

USER MANUAL VU01

Ventilation unit
for SR20 pyranometers and IR20 pyrgeometers



Warning statements



Always power off the ventilation unit when conducting maintenance or installing VU01.



VU01 is designed for use with standard SR20, IR20 & IR20WS sensors. VU01 is not meant to be used with other pyranometers and pyrgeometers, including –TR versions.



Accidentally exchanging the VU01 cable and sensor cable will not damage the sensor, but the instrument and ventilation unit will not function.



In case of cable replacement / extension beyond 5 m, please note that the voltage drop across the VU01 cable becomes significant; a higher voltage power supply may have to be used.

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List of symbols

Quantities

Voltage output
 Electrical resistance
 Current
 Time in seconds
 Fan speed

Symbol

U
 R_a
 I
 t
 N

Unit

V
 Ω
 A
 s
 1/min

Subscripts

U_A
 $U_{A,high}$
 $U_{A,low}$
 N_g
 I_{sink}

alarm operating voltage
 alarm signal high
 alarm signal low
 alarm trip speed limit
 sink current

Introduction

VU01 is a high-quality ventilation unit for use with pyranometer model SR20 and pyrgeometer models IR20 and IR20WS. Its purpose is to improve the dependability of the measurement. Measurement accuracy improves because offsets are reduced. Reliability benefits from prevention of dew and frost formation and quick evaporation and sublimation of water and snow. ISO/TR 9901 "Solar Energy - Field Pyranometers - Recommended practice for use" recommends use of ventilators where high accuracy and reliability are required.

VU01 provides an airflow over the instrument body and dome and has a 5 W and a 10 W heater on board to heat the air. The VU01 ventilation unit runs on 12 VDC voltage. VU01 may be used in combination with Hukseflux' SR20 secondary standard pyranometers and IR20 and IR20WS research grade pyrgeometers.

Ventilation promotes thermal equilibrium between all components of radiometers, and thereby reduces zero offsets. Dew and frost formation is prevented. Additional heating will promote evaporation of water droplets and sublimation of snow. It should be noted that heating in combination with pyranometers will lead to increased thermal offsets, so heating is only recommended if necessary.

Using VU01 is easy. The ventilator is generally used continuously; the heater is typically controlled by the datalogger. ISO/TR 9901 "Solar Energy - Field Pyranometers - Recommended practice for use" recommends use of ventilators where high accuracy and reliability are required. More details can be found in paragraph 5.2.2 and annex A. The Baseline Surface Radiation Network, BSRN, recommends ventilation for radiometers in its BSRN operations manual v2.1.



Figure 0.1 *VU01 ventilation unit with SR20 secondary standard pyranometer*

VU01 is designed, using high-quality materials, in agreement with the recommendations of ISO/TR 9901 and BSRN. The footprint of VU01 is small, which prevents accumulation of snow. The ventilator power is relatively high in order to increase the airflow. The heaters should be activated using external relays. The alarm output may be used to monitor rotation of the fan. The high / low voltage output may be adjusted by the user with a fixed resistor.

For specifications of pyranometers and pyrgeometers and general considerations concerning site selection and maintenance for such instruments, please consult the [SR20](#) and [IR20](#) manuals.

1 Ordering and checking at delivery

1.1 Ordering VU01

The standard configuration of VU01 is with 5 metres cable. Options are: longer cable (in multiples of 5 m) and a pack of 5 filters.

Supply of products is subject to Hukseflux' General Conditions of Sale. The product warranty (involving repair or replacement without charge for product or working hours) is 24 months.

Hukseflux does not accept any liability for losses or damages related to use of the supplied products. See the appendix and Hukseflux' General Conditions of Sale for detailed statements on warranty and liability.

1.2 Included items

Arriving at the customer, the delivery should include:

- ventilation unit VU01
- cable of the length as ordered
- sensor mounting hardware (affixed to VU01):
 - (1 x) sensor mounting plate and gasket
 - (4 x) M5x10 screw
- torx key T25 (1 x)
- VU01 mounting hardware:
 - (2 x) M5x60 screw
 - (2 x) M5 retaining torque nut
 - (4 x) $\varnothing 5 \times 10^{-3}$ m washer
- spare filter (1 x)
- product certificate
- any other options as ordered

1.3 Options

- longer cable, in multiples of 5 metres (please note the voltage drop of cabling). Specify total cable length. In case of cables longer than 15 m consult Hukseflux.
- pack of 5 filters. Specify order number VU01F.

1.4 Quick instrument check

A quick test of the ventilation unit can be done by using a simple hand held multimeter and a 12 VDC power supply, using the wiring diagram in chapter 5 of this manual.

1. Check the electrical resistance of the heaters; 27 Ω each
2. Connect fan wires to a 12 VDC power supply: the fan should run
3. When running, an alarm signal can be measured
(see chapter 5 for the optional alarm configuration instructions)

2 Instrument principle and theory

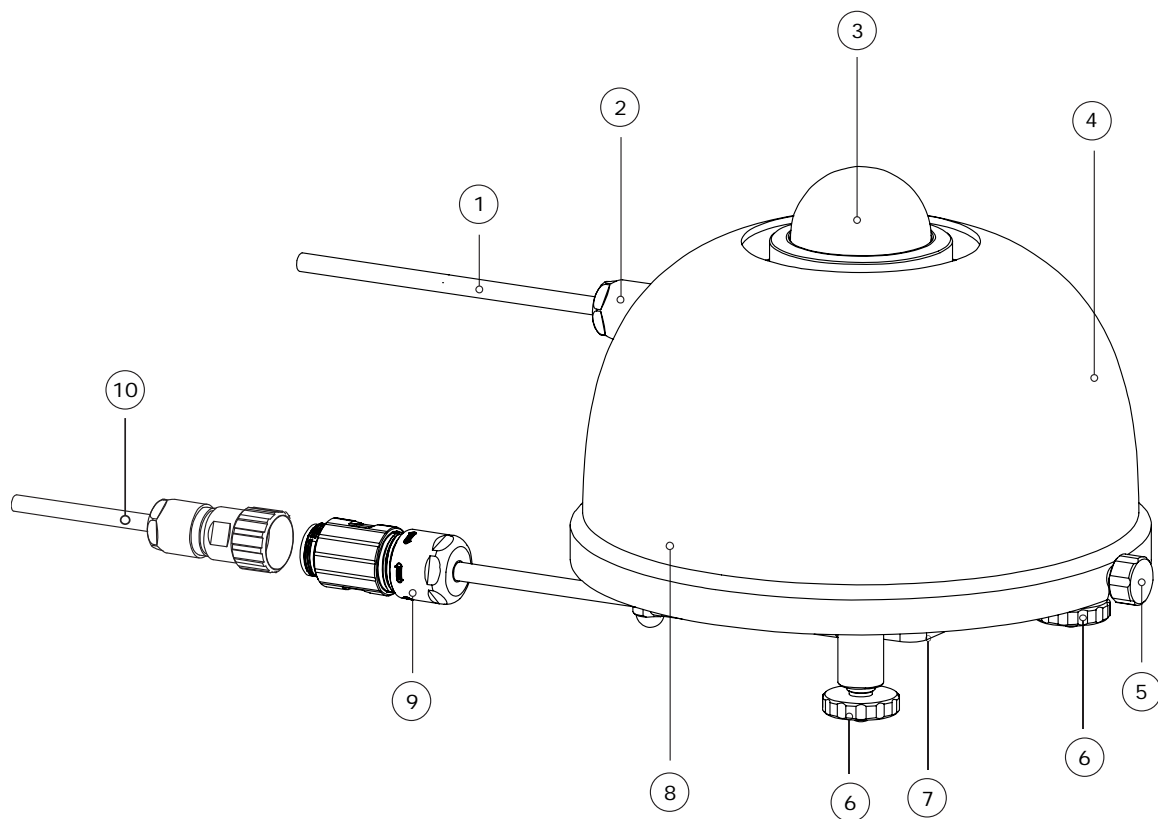


Figure 2.1 Overview of VU01 with SR20:

- (1) SR20 cable
- (2) SR20 connector
- (3) SR20 dome
- (4) VU01 cover
- (5) VU01 fixation of cover
- (6) VU01 levelling feet
- (7) VU01 filter retainer
- (8) VU01 ventilator, heaters and filter replacement system (below cover)
- (9) VU01 connector
- (10) VU01 cable and cable connector

Ventilation promotes thermal equilibrium between all components of radiometers, and thereby reduces zero offsets. Dew and frost formation is prevented. Additional heating will promote evaporation of water droplets and sublimation of snow. It should be noted that heating in combination with pyranometers will lead to increased thermal offsets, so heating is only recommended if necessary.

3 Specifications of VU01

3.1 Specifications of VU01

VU01 is a high-quality ventilation unit that may be used with pyranometer model SR20 and pyrgeometer models IR20 and IR20WS. Its purpose is to improve the dependability of the measurement. Measurement accuracy improves because offsets are reduced. Reliability benefits from prevention of dew and frost formation and quick evaporation and sublimation of water and snow. For specifications of pyranometers and pyrgeometers, please consult the [SR20](#) and [IR20](#) manuals.

Table 3.1.1 *Specifications of VU01 (continued on next page)*

VU01 SPECIFICATIONS	
Compatible instruments	SR20, IR20, IR20WS
Excluded	-TR versions
Compliance with standards	ISO/TR 9901
	BSRN operations manual
Rated operating power	7.8 W at 12 VDC (unheated)
Rated operating voltage range	10.8 to 13.2 V
Rated operating temperature range	-40 to +70 °C
Alarm output	high / low adjustable voltage (optional use)
Heater	5 and 10 W at 12 VDC (optional use) (with remote relays)
Increase of air temperature	0.5 °C at 0 W heating; 1.0 °C at 5 W heating; 1.5 °C at 10 W heating
Zero offset a SR20 ventilated	2.5 W/m ² at 0 W heating
Offset SR20 by heating	-2 W/m ² at 5 W heating
Offset SR20 by heating	-4 W/m ² at 10 W heating
Offset IR20 by heating	0 W/m ² at 5 W heating
Offset IR20 by heating	0 W/m ² at 10 W heating
Cable resistance	0.3 Ω/m (2 x 0.15 Ω/m)
Voltage drop at 7.8 W ventilation	0.2 V/m
Voltage drop at 10 W heating power	0.24 V/m
Footprint diameter	0.17 m
Fan speed	5050 to 5400 1/min at 12 VDC (depends on supply voltage)
Standard cable length (see options)	5 m
Cable diameter	5.3 x 10 ⁻³ m
VU01 connector	M16 straight connector, male thread, 10-pole
VU01 connector type	HUMMEL AG 7.820.400.000 straight connector, male thread, for cable 5 to 9 x 10 ⁻³ m
Cable connector	M16 straight connector, female thread, 10-pole
Cable connector type	HUMMEL AG 7.810.300.00M straight connector, female thread, for cable 3 to 6 x 10 ⁻³ m, special version
Connector protection class	IP 67 / IP 69 K per EN 60 529 (connected)
Cable replacement	replacement cable with cable connector can be ordered separately from Hukseflux
IP protection class VU01	IP 54 (SR20 and IR20: IP 67)
Gross weight including 5 m cable	1.55 kg
Net weight including 5 m cable	1.35 kg
Packaging	box of (200 x 200 x 150) x 10 ⁻³ m

Table 3.1.1 Specifications of VU01 (continued)

VERSIONS / OPTIONS / ACCESSORIES	
Longer cable, in multiples of 5 metres	option code = total cable length (please note the voltage drop of cabling; in case of cables longer than 15 m consult Hukseflux)
Pack of 5 filters	order code = VU01F

3.2 Dimensions of VU01

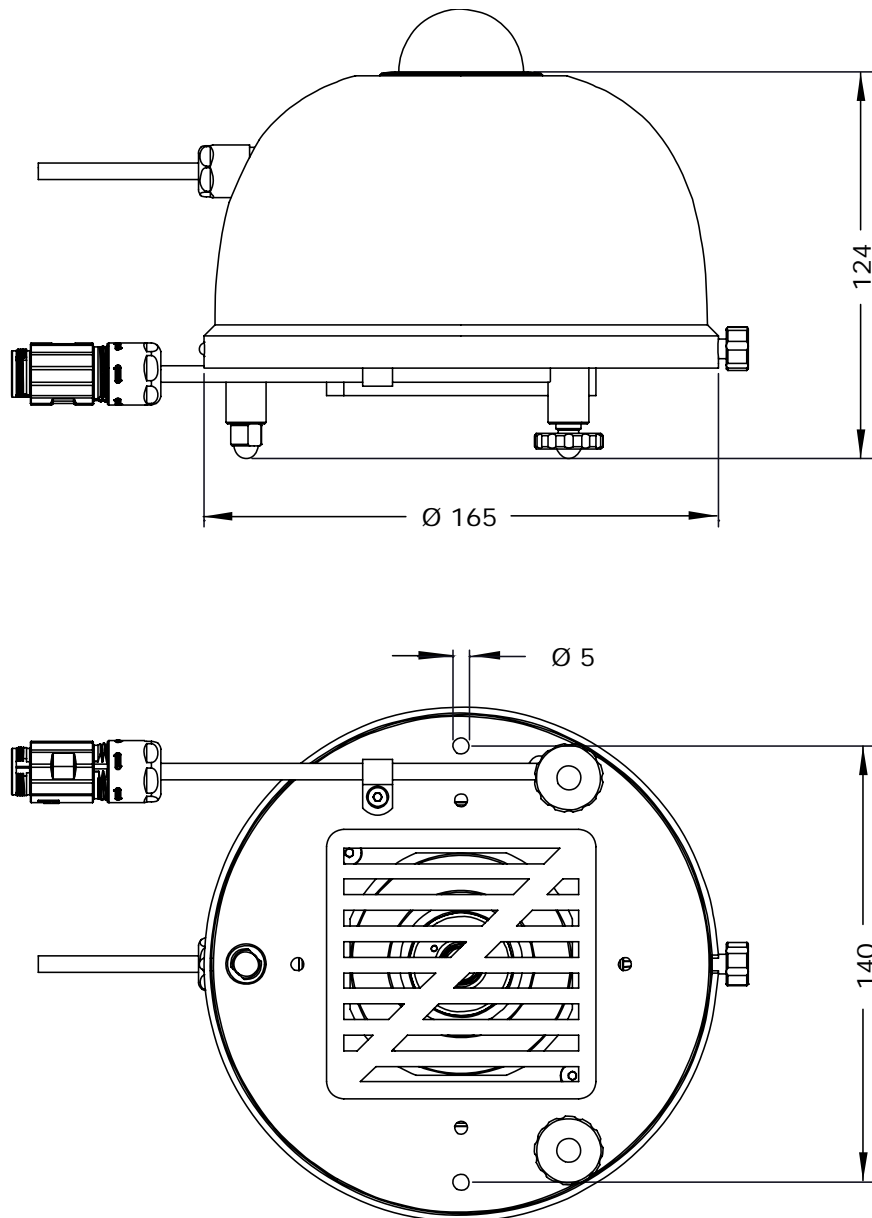


Figure 3.2.1 Dimensions of VU01 in 10^{-3} m.

4 Standards and recommended practices for use

Pyranometers are classified according to the ISO 9060 standard and the WMO-No. 8 Guide. In any application the instrument should be used in accordance with the recommended practices of ISO, IEC, WMO and / or ASTM.

Pyrgeometers are not subject to standardisation. The World Meteorological Organization (WMO) is a specialised agency of the United Nations. It is the UN system's authoritative voice on the state and behaviour of the earth's atmosphere and climate. WMO publishes WMO-No. 8; Guide to Meteorological Instruments and Methods of Observation, in which paragraph 7.4 covers "measurement of total and long-wave radiation". For ultra high accuracy measurements, the following manual may serve as a reference: Baseline Surface Radiation Network (BSRN) Operations Manual, Version 2.1, L. J. B. McArthur, April 2005, WCRP-121, WMO/TD-No. 1274. The BSRN manual also includes chapters on pyrgeometer installation and calibration.

Table 4.1 *Standards with recommendations for instrument ventilation*

STANDARDS FOR INSTRUMENT USE FOR SOLAR AND LONGWAVE RADIATION		
ISO STANDARD	EQUIVALENT ASTM STANDARD	WMO
ISO/TR 9901:1990 Solar energy -- Field pyranometers -- Recommended practice for use	ASTM G183 - 05 Standard Practice for Field Use of Pyranometers, Pyrheliometers and UV Radiometers	WMO-No. 8; Guide to Meteorological Instruments and Methods of Observation, chapter 7, measurement of radiation, 7.3 measurement of global and diffuse solar radiation, 7.4 measurement of total and long-wave radiation BSRN Operations Manual, Version 2.1, April 2005

5 Installation of VU01

5.1 Installation of the ventilation unit

Once the VU01 cover is removed, the ventilation unit can be mounted to a flat mounting surface using the supplied VU01 mounting hardware.

Optionally a large hole can be made by the user in the mounting surface under VU01 if obstruction of the airflow from the sides is expected, for example by snow buildup. The hole diameter should not exceed 120×10^{-3} m.

5.2 Installation of the sensor

- Remove the sun screen of SR20 / IR20 / IR20WS.
- Attach the sensor mounting plate to the bottom of the sensor using two M5x10 screws (See Figure 5.2.1). A T25 torx key to do so is included with VU01.
- Affix the sensor with the sensor mounting plate to the ventilation unit using two M5x10 screws (See Figure 5.2.1 for placement of the gasket).
- The sensor cable connector should be positioned alongside the engraved "cable" marking on the VU01 base.
- The VU01 levelling feet can be used to finetune the sensor levelling. Even with the VU01 cover installed (see next page), the sensor can still be levelled since the instrument's bubble level is still visible below the VU01 cover.

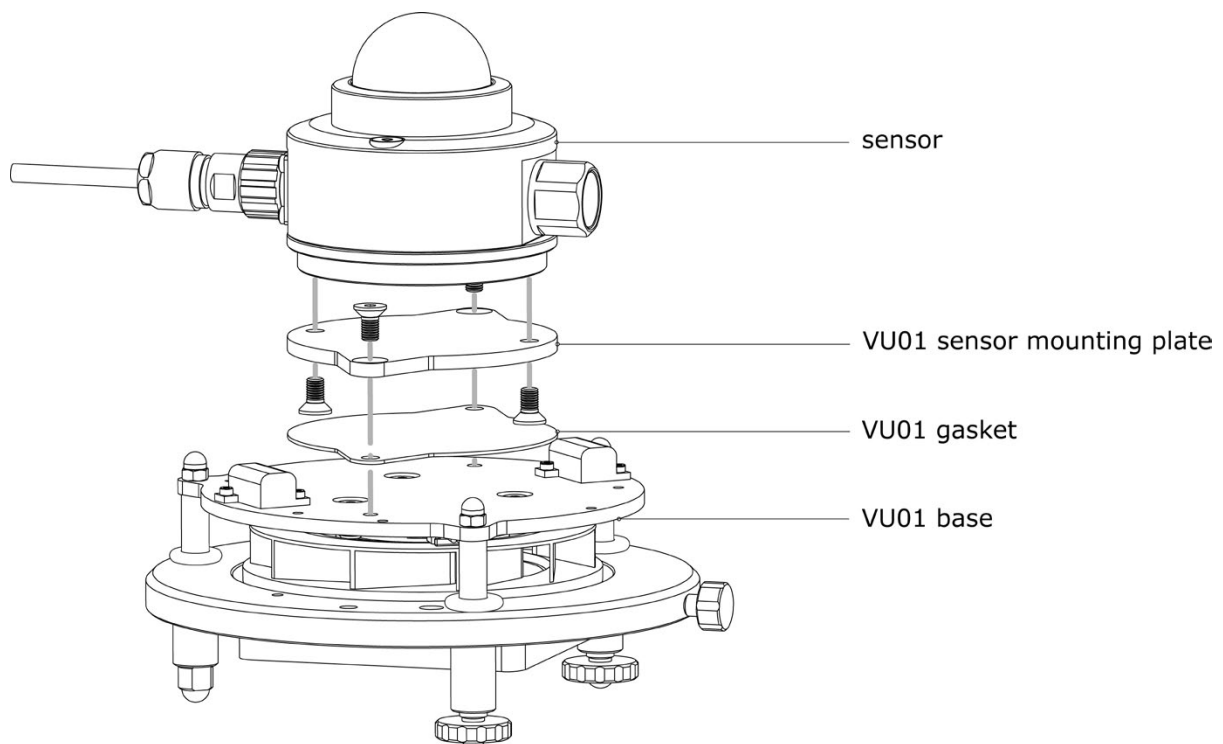


Figure 5.2.1 VU01 base with gasket, sensor mounting plate and SR20 pyranometer: the instrument is affixed to VU01 using four M5x10 screws.

5.3 Installation of the VU01 cover

To install:

- Connect the sensor cable connector (3) to the sensor, guiding the connector through the designated hole in the VU01 cover
- Position the cover (2) at an angle on positioning pin (5)
- Close the cover using positioning pin (5) as swivel point
- Affix the cover using thumbscrew (1)
- Connect the VU01 cable connector to the VU01 connector (4)

To remove cover:

- Loosen thumbscrew (1) by turning counterclockwise until the tapered part of the thumbscrew is ejected from the ventilation unit base
- Lift the cover, tilting around positioning pin (5)

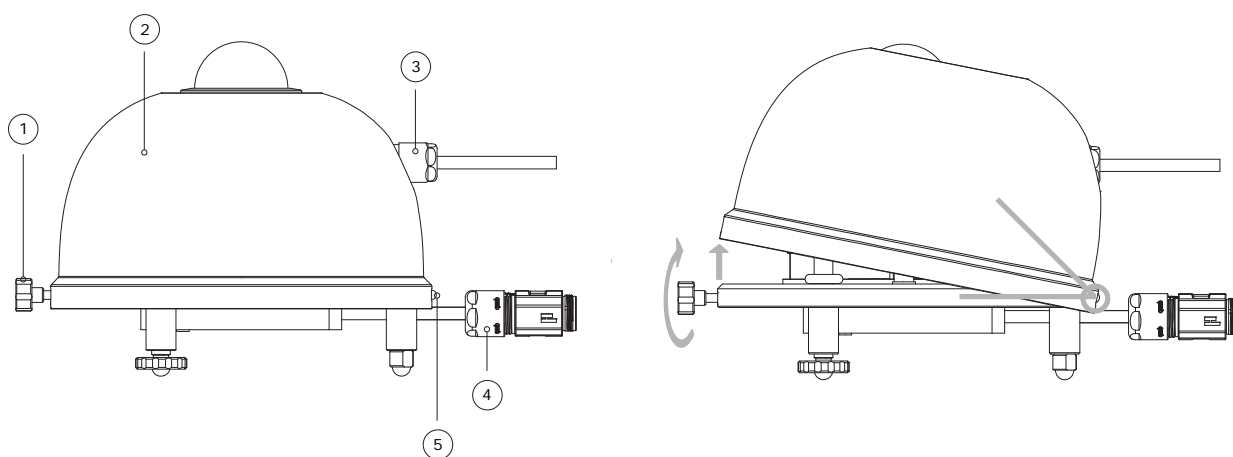


Figure 5.3.1 Installation and removal of ventilator cover: (1) VU01 thumbscrew, (2) VU01 cover, (3) sensor connector, (4) VU01 connector, (5) VU01 positioning pin.

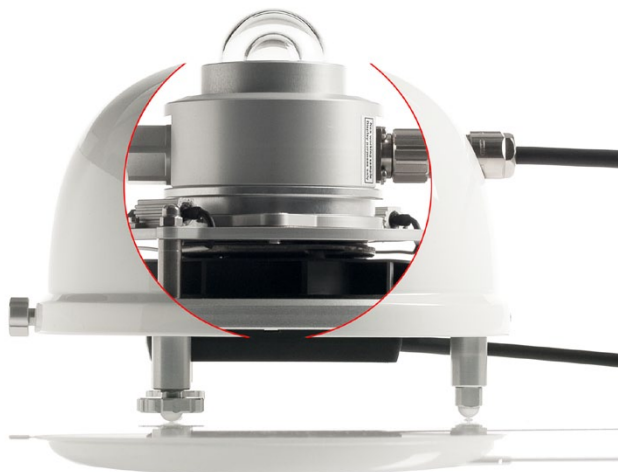


Figure 5.3.2 Cutaway of VU01 showing internal components and SR20 pyranometer.

5.4 Electrical connection of VU01

The cables of VU01 and SR20 / IR20 have an identical M16 straight connector. Do not connect the VU01 connector to the SR20 / IR20 cable and do not connect the SR20 / IR20 connector to the VU01 cable; both VU01 and SR20 / IR20 will not function.

Cables generally act as a source of distortion, by picking up capacitive noise. We recommend keeping the distance between a datalogger or amplifier and the sensor as short as possible. For cable extension, see the next paragraph and appendix on this subject.

Table 5.4.1 *The electrical connection of VU01. The heaters and alarm signal are not necessarily used; their use is optional.*

PIN	WIRE	VU01	CONNECTION
1	Brown	fan [+]	12 VDC [+]
4	Yellow	fan [-]	common [-]
6	Blue	alarm	see figure 5.6.1
2	Red	heater 1 [+]	12 VDC [+]
8	Grey	heater 1 [-]	common [-]
3	Pink	heater 2 [+]	12 VDC [+]
5	Green	heater 2 [-]	common [-]
7	White	not connected	not connected
9	Black	shield	ground

Optionally an alarm signal can be connected by the user as shown in the wiring diagram in figure 5.6.1. See paragraph 5.6 in this manual on using the alarm signal.

5.5 Power supply and cable length

In case of cable replacement or extension beyond 5 m, please note that the voltage drop across the regular VU01 cable becomes significant and that a higher voltage power supply or a thicker cable may be used.

Using a 12 VDC power supply and a cable of 5 m, the voltage drop is around 1 V and the VU01 ventilator will effectively run on 11 VDC. The ventilator will continue running down to a supply voltage of around 7.5 VDC; the flow rate will however decrease significantly (based on power by a factor 4). This level is reached at a cable length of 20 m.

We recommend to adapt the supply voltage or use cables with a lower resistance per meter when working with cable lengths longer than 15 m, the ventilator then works at 9 VDC, at a flow rate of 80 % relative to 5 m cable.

5.6 Using the alarm signal

Using the alarm signal is optional: the alarm output may be used to monitor rotation of the fan. The VU01 alarm emits a high, continuous signal during trouble-free operation of the fan. When opting for using the alarm signal, see figure 5.6.1 and paragraph 5.4 for the electrical connection of VU01.

To use the alarm, the user must supply an alarm operating voltage U_a of maximum 60 VDC. An external load resistor is required to make sure the sink current is between 2 and 20×10^{-3} A. For example, using a 1000Ω load resistor will allow alarm operating voltages between 2 and 20 VDC.

A signal, $U_{A,high}$, is provided when the fan speed N is above the alarm trip speed limit N_g of 1500 rotations per minute. The signal is equal to the alarm operating voltage U_A . When the fan is running slowly or not at all, a low signal $U_{A,low}$ is provided.

The alarm will only function when VU01 itself is powered.

Table 5.6.1 Alarm signal variables

VARIABLE	DESCRIPTION	VALUE
U_A	Alarm operating voltage [V]	≤ 60 V
$U_{A,high}$	Alarm signal high [V]	U_A
$U_{A,low}$	Alarm signal low [V]	≤ 0.4 V
I_{sink}	Sink current [A]	2 to 20×10^{-3} A
R_a	Resistor [Ω]	
N	Fan speed [1/min]	
N_g	Alarm trip speed limit [1/min]	$1500 \text{ min}^{-1} \pm 100 \text{ min}^{-1}$
t_2	Alarm start-up delay time [s]	< 15 s

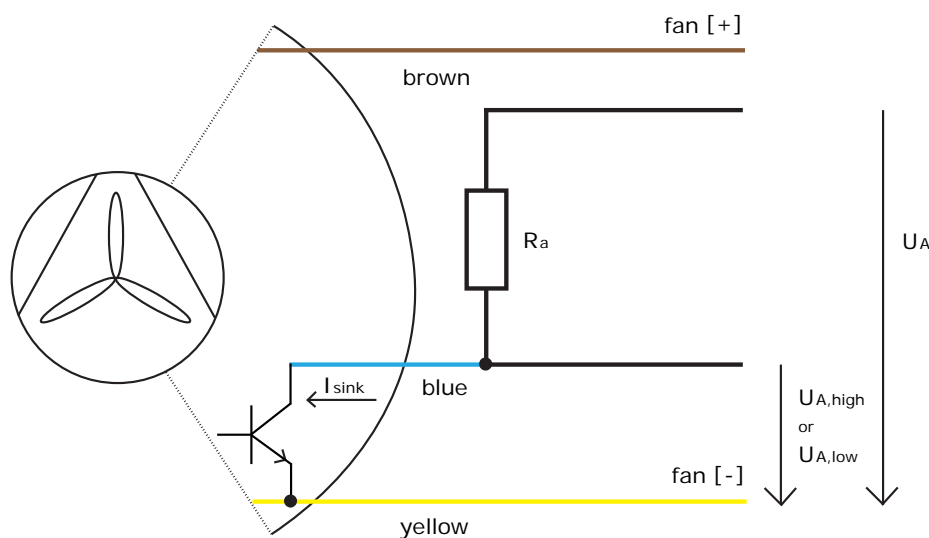


Figure 5.6.1 Wiring diagram required to use VU01's alarm function. The use of the alarm signal is optional. See table 5.4.1 for the electrical connection of VU01.

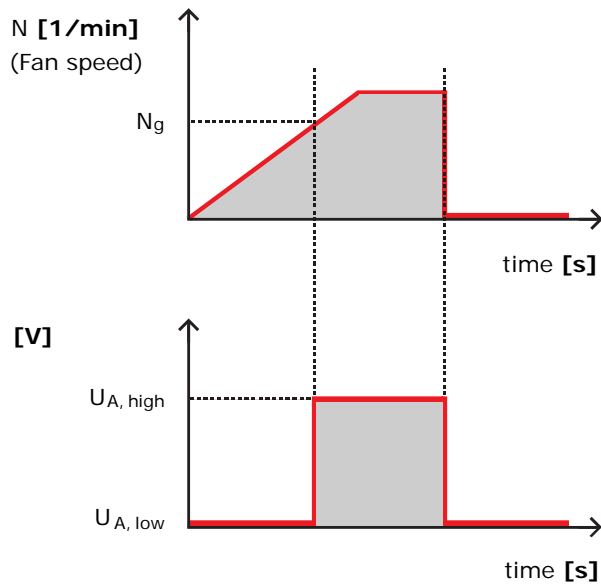


Figure 5.6.2 An alarm signal, $U_{A,high}$, is provided when the fan speed N is above the alarm trip speed limit N_g . Using the alarm signal is optional.

6 Maintenance and trouble shooting

6.1 Recommended maintenance and quality assurance

For maintenance and trouble shooting of pyranometers and pyrgeometers consult the SR20 and IR20 manuals.

When conducting maintenance on VU01, always power off the ventilation unit. Powering off VU01 may be done by disconnecting the VU01 connector.

Table 6.1.1 *Recommended maintenance of VU01*

MINIMUM RECOMMENDED VENTILATION UNIT MAINTENANCE			
	INTERVAL	SUBJECT	ACTION
1	1 week	check	check the operational status of the ventilator and heaters by checking the optional alarm signal or by on-site inspection
2	1 week	cleaning	clean ventilator cover and ensure air inlet is free of obstructions such as leaves or snow buildup
3	1 year	filter	replace ventilator filter, as described in the appendix

6.2 Trouble shooting

Table 6.2.1 *Trouble shooting for VU01*

PROBLEM	SOLUTION
Fan and / or heaters do not function	check wiring for correct connection of [+] and [-] check power supply
Fan does not work	check for obstructions of fan
Fan provides little airflow	check for obstructions of airflow replace filter if clogged check wiring connections

7 Appendices

7.1 Appendix on filter replacement

To replace the filter:

- power off the ventilation unit by disconnecting the VU01 connector
- insert the tip of a flat screwdriver in the designated slot of the front side the filter retainer
- turn the screwdriver 90° to detach the filter retainer from the finger guard
- replace the used filter cloth with a fresh filter (spare part VU01F)
- slide the filter retainer under the ventilation unit
- take care to position the slot to the front (thumb screw) side of the ventilation unit
- lift and click the filter retainer in place

7.2 Appendix on tools for VU01

Table 7.2.1 *Specifications of tools for VU01*

tooling required for sensor mounting and removal	torx key T25 (included)
tooling required for fixing VU01 to platform	hex key 3
tooling required for filter replacement	screwdriver, flat

7.3 Appendix on spare parts for VU01

- levelling feet (set of 2)
- static foot
- cover
- pack of 5 filters
- cable with cable connector (specify length in multiples of 5 m; in case of cables longer than 15 metres please consult Hukseflux)

7.4 Appendix on cable extension / replacement

When opting for cable extension or cable replacement please note the voltage drop in cabling. In case of cables longer than 15 metres consult Hukseflux. See the specific paragraph in this manual about power supply and cable length.

The cable of VU01 is equipped with a M16 straight connector. In case of cable replacement, it is recommended to purchase a new cable with cable connector at Hukseflux. An alternative is to choose for a Do-it-yourself (DIY) approach; please ask for the DIY connector assembly guide. In case of cable extension, the user may choose between purchasing a new cable with cable connector at Hukseflux or extending the existing cable himself. Please note that Hukseflux does not provide support for DIY connector- and cable assembly.

Cables act as a source of distortion by picking up capacitive noise. Keep the distance between data logger or amplifier and sensor as short as possible.

VU01 connector, cable and cable connection specifications are summarised below.

Table 7.1.1 Preferred specifications for VU01 cable replacement and extension

General replacement	please order a new cable with connector at Hukseflux or choose for a DIY approach. In case of DIY replacement by the user see connector specifications below and ask for the DIY connector assembly guide
General cable extension	please order a new cable with connector at Hukseflux or solder the new cable conductors and shield to the original sensor cable and make a connection, using adhesive-lined heat shrink tubing, with specifications for outdoor use. Always connect shield
Connectors used	VU01: M16 straight connector, male thread, 10-pole, HUMMEL AG 7.820.400.000 straight connector, for cable 5 to 9 x 10 ⁻³ m cable: M16 straight connector, female thread, 10-pole, HUMMEL AG 7.810.300.00M straight connector, for cable 3 to 6 x 10 ⁻³ m, special version
Cable	8-wire, shielded, with copper conductors (at Hukseflux 8-wire shielded cable is used, of which 2 wires are used to power the fan, 4 for heating and 1 for the alarm signal)
Conductor resistance	< 0.1 Ω/m
Length	cables should be kept as short as possible, in case of cables longer than 15 m consult Hukseflux.
Outer sheath	with specifications for outdoor use (for good stability in outdoor applications)

7.5 Appendix on conditions of sale: warranty and liability

Delivery of goods is subject to Hukseflux General Conditions of Sale.
Hukseflux has the following warranty and liability policy:

Hukseflux guarantees the supplied goods to be new, free from defects related to bad performance of materials and free from faults that are clearly related to production and manufacturing. Warranty on products is valid until 24 months after transfer of ownership. The warranty does not apply if the application involves significant “wear and tear”, if it involves use outside the specified range of application, or if it involves accidental damage or misuse. The warranty expires when anyone other than Hukseflux makes modifications to or repairs the products.

Hukseflux is in no event liable for damages, to its customers or anyone claiming through these customers, associated to the goods or services it supplies.

7.6 EC declaration of conformity



We, Hukseflux Thermal Sensors B.V.
Delftechpark 31
2628 XJ Delft
The Netherlands

in accordance with the requirements of the following directive:

2004/108/EC The Electromagnetic Compatibility Directive

hereby declare under our sole responsibility that:

Product model: VU01
Type: Ventilation unit

has been designed to comply and is in conformity with the relevant sections and applicable requirements of the directive.

A handwritten signature in black ink, appearing to read 'Kees Van den Bos', with a long horizontal flourish extending to the left.

Kees VAN DEN BOS
Director
Delft
October 24, 2013

