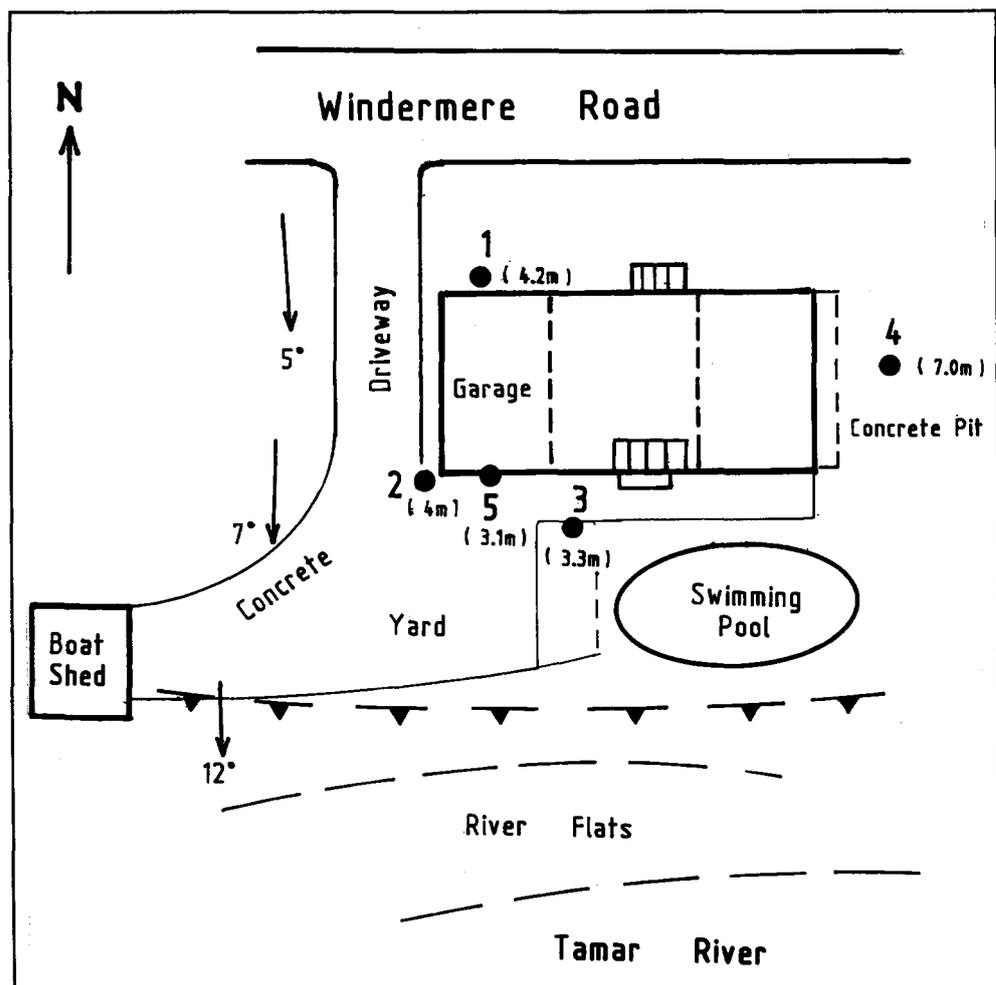


Figure 1.

via an external outlet located under the fuse box on the west wall.

To monitor movement of the house a five metre long drill rod was concreted into the ground to a depth of 4.5 metres. The rod was positioned as close to the north wall as possible (about one metre; see fig. 3). A strain gauge was then attached to the drill rod, with a threaded rod connecting the strain gauge to an anchor on the brickwork on the north wall of the house (Appendix 2).

To obtain a qualitative result the drill rod has to be securely anchored into the bedrock below, so that any surface movement will not affect the position of the anchor (drill rod) position. This is virtually impossible in low-cost investigations, so the results have to be treated as one movement relative to the other. However the drill rod was surveyed in and is checked at regular intervals to ascertain if the drill rod is actually moving as well. The movement observed by the surveyor can be used as a correction factor by the data processor, if the need should arise.

The strain gauge measures movement in terms of the distance between the house and the drill rod, so if the movement of the house is up or down this can be also interpreted as a downslope movement. Care must be taken when interpreting the results, and it is suggested that the interpreter consult the surveyor when processing the data.

To monitor the movement of the water table a water probe, which measures water table variations up to ten metres, was placed in an existing observation hole (borehole 4 on fig. 1) at depth of ten metres (Appendix 1).

Data from the strain gauge and water probe are recorded as an average over a three-hour interval. This gives a smoothing effect to the data, so as to take out any sudden un-natural variations. The control program is given in Appendix 4.

## MAINTENANCE

This installation should be serviced by the Toshiba laptop computer at least once every six weeks or so, as the memory within the data logger can be filled very shortly after this period of time (Sedgman and Weldon, 1988).

To carry out any electrical or mechanical adjustments requires the use of a multimeter, screw drivers, a pair of shifting spanners, and a special triangular-headed key to open the Unidata enclosure. Remove the lid of the Unidata enclosure and connect the negative lead of the multimeter to pin 41. To measure the output of the transducers the following pins are used (see Appendix 3 for circuit connections):

- a: pin 39      strain gauge
- b: pin 36      water depth probe

Maintenance requirements are as follows:

- 1: *Effect*—Strain gauge readings go off scale.

*Remedy*—Loosen the nut on the threaded rod that is attached to the drill rod. Now lengthen or shorten the length of this piece of rod until a reading of about 1.25 volts on the multimeter appears when it is connected to pin 39.

- 2: *Effect*—Erratic readings on the water probe.

*Remedy*—Replace probe.

## REFERENCES

MOORE, W. R. 1988. Investigation of a cracked house in Windermere Road, East Tamar. *Unpubl. Rep. Dep. Mines Tasm.* 1988/21.

SEDGMAN, R. J.; WELDON, B. D. 1988. Field manual for the Toshiba laptop computer. *Unpubl. Rep. Dep. Mines Tasm.* 1988/22.

[26 June 1989]



**Figure 2.** *The Unidata recorder (left), and the strain gauge amplifier and power supply installations (right).*

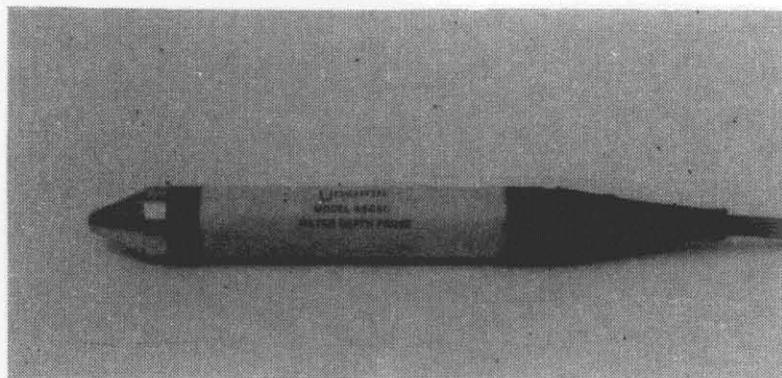


**Figure 3.** *Position of Unidata installation and anchor rod.*

## APPENDIX 1

### Water probe 10 m

The water probe is a low cost, solid-state probe designed to measure the hydrostatic pressure of water. In conjunction with the data logger it has a resolution of  $\pm 40$  millimetres.



### Model 6508A/B/C/D – Water Depth Probes

Low cost, solid state probe designed to measure the hydrostatic pressure of water. Ideal for drainage, bore hole and river height recording projects. Sealed and factory calibrated to standard ranges, these probes are interchangeable. As many as eight Water Depth Probes may be connected to the Data Logger.

- Sensor: Semi-conductor strain gauge element
- Electronics: Integrated amplifier and correction circuitry
- Power: 5 VDC, 4ma (4% of battery life)
- Construction: Sealed PVC (UV resistant)
- Cable: 3 core vented cable with shield. 50m maximum
- Resolution: 0.5% of range (-1 to 40 deg C)
- Size: 25mm diameter, 180mm long
- Weight: 200 grams (excl cable).
- Range:
  - Model 6508A** 0 to 1 metre of water
  - Model 6508C** 0 to 5 metres of water
  - Model 6508D** 0 to 10 metres of water
  - Model 6508E** 0 to 20 metres of water

## APPENDIX 2

### Strain gauge

To measure strain it was decided to use what is called a proving ring. This consists of four strain gauges mounted on an aluminium ring (two on opposite external sides and two on opposite internal sides) (see fig. 4). An amplifier

is required to give an output which is suitable for measuring with the data loggers, which have an output of 0 to 2.55 volts. The amplifier chosen was the Radio Spares type 308-815 (see fig. 5 for construction details).

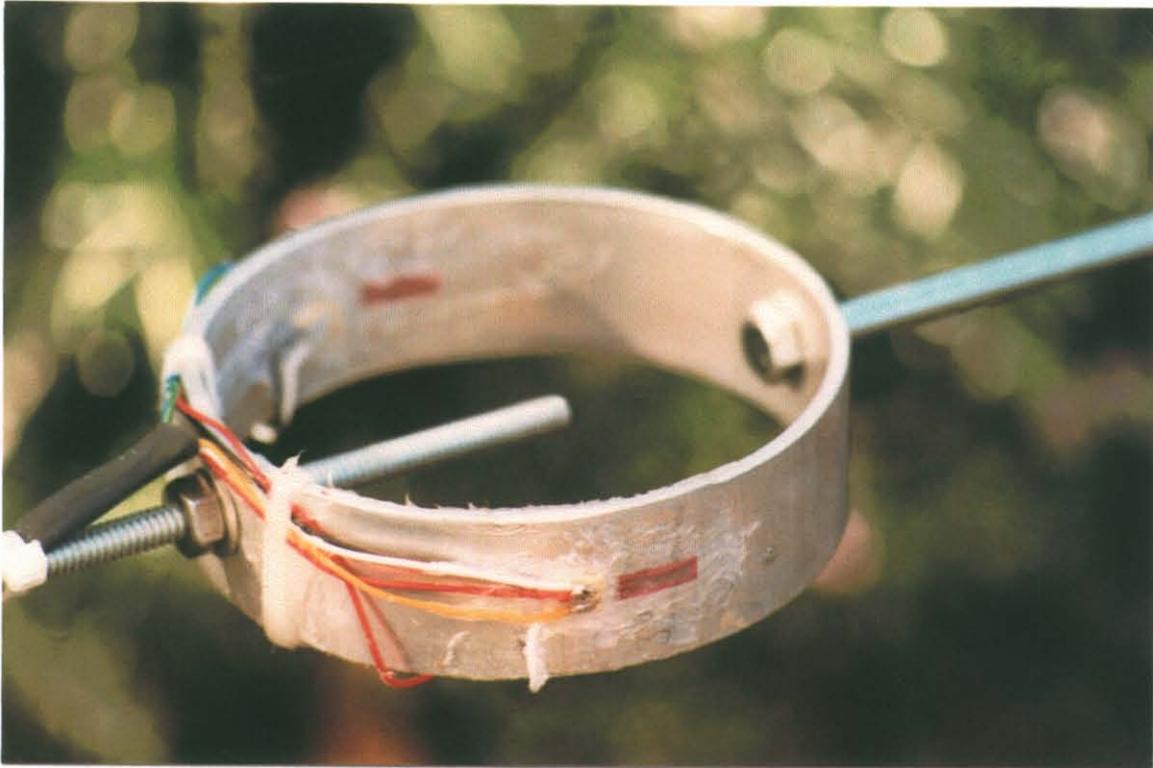
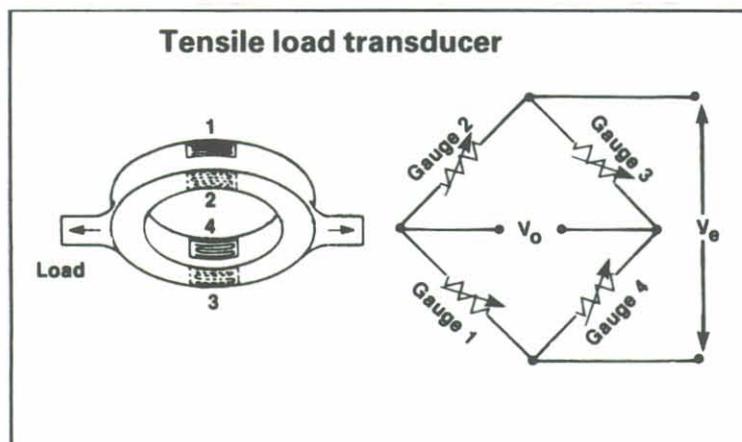


Figure 4. Proving ring.



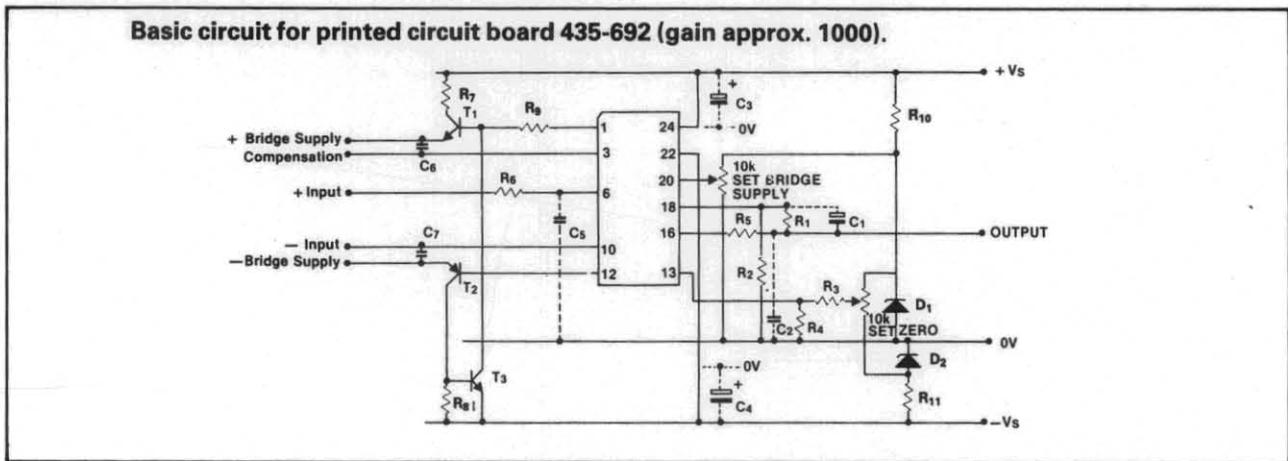
**6604**

**Specification**

(At 25°C ambient and ±12V supply unless otherwise stated.)

|                                  |                |
|----------------------------------|----------------|
| Supply voltage                   | ±2 to ±20V dc  |
| Input offset voltage             | 1 mV max       |
| Input offset voltage/temperature | 1 μV/°C max    |
| Input offset voltage/supply      | 5 μV/V max     |
| Input offset voltage/time        | 1 μV/month max |
| Input impedance                  | >2.5 MΩ min    |
| Input noise voltage              | 1 μV p.p max   |
| Band width (unity gain)          | 400 kHz        |

|                                   |                       |
|-----------------------------------|-----------------------|
| Output current                    | 5 mA                  |
| Output voltage span               | ±(V <sub>s</sub> -3)V |
| Closed loop gain (adjustable)     | 5 to 10,000           |
| Open loop gain                    | >100 dB               |
| Common mode rejection ratio       | >100 dB               |
| Bridge supply voltage/temperature | 20 μV/°C              |
| Maximum bridge supply current     | 12 mA                 |
| Power dissipation                 | 0.5W                  |
| Warm up time                      | 5 mins                |
| Operating temperature range       | -25°C to +85°C        |



**Component values**

|                           |  |   |
|---------------------------|--|---|
| R <sub>1</sub> 100k       | R <sub>7</sub> 47R   | C <sub>2</sub> , C <sub>5</sub> 10n (typ.)  |
| R <sub>2</sub> 100R       | R <sub>8</sub> 10R   | C <sub>3</sub> , C <sub>4</sub> 10 μ(tant.) |
| R <sub>3</sub> 100k*      | R <sub>9</sub> 1k0   | T <sub>1</sub> BD 135                       |
| R <sub>4</sub> 68R*       | R <sub>10</sub> 680R   | T <sub>2</sub> BD 136                       |
| R <sub>5</sub> 10R        | R <sub>11</sub> 680R   | T <sub>3</sub> BC 108                       |
| R <sub>6</sub> 100R(typ.) | C <sub>1</sub> , C <sub>6</sub> , C <sub>7</sub> 100n (typ.) | D <sub>1</sub> , D <sub>2</sub> 1N827       |

A glass fibre printed circuit board, stock number 435-692, is available for the basic circuit as given in Figure 7.

The board is 46 x 98mm in size and is complete with screen printed component identification and a solder mask.

Only typical values are given for certain components, as adjustment of these values may be necessary in specific applications to obtain optimum noise reduction (see Minimisation of Noise, page 5).

\*R<sub>3</sub> and R<sub>4</sub> values may be adjusted to alter the zero adjustment range when compensating for bridge imbalance.

Notes:

Gain is defined as  $1 + \frac{R_1}{R_2}$

Zero adjustment range  $\pm 6.2 \times \frac{R_4}{R_3 + R_4}$  Volts

Total bridge supply = 2 × bridge ref input (pin 20)

C<sub>5</sub> may be omitted for input lead lengths of less than 10 metres.

T<sub>1</sub> and T<sub>2</sub> provide bridge currents up to 60 mA and should be kept away from the amplifier.

T<sub>3</sub> and R<sub>5</sub> provide current limit of approx 60 mA.

Where high stability power supplies are being used zero and bridge supply reference may be taken direct from the power rails.

Figure 5. Construction details of amplifier

### APPENDIX 3

#### Circuit connections

| <i>Transducer</i>      | <i>Termination strip number</i> |    |                |    |
|------------------------|---------------------------------|----|----------------|----|
| Strain gauge           | signal                          | 39 | power external | 40 |
| Water probe            | signal                          | 36 | power internal | 15 |
| all grounds are 41, 38 |                                 |    |                |    |

### APPENDIX 4

#### Scheme definition

Scheme ASPINL, Title: Aspinall strain and water level. RJS.

Communication port 1

Access form: Direct

Logger size 8k

Logger cycle rate 5 seconds

Log interval 180 minutes

Log a1 as AV Strain, being strain

Instrument 6508d measuring water depth 10m

Log a2 as AV Depth, being depth 10m

Total 2 entries, 2 bytes logged, 3327 log entries giving a maximum logging time of 138 days, 15 hours

Lotus file generated

Detailed print-out to scrn:

Plot 2

Plot 3

Plot 2 and 3