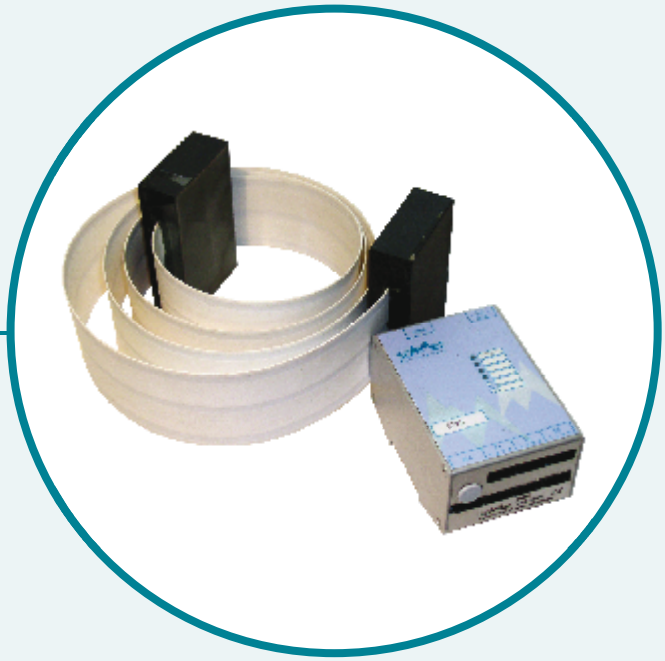
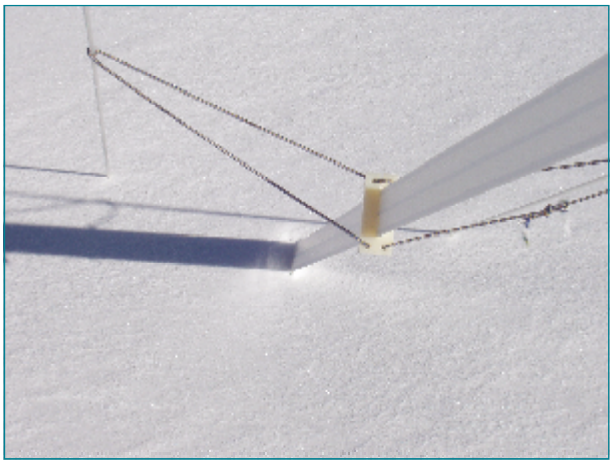
PRODUCT INFORMATION

sommer
MESS-SYSTEMTECHNIK

SPA

Snow Pack Analysing System





Properties and Advantages

- **Registration of the snow parameters:**
  - Snow depth
  - Snow density
  - Snow water equivalent
  - Contents of liquid water and ice
- **System assembly on demand**
  - Information above the whole snow cover
  - Information above a specific snow depth level
  - Information above an extended area, by measuring with up to 4 SPA- sensors
- **No measurement errors caused by ice layers in the snow cover**
- **Simple and convenient installation even at hillsides**
- **Automatic, continuous measurement**
- **Energy- saving sensor operation**
  - „Standby“ between the measuring phases
  - Optimum for solar- powered stations

Introduction

Automatic and continuous measurement

Getting information about snow by measurements is very difficult. There is the necessity to registrate many parameters to make reliable statements about the snow pack. Additionally, snow has an enormous variability in space and time. Until now there are only punctual measurements available for the relevant parameters. The *Snow Pack Analysing System* (SPA) constitutes a revolutionary innovation in snow measurement. It´s a world unique system for automatic and continuous measurement of all the relevant snow parameters like snow depth, snow density, snow water equivalent and contents of liquid water and ice. Due to that, there generates a huge gain of information about the state of the snow pack. The SPA offers a modern and highly time delayed data gathering. There are several possibilities to install the system, depending on demand. Moreover, the system helps to reduce dangerous and expensive adoption of human resources in the wintry area.

Principles of the measurement

Snow depth

The sensor´s principle of measurement deal´s with the transit- time measurement of an ultrasonic pulse between the sensor and the snow surface. The influence of the temperature is getting compensated automatically.

Measuring the dielectric constant

Snow consists out of the three components ice, water and air. Using different measurement frequences, these components show different dielectric constants. Measuring the complex impedance along a flat ribbon sensor (SPA- sensor) with at least two frequencies allows to estimate the volume contents of the individual component.

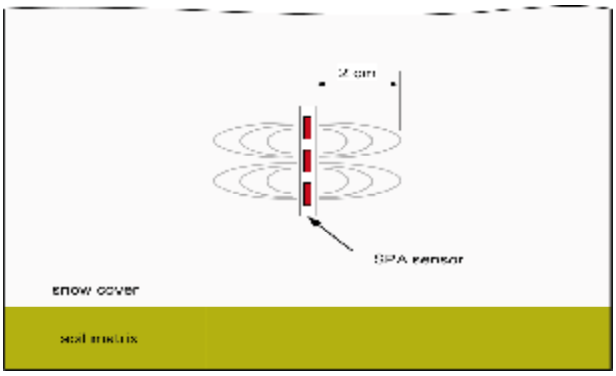


Fig. 1: Measurement principle of the SPA- sensor.

Liquid water and ice content, snow density and snow water equivalent

The specific volume contents equate the liquid water and ice content in the snow pack. With this information the snow density can be calculated. Combining the data of snow density with the snow depth defines the snow water equivalent.

Installation of the system

The SPA- system can be installed simply and conveniently into existing weather stations, also it can be realized in new stations. Even hillside installations are possible. The snow depth sensor is getting fixed on a mast system with a beam. One side of the SPA- sensor is fixed by a suspension on a mast, too. The other side is getting anchored in the soil. The sensor length can varay between 3 and 10 m. Central part of the SPA- system is the measurement and control device. It analyses the input data and transfers it by a RS 232 to a data logger.

Fields of application

For hydropower companies and flood prevention authorities the precise monitoring of water resources on catchment scales is indispensable for the prognosis of snowmelt run- off, which in return is relevant for flood prevention. In agriculture and mining estimations of the infiltration of melting water into the soil or underground are of basic interest.

The information about the liquid water content of the snow pack makes it possible to estimate the point of saturation and snowmelt run- off. This point can be measured by the SPA- system. Thereby the system offers an important upgrading information for hydrological models. Furthermore these information is also important for snowmelt models, refering to remote- sensing data. The SPA can be a ground control for calibration. Snow density and liquid water content are fundamental parameters for the risk assessment of wet snow avalanches. The SPA helps to improve the quality and density of data for the responsible authorities. Thereby the systems contributes to increase the security of alpine villages and ski- regions.

No influence by ice layers

Snow pillows often have problems by ice layers in the snow pack. This phenomenon occurs often in regions with many melting and freezing periods in one winter- season and influences the result of the measurement. The SPA- system is not affected by ice layers.

System assembly on demand

The SPA- system can operate with up to four SPA-sensors. Their quantity and assembly is related to the desired measurement demand. The sensors can be spaned slopingly or horzontally into the snow pack. Resulting of that there are several different possibilities for installing the system to optimize the information on demand. Three of them are presented here:

Combination

This version consists of a sloping and an horizontal SPA- sensor. The snow density, the snow water equivalent and the ice and liquid water contents of the complete snow cover are determined by the sloping sensor, the horizontal sensor supplies additional information about the snow conditions close to the ground layer.

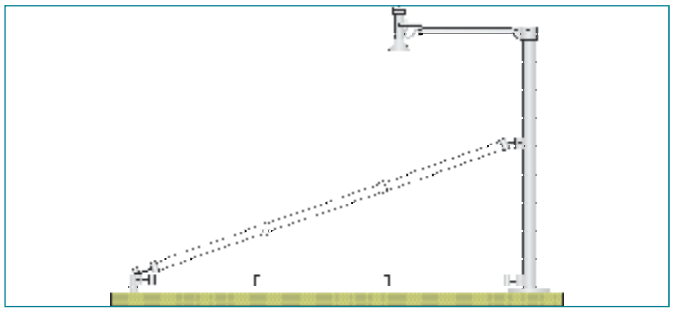


Fig. 2: Schematically figure of the system assebly Combination.

Profile

The SPA- sensors are installed horizontally with increasing levels and result in getting a profile of snow densities and liquid water contents at the defined positions in the snow pack. With this arrangement it is possible to detect the transit of snowmelt water through the snow pack and to generate a snow density profile.

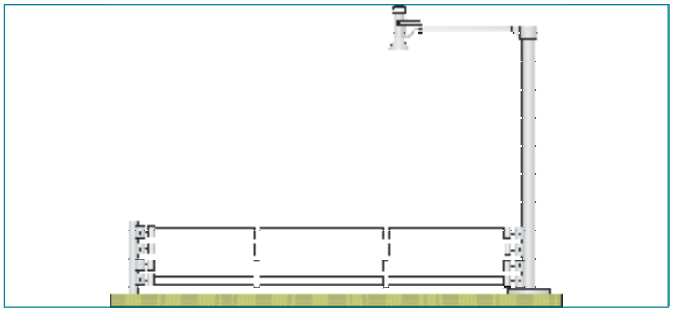


Fig. 3: Schematically figure of the system assebly Profile.

Area

Multiple SPA- sensors are installed in a star shape. The measurement values of the sensors are averaged and supply information with a high spatial extent as it is used for example to calibrate remote- sensing data.

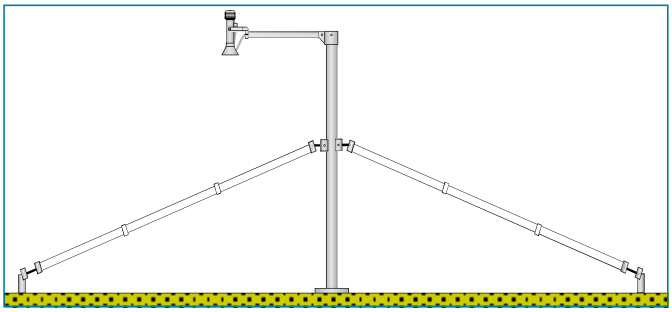


Fig. 4: Schematically figure of the system assebly Area.

Example for application

The SPA- system measured high resolution data in the winter season 2006/2007 for the parameters snow water equivalent, snow density, snow depth and liquid water content of the snow pack. The snowmelt period in april is the most interesting period. First the snow depth is decreasing (A), then the liquid water content is rising (B) and ten days after that the snow water equivalent is decreasing (C). At that point the snowmelt run- off starts. That shows, that the SPA- system can improve the prediction of snowmelt run- off.

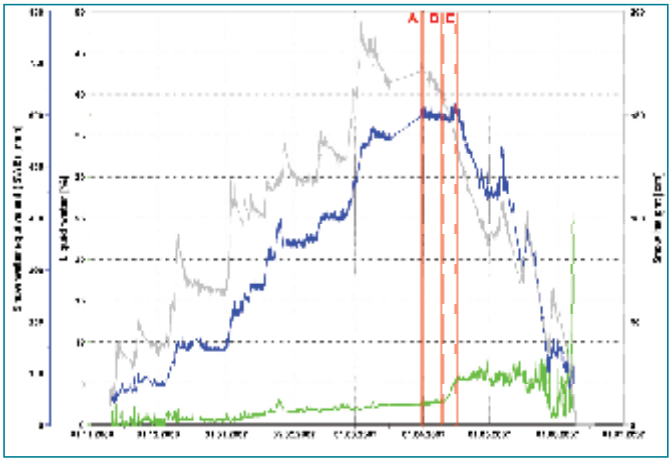


Fig. 5: Data of the SPA- System in the winter season 2006/2007.

Components of the system

Component	Description
SPA- sensor	1-4 sensors mountable
	3-10 m sensor length
	Weatherproof and UV-resistant flat band that includes three wide copper wires
	4 cm depth of penetration of the measurement field
Suspension of the SPA- sensor	Mechanic for fixing and spaning of the SPA- sensors
	Sloping sensors featured with a displacement sensor to improve the calculations of the sensor length
Measurement and control unit	Impedance analyser performing the measurements of the complex impedance along the SPA- sensor
	Multiplexer controls the switching between multiple sensors and connects the snow depth sensor
	Control unit performs the measurements and the calculations of the snow parameters; serial interface RS 232; ASCII format
Snow depth sensor	Ultrasonic snow depth sensor with integrated temperature compensation
Optional components	Integration of up to two sensors for temperature (snow, soil, surface)
	Mast & mechanics
	Power supply
	Data logging & data transfer

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