

Clip-On Evaluation Cable for SFM3x0x-AW/D

Applicable to following sensors:

SFM3304-D, SFM3200-AW, SFM3300-AW/D, SFM3400-AW/D

Key content:

- Clip-on evaluation cable description
- Clip-on cable use cases
- Technical information on clip-on cable
- Recommended approach for customized solution

Summary

This application note describes the clip-on cap interface for the proximal flow sensors SFM3304-D, SFM3300-AW/D, SFM3400-AW/D and the expiratory sensor SFM3200-AW. These sensors have in common that they can easily be swapped to allow for cleaning (AW-type) or exchanged and disposed of (D-type). Both types therefore feature the clip-on interface which allows for user friendly and reliable connection by medical staff.

This application note provides relevant information about the evaluation cable, how to use it for initial feasibility and later implement it in prototypes. Technical details and guidance are provided for customers looking to implement a customized cable solution for their final device.

1 Introduction

Sensirion's autoclavable, washable and single-use mass flow sensors are optimized for proximal flow measurements in respiratory applications with adults and children (SFM3304-D, SFM3300-AW/D), neonates (SFM3400-AW/D) and for expiratory measurements requiring minimal pressure drop (SFM3200-AW).

Since these sensors are exposed to the exhaled media from the patient, they need to be replaced regularly or cleaned by the medical personnel. Therefore, these sensors require a user-friendly and reliable interface with a cable which connects them to the respiratory device.

Sensirion's clip-on evaluation cable demonstrates the advantages of the proposed clip-on solution and offers various possibilities to evaluate the sensor firsthand and with little effort even in the customer's own setup. This application note also provides information for customers on how to design or source a customized solution tailored to their specific respiratory device.

2 Order Information

Please note that the evaluation cable is replaced by the generation 2, compatible with the SFM3304-xxx-D.

Evaluation cable	Part number	Compatible with	Available
SEK-SFM3xxx-AW/D Evaluation Kit Cable	3.000.518	SFM3300-D and -AW SFM3400-D and -AW SFM3200-AW	Sensirion.com Distribution
SEK-SFM3xxx-AW/D Evaluation Cable Gen. 2	3.001.306	SFM3304-D SFM3300-D and -AW SFM3400-D and -AW SFM3200-AW	Sensirion.com Distribution

For customized solutions, please refer to chapter 4.

3 The Clip-On Cap in the evaluation cable

Sensirion's evaluation cable is shown in **Figure 1** below. The evaluation cable has on:

- Sensor side: a clip-on cap with microcontroller and pressure sensor
- Computer side: a USB connector



Figure 1. Evaluation cable and SFM3300-AW sensor.

3.1 Clip-On Cap Functionality

The clip-on cap incorporates a miniaturized PCB with a microcontroller which enables the following features and advantages.

Pressure Sensor in Clip-On Cap

In respiratory applications the patient's breathing pressure often must be measured as close as possible to the patient, typically at a proximal location. In order to avoid having to loop back a thin tube carrying the pressure signal back to the respiratory device (e.g. the ventilator), a fast, high resolution and sensitive pressure sensor has been integrated into the re-usable clip-on cap (Type: AMS 5915-0200-D-B). This allows measuring the pressure proximal to the patient while avoiding additional tubes running back to the ventilator, which delay and attenuate the pressure signal.

The evaluation cable features the clip-on cap with an integrated pressure sensor and a pressure port² which can be connected to the breathing circuit (e.g. the WYE piece) with a short tube.

² Appropriate connector type: 158442 Luer-Tubing Adapter (Male) for Flexible Tubing (<https://www.rct-online.de/en/>)

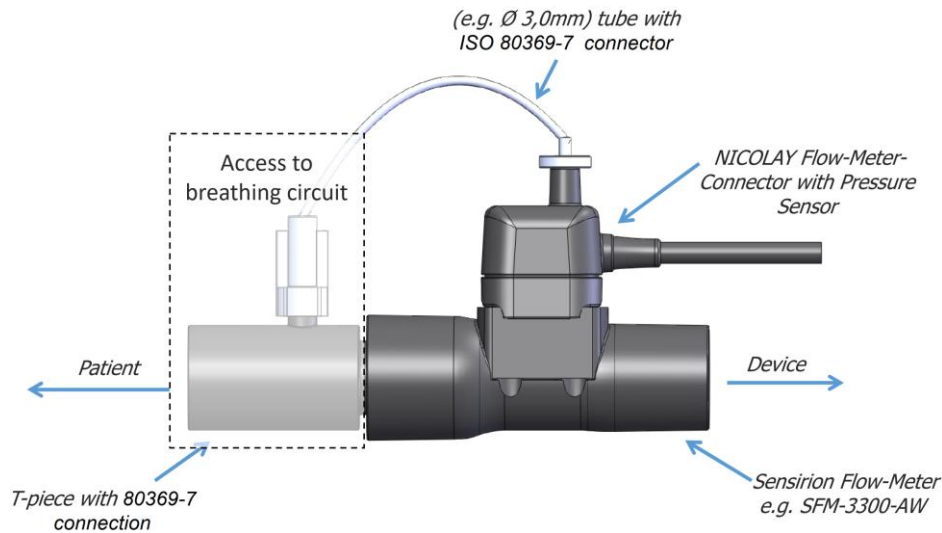


Figure 2. Clip-on cable featuring the pressure port. Flow and pressure readings are returned electrically to the respiratory device.

External Heater

In specific applications it is necessary to take scenarios of condensation or even icing of the sensor element into consideration. To allow the sensor to operate in such harsh environments, a resistor has been placed on top of the flow sensor PCB which can be used as a heater element. Heating power is limited to 0.5 W and can be directly controlled by communication commands through the cable to values between 0 and 100%. The new evaluation cable (generation 2) will limit heating such that the flow sensor temperature does not exceed 50°C.

As heating the flow tube induces a thermal gradient over the sensing element, the set external heater power may affect the sensor accuracy. Depending on the heater power applied and the accuracy requirements, additional testing in the specific design-environment is recommended. Generally, it is recommended to only apply sufficient power for the intended scenario, e.g. to avoid condensation, and not to continuously set the heater to 100%.

Sensor Supply Voltage On/Off Capability

Via communication commands to the microcontroller inside the clip-on cable the power supply to the sensor can be switched on and off, to perform a hard reset.

Protocol/Bus Conversion

The sensor's I2C protocol is intended for communication over short cable lengths (<10cm) only and therefore not ideal to connect proximal sensors to a ventilator device with cable lengths typically extending beyond 1m.

In comparison the UART protocol is a much more robust communication protocol and better suited for signal transport over longer distances. For this reason and in order to provide the functionalities mentioned above, a microcontroller is incorporated inside the clip-on cap of the cable. This microcontroller reads the flow and pressure signals from the flow and pressure sensor over a short distance via the I2C protocol and transmits the measurement values using RS232 to the USB connector. Inside the USB connector the signal is then transformed into a USB signal.

3.2 Evaluation cable – Use cases

The evaluation clip-on cable was designed to allow for prototype testing as well as initial integration into customer devices for feasibility testing. While allowing the clip-on cap to accompany the development process as far as possible, several different use cases were considered:

Sensor Evaluation and Initial Testing with Sensirion's Control Center Software

Sensor evaluation and initial testing is straightforward using our quick starter guide:

1. Download install Sensirion's Control Center Software:
<https://www.sensirion.com/en/controlcenter/>
2. Connect the sensor with the Clip-on evaluation cable to your computer
3. Start the software and run flow measurements

Proprietary Software on a PC interfacing via USB

The cable's readings from the sensor can also be integrated into a customer specific application, e.g. a Simulink environment or any other proprietary application. For details on the communication protocol, please refer to the Nicolay cap/cable communication protocol in section 3.3.

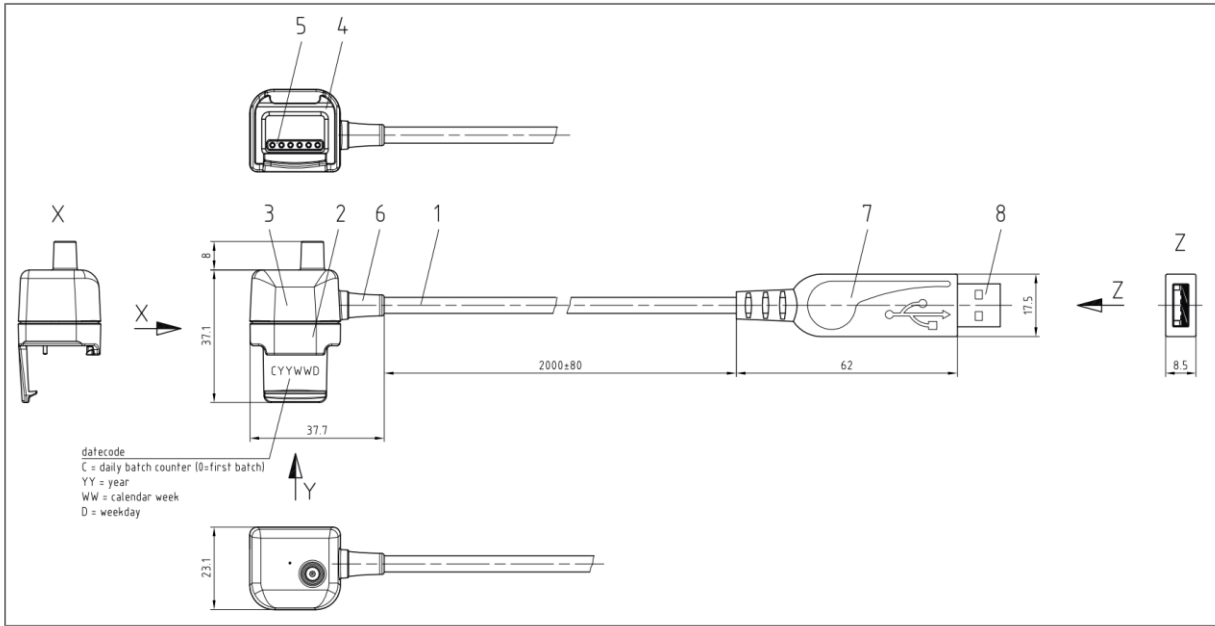
Installation of the FTDI USB driver might be required and can be downloaded from the following link:

www.ftdichip.com/Drivers/VCP.htm

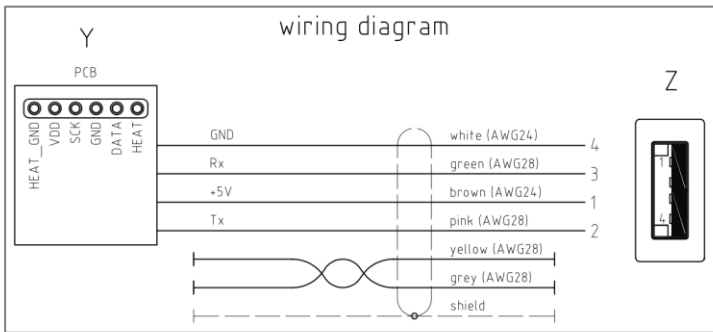
Prototype and interfacing via UART

The sensor can also directly be connected to an electronic circuit board and interfaced with the UART RS232 interface. This requires cutting off the USB connector and following the wiring diagram of section 3.3 for correctly connecting the cable as well as the outlined communication protocol (see section 3.3).

3.3 Key Characteristics of Clip-On Cap/Cable



-	1	pressure sensor with digital output			AMS 5915-0200-D-B
8	1	USB plug			
7	1	plug-insulation	Hotmelt	black similar RAL 9005	
6	1	strain bend relief	M-PUR	black similar RAL 9005	
5	1	PCB assembled with 6-pin spring-loaded connector			surface Au
4	1	sealing	silicone	black similar RAL 9005	
3	1	cover	PUR	black similar RAL 9005	
2	1	housing	PUR	black similar RAL 9005	
1	1	6-lead shielded cable $\phi 4.5+0.2$	M-PUR	black similar RAL 9005	464478100
pos	quantity	description	material	color	note



Communication Protocol

The communication protocol (Nicolay flow meter connector with pressure sensor) is described in a separate datasheet and provided by Nicolay. The PDF can be downloaded from the following Nicolay's website:

Evaluation cable	Communication protocol	Comment
SEK-SFM3xxx-AW/D Evaluation Cable (Gen. 2)	<u>Flow sensor P sensor Communication protocol</u>	Additional compatibility with SFM3304-D

4 Recommendation for Customized Cap/Cable Solutions

Sensirion partnered with the company Nicolay for the development and manufacturing of our clip-on evaluation cable. Nicolay has production tools readily available (e.g. molding tool for the clip-on interface) and offers various options for customization of the clip-on cable. The sealing inserted into the cap, which protects the sensor's PCB and the cable pins against spilled water is just one example of Nicolay's expertise with cables for medical applications.

Many global projects have tested and adopted the clip-on cables manufactured by Nicolay. For any project going beyond the initial feasibility, Sensirion recommends reaching out directly to Nicolay regarding a clip-on cable solution for our proximal and expiratory sensors. **Please note that the medical device manufacturer is responsible for the validation for medical purposes of the cable including its PCB and firmware.**

The contact details are the following:



Name: Joel Bischoff
Phone: +49 7452 823 138
Email: joel.bischoff@nicolay.de
Website: www.nicolay.de

Nicolay GmbH
Graf-Zeppelin-Str. 21
72202 Nagold
Germany

4.1 Available Options and Inquiry Form

The table below summarizes the most common cap/cable options offered by Nicolay. Please reach out directly to Nicolay to discuss your preferences, requirements, and commercial aspects.

Configuration Options	Customer Selection
Cable length (10cm – 400cm, default 2m)	_____cm
Select cable exit side 	☐ left ☐ right
Cap with or without pressure sensor	☐ with pressure sensor ☐ without pressure sensor
Select PCB communication protocol	☐ RS485 ☐ RS232
Select device connector interface 	☐ Nicolay mini7 plug ☐ Nicolay mini12 plug ☐ USB connection ☐ Open end cable (pigtail) ☐ other: _____
Please indicate order quantity (MOQ = 100pcs)	_____pcs

5 Own Clip-on Cap/Cable Design

In this chapter details are provided for customers preferring to design their own cap/cable clip-on. Please note that Sensirion does not have a molding tool and solely offers the evaluation cable based on Nicolay's solution. As explained in section 3.1 it is recommended to integrate electronics inside the cap which allows to implement the following functionality:

- Conversion of the communication protocol from I2C to robust long-range protocol (RS485/RS232 etc.)
- Hard reset by switching sensor supply voltage on and off
- Control of the external heater resistor
- Communication with flow and optional pressure sensor

The connector interface of the proximal and expiratory sensors is designed to enable easy and user-friendly connecting and disconnecting of the sensor. Sensirion's proposed connecting method is to utilize a connector-cap which attaches mechanically to the sensor with a clip-on interface and allows electrical connection via spring loaded pogo-pins and the pads on printed circuit board (PCB).

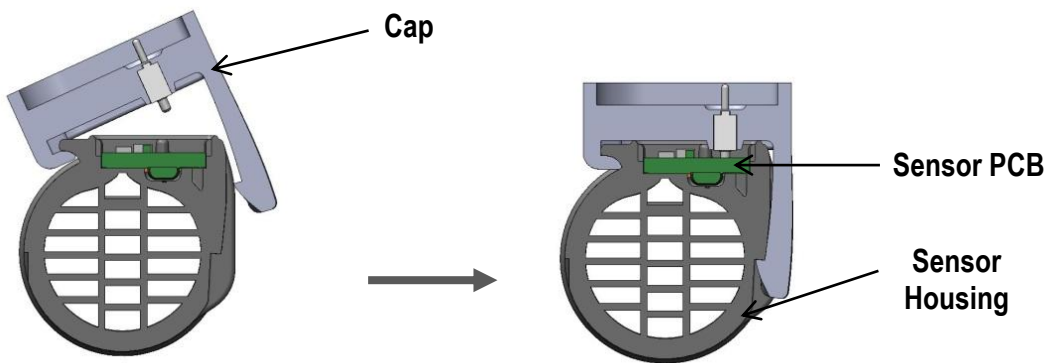


Figure 3. Cross sectional view of clip-on cap and sensor housing

Figure 3 shows a cross sectional view with the drawing plane perpendicular to the flow direction of the flow sensor and an attached cap. The sensor housing is dark grey, the PCB green and the connection-cap in light blueish grey. To allow easy and secure fastening and removal of the sensor, the sensor connector interface is designed with a simple snap-fit mechanism. The CAD file of the connector interface can be downloaded from Sensirion at the following link: www.sensirion.com/file/stepfile_sfm_cap

The following figure shows the top view of the sensor's connector interface and the location of the electrical pads. These pads on the PCB are best contacted via spring-loaded pins. The recommended component is the connector Preci-Dip 811-S1-006-10-014101 or Preci-Dip 811-31-006-30-630191.

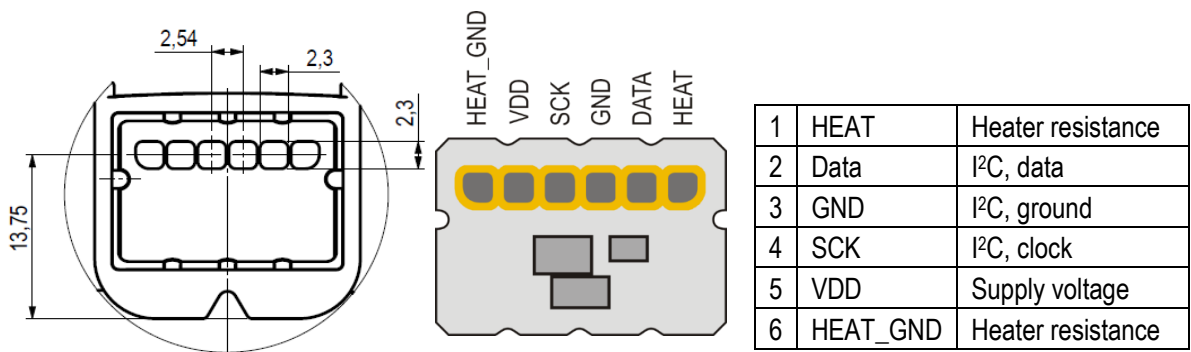


Figure 4. PCB pad layout of sensor

The heater resistor on the top side of the PCB is specified to 51 Ohms and a maximum 0.5 W heating power. Therefore, the supplied voltage drop over the resistor applied with pin 1 and 6 should never exceed 5 V, respectively the current should not exceed 99 mA for full heating power.

6 Revision History

Date	Author	Version	Changes
Jan 2021	LOEH	1.0	Entire new version with description of evaluation kit details. Previous version is now covered in chapter "Own Clip-on Cap/Cable Design".
Sept 2021	PSIM	1.1	Removed preliminary disclaimer
Oct 2024	PSIM	1.2	New contact details at Nicolay
Apr 2025	PSIM	2.0	Add new cable generation 2
Aug 2026	PSIM	2.1	complete update for generation 2 cable

7 Headquarters and Subsidiaries

SENSIRION AG
Laubisruetistr. 50
CH-8712 Staefa ZH
Switzerland

phone: +41 44 306 40 00
fax: +41 44 306 40 30
info@sensirion.com
www.sensirion.com

Sensirion Inc., USA
phone: +1 805 409 4900
info_us@sensirion.com
www.sensirion.com

Sensirion Japan Co. Ltd.
phone: +81 3 3444 4940
info@sensirion.co.jp
www.sensirion.co.jp

Sensirion Korea Co. Ltd.
phone: +82 31 337 7700 3
info@sensirion.co.kr
www.sensirion.co.kr

Sensirion China Co. Ltd.
phone: +86 755 8252 1501
info@sensirion.com.cn
www.sensirion.com.cn

Sensirion AG (Germany)
phone: +41 44 927 11 66
info@sensirion.com
www.sensirion.com

To find your local representative, please
visit www.sensirion.com/contact