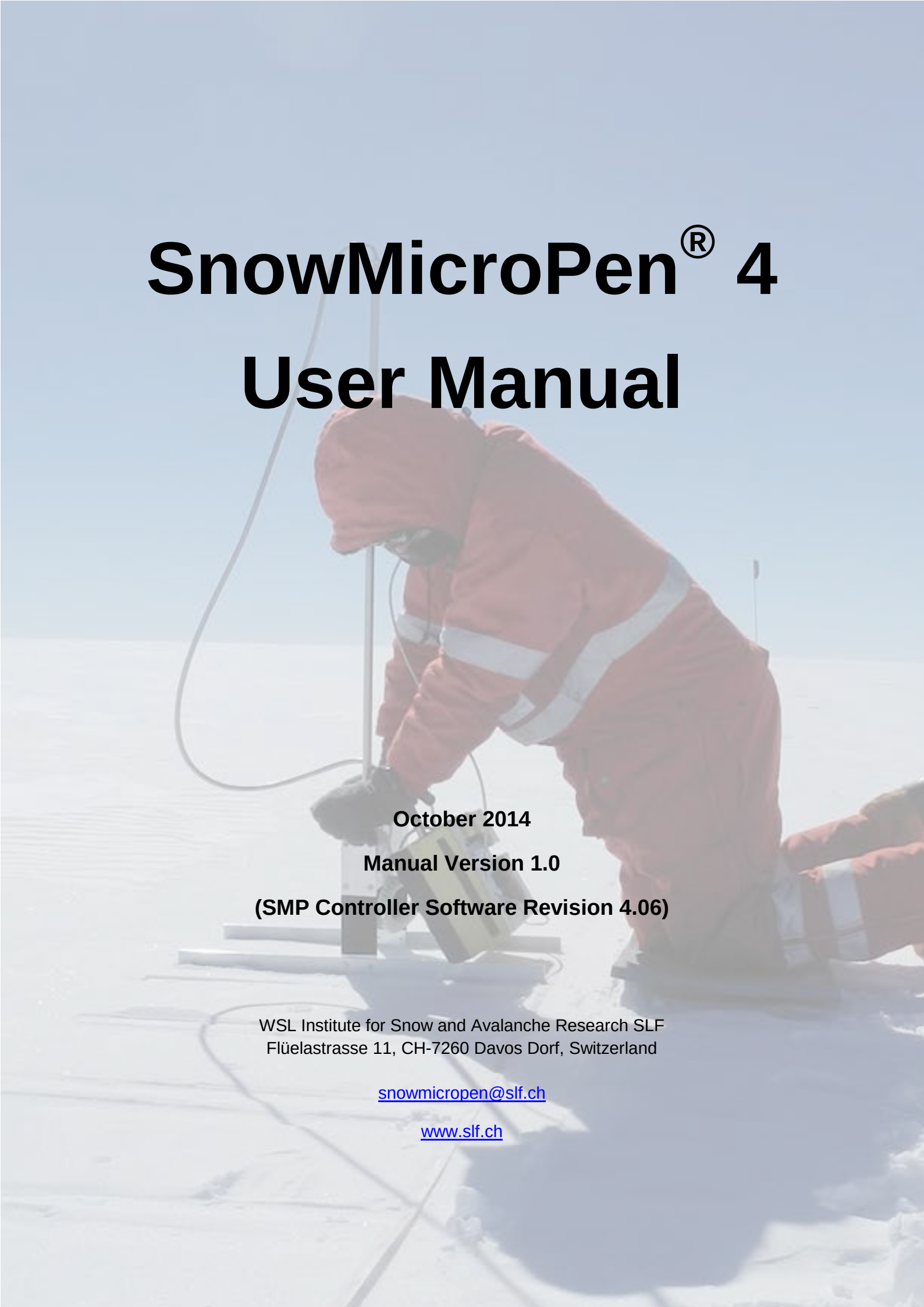
SnowMicroPen® 4
User Manual



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Introduction

The SMP is the first high-resolution snow penetrometer. It measures the bonding force between snow grains, with high spatial resolution and high speed. The SMP can be used in different applications as snow profiling (avalanche forecasting, snow stratigraphy, remote sensing ground truth), ski track characterization (ski racing) or snow runway characterization (stability testing).

The SMP4 is designed for field measurements. The device is composed of two components:

1) a piezoelectric force sensor in a geared rod and the motor unit and

2) a controller unit.

The SMP is pressed down to the snow surface while the rod is driven into the snow pack. A piezoelectric force sensor measures penetration resistance as function of depth. The measured data is displayed on the controller and stored in binary format on a SD card. The files on the SD-card are on a FAT-compatible file system, and can be read as normal files. The binary files can be read, plotted and evaluated by the free open source program "SnowMicroPyn", either as Python code or as standalone executable on Windows, Mac and Linux.

Although the SMP is developed for outdoor usage, it is a precision instrument, and must be handled with care. The controller is protected against splash water, but not waterproof. The controller works down to -30°C, but the display becomes slow. For temperatures below -25°C, special heating of the controller is recommended.

This manual will help you to successfully perform measurements and maintaining the device. Please read it carefully.

Additional information can be found on the SnowMicroPen homepage:

http://www.slf.ch/ueber/organisation/schnee_permafrost/schneephysik/SnowMicroPen

Specifications

Table 1 shows the current SMP4 specifications:

probe length (*standard version)	270 mm / 830 mm / **1250 mm *** / 1720 mm
sampling rate	242 samples mm^{-1}
rod velocity	20 mm/s
resolution of A/D conversion	16 Bit
spatial sampling resolution	4 µm
layer resolution	0.5 mm
noise	< ± 5 mN
force range sensor 9207	-50 N … 50 N
force resolution sensor 9207	1.52 mN
force range sensor 9203	-500 N … 500 N
force resolution sensor 9203	15.2 mN
operating temperature	-30 °C .. 0 (35) °C
GPS module	± 10 m
memory	SD card, 4 GB class 10 (industrial version)
power supply	Li-Polymer Battery (14.8 V, 48 Wh) in or outside controller unit. Additional external battery if required.
internal clock	synchronized by GPS
operating weight	ca 7 kg (1250 mm)
transportation weight	ca 18 kg (1250 mm)

Table 1: *SMP 4 specifications.*

Components

Motor Unit

The motor unit (1) shown in Figure 1, is kept perpendicular to the snow surface by the two ski poles (14), that are setup through the feed holes and fixed by two locking screws (3). The motor unit (1) contains a built-in motor that drives the rod (4) with a user-defined velocity, between 10 mm/s to 20 mm/s, into the snow pack. The conic measurement tip of the sensor (5) breaks the bonds between the snow grains and transduces the force to the piezoelectric force sensor (Kistler instruments). The charge signal is transferred through a coaxial wire inside the rod to the charge amplifier (6) at the top of the shaft. The signal is then transmitted through the sensor cable (7) to the controller.

Sensitive pieces

The force sensor is easily damaged by shear forces and by larger normal forces than specified. Therefore, a protective tube (8) covers the sensor when not in use. To prevent the rod of sliding out of the tube, there is a locking screw (9) and a protection cap (10). Please remove these parts before measurements and always mount them after finishing measurements. Snow might freeze on the rod. The brush ring (11) removes ice and snow from the gear.

The black transportation tube (12) protects the gear rod during field transportation. It is mounted on the motor unit and fixed by a snatch screw (13) and a strap with hook (14). The transportation tube comes with carrying straps (15) to fix the SMP on a backpack or to carry it by hand.

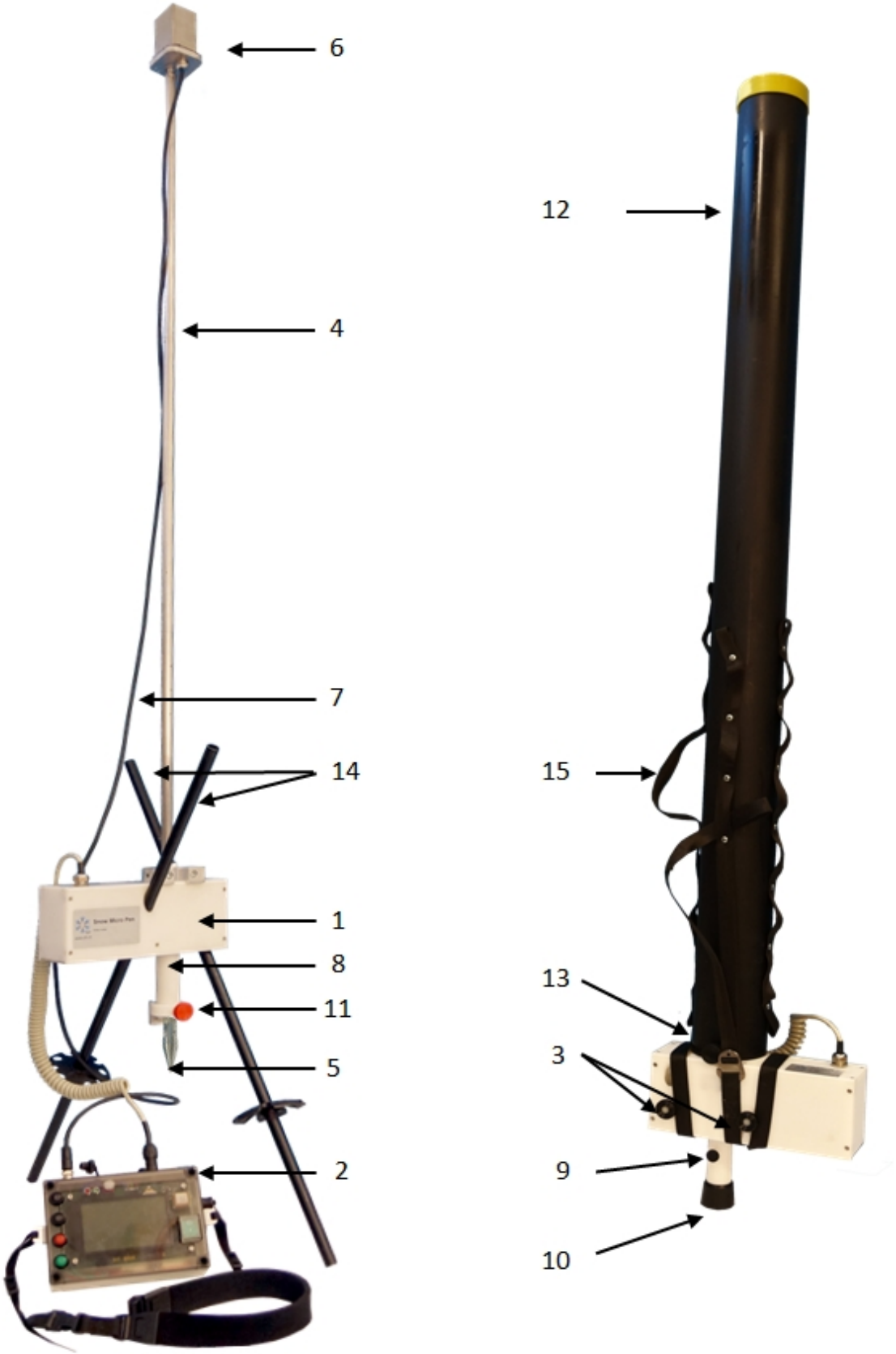


Figure 1: *All components of the SMP. (1) Motor unit, (2) controller unit, (3) locking screws (ski poles), (4) rod, (5) conic measurement tip, (6) charge amplifier box, (7) sensor cable, (8) protective tube (rod and force sensor), (9) locking screw (rod), (10) protection cap (measurement tip), (11) brush ring, (12) transportation tube, (13) snatch screw, (14) ski poles and (15) carrying straps.*

Controller Unit

The controller unit controls all functions of the SnowMicroPen . The controller unit (Figure 2) is designed for field applications.

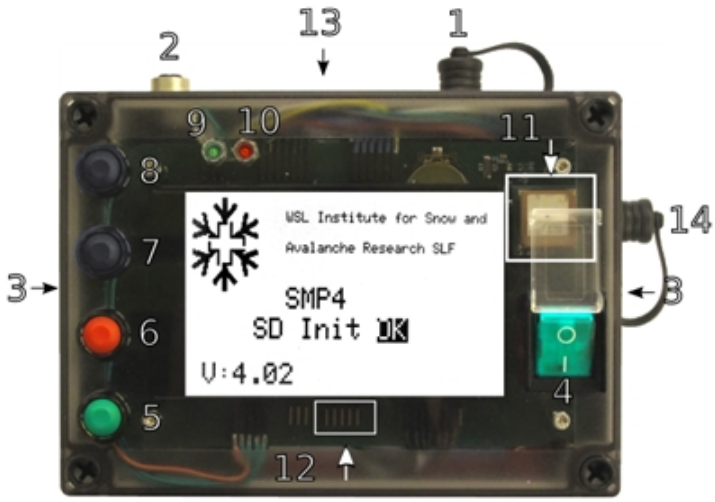


Figure 2: *The SMP 4 controller unit. (1) Connector motor cable, (2) connector sensor cable, (3) ribbon brackets (not visible on picture), (4) main switch, (5) confirm / enter button, (6) cancel / escape button, (7) (menu-) down button, (8) (menu-) up button, (9) green LED, (10) red LED, (11) GPS (inside controller), (12) Jtag, (13) slot SD-card, (14) connector battery or battery charging device.*

The motor cable and the sensor cable are connected to the corresponding connectors (1,2). Two metal links (3) allow mounting a ribbon for handling purposes. The green main switch (4) under the protection cap powers on the instrument. Four buttons on the controller are used to operate: The green confirm button (5), the red discard button (6), and the two black up (7) and down (8) buttons. The arrangement of the buttons can vary between versions. For detailed navigation, please consult the corresponding section Controller Software Navigation.

The green LED (9) lights up when the controller is switched on. The red LED (10) lights up when the motor is running or a warning/error occurred. Inside the case, you can see the GPS module (11). Make sure it points to the open sky during measurements to guarantee good GPS signal quality. Inside the controller unit, there are five accessible JTAG pins (12). Please consult section Controller Software Navigation for further information.

SD-Card

The SMP control parameters (config.txt) and measured data is stored on the root system of the provided 4 GB class 10 SD-card. The card is FAT32 formatted and rated for temperatures down to -40 °C. Multiple SD-cards can be used. The SD-card must be inserted in the slot and protected against snow and split water by a cap (Figure 2, (13)). We strongly recommend using the SD-card in write lock mode. Thus, the controller still writes on the storage card, but the PC cannot write or delete any files accidentally. Maximum storage size of the SD-card is 4 GB due to restrictions of the microcontroller. Class 10 cards with writing speed of 30MB/sec.

Battery and Power Supply

The SMP is powered by a 48.8 Wh 14.8 V internal or external Lithium-Polymer battery. The battery plug (Figure 2, (14)) is used to charge the internal battery with the provided power supply (only use this power supply). Alternatively, an additional or external battery can be

connected. The battery can only be recharged if the battery temperature is above +5°C. At lower temperatures, the charger misleadingly indicates the battery to be fully charged.

A fully loaded battery should last to measure during a whole day (about 200 m of depth measurements). Since batteries are temperature sensitive, we recommend using an external battery in very cold conditions (below -15° C). The external battery can be kept warm in a jacket pocket.

The delivered internal as well as external Li- batteries are not considered as dangerous good under IATA. We confirmed that ourselves and with the seller of the batteries. For a detailed description see in the chapter Shipping.

Controller Software Navigation

The four buttons on the left side of the controller are used to navigate through the SMP menu. The red button cancels operations and is used to leave menus. The green button confirms user entries and enters menus. The two black up and down buttons select menu items and drive the engine manually in corresponding submenu. The following schemes illustrate the menu structure with all available display messages used by current controller software. The schemes are divided in initialization, main and measurement menu. Red, green and black continuous arrows indicate user interactions, where black dashed arrows are automatic processes. Red-framed displays represent fatal errors and green-framed windows point to successful endings.

Initialisation Procedure

In Figure 3 the initialization procedure is shown which takes place in the background right after switching on the controller. You can call the hidden "RTC Sync" menu by pressing the “up” button and the green button simultaneously while switching on the device. This menu synchronizes the internal clock with the GPS UTC time stamp. In case that the user enters the "RTC Sync" menu but there is no GPS connection, the menu can be quitted with the red button. The old time value of the internal clock is then hold.

If no SD-card or no config.txt is detected, the initialization fails and the program stops. In this case the SnowMicroPen cant operate.

Else, the configuration file parameters are checked for valid ranges. Wrong parameters are corrected automatically and cause a warning to pop up. Refer to chapter Configuration File for the detailed parameters explanation. The initialization ends with an information screen, which tells to loosen the locking screw and to remove the protection cap before measurement.

Parameter in config.txt	**Check for valid value**	**Automatic corrected value**
File Number (0-9999)	>= 9999	0
Default Length	< 0 or > Max Length	300
Maximum Length	< 0 or > 1720	1720
Sensor Type	= 9207 or = 9203	Warning on Display
Amplifier Range (pC)	= 10000 or = 5000	5000
Overload Range [N]	*Max Overload = (Amplifier Range / Sensitivity) - 1* If Overload Range > Max Overload	Max Overload
Velocity [mm/s]	≠ 20	Warning on Display

	< 10 > 20 ≠ integer (10..20)	20 20 integer (10..20)
Samples per mm	≠ 242	242

Table 2: *During the initialization of the controller software some of the parameters on the config.txt file are checked and automatically corrected if they are out of valid range.*

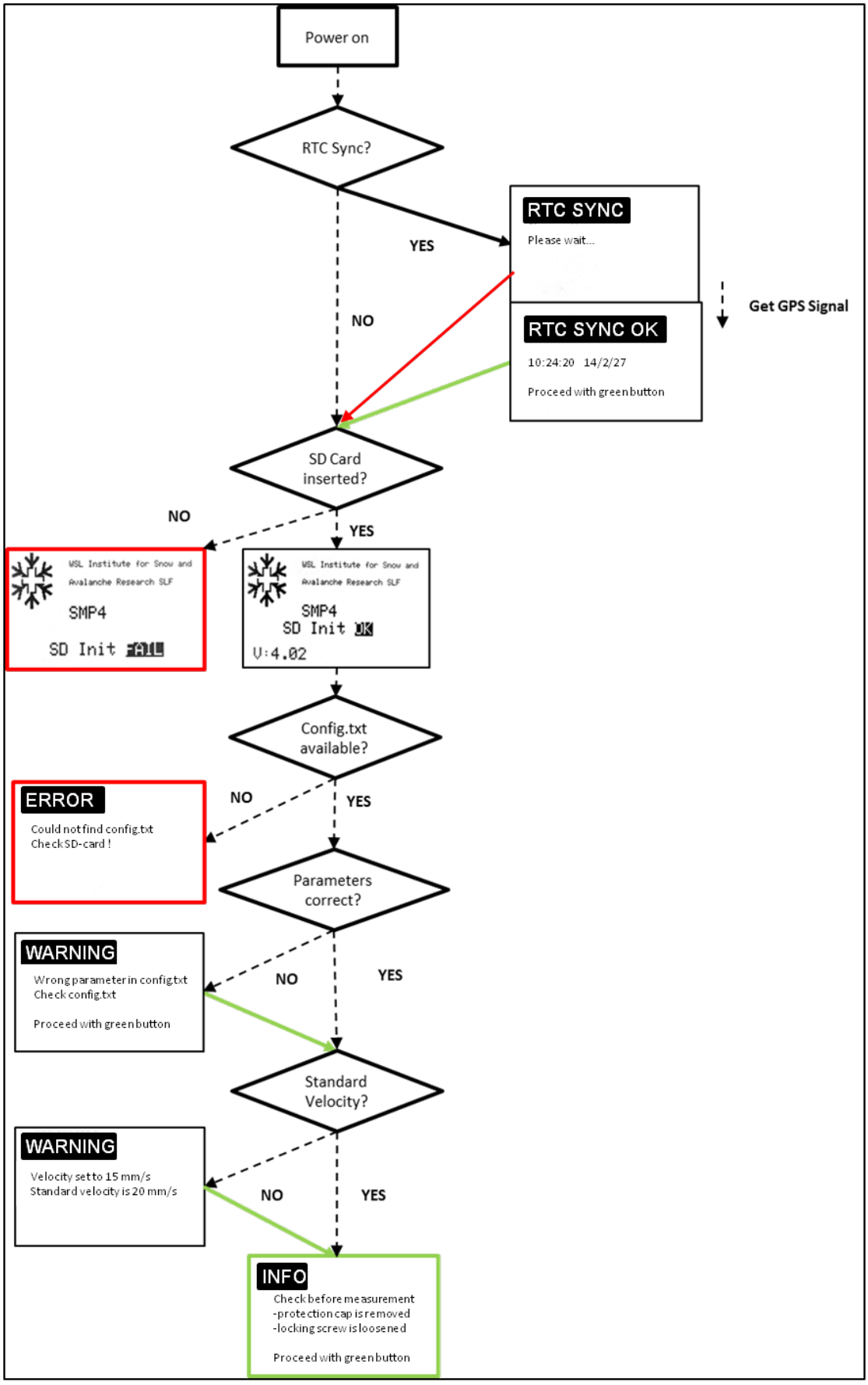


Figure 3: *SMP start-up initialization scheme*

Main Menu

Figure 4 shows the main software navigation. After switching on the SMP, it is initialized automatically. If successful, the SMP main menu is shown. You can choose between the submenus “Measure”, “Drive Engine” or “Settings”.

- The "Setting" menu displays device and measurement relevant parameters from the configuration file.
- The "Drive Engine" menu can be used to drive the motor manually. The up button drives the rod upwards until its home position is reached. The down button drives the rod downwards as long as the button is pressed.
- In the "Measure" menu, the two submenus “START” and "Depth” are available. By default, the measurement length set in the configuration file is used. You can customize the value by entering the depth submenu and using the up and down buttons. The measurement procedure is started right after pressing the green button on “START”.

After a successful measurement, recorded data is shown on the display. Additionally, maximum detected force, the measured depth and the file name of the stored data are shown on the display. Press the red button to go back to the "Measure" menu.

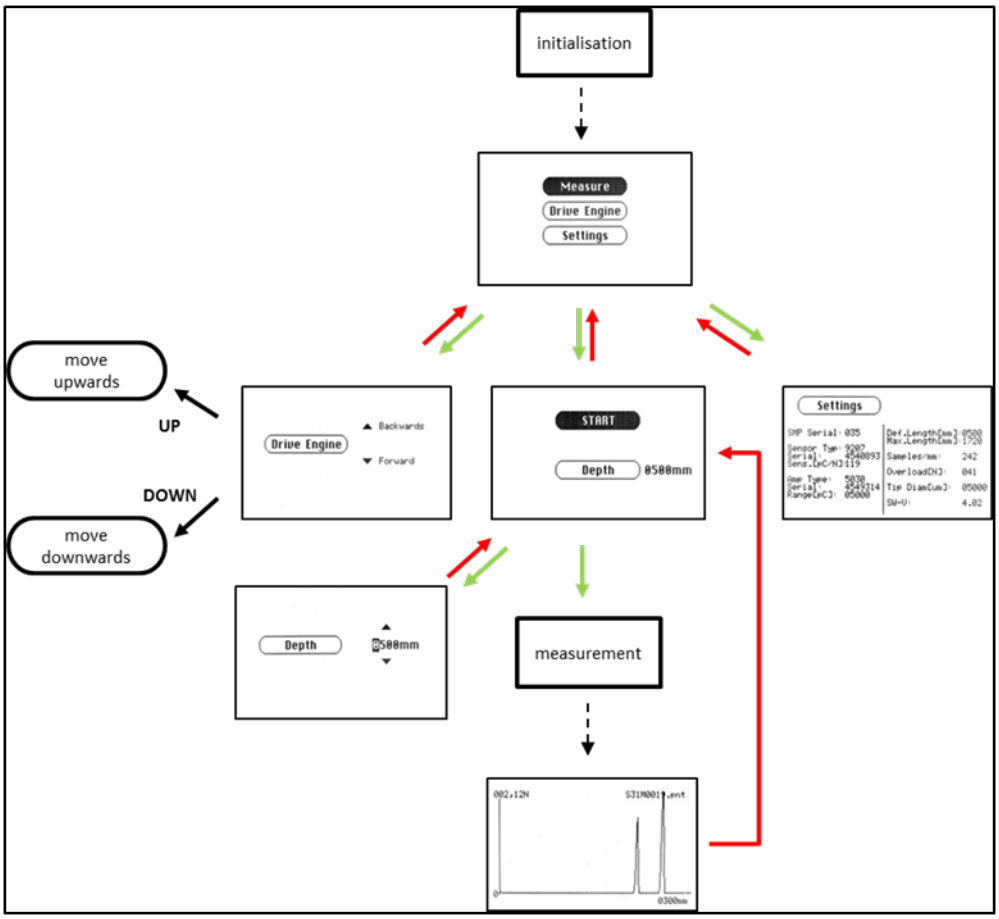


Figure 4: *SMP main menu scheme.*

Measurement Menu

To start a SnowMicroPen measurement, the "Measure" menu in the main menu must be selected which is illustrated in Figure 5. The submenus "Start" and "Depth" are opened. The submenu "Depth" is to change the penetration depth for the measurements. The value in "Depth" is set back to the value defined in the configuration file (parameter default length) after switching on/off the controller device.

The submenu "Start" immediately starts a measurement procedure. First, the file number is read out from the configuration file and incremented. Then it is checked whether the new measurement filename, consisting of prefix and file number of the configuration file, already exists on the SD-card. If so, the program searches automatically the next free file name instead of overwriting existing files. Next, the new file number is written into the config.txt. If this is somehow not possible, an error message will pop up and the program stops. In this case, check the SD-card.

If the rod is not homed while starting a measurement, the device will reset it automatically before starting the measurement. The measurement starts with a three second delay announced by the blinking “WAITING” on the display. This delay is necessary for the measuring person to press down the SMP. Then, the displayed “RUNNING” indicates that the motor starts driving the rod into the snowpack. The gear rod is driven into the snow pack until the user-defined length is measured. Afterwards, the measurement is saved to the SD-card while the rod is homed. Again, SD writing errors lead to a program stop indicated by a pop up error on the display.

After writing the measured data to the SD-card, the rod can be still going to home position, the controller searches a GPS signal if the GPS is activated in the configuration file. As soon as the GPS connection is good, the coordinates and the GPS time are written into the header. The user can overwrite this step by pressing the green button, in case that the GPS cant connect properly (e.g. indoor). As soon as the rod is back in home position, the current measurement is displayed. Press the red button to return to the "Measure" menu.

EXCEPTIONS

- During the measurement, the red button acts as emergency break. Already recorded data up to emergency stop will be saved.
- The measurement stops automatically if the force reached the overload range. Recorded data up to the overload stop will be saved.
- During backwards driving rod the red button acts also as emergency break. Use the "Drive Engine" menu to drive the rod manually to home position once the reason for emergency is removed. For safety reasons, measurements can only be started, when the rod is in home position.

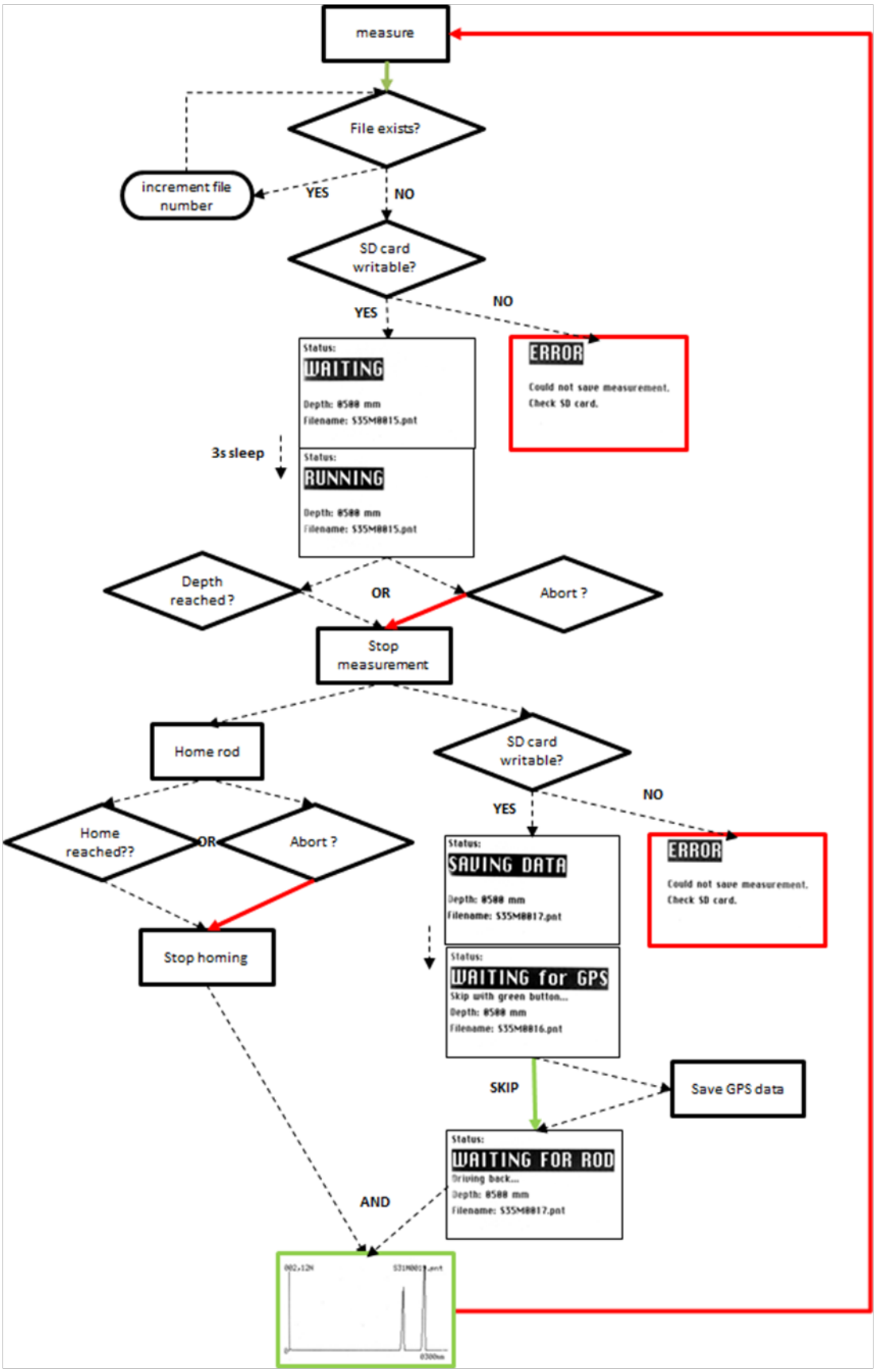


Figure 5: *SMP measurement menu scheme*

Operating the SnowMicroPen

Warning

- Never plug or unplug cables on the powered controller. This might severely damage the electronics.
- The protective tube covers the force sensor only in home position. Never apply shear forces to the sensor since it might break easily.
- The controller is not fully protected against moisture. Do not use the controller without additional protection (e.g. a plastic bag) when it is raining. Cover the controller during snowfall when it is not used. Always remove snow and water droplets from the device.
- Never probe into water. The force sensor is only splash water protected and specified.
- Measure always perpendicular to the surface. At plumb, measurements are not allowed, might lead to spurious signals, and may damage the force sensor. Bending of the tip on snow-layer transitions and the consequential shear forces causes this.

Quick measurement instructions

Before usage

- ✓ SD-card with free memory and correct configuration file is inserted
- ✓ The battery is fully charged
- ✓ All parts are present (controller unit, motor unit and the two fixing poles)
- ✓ Device is acclimated to outdoor temperature (rod must be at snow temperature)

Start a measurement

It takes about five minutes to assemble the instrument. Once the device is set up, measurements are done within three minutes.

1. Remove the transportation tube
2. Insert the two ski poles into the mounting holes on the motor unit
3. Remove the force sensor protection cap off the motor unit and loose locking screw
4. Mount the stripping brush onto the protective tube on the bottom of the motor unit
5. Connect force sensor and motor cable to the controller
6. Switch on the controller
7. Drive the rod manually ("Drive Engine" menu) out to check if the measurement tip and the O-ring is placed correctly
8. Drive the rod back to home position -> READY to Measure !

Finish a measurement

1. Switch off the controller
2. Unplug the force and motor cable
3. Tighten locking screw
4. Dismount stripping brush and mount sensor protection cap
5. Disassemble ski poles
6. Mount the transportation box

After usage

- ✓ Let the SMP dry out well
- ✓ Clean the device (also refer to section “Maintenance”)
- ✓ Store the SMP in warm and dry environment
- ✓ Remove the measurement tip
- ✓ Recharge the battery
- ✓ Save your measurement data on a computer
- ✓ If you can't dry out the SMP for at least 8 h, keep it always below 0°C

Detailed measurement instructions

Before performing measurements, the instrument must be acclimatized to the outside temperature. Otherwise, strong signal drift might occur as a temperature effect. On slopes, use the adjustable poles to make sure the drive rod is oriented perpendicular to the snow surface. The instrument must NOT be operated in horizontal or upside-down position since the geared rods or the force sensor might get damaged. Figure 6 shows a correct setup of the SMP before running a measurement.

Figure 6: *Correct measurement setup. The SMP is held perpendicular to the slope.*

At warm temperatures, the measurement tip might be at a temperature above 0°C. Melting snow might influence the measured signal and water can enter the force sensor unit where refreezing blocks the sensor tip. In this situation, it is recommended to spray alcohol or deicing fluid on the tip.

Measurement tip

It is important that the measurement tip is correctly positioned. Between outer cone and measurement tip is an O-ring which is absolutely necessary. The measurement tip and the O-ring are shown in Figure 7:

Figure 7: *Measurement tip of the SnowMicroPen with O-ring.*

The O-ring must be placed correctly between the measurement tip and the conical part of the rod as shown in the right picture in Figure 7. After screwing in the measurement tip into the force sensor by hand, the O-ring must be carefully moved in the groove with the fingernail.

The O-ring protects the force sensor from large side forces and prevents lateral oscillations, which would give noise effects in the force signal. Furthermore, the O-ring protects the force sensor from splash water, moisture and dirt.

A blocked measurement tip can be detected by making a short (15 cm) measurement in air. A small force is applied when the tip exits the cover, then released, such that the tip moves for an additional about 5 cm in air. If the zero force signal in air at the beginning and the end is not equal, then the tip is blocked, usually by frozen water. In this case, de-ice, clean and place the O-ring.

Effects of the surface below the snowpack (soil, rock, ice)

Scree or rock fields

Measurements to the ground on scree slopes and boulder fields are critical to the sensor. Touching rocks, high bending forces might damage the sensor. Therefore minimize the risk of damage by measuring the actual depth with a calibrated avalanche probe. Additionally, set the force overload range in the configuration file to a low value, e.g. 25 N. Most important is that the SMP is pressed down so no upward movement is possible. If your maximal force is set to 50 N, press down by at least 300 N. For higher forces, two persons may be necessary to press down.

Solid rock

Very high transient forces might occur when the tip hits solid ground and cannot be stopped quickly enough. Set the overload range to 25 N if you expect to hit solid surfaces. Otherwise, the tip itself may get damaged and/or blunt.

Soil and frozen soil

Measurements into mineral or organic soils are no problem if there are little or no stones embedded. However, often clay, silt or fine organic materials easily stick on the tip, especially in the tip O-ring groove. Clean the tip of the SMP with a soft brush after such measurements. If you are unsure about the type of the soil, reduce the maximal force to 25 N.

Influence of Temperature

The current measurement setup of the SMP is actually not laid out for temperature changes during a measurement. Temperature changes (temperature gradient) during a measurement cause temperature drift in the force signal. Often the temperature changes during a measurement are negligible when the air temperature (also the temperature of the device) is low and similar to the temperature in the snowpack. A strong temperature drift is observed mostly on warm days in springtime having high solar radiation as well. This effect should be considered while measuring on warm days with high solar radiation. If it is possible the SMP should be shadowed and protected from the direct sunlight (a protection against direct radiation from the sun is under construction ...).

However, there is a small signal drift even when the device is nearly in temperature equilibrium. But the value of the drift is small, it is less than 0.2 mN per second which is determined by an air measurement. The noise and the offset of the force signal are independent of the temperature.

The following graph shows the influence of the signal drift caused by temperature disequilibrium:

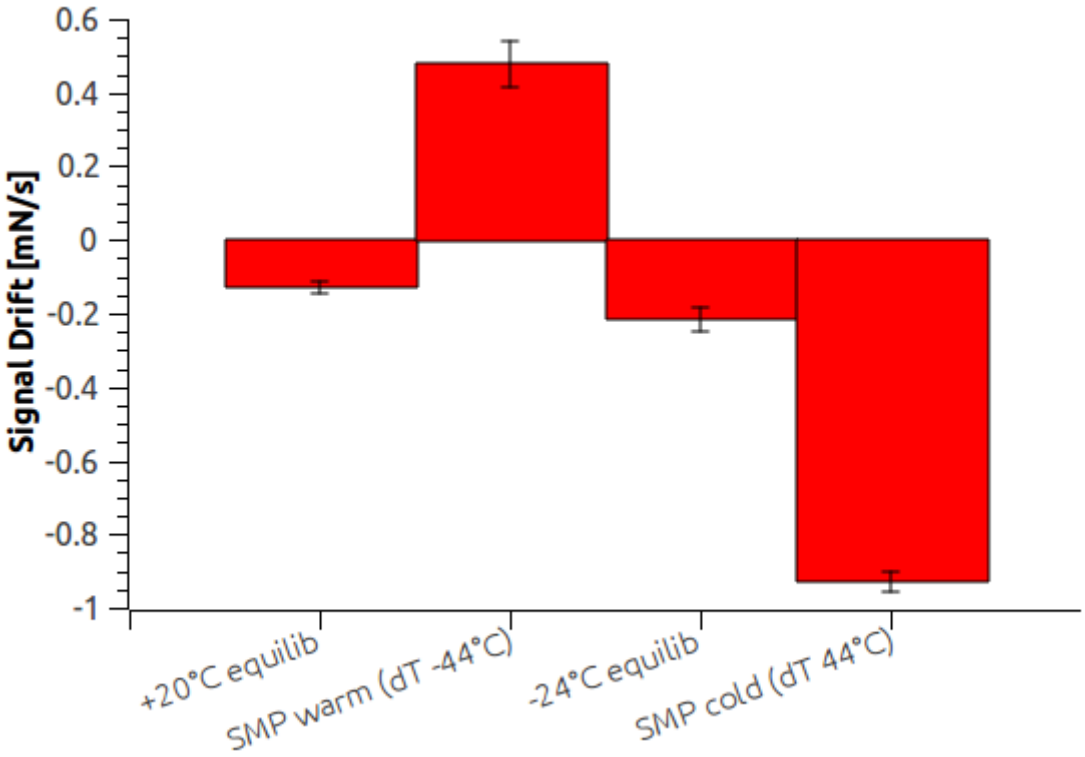


Figure 8: *Influence of the temperature to the signal drift in an air measurement.*

Figure 8 shows four different temperature gradient situations when measuring with the SMP in the air. In two of these situations the force sensor of the SMP is nearly in a temperature equilibrium, only a very small, natural temperature gradient, at +20 °C and at -24 °C. In the other two situations an extreme disequilibrium is induced. The warm SMP is put to a cold area (Δ T = -44 °C) and the opposite; a cold SMP is put to a warm area (Δ T = +44 °C).

The signal drift is caused by a temperature gradient on the force sensor.

Independent of the temperature when the device is in an equilibrium condition, the signal drift is slightly negative. The absolute value is less than 0.2 mN/s. A typical springtime situation when the air temperature (and device) is warm and the sensor is cooled down while penetrating into the snow, a positive signal drift is induced. Also the opposite effect is possible.

Configuration File

Specific device information and measurement parameters are stored in a configuration file on the SD-card. Without the correct *config.txt* in the storage root folder, measurements are not valid. Windows formatted, carriage return and line feed have to terminate each line. Each entry is composed by its name, followed by a tab, a colon and without space the actual entry value. The configuration file is structured as shown in Figure 9:

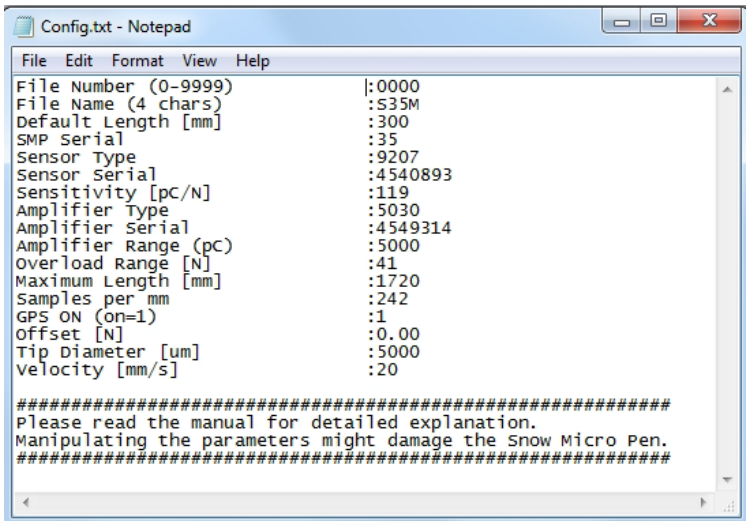


Figure 9: *Configuration file which must be stored on SD-card as config.txt*

Parameters and meaning:

File Number: Consecutive, four digits number, which gives the suffix of the measurement file name. Before each measurement, this number is incremented and written into the file by the controller. If a file exists, the controller will increment the file number up to the next free file name. Wrong entries will raise an exception that is indicated during start up of the controller. The file number should not changed by user. When the number reaches 9999, the controller will set it back to 0. Before that happens the files on the SD-card should be deleted.

Filename: Four ASCII characters, which give the prefix of the measurement file name.

Default Length [mm]: Sets the default measurement length in mm after start-up of the controller. Do not set a higher value than given in *Maximum Length [mm]*. Higher values throw an exception during controller initialisation and are corrected automatically.

SMP Serial: SMP serial number.

Sensor Type: Kistler force sensor type, either 9207 (50 N) or 9203 (500 N). Regardless of the force range specification, the sensors might be in linear sensing regime for up to 50% overload.

Sensor Serial: Force sensor serial number.

Amplifier Type: Kistler charge amplifier type.

Amplifier Serial: Charge amplifier serial number.

Amplifier Range [pC]: Gives the maximum amplifier range in picocoulombs, can be set either 5000 pC or 10’000 pC. Range 5000 pC allows to measure forces up to 41 N and 410 N respectively depending on the sensor type. Range 10’000 pC is valid for forces up to 75 N and 750 N, respectively.

Overload [N]: The maximum measurable force. Higher forces then the set value will lead to a force overload and the measurement is stopped. Use an adequate range matching to amplifier range, sensor type and measurement conditions. Maximum overload is given by *Range [pC]/Sensitivity[pC/N]*. Higher values lead to an error message during start up and are automatically corrected.

Maximum Length [mm]: Gives the maximum penetration depth in millimeters. This value is determined by the rod length.

Samples per mm: Sampling rate per millimeter. Do not change this value 242 mm^{-1}. It is a fix number and given from the encoder part of the motor.

GPS ON (on=1): If the value 1 is set, GPS is used to save measurement coordinates, if available. If the value is 0, the GPS module in the controller is off. The time-stamp in the measurement files is set by the internal clock. No coordinates are written to the file if the value is 0. The time-stamp in the measurement files is always written, but may be not precise, if the GPS is off.

Offset [N]: Adjustable force sensor offset in Newton. The Offset is subtracted from the measured signal to compensate a non-zero offset. The offset is taken into account after the measurement, thus does not influence the overload criteria.

Tip Diameter [µm]: Measuring tip diameter in µm, can be used to calculate pressure.

Speed [mm/s]: measuring speed in millimeters per second. Allowed are values from 10 mm/s to 20 mm/s, where standard speed is 20 mm/s. Speed values different from 20 mm/s are experimental.

 Wrong parameters might result in false measurement data or even damage the device. Do only change the entries *File Name, Default Length, GPS and Offset*. To change others values contact the manufacturer first.

Saved binary data

The measurement data is stored in a custom binary ".pnt" format on the SD-card. Connect the SD-card to your computer to transfer the files. A USB to SD-card connector belongs to the SMP equipment.

We provide software to read, analyse and export data, *SnowMicroPyn*, a Python based Software distributed as source code and as compiled cross-platform executable for Windows, Mac and Linux. The programs are online available for download:

https://sourceforge.net/projects/pyntreader/

Optionally, we provide Matlab and IDL scripts, or you can write your own reader software. The .pnt file consists of a 512 byte header and the measurement values are stored as integer values following blocks. The first measurement point starts at byte 512 and ends at byte 512+4*(number of force samples). In Table 3, the detailed header structure is given.

Information	Data Type	Position	Length
Software Version	short int	0	2
Total no. of samples	long int	2	4
Distance between samples	float	6	4
Conversion factor digits to force	float	10	4
Conversion factor digits to pressure	float	14	4
*Offset of zero value calculated at the start	short int	18	2
Year	short int	20	2
Month	short int	22	2
Day	short int	24	2
Hours	short int	26	2
Minutes	short int	28	2
Seconds	short int	30	2
*Swiss spatial coordinate (x)	double	32	8
*Swiss spatial coordinate (y)	double	40	8
*Swiss spatial coordinate (z)	double	48	8
*Battery voltage	double	56	8
Average speed (mm/s)	float	64	4
*Loopsize, size of subarray between force reset	long int	68	4
*Waypoints, return points of force reset	long int array	72	40
*Calstart, force sensor offset at start of reset	int array	112	20
*Calend, force sensor offset at end of reset	int array	132	20
*Length of optional comment	short int	152	2
*Optional comment	string	154	102
Filename string	string	256	8
Latitude [deg]	float	264	4
Longitude [deg]	float	268	4
*Height [cm]	float	272	4
pdop	float	276	4
North [N/S]	char	280	1
East [E/W]	char	281	1
*Numsats	short	282	2
Fixmode	short	284	2
GPS-State	char	286	1
reserved	-	287	1
*Local x	short	288	2
*Local y	short	290	2
*Local z	short	292	2
*Local theta	short	294	2
reserved	-	296	62
Number of force samples	long int	358	4
*Number of temperature samples	long int	362	4
Kistler Range	short int	366	2
Range of amplifier	short int	368	2
Sensitivity	short int	370	2
Temperature offset	short int	372	2
*Hand operation	short int	374	2
Tip diameter [µm]	long int	376	4
Overload [N]	short int	380	2
Sensor Type	char	382	1
Kistler Type	char	383	1
SMP serial number	short int	384	2
Max. length [mm]	short int	386	2
reserved	-	388	4
Sensor Serial	string	392	20
Kistler Serial	string	412	20
reserved	-	432	80

Table 3: *SMP binary *.pnt structure. Entries beginning with (*) are not used.*

Maintenance

Storage and Cleaning

The device does not need large maintaining effort:

- Store the device in a dry environment above freezing point
- Remove dirt from the gear rod with a copper brush
- Make sure all parts are dry
- Remove measurement tip carefully to dry the sensor
- Make sure that the O-ring is intact
- The display can be cleaned with a soft cloth
- Make sure that the screws on the charge amplifier box in the end of the rod are tightened
- Make sure that the bolts between the single rod elements do not overlap the diameter of the rod
- If there is no mechanical resistance after screwing in the tip (so the sensor itself might be loose), see chapter Disassembling the device or contact the manufacturer

Controller Software Update

New SMP controller software may contain bug fixes and new features. Updates are released on the SMP homepage: Software

You can subscribe to a newsletter to become informed about updates.

How to perform a software update:

Necessary components

- SMP controller
- Computer with USB port and CD-ROM drive (Windows XP, Vista or 7)
- PICkit2 containing PICkit Starter Kit Software, USB Interface Cable, HI-TECH PICC Lite Compiler (delivered with all SMP4 controllers)
- Installed PIC Software
- Extension cable from PICkit2 to SMP controller
- Screw driver
- latest software binary as *"main.hex"*

Preparation of the SnowMicroPen4 Controller

Wear an anti-static wrist wrap when opening the controller body. This prevents electrostatic discharges which can damage electronic parts.

1. Loosen the four screws to open the controller body
2. Connect the PIC adapter and the controller as shown in Figure 10)
3. Connect the PIC USB cable to the computer
4. Switch the SMP controller on

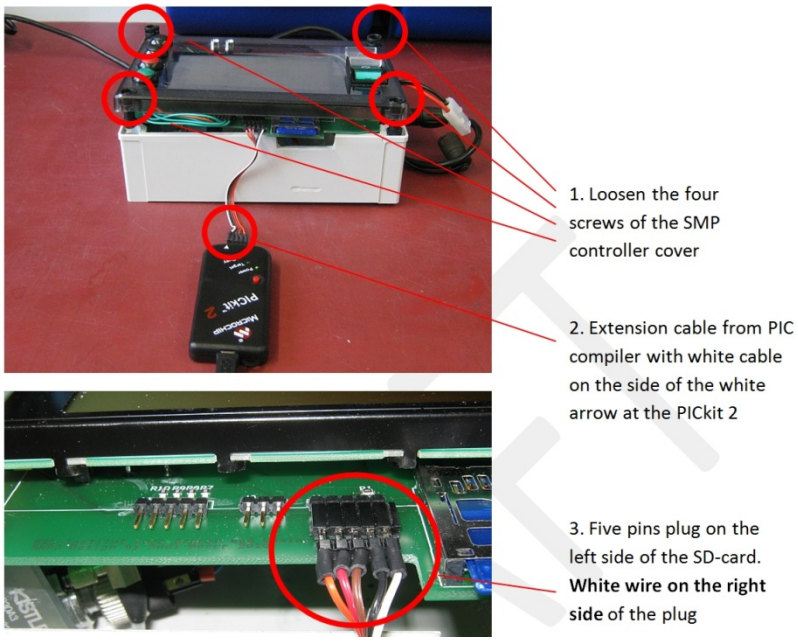


Figure 10: *Preparation of the SMP controller for the software update.*

Software Update

1. Start the previously installed PICkit Software. The program detects the PICkit and the connected controller automatically, see Figure 11. If the controller is not found, go to “Tools” and enable “Fast Programming”. Then go to Tools -> Check Communication. Make sure device type PIC18F_J is identified.
2. Go to File -> Import Hex and selected downloaded SMP software update “main.hex”
3. Press “Write” to upload the software to the micro controller
4. Press “Verify” to check the software update. If the update procedure was not successful, try again.
5. Disconnect the PICkit
6. Switch SMP controller off and reassemble the controller
7. Perform and evaluate test measurements to verify proper function of the SMP

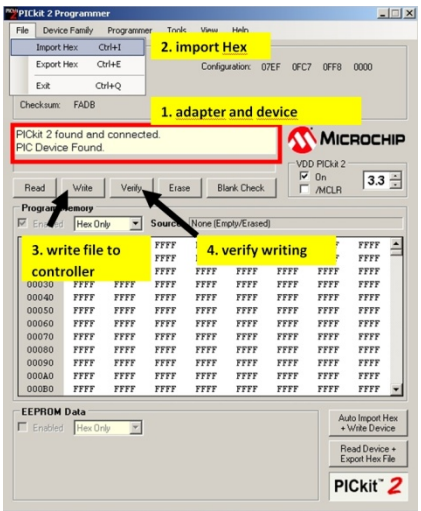


Figure 11: *PicKit2 user interface for software update of SMP controller.*

Shipping

The SMP is either transported in a case (Figure 12) or a ski bag with following specifications:

type	length [cm]	width [cm]	height [cm]	weight [kg]
flight case	175	31	22	18
ski bag	210	35	30	20

List of Shipped Components

- ✓ SnowMicroPen4 controller, motor unit and drive rod
- ✓ Transportation tube
- ✓ Measurement tip with O-ring (+ 1 set as spare part)
- ✓ Brush ring
- ✓ SD-card 4 GB class 10SD & USB SD card reader
- ✓ PICkit for upgrading controller firmware, cable and installation CD
- ✓ In- or external Li-Polymer battery and battery charging device and cable
- ✓ Standing poles and screws
- ✓ Spare parts
- ✓ User manual

The tip of the SnowMicroPen must be completely covered by the white protecting tube during transportation. If the tip is not covered, unexpected forces may destroy the force sensor. The cable of the SnowMicroPen must be disconnected from the controller during transportation.

Figure 12: *Transportation box for SMP with standard rod (1250 mm).*

Special Customs Declaration

For the customs declaration for the Li-Polymer battery it is important to mention the following:

- that the battery is "contained in equipment" - contained in a strong aluminium cover
- that there are not more than 2 batteries
- and that the total battery capacitance is less than 100 Wh

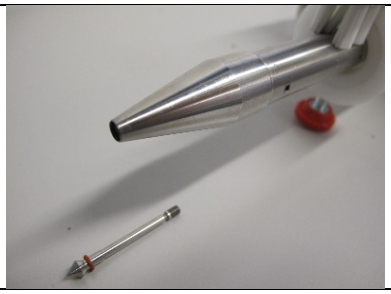
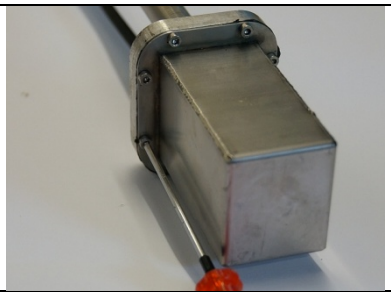
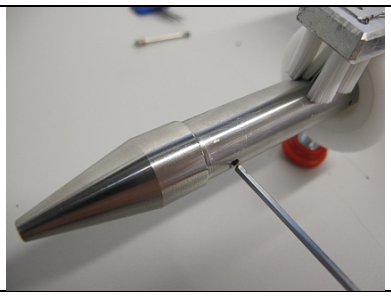
According to the IATA Li-**-Battery guidance (UN3481), the Li-Polymer battery of the SnowMicroPen is NOT a dangerous good. It does NOT require a label on the transportation box and the battery must NOT be mentioned in the airway bill.

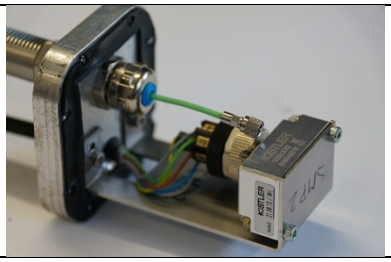
Disassembling the device

For normal usage it should not be necessary to disassemble the SMP to get to the force sensor or to open the charge amplifier box. But in the some situations it might be the only solution to fix the device:

1. When you screw in the tip by hand and you can not feel any resistance at the end of the thread, the force sensor has probably loosened from the rod or is broken
2. The black sensor cable is pulled out of the charge amplifier box
3. There is no force signal measurable

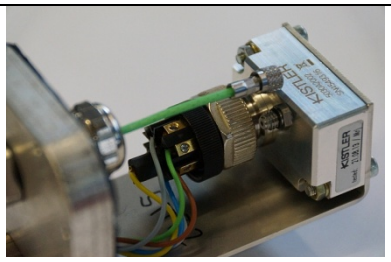
In case of opening the charge amplifier box and or doing manipulations at the force sensor, please always contact the manufacturer first.

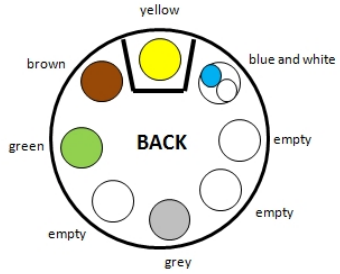
	(Repairing purpose 1-3) First remove the measurement tip from the force sensor. This is a general precaution during manipulations on the SMP that the force sensor is prevented from unexpected forces / impacts.
	(Repairing purpose 1-3) Remove the eight socket screws. The cap of this charge amplifier box can then easily be removed (sometimes it sticks to the rubber seal).
	(Only repairing purpose 3) Remove the headless screw. The screw holds the conical front part with the cylindrical part of the rod together.



(Repairing purpose 3) There is no force signal measurable

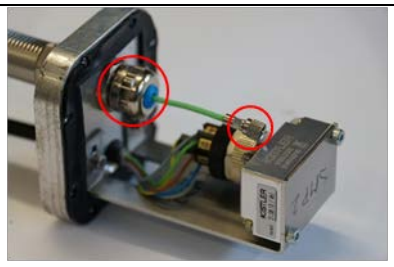
The green cable coming out of the rod is not connected with the charge amplifier. Reconnect it but be very carefully that the green cable is not bent too much.





(Repairing purpose 2) The black sensor cable is pulled out of the charge amplifier box

In the picture the proper situation is shown, but in case that the black sensor cable was pulled out all the six wires (yellow, grey, brown, green, blue and white) are not anymore connected to the charge amplifier. Reconnect them according the following scheme:



(Repairing purpose 1) There is no resistance from the force sensor when you want to screw the measurement tip in.

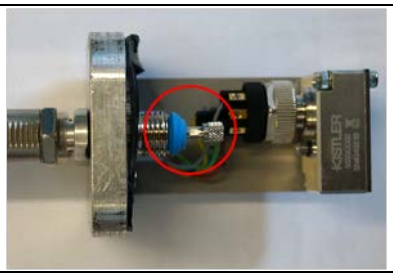
Remove the cable from the charge amplifier (right red circle in the picture). Take care that the green cable from the sensor is not bent too much !

Loosen the screw nut (left red circle in the picture) which presses the blue rubber seal around the green cable and prevents it from moving.

Now, it is possible to pull the conical part holding the force sensor out from the cylindrical part of the rod, but only until the plug on the other side of the cable touches the blue rubber seal (picture above). It is around 3-4 cm !

Then, tighten the force sensor against the conical part of the rod (red circle in the picture).

Do not remove the force sensor completely from this conical part of the rod. This part is a protection for the

	force sensor as well. The front part of the force sensor is really sensitive against side forces and can break easily.
	To "pull the sensor back" into the cylindrical part of the rod, pull on the green cable on the side of the charge amplifier box. It is not allowed to push the cable because of bending and breaking. Reassemble everything !

SnowMicroPyn

About

SnowMicroPyn is open source cross-platform, freely distributed software to view and pre-evaluate SMP files in .pnt format. The software is available as executable .exe for Windows, .app for Mac, .bin for Ubuntu as well as Python code. This allows the user to implement their own functions or to use code pieces. The files can be downloaded on SourceForge.net in the file section:

https://sourceforge.net/projects/pyntreader/

This open source project allows all SMP users to actively develop and contribute to the reader. Feel free to ask for a developer account for the GIT repository.

Source Code

The source is written in Python 2.7 and uses numpy,scipy and matplotlib for data evaluation as well as wxpython 3.0.0 as cross platform GUI toolkit. Please download and read the README.txt for further information. The provided executable binary is a simple compilation by pyinstaller.

Short explanation of the file structure:

- **./src/SnowMicroPyn.py:** This is the main file and contains the GUI programming. Run this file to start the software. If you use a list of .pnt files as argument while executing the program, the files are opened and displayed automatically.
  Usage:
  python Snowmicropyn.py File1.pnt File2.pnt FileX.pnt
- **./src/artwork/:** The artwork folder contains icons and .png image files that are used by the toolbar and the program.
- **./src/extensions/:** Subroutines of the main program are stored in this folder. It contains e.g. python files to extract .pnt data (smp.py), mathematic functions (mathematics.py), google maps functions (map.py) and so on. Have a look at the respective files for further information.
- **./src/outdated/:** This is the trash folder for unused python files.

Program Usage

You can start the program by double clicking the file or choosing “open with” with one or more .pnt files.

Useful key combinations and short cuts

- Ctrl + o: open .pnt files
- Ctrl + k: close ALL files
- Ctrl + w: close current file
- Ctrl + q: close program
- Ctrl + s: save current file
- Ctrl + Shift + a: save ALL files
- Ctrl + left click on plot: set surface to mouse position (if view-> show surface is activated)

- Shift + left click on plot: set ground to mouse position (if view-> show ground is activated)

FAQ

Although we test soft- and hardware carefully, we do not discover all bugs. If you discover a bug, please contact the support for bug report and/or help.

Errors

- **SD init fail / boot fail:**
  Problem: *Randomly, the controller gets stuck on the boot screen or SD init fails*.

  Solution: Restart the controller. If the problem occurs more often, try formatting the SD-card.

- **SD writing error:**
  Problem: *SD-card is not writable for measurements.*

  Solution: Restart the controller. If the problem remains, try formatting the SD-card. Always unmount the card safely from your computer to prevent corrupting the file system.

- **Controller doesn't respond:**
  Problem: *The Controller doesn't react to use input.*

  Solution: Restart the controller. Sporadically, the microcontroller stalls.

Links and Contact

Please send all requests to

snowmicropen@slf.ch or call +41 81 417 01 11

For administrative questions, offers, data analysis etc. contact

Martin Schneebeli, schneebeli@slf.ch, +41 81 4170 181

For technical support, maintenance, repairs and SnowMicroPyn ask

Matthias Jaggi, jaggi@slf.ch, +41 81 4170 179

Following links may be helpful

SnowMicroPen Homepage	SMP project web site with further information and downloads
Publications	list of selected publications
SnowMicroPyn	python based SMP data visualization and export software
Snow Pack Analysis	snowpack variability and –stability investigated with the SMP

Appendix 1 - How to install PICkit software

The installation is straight forward. Make sure, you have internet access and administrator privileges on your Windows computer.

1. Insert the PICkit CD in the CD-ROM drive
2. Start the installer
3. Choose "*Programmer Only*" on the left side of the user interface (Figure 13)

4. Choose "*Install PICkit TM 2 Programmer Application*" (Figure 14)
5. Installation

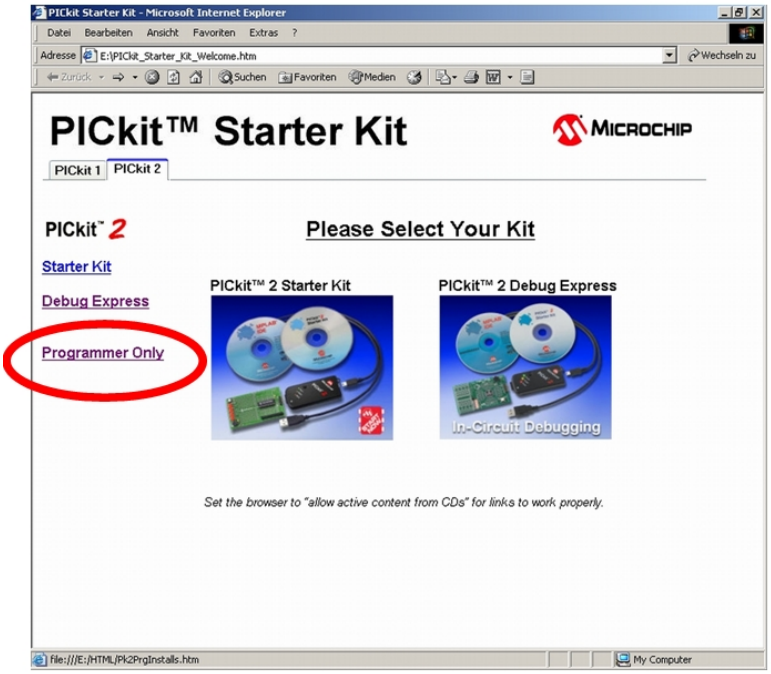


Figure 13: *Installation of PICkit software.*

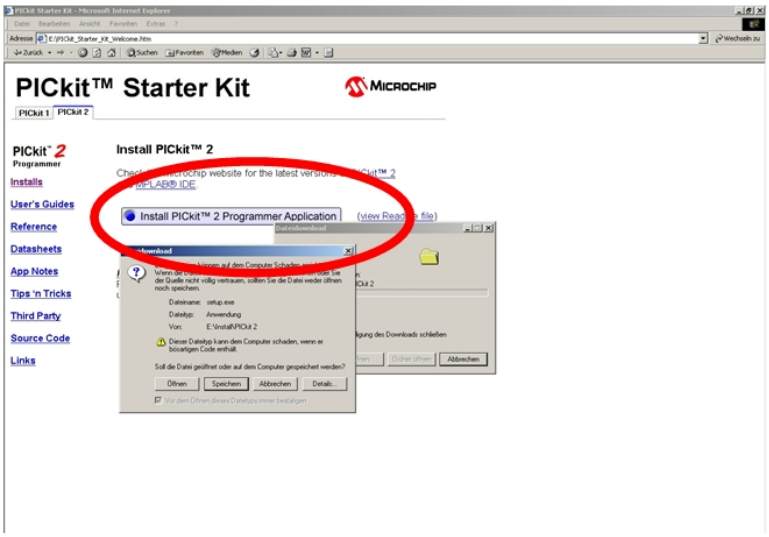


Figure 14: *Installation of PICkit software.*