A NEW SENSOR FOR SNOW WETNESS MONITORING

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ABSTRACT

For long-term measurements of snow wetness a flat dielectric sensor has been developed. The sensor measures the dielectric constant of the surrounding or underlaying medium; it is operated at a fixed frequency of 20 MHz. Snow wetness can easily be calculated from the measured snow permittivity and snow density. The measurement system consists of a relatively small flat capacitive sensor connected to a tuning and display unit with a built-in microcomputer. Measurements of snow permittivity can be made every 8 seconds; the data are displayed on a LCD and are also stored in a 32kB RAM. The system can be operated at ambient temperatures down to -20 °C, it is battery operated (Pb-accu) and the total power consumption is less than 0.7 Watts at 6V operating voltage.

Typical field applications and measurements with this system are reported:

- Measurements of snow wetness profiles
- Monitoring of snow wetness variations with time
- Detection and registration of percolating melt-water waves.

INTRODUCTION

One of the critical parameters of snow cover stability is the amount of liquid water content. It affects also the rain- or meltwater flow-characteristics in snow and snow metamorphism. The most efficient methode for snow wetness measurements in the

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field is the measurement of the dielectric constant (relative permittivity) at radio frequencies. Snow liquid water determination should be easy and quick to perform, and the measuring error should be less than 0.5% by volume. A hand-held instrument which meets these requirements has been developed in the last years (Denoth and Wilhelmy, 1988). The special design of the flat capacitive sensor allows nearly non-destructive measurements; the instrument has to be tuned by hand.
To allow long-term measurements of snow wetness with buried sensors, the dielectric device has recently been improved by a built-in microcomputer.

THE MEASUREMENT SYSTEM

The measurement system consists of three parts: a flat capacitive sensor (CS), a microcomputer with a display unit (LCD) and a real-time clock (RTC),and a battery-unit (DC/DC-converter). A block- diagram of the sensor- and microcomputer electronics is shown in Figure 1.

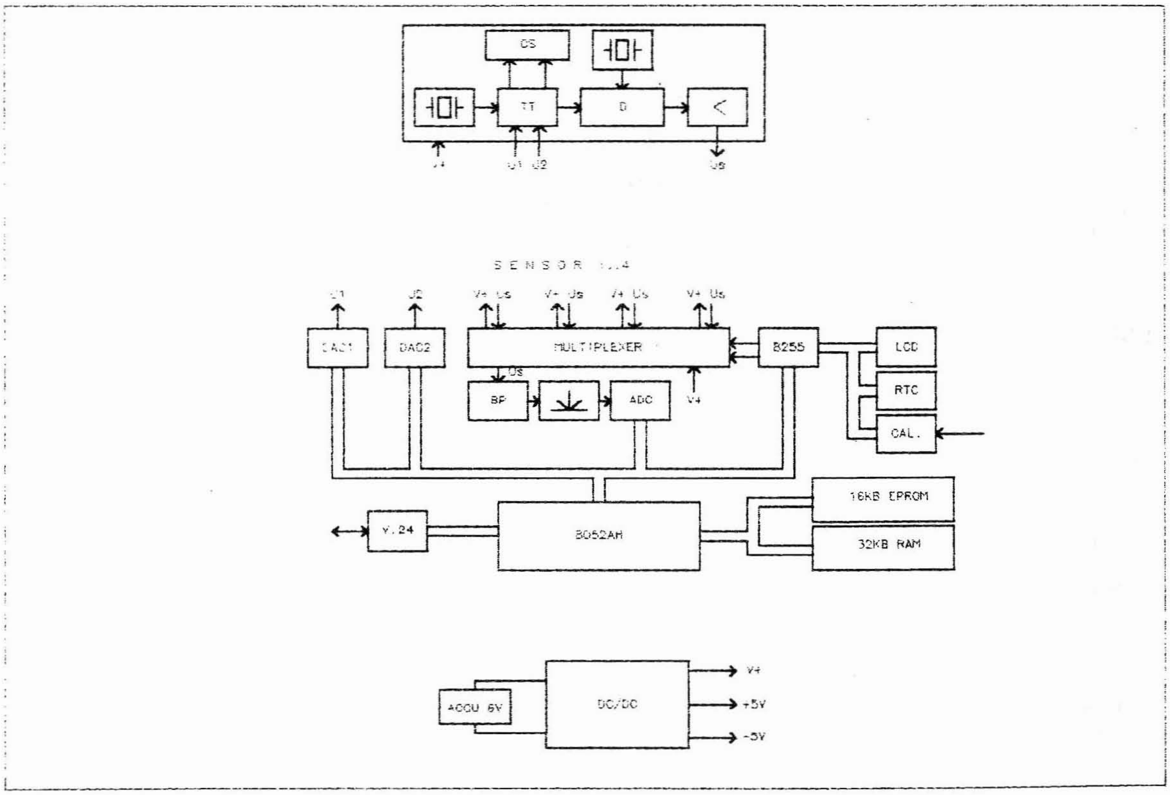

Figure 1. Block diagram of the sensor- and microcomputer electronics
Top: Sensor electronics; Middle: Microcomputer
Bottom: Battery unit

The capacitive sensor is connected to a twin-T-bridge (TT) with an operating frequency of 20MHz. The effective measuring area is 12.5 x 19cm^2 for surface- and 12.5 x 14 cm^2 for volume measurements of snow wetness. Up to 4 sensors can be connected to the microcomputer and can be operated simultaneously. The measurement data are stored in a 32kB RAM. The time interval between successive measurements can be preselected (using an external PC), the minimum measurement interval is 8 seconds. At the end of a measurement periode, the data can be transferred to a PC via a V.24 interface for further data processing.

FIELD APPLICATIONS

Typical field applications of this new computerized snow wetness meter are the recording of wetness profiles, long-term measurements of snow wetness variations and the detection and registration of meltwater/rainwater waves in snow.
A measurement of a wetness profile is shown in Figure 2. It consists of 43 single measurement points taken at a spatial interval of approximately 5 centimeters; the total measuring time to take this profile was 12 minutes.

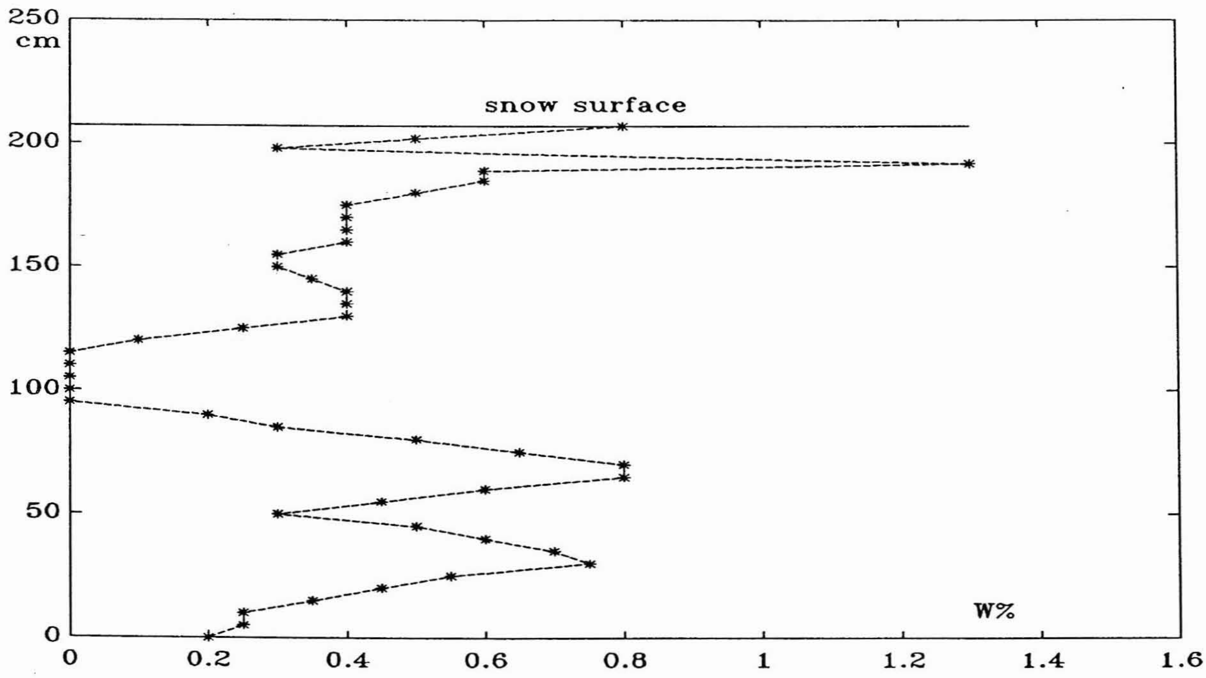

Figure 2. Snow wetness profile

An application of this sensor for long-term registration of snow wetness variations is shown in Figure 3. The time interval between successive measurements was preset to 30 seconds. Two sensors have been buried in the snow cover at a depth of 40cm and 70cm, respectively, and have been operated simultaneously. The sharp increase of the relative permittivity recorded with the two sensors is caused by a short but heavy rainfall. Due to the relatively high initial water content of the snow cover of W= 5%, and due to the heavy rainfall a marked water shock-wave is formed.

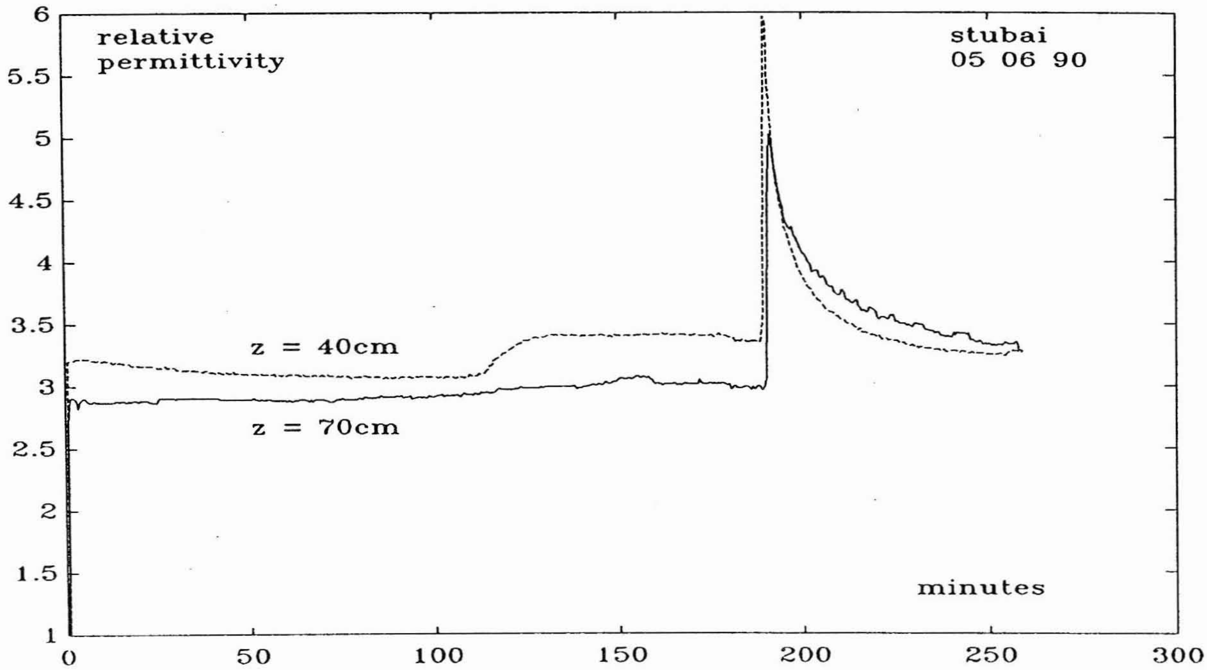

Figure 3. Long-term measurements with two simultaneously operated sensors at a depth of 40cm and 70cm

In order to observe the movement of a water shock-wave through the snow cover, a third sensor has been buried in a depth of 110cm. Figure 4 shows the simultaneous recording of the three sensors. The time-lag between the shock-fronts arriving at the three measurement levels can easily be detected.

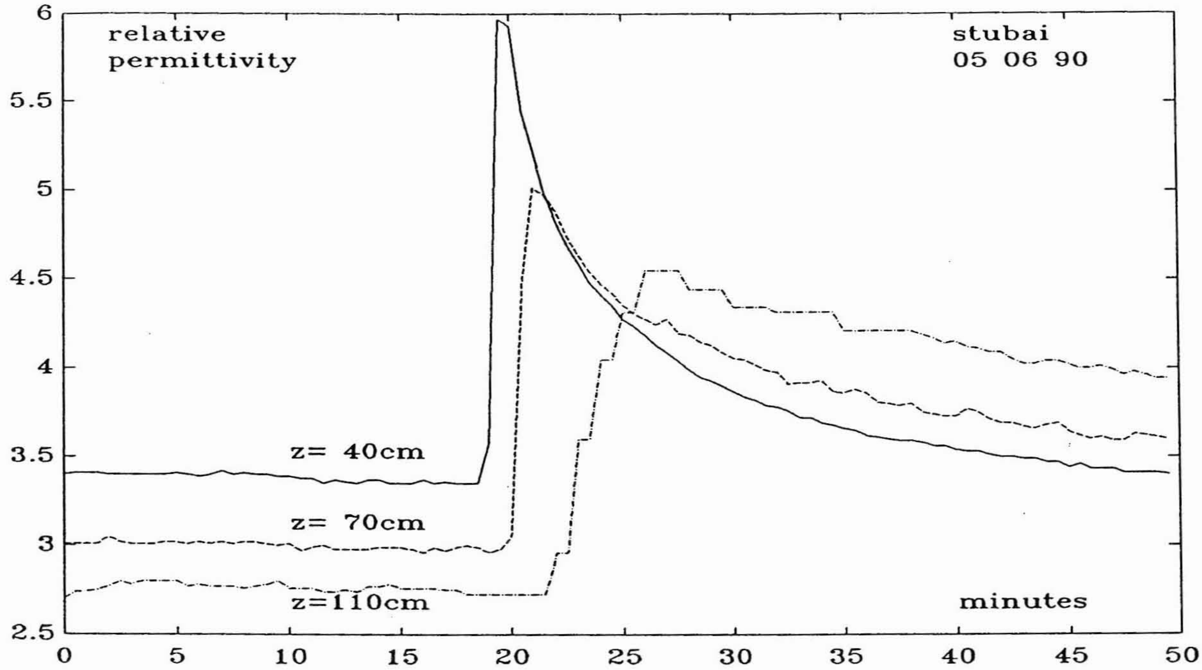

Figure 4. Detection of water waves (shock-fronts) with three simultaneously operated sensors

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REFERENCE

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