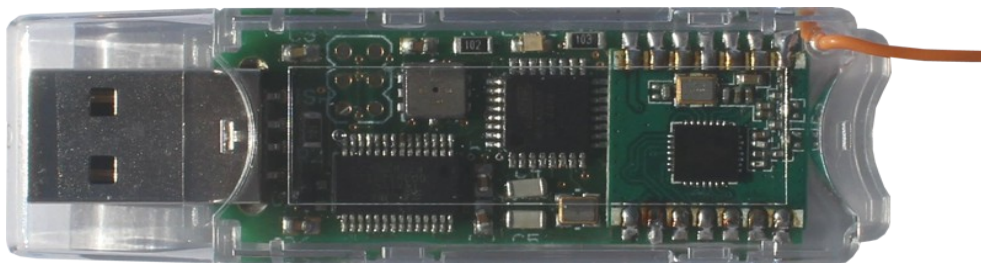


Meteostick Manual

Thank You for having purchased Meteostick. Meteostick operates as a receiver for radio frequency data from your Davis®¹ Vantage Pro2™, Vantage Pro2 Plus™, Vantage Vue™ RF sensors. Data is sent out by these devices in license free RF bands (915 MHz in the US, 868 MHz in Europe) where Meteostick listens and makes data available for computation. Meteostick can report data as

- explanatory text or
- ready computed data to feed your programs or
- raw data 1:1 as the sensors send it without any processing

Meteostick hardware is not intended for outdoor use, it needs a dry and reasonable temperatured environment, like your computer does. Meteostick is powered by the USB port it is connected to, there is no need for an additional power supply.



Components

The Meteostick package includes

- Meteostick in transparent USB stick like housing (see picture above) with protection cap for USB connector. Attached to the Meteostick is a flexible wire antenna.
- this manual, also available online at <http://www.smartbedded.com/meteostick>
- PE transport bag

Voiding Warranty

Meteostick has a transparent housing to satisfy any curiosity about what is inside. So there is no need to open the housing, you won't see anything you can't see from the outside. If you open the case you have voided the warranty and you are at your own from that point. I kindly ask you and recommend not to do that.

Getting Started

Please read the tiny manual inside the package to understand how to operate Meteostick. Physical operation is very easy. Just remove the transparent cap from the USB male connector of Meteostick and plug it into the USB Port of your device of choice. Please take care of the antenna, which should rise up straight into the air. Antenna operates best when it is not close to other material that can act as shielding. Antenna should not be used as a handle to pull out the USB stick. When doing too much force to it, it will break and will render the stick useless.

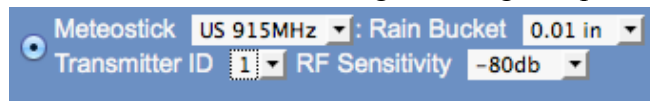
¹ The Davis logo and text is a registered trademark of Davis Instruments Corp. Vantage Pro2, Vantage Pro2 Plus and Vantage Vue are trademarks of Davis Instruments Corp. Whenever Davis or Vantage is mentioned in this document these trademarks are referenced, even if a TM or ® should be missing.

Barometer Data

As the barometer of the Davis® stations is in the console Meteostick also has a high quality pressure sensor on board to report barometer data. This sensor also reports indoor temperature, but reading will be a few degrees to high caused by the heating up of the components during operation. So please don't pay too much attention to indoor temp and ignore indoor humidity (which is reported as constant 30% when asked for it).

Use with Meteobridge

Plugin the Meteostick into the USB Hub connected to your Meteobridge (if a TP-Link or D-Link model) or connect it directly to the Meteobridge (if it is an Asus model). Goto your Meteobridge's „Select Station“ tab and select „Meteostick“ as weather station. Please also select frequency band matching your geography (US and EU are provided to select from). As Meteobridge does only support one Davis ® integrated sensor suite (ISS) like Vantage Pro2™, Vantage Pro2 Plus™, Vantage Vue™ you also have to select the transmitter ID of the station Meteobridge should receive data from. Example below listens on the US frequency band for transmitter ID 1 and assumes the rain tip buckets taking 0.01 inch of rain and defines a signal strength clip level of -80db.



When done press „Save“ and data logger will make use of Meteostick to get this data. Please allow up to two minutes until data shows up on „Live Data“ tab. Reason for the delay is, that Meteostick has to sync on the frequency hopping of the chosen transmitter and that can take some time. Meteobridge supports all sensors of an ISS but no additional sensors. Each time Meteostick receives a valid packet from your sensors the green LED in the transparent housing will blink.

Use with Meteohub

When connected to a Meteohub the Meteostick can operate on up to 8 Davis® sensor units in parallel. Meteohub can handle any combination of integrated sensor suite (Vantage Pro2™, Vantage Pro2 Plus™, Vantage Vue™), temp/hum stations, soil/leaf stations, additional rain and wind stations. RF repeater are not supported.

Connect the Meteostick to the USB port of your Meteohub and goto „Weather Station“ page. Add station „Meteostick“ from drop-down menu. When station template appears, select „USB serial“ as connection type, select one of the proposed device identifier (/dev/ttyUSB0 for example), set station altitude (needed for pressure correction) and choose from offered methods for sea level pressure calculation and wind chill computation. Next, select rain tip bucket size and frequency band used in your geography (US or EU) and the signal strength threshold (drop below -95db in the example).

Drop-down menus for each of the transmitter IDs let you choose between these station types.

- none: don't take data from this transmitter ID (even if it might be there)
- ISS: an integrated sensor suite like Vantage Pro2™, Vantage Pro2 Plus™, Vantage Vue™
- Wind: an additional wind station
- Rain: an additional rain station (all rain stations have to share the same rain tip bucket sizes)
- Temperature/Humidity: an additional station for temperature and/or humidity
- Soil: an additional soil moisture station
- Leaf: an additional leaf wetness station

Example below shows a Meteostick setup with two ISS and one temp/hum station and a soil station connected. When all settings are complete, press „Save“ and the station is added to your Meteohub setup and data logger is restarted to receive data from Meteostick.

Weather Station 0 (Meteostick)

Name	<input type="text" value="meteostick"/>	
Type of Connection	<input type="text" value="USB serial"/>	
Device	<input type="text" value="/dev/ttyUSB0"/>	<input type="button" value="select"/>
Hold time for live data	<input type="text" value="300"/>	seconds
Station's Altitude	<input type="text" value="0"/>	m
Sea Level calculation	<input type="text" value="based on station's altitude"/>	<input type="text" value="th0"/>
Wind Chill calculation	<input type="text" value="compute from wind and temperature readings"/>	
	<input type="text" value="th0"/>	
Data Logging	<input type="checkbox"/> stopped	
Rain Bucket	<input type="checkbox"/> 0.01 inch instead of 0.2 mm	
Radio Frequency	<input type="text" value="auto"/>	
RF Sensitivity	<input type="text" value="-95db"/>	
Transmitter 1:	<input type="text" value="ISS"/>	
Transmitter 2:	<input type="text" value="ISS"/>	
Transmitter 3:	<input type="text" value="ISS"/>	
Transmitter 4:	<input type="text" value="none"/>	
Transmitter 5:	<input type="text" value="none"/>	
Transmitter 6:	<input type="text" value="none"/>	
Transmitter 7:	<input type="text" value="Leaf/Soil"/>	
Transmitter 8:	<input type="text" value="none"/>	

Please allow up to two minutes until first data shows up on „Sensor“ page. Reason for the delay is, that Meteostick has to sync on the frequency hopping of the chosen transmitter and that can take some time. You can now assign sensor IDs for the newly received sensors to bind incoming data to these specific IDs. Each time Meteostick receives a valid packet from your sensors the green LED in the transparent housing will blink.

Setup with 3rd Party Software

Making use of Meteostick with 3rd party software is done by a serial data protocol. Meteostick communicates with its FTDI RTL232 chip with your PC. Drivers from FTDI on your PC take care that a virtual communication port (VCP) is established, when the stick is plugged in into your PC. On linux and MAC OSX these drivers are already there, on Windows it might be necessary to install them manually from FTDI (Link: <http://www.ftdichip.com/Drivers/VCP.htm>).

When the port is establish a clear text communication at 115200 baud, 8N1 can be established. When you connect, Meteostick will send a login message like shown below.

```
# Meteostick Version 1.0, Free RAM 1290, SN: xxxxxxxxxxxx
# License Information:
#   Meteostick (c) 2014 by smartbedded.com is closed source and makes use of
#   - Davis Vantage (R) frequency tables as published by user 'dekey' at blogs/forums:
#     http://madscientistlabs.blogspot.de/2014/01/more-than-one-way-to-skin-cat.html
#     http://www.wxforum.net/index.php?topic=18718.0
#   - port library interface to BMP085 sensors connected via I2C
#     provided by 'jc@wippler.nl' (2009) published for use according to MIT license
#   - some parts of the ATSHA204 library provided by Alessandro Chedini (2013)
#     published for use according to MIT license
#   - JeeLink HW design (USB stick like PCB) provided by 'jc@wippler.nl' (2012)
#     published for use according to cc-by license
#
?
```

When the „?“ appears, Meteostick is ready to receive your commands.

Reset command: r

Meteostick can be rebooted by sending the command „r“. It will take a couple of seconds until reboot is done and the login screen appears again.

Transmitter command: t

First of all you specify which transmitter IDs Meteostick should listen to. This is done in a bit wise representation, where transmitter ID 1 is represented by the lowest bit, ID 2 by the next bit, etc. As we have up to 8 transmitter IDs, the setup is represented in a byte with a value range from 0-255. When you want Meteostick to listen to transmitter IDs 1, 3 and 6 then the value is bits 1, 3 and 6 set which results into binary 00100101 which is $32+4+1 = 37$ in decimal. Command is „t37“ with no spaces.

```
t37
# listening to transmitters 1 3 6
```

Filter command: f

Meteostick does frequency hopping to follow the transmitters you have selected. During that hops Meteostick might receive data from not selected transmitters. Per default Meteostick will also show this data of „alien“ sensors if they occur during wait for the next transmission of one of the selected transmitters. You can inhibit display of these sensors by giving a filter command. „f1“ turns on the filter, „f0“ turns off the filter.

```
f1
# filter on
```

Output command: o

Meteostick can provide data output in three formats.

- Per „o0“ output as raw data is selected.
- „o1“ presents data as computed values separated by blanks.
- „o2“ shows data in human readable text.

Which of these presentations does fit your needs best, depends on your type of application.

Definition of the formats is done in the next chapter.

```
o2
# output clear text
```

Mode of operation command: m

After all setup commands have been send Meteostick needs to be told in which frequency band to operate. „m0“ selects the USA band at 915 MHz and „m1“ selects the Europe band at 868 MHz. As Meteostick does listen only there can be no harm, when you select the wrong band. You simply will not receive data as no stations sending there.

```
m0
# frequency band 915MHz selected
```

After sending the mode of operation command Meteostick will start listening for sensors and will report data via the serial connection. Your program now has only to listen to an ongoing stream of data.

Data Formats for use with 3rd Party Software

Output of data from Meteostick depends on the selected output mode

Clear Text Data

When „o2“ command has been sent, Meteostick will report data in a human readable style. This is good for manual inspection of what the incoming data looks like. Below you find a listing of the output generated by listening to a Vantage Vue on transmitter IDs 1 and 2, a Vantage Pro2 Plus on ID 3 and a soil/leaf station on ID 7.

```
Outdoor id:3 temp:20.2C hum:34% signal:-66db lowbat
Wind id:3 speed:0.89m/s dir:278deg signal:-66db lowbat
Outdoor id:1 temp:19.5C hum:37% signal:-69db
Wind id:1 speed:0.89m/s dir:226deg signal:-69db
Wind id:1 speed:0.44m/s dir:189deg signal:-72db
Rain id:1 ticks:44 signal:-69db
Wind id:1 speed:0.89m/s dir:189deg signal:-69db
Leaf Wetness id:7 channel:2 wetness:0 signal:-52db
Wind id:1 speed:0.44m/s dir:189deg signal:-69db
Wind id:3 speed:2.23m/s dir:0deg signal:-66db lowbat
Outdoor id:1 temp:19.5C hum:38% signal:-69db
Wind id:1 speed:0.44m/s dir:189deg signal:-69db
Soil Moisture id:7 channel:1 moisture:46cbar signal:-50db
Soil/Leaf Temp id:7 channel:1 temp:22.1C signal:-50db
Outdoor id:3 temp:20.2C hum:34% signal:-67db lowbat
Wind id:3 speed:1.34m/s dir:306deg signal:-67db lowbat
Wind id:1 speed:0.44m/s dir:188deg signal:-71db
Rain id:3 ticks:128 signal:-64db lowbat
Rain id:1 ticks:44 signal:-69db
Wind id:1 speed:0.44m/s dir:188deg signal:-69db
Wind id:3 speed:0.89m/s dir:320deg signal:-64db lowbat
Indoor temp:35.5C press:1024.30hPa
Wind id:1 speed:1.34m/s dir:188deg signal:-69db
Wind id:3 speed:0.44m/s dir:320deg signal:-65db lowbat
Panel id:2 power:26.1% signal:-68db
Wind id:2 speed:0.44m/s dir:100deg signal:-68db
Outdoor id:1 temp:19.5C hum:38% signal:-70db
Wind id:1 speed:1.78m/s dir:189deg signal:-70db
Outdoor id:3 temp:20.2C hum:34% signal:-66db lowbat
Wind id:3 speed:0.44m/s dir:320deg signal:-66db lowbat
Rain id:2 ticks:128 signal:-66db
Wind id:2 speed:0.44m/s dir:140deg signal:-66db
Panel id:1 power:21.5% signal:-70db
Wind id:1 speed:1.34m/s dir:189deg signal:-70db
Rain id:3 ticks:128 signal:-67db lowbat
Wind id:3 speed:0.44m/s dir:320deg signal:-67db lowbat
Wind id:2 speed:0.44m/s dir:140deg signal:-70db
Leaf Wetness id:7 channel:2 wetness:0 signal:-51db
Rain id:1 ticks:44 signal:-70db
Wind id:1 speed:0.89m/s dir:189deg signal:-70db
Wind id:3 speed:0.44m/s dir:320deg signal:-64db lowbat
Outdoor id:2 temp:18.8C hum:32% signal:-73db
Wind id:2 speed:0.00m/s dir:140deg signal:-73db
Soil Moisture id:7 channel:1 moisture:46cbar signal:-49db
Soil/Leaf Temp id:7 channel:1 temp:22.1C signal:-49db
Wind id:1 speed:0.89m/s dir:189deg signal:-70db
Wind id:3 speed:0.00m/s dir:320deg signal:-64db lowbat
Wind id:2 speed:0.00m/s dir:140deg signal:-68db
```

Computed Values

When „o1“ command has been sent, Meteostick will report data in a machine readable style. This is

good for feeding it into a program. Meteostick does report sensor data in the following format, where each line starts with a one letter sensor identifier, followed by transmitter id and sensor dependent values.

sensor identifier	transmitter id	value 1	value 2	signal strength	low battery indicator	description
B	omitted	temperature in Celsius	pressure in hPa	omitted	omitted	pressure sensor inside Meteostick
W	X	current wind speed in m/s	wind direction in degrees	in db	„L“ or blank	wind sensor of a Vantage Pro2, Vue or wind station
T	X	temperature in degree Celsius	humidity in percent	in db	„L“ or blank	temperature / humidity sensor of a Vantage Pro2, Vue, temp/hum station
R	X	counter value (value 0-255)	omitted	in db	„L“ or blank	rain sensor of a Vantage Pro2, Vue or rain station
S	X	solar radiation in W/qm	omitted	in db	„L“ or blank	solar radiation data of a Vantage Pro2
U	X	UV index	omitted	in db	„L“ or blank	UV index data of a Vantage Pro2
L	X	channel number (1-4)	leaf wetness (0-15)	in db	„L“ or blank	wetness data of a leaf station
M	X	channel number (1-4)	Soil moisture in cbar (0-200)	in db	„L“ or blank	soil moisture of a soil station
O	X	channel number (1-4)	soil/leaf temperature in degrees Celsius	in db	„L“ or blank	soil/leaf temperature of a soil/leaf station
P	X	solar panel power in (0-100)	omitted	in db	„L“ or blank	Vantage Vue reports percentage power of solar panel

Below you find a listing of the output generated by listening to a Vantage Vue on transmitter IDs 1 and 2, a Vantage Pro2 Plus on ID 3 and a soil/leaf station on ID 7.

```

T 3 20.8 36 -53 L
W 3 0.00 261 -53 L
W 1 0.44 241 -67
R 2 128 -67
R 3 128 -53 L
W 3 0.00 261 -53 L
R 1 44 -66
B 35.2 1023.57
W 1 0.44 233 -68
L 7 2 0 -52
W 2 0.00 83 -72
T 1 19.6 41 -66
W 3 0.00 261 -54 L
M 7 1 49 -51
O 7 1 22.3 -51
W 2 0.00 83 -66
W 1 0.00 234 -66
T 3 20.8 37 -54 L
P 1 21.1 -68
W 2 0.00 83 -70
R 1 44 -66
W 1 0.00 233 -66
R 3 128 -52 L
W 1 0.00 234 -67
U 3 0.4 -58 L

```

W 3 0.00 261 -58 L
T 1 19.6 41 -68
S 3 267.3 -55 L

Raw Data

When „o0“ command has been sent, Meteostick will report raw sensor data. Only data that has a valid CRC is reported, so you can be quite sure that no false data will go through. How to compute meaningful values from these raw data is not documented by Davis® and will also not be published by smartbedded UG. Format of the packets is as follows:

sensor type	RF channel	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	signal strength	Time since last reception	description
I	X	in hex	in hex	in hex	in hex	in hex	in hex	in hex	in hex	in db	in micro seconds	raw sensor data
B	omitted	raw value	raw value	indoor temp in 1/10 degrees Celsius			pressure in 1/100 hPa			omitted	omitted	pressure sensor on Meteostick PCB

Copyright

Meteostick (hardware and firmware) is copyright of smartbedded UG (limited liability) to be contacted by email „info@smartbedded.com“. You are not allowed to make copies of the embedded Meteostick firmware or the hardware layout unless otherwise agreed in writing.

Open Source Obligations

While being closed source Meteostick is related to these pieces of work published as Open Source:

- Meteostick hardware is derived from a concept that Jean Claude Wippler (2012) has created as „JeeLink“ and published under Creative Commons license type „cc-by“ (<https://creativecommons.org/licenses/by/3.0/>). You can find more details about „JeeLink“ here: <http://jeelabs.net/projects/hardware/wiki/JeeLink>
- Meteostick firmware makes use of BMP085 Arduino library from Jean Claude Wippler (2009) published under MIT license (<http://opensource.org/licenses/mit-license.php>). Link to code: <https://github.com/jcw/jeelib/blob/master/examples/Ports/bmp085demo/bmp085demo.ino>
- Meteostick uses parts of the ATSHA204 library provided by Alessandro Chedini (2013) published under MIT license (<http://opensource.org/licenses/mit-license.php>). Link to code: <https://gist.github.com/ghedo/6751045>
- Meteostick firmware uses the standard Arduino libraries provided under LGPL (<http://www.gnu.org/copyleft/lesser.html>), linked only, without modification.

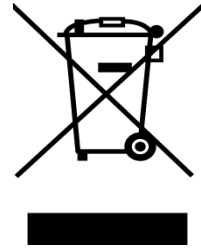
References

Understanding the frequency hopping schema of the Davis ® weather stations was significantly supported by publications of forum user „dekey“ (wxforum.net) and his blog.

- <http://www.wxforum.net/index.php?topic=18718.0>
- <http://madsdentistlabs.blogspot.de/2014/01/more-than-one-way-to-skin-cat.html>

Technical Data

storage temperature:	-20° to 50° Celsius
operating temperature:	0° to 50° Celsius (not condensing)
Meteostick size:	75mm x 24mm x 10mm (without antenna)
weight:	20g (without packaging)
connector:	USB-A, 2.0, 1.x
antenna:	flexible wire antenna about 150mm long
operating frequencies	868 MHz in Europe, 915 MHz in USA, receive only



Certification

smartbedded UG (limited liability) declares compliance of Meteostick in regard to RoHS. All parts used are RoHS compliant.

Declaration of Conformity



We, smartbedded UG (haftungsbeschränkt)
Querweg 35, 24632 Lentförhden, Germany

Declare under our sole responsibility that the product:

Product name:	Meteostick
Trade name:	Meteostick
Type of model:	1.0

To which this declaration relates is in conformity with the requirements of the following specifications:

- ANSI C63.4
- FCC 47 CFR Part 15, Subpart B, Class B Digital Device.

Supplementary information:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Test report no. 14009112, Issue Date: 2014-04-07

Signed by or for the manufacturer :

Name (in writing): Anke Pasternak
Title: CEO
Place and date of issue: Lentförhden, April 7, 2014

Declaration of Conformity



We, smartbedded UG (haftungsbeschränkt)
Querweg 35, 24632 Lentförhden, Germany

Declare under our sole responsibility that the product:

Product name:	Meteostick
Trade name:	Meteostick
Type of model:	1.0

Is in conformity with the applicable requirements of the following documents:

- DIRECTIVE 1999/5/EC on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity
- DIRECTIVE 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC
- DIRECTIVE 2009/125/EC on establishing a framework for the setting of ecodesign requirements for energy-related products
- DIRECTIVE 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment

I hereby declare that the equipment named above has been designed with the relevant sections of the above referenced specifications. The unit complies with all applicable essential requirements of the directives.

Signed by or for the manufacturer :

Name (in writing): Anke Pasternak
Title: CEO
Place and date of issue: Lentförhden, April 7, 2014