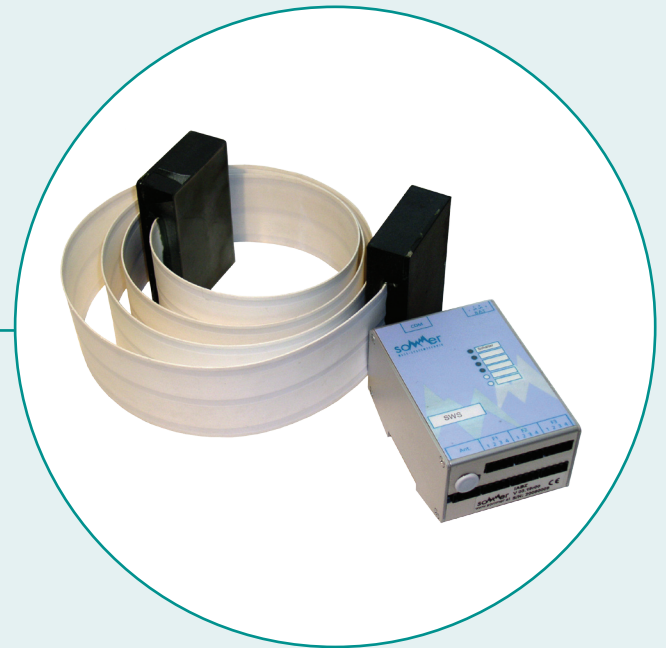
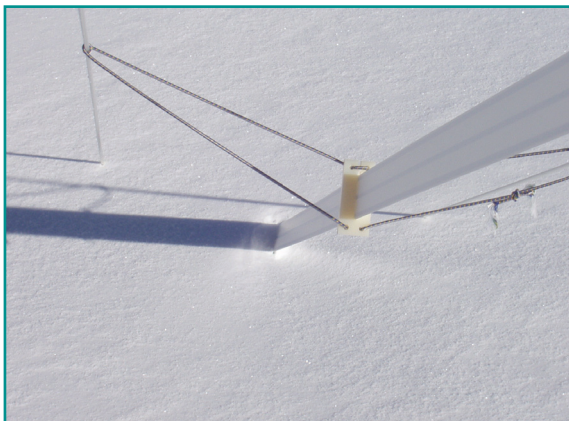


SPA

Snow Pack Analyzing System is a unique device for automatic and continuous measurement of all relevant snow parameters.



Properties and benefits

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

Introduction

Automatic and continuous measurement

Getting information about snow by measurements is very difficult. There is the necessity to register 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

Measurement principle

Snow depth

The measurement principle deals with the current 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 frequencies, 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.

Installation of the systems

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 ground. The sensor length

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-

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 deployment in the wintry area.

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.

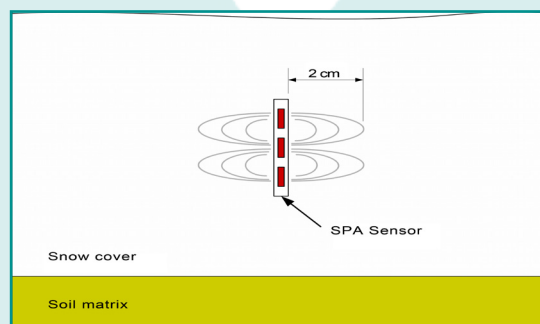


Figure 1: Measurement principle of the SPA-sensor.

can vary 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.

season and this 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 horizontally into the snow pack. Resulting of that there are several different possibilities

for installing the system to optimize the information on demand. Two of them are presented here:

Combination

This version consists of a sloping and a 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.

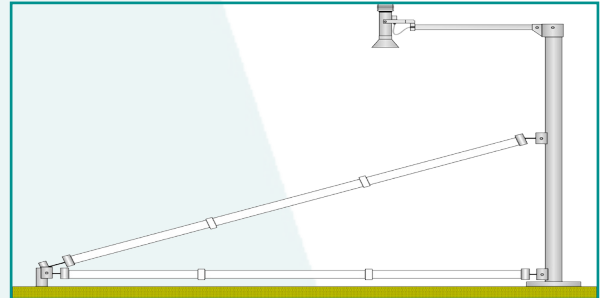


Figure 2: Schematically figure of the system assembly combination.

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.

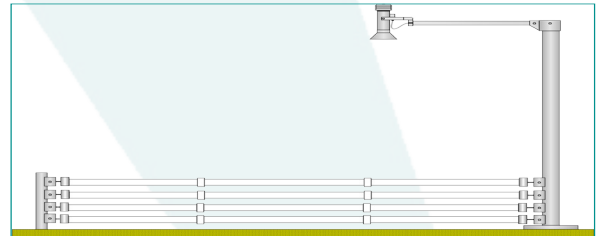


Figure 3: Schematically figure of the system assembly profile.

Application area and example

Hydropower companies & flood security	Expected water quantity during snowmelt
Agriculture & Mining	Expected infiltration of melting water into ground or underground
Hydrologist	Point of saturation and snowmelt discharge
Alpine ski areas & communities	Snow density and liquid water content for risk assessment of wet snow avalanches
Research	Snow depth, snow density, snow water equivalent, contents of liquid water and ice

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 rise starts. That shows, that the SPA-system can improve the prediction of snowmelt rise.

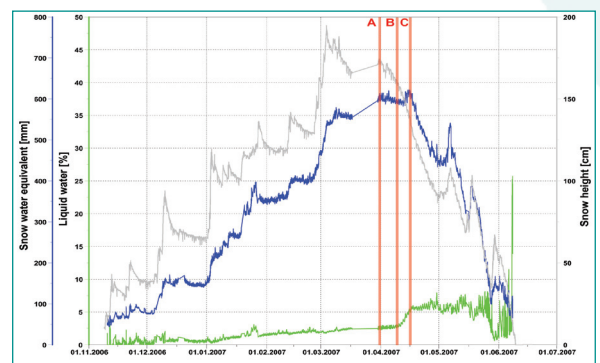


Figure 4: Data of the SPA-System in the winter season 2006/2007

Technical Data

General	
Dimensions Framework	6360 x 1100 x 3000 mm
Power supply	Supply voltage: 10.5 ... 15 VDC Reverse voltage protection Overvoltage protection
Operating temperature	-35 ... 60°C
Housing	Dimensions: 70 x 100 x 55 mm (L x H x W) Material: Anodized aluminium
Protection	IP 55
System components	
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 spanning of the SPA- sensors
	Sloping sensors featured with a displacement sensor to improve the calculations of the sensor length
Measurement 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 up to two sensors for temperature (snow, ground, surface)
	Mast & mechanics
	Power supply
	Data logger & remote data transmission