UVP6

Specifications for supervised piloting and the processing of real time data

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1. Introduction

This document presents the specifications for the supervised piloting and the real time process of the UVP6 data by an autonomous vector. It first describes the instrument checks and piloting commands needed to pilot the UVP6. It also describes the UVP6 transmitted data, gives advises for the data processing by the vector and what is expected to be received on land.

Detailed information about the UVP6 instrument can be found in the user manual.

This document applies for versions more recent than 2022.01. Changes compared to older versions are described at the end of the document.

2. General description of the functioning of the UVP6

Communication between the UVP6 and the vector are done by rs232 serial port. The downloading of the raw UVP6 data using the Ethernet connexion is not described in this document.

The UVP6 will automatically send an information frame when powered. Other information, like the acquisition configurations present in the UVP6, can be checked by special commands. This has to be part of an initial checking procedure by the vector in order to verify that the programming of the UVP is correct.

There are three different kinds of configurations: the hardware configuration “hw”, the acquisition configuration “acq” and the taxonomic configuration “taxo”. The hw configuration is about instrument parameters such as serial number and calibration. The acq configurations are 10 config files with the parameters for 10 acquisitions, such as images frequency and image trigger mode. The taxo configurations are config files describing and aiming at a classification model.

Each acquisition configuration of the UVP6 allows to select different frame rates, black frame rates, size of frames blocs, etc. The configurations are pre-set in the UVP6 and will be selected depending on the uses of the instrument. The vector will start an acquisition by selecting the chosen configuration, and will stop it with a simple command. During an acquisition, the UVP6 will record data and sending a data frame per bloc of images until receiving a stop command (or being powered OFF).

For the UVP6 embedded classification, the UVPapp application permits to load only one standard classification model even if expert operators can create their own models using the tools designed at Laboratoire d’Océanographie de Villefranche and available on GitHub.

The UVP6 data could be too large to be entirely transmitted by satellite. The vector must thus reduce the size of the data, mostly by depth average. The complete data could be recovered with the recovery of the sensor.

3. Description of the global metadata and data flows

The metadata and data flow described is the “remote data flow” through satellite. The path goes through the vector before transmission to the land. Communication between the uvp6 and the vector is essential,

as well as the satellite transmission. This could limit the data flow and require the vector to apply a reduction process to the data. Metadata and data must be formatted on land to fill the EcoPART standard.

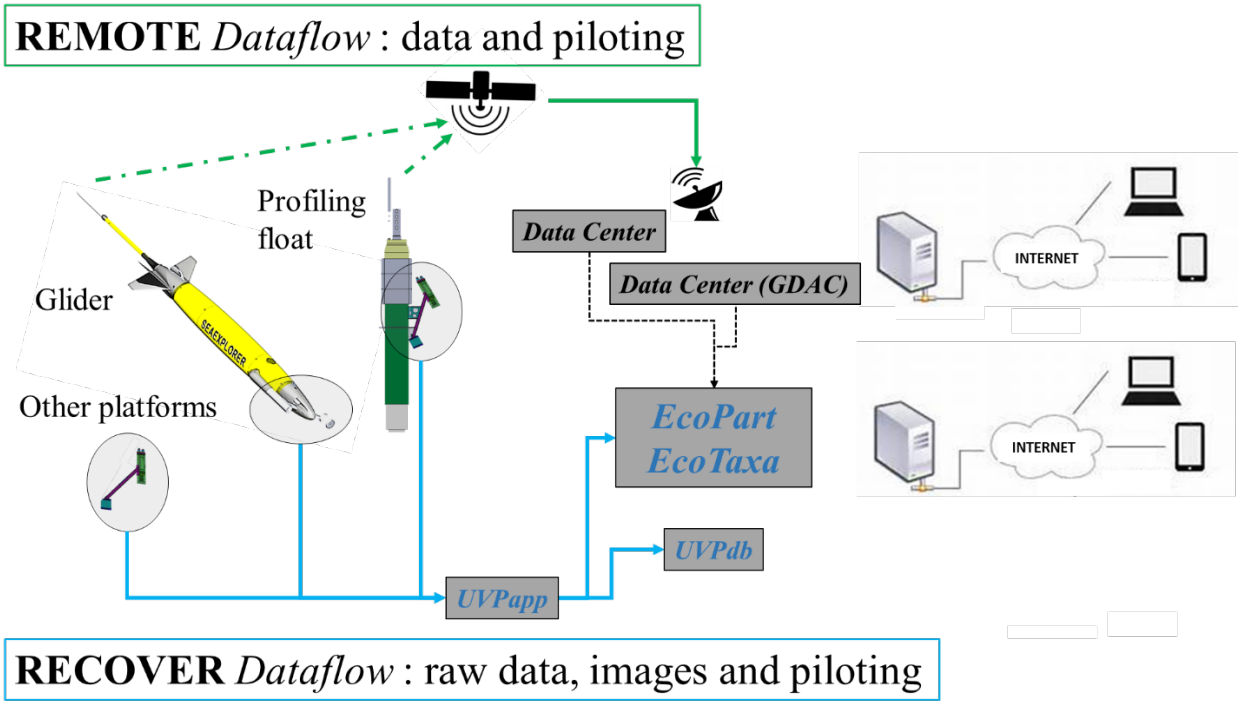
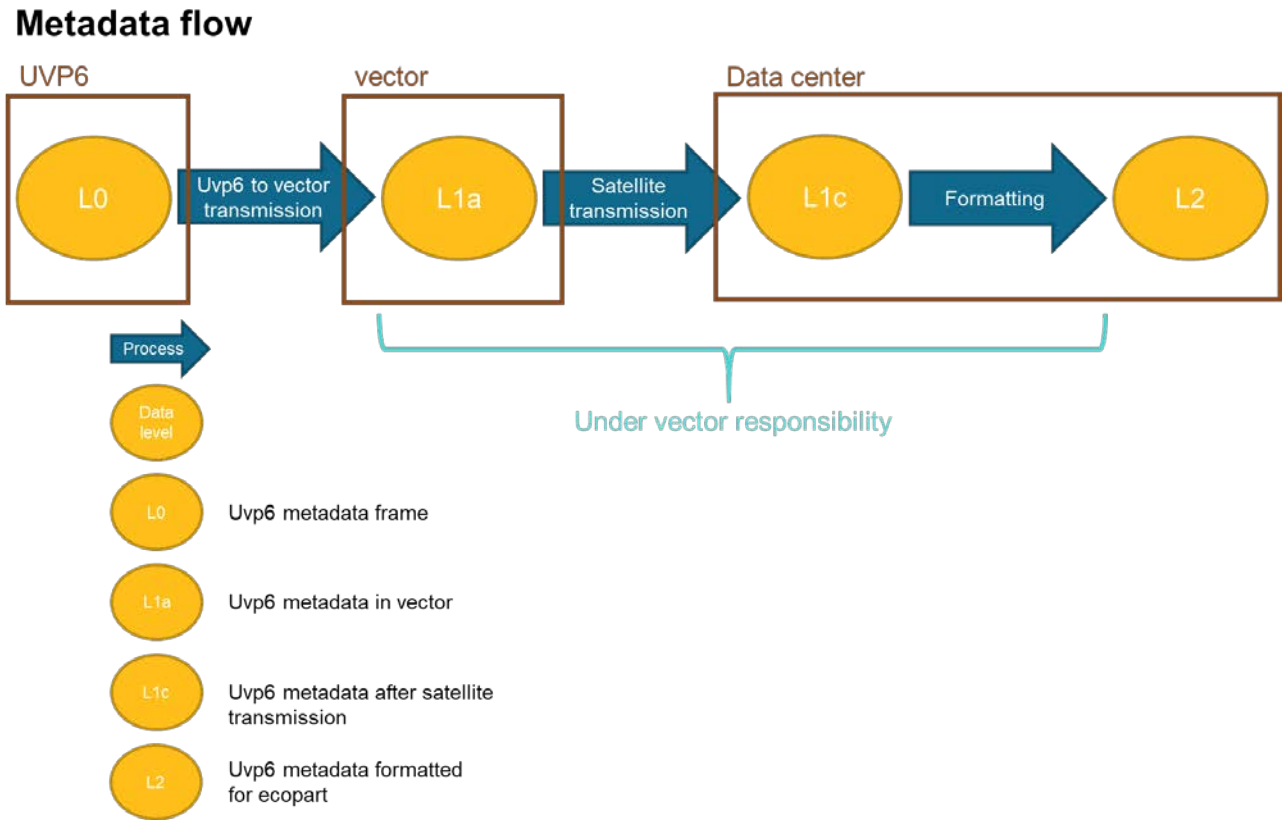
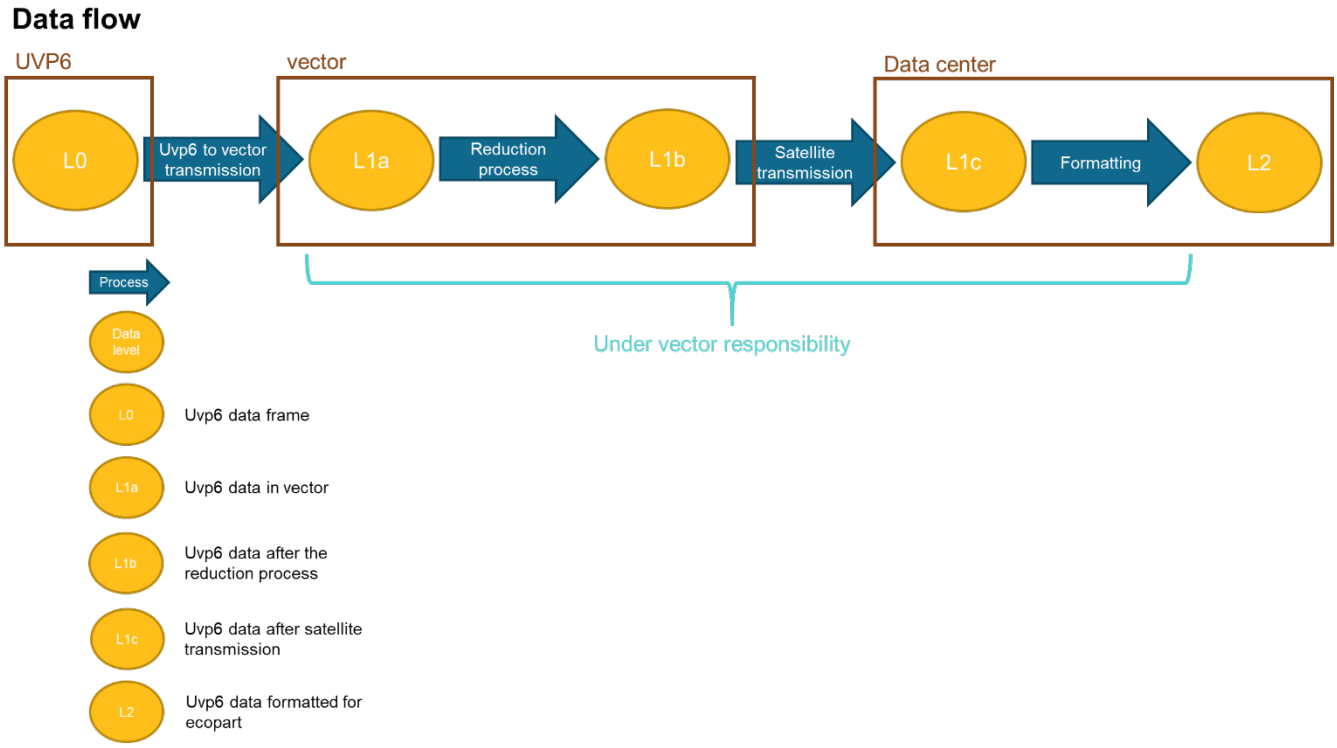


Figure 1: uvp6 remote and recover data flow. Picheral et al 2021

The instrument metadata are hardware, acquisition and taxonomic configurations. They are all recovered from the uvp6 during the instrument check sequence at the beginning of the mission and transmitted directly to land. The metadata flow steps include a transmission from the uvp6 to the vector, a transmission from the vector to land and a final formatting.



The data flow is for particles, black and taxonomic data. They are transmitted to land after acquisition and when possible. Due to the limited satellite transmission, an additional step, the reduction process, is made by the vector to aggregate data by depth or time slices. The rarer black data are never reduced.



Only data and metadata send by the uvp6 to the vector (L0) are described in this document.

Advices for the reduction process are also given.

4. Instrument check sequence

The goal of the check sequence is to verify that the uvp6 contains the right configurations that will be used during the mission.

At the beginning of the mission, the vector should check the configurations of the instrument. After powering on the instrument, the vector can have access to the hw configuration, the different acq configurations and the possible taxo configurations.

The acq configuration names from the uvp should be checked against the acq configuration names set in the vector. All the uvp configurations should be recovered from the UVP6 and sent to land at the beginning of the mission (as a minimum).

In addition, an autocheck procedure should be run in the uvp6. A failure to that procedure tell that the uvp has a problem and can not go into mission.

The last field of the HW frame indicates the UVP6 version of the firmware. This document applies for versions more recent than 2022.01.

Configuration checking sequence
Ask for hw conf

$hwconfcheck;
Answer the hw conf line
$HW_CONF,000175LP,0,UNDEFINED,0,000180VE2,0,250,,0.600,393857,10000,2,0,40000,0,16,2340.000,1.300,73,0.660,UNDEFINED,202204270906,camille.catalano@imev-mer.fr,50.8,64,80.6,102,128,161,203,256,323,406,512,645,813,1020,1290,1630,2050,2580,ver2022.01;
Ask for the acq conf ACQ_XX
$confcheck:ACQ_XX**;**
Answer the acq conf line for ACQ_XX
*$ACQ_CONF,**ACQ_XX**,2,0.100,1,1,0,0,1,0,10,2,620,1.5,50,10,0,1000,0,60,alice.pierret@imev-mer.fr,NO_RE,1,2,0,0;*
…
Ask for the taxo conf TAXO_XX
$taxocheck:TAXO_XX;
Answer the taxo conf line for TAXO_XX
$TAXO_CONF,TAXO_XX,MODEL_14,65535,12,100000,100001,100002,100003,100004,100005,100006,100007,100008,100009,100010,100011,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;

The ACQ and TAXO configuration are saved in up to 10 slots each, and have names (typically ACQ_XX and TAXO_XX) utilized to check the table presence via a RS232 command.

The vector should check the presence of the acq configurations set in its programing (i.e. if the programming of the vector require the use of a given UVP6 configuration, this configuration must be present in the UVP memory).

Autocheck sequence
Start the autocheck

$autocheck;
<u>Answer</u>
$autocheckpassed;

5. Acquisition sequence

5.1. Acquisition strategies

Each of the ten acquisition configurations of the UVP6 allows to select different frame rates, black frame rates, size of frames blocs, etc. The configurations are pre-set in the UVP6 and will be selected depending on the operational requirements. It means that different configurations can be used at different depth, thus inside a unique profile/sample. The reconstruction of the profile/sample data will be done by the vector or by a post process on land.

5.2. Communications

Starting an acquisition is made with a $start command possibly including date and time (in UTC) to synchronize the UVP6 time on the vector-GPS time. Following a start command the uvp replies with the acq conf line and a potential taxo conf line, and confirms the beginning of the acquisition with a $startack; message.

During the acquisition, the uvp6 sends a data frame per bloc of images, or bloc of black images. The number of images in the bloc, and the bloc images frequency are defined in the acq configuration. If the classification is activated, a taxo line is sent before each lpm line.

If the Black image measurement is activated (default setting), an acquisition starts with a black bloc of images.

Stopping an acquisition is made with a $stop; command. The uvp can be busy/sleepy so the $stop; command must always be sent twice unless a $stopack; response is obtained after the first sending. Confirmation of the end of the acquisition is made with a $stopack; message.

If a command is sent while the instrument is busy/sleepy, it will send an error message : $starterr:33;

If the ambient light is too high and the instrument is overexposed during an acquisition, it is not going to analyse the image. The potential taxo line only indicates that zero image has been analysed. The lpm data contains the metadata of the image bloc and only zeros for particules data. Those lines arrive after an “overexposed error” $starterr:44;

Example:

$starterr:44;
TAXO_DATA,0;
LPM_DATA,542.46,20220202,085445,0,26.69,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
,0,0,0,0;

5.3. Summary of the data stream from the UVP6

This is a complete example of an acquisition with black and taxo activated.

bold : commands sent by vector

Italic : answers sent by UVP6

underline : comments

Just after powering ON -> HW conf frame
HW_CONF,000175LP,0,UNDEFINED,0,000180VE2,0,250,,0.600,393857,10000,2,0,40000,0,16,2340.000,1.300,73,0.660,UNDEFINED,202204270906,camille.catalano@imev-mer.fr,50.8,64,80.6,102,128,161,203,256,323,406,512,645,813,1020,1290,1630,2050,2580,ver2022.01;
Start acquisition with config ACQ_XX and time setting (UTC) of the UVP6
$start:ACQ_XX,20220223,040051;
Two or three (taxo) frames to confirm the beginning of the chosen acquisition
ACQ_CONF,ACQ_XX,2,0.100,1,1,0,0,1,0,10,2,620,1.5,50,10,0,1000,0,60,alice.pierret@imev-mer.fr,1,2,0,TAXO_0,393675;
TAXO_CONF,TAXO_0,MODEL_14,65535,12,100000,100001,100002,100003,100004,100005,100006,100007,100008,100009,100010,100011,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;
$startack;
First black frame
BLACK_DATA,1554.02,20220223,040051,1,23.69,48,0,4,0,2,0,1,0,1,1,1,2,0,0,1,0,0,2;
Data frames, coming after a taxo frame
TAXO_DATA,1,8,1299,43,8,17085,49,8,12379,50;
LPM_DATA,1554.09,20220223,040052,1,23.69,33,0,4,2,1,0,1,1,0,1,1,2,0,0,1,0,0,2,23,0,17,21,20,0,21,19,0,29,30,35,0,0,43,0,0,50;
TAXO_DATA,1,8,1451,42,8,17728,49,8,11166,53;
LPM_DATA,1554.16,20220223,040054,1,23.69,38,0,6,1,4,0,0,2,0,1,1,3,0,0,1,0,0,2,23,0,18,20,21,0,0,22,0,32,31,31,0,0,42,0,0,51;
…
Black frame
BLACK_DATA,1555.81,20220223,040453,1,24.19,42,0,5,0,1,0,1,1,0,0,0,0,0,0,0,0,1,3;

Data frames
TAXO_DATA,1,10,759485,157,8,6966,43,8,17181,59,8,4778,41;
LPM_DATA,1555.81,20220223,040454,1,24.19,49,0,1,2,0,1,1,1,0,0,0,0,0,0,0,0,1,3,22,0,17,21,0,19,21,23,0,0,0,0,0,0,0,0,41,86;
…
Frame to stop the acquisition
$stop;
Usual error answer because the instrument is generally busy/sleepy
$starterr:33;
Instant re-sent of the stop acquisition frame
$stop;
Acquisition stopped
$stopack;

6. UVP6 to vector transmitted metadata and data L0

6.1. UVP6 to vector metadata L0

The three metadata frames are described in details here. The first sets of UVP6 may have slightly different HW and ACQ frames (read about versioning above).

The HWconf frame is automatically sent when the instrument is powered on. The according ACQconf frame is sent when an acquisition is started, following by the possible associated TAXOconf.

HWconf variable name	Type	Unit	Explanation	Example
	text		frame name	HW_CONF
Camera_ref	text		UVP6 serial number (XXXXXXXX)	000176LP
Acquisition_mode	integer		0: SUPERVISED mode, 1: AUTONOMOUS mode (including CTD mode), 2: TIME-programmed mode	1
Default_acquisition_configuration	text		Name of the acquisition configuration automatically launched when Acquisition_mode = 1	ACQ_CAL_FULL
Delay_after_power_up_on_time_mode	integer	min	Optional delay before starting image acquisition when Acquisition_mode = 1 (AUTONOMOUS)	0
Light_ref	text		Light unit serial number	000178VE2

Correction_table_activation	boolean		Selection of the lighting correction LUT -> 0: no correction, 1: light unit correction #1, 2: light unit correction #2 (default : 1)	1
Time_between_lighting_trigger_and_acquisition	integer	µS	Delay between light unit trigger and image sensor shutter	250
Pressure_sensor_ref	text		Pressure sensor serial number (empty if no sensor installed)	
Pressure_offset	float	M	Vertical distance between the image plan and the pressure measurement point (>0 if pressure sensor above image field, if undefined, set 999)	0,6
Storage_capacity	integer	MB	SD card storage capacity, automatically updated by UVP6 when parameters are modified, do not edit	393857
Minimum_remaining_memory_for_thumbnail_saving	integer	MB	Minimal memory remaining in the SD card to keep saving images or vignettes, do not edit	10000
Baud_Rate	integer		UVP6 RS232 baud rate selection -> 0: 9600 bauds, 1: 19200 bauds, 2: 38400 bauds	2
Black_level	integer	12 bits gray level	Image sensor black level parameter	0
Shutter	integer	µS	Image sensor integration time (shutter)	64
Gain	integer	dB	Image sensor gain, do not edit	6
Threshold	integer	8 bits gray scale	Threshold for image segmentation (pixels <= Threshold are considered background)	20
Aa	integer	µM²	Calibration parameter (corresponding area in the scene represented by each pixel)	2300
Exp	integer		Calibration parameter (adjusting for specular reflections)	1,136
Pixel_Size	integer	µM	Uncalibrated pixel size (side of the pixel in the image field)	73
Image_volume	float	L	Image volume	0,55
Calibration_date	date	YYYYMMDDHHMM	Calibration date for the values in this table	20220504
Last_parameters_modification	date	YYYYMMDDHHMM	Automatically updated by UVP6 when hardware parameters are modified	2,02206E+11
Operator_email	email		Identification of the operator filling this configuration table	alice.pierret@imev-mer.fr
Min_esd_class_01	float	µM	Lower Equivalent Spherical Diameter for class 01	50,8
Min_esd_class_02	float	µM	Lower Equivalent Spherical Diameter for class 02	64

Min_esd_class_03	float	µM	Lower Equivalent Spherical Diameter for class 03	80,6
Min_esd_class_04	float	µM	Lower Equivalent Spherical Diameter for class 04	102
Min_esd_class_05	float	µM	Lower Equivalent Spherical Diameter for class 05	128
Min_esd_class_06	float	µM	Lower Equivalent Spherical Diameter for class 06	161
Min_esd_class_07	float	µM	Lower Equivalent Spherical Diameter for class 07	203
Min_esd_class_08	float	µM	Lower Equivalent Spherical Diameter for class 08	256
Min_esd_class_09	float	µM	Lower Equivalent Spherical Diameter for class 09	323
Min_esd_class_10	float	µM	Lower Equivalent Spherical Diameter for class 10	406
Min_esd_class_11	float	µM	Lower Equivalent Spherical Diameter for class 11	512
Min_esd_class_12	float	µM	Lower Equivalent Spherical Diameter for class 12	645
Min_esd_class_13	float	µM	Lower Equivalent Spherical Diameter for class 13	813
Min_esd_class_14	float	µM	Lower Equivalent Spherical Diameter for class 14	1020
Min_esd_class_15	float	µM	Lower Equivalent Spherical Diameter for class 15	1290
Min_esd_class_16	float	µM	Lower Equivalent Spherical Diameter for class 16	1630
Min_esd_class_17	float	µM	Lower Equivalent Spherical Diameter for class 17	2050
Min_esd_class_18	float	µM	Lower Equivalent Spherical Diameter for class 18	2580
Firmware_version	text	verYYYY.nn	Firmware version : prefix, year and no	ver2022.01

ACQconf variable name	**Type**	**Unit**	**Explanation**	**Example**
			frame name	ACQ_CONF
Configuration_name	text		Name used to launch this configuration	ACQ_NKE_0
PT_mode	integer		0: Triggered by vector, 1: Asks for pressure and time, 2: Use UVP6 Acquisition_frequency, 3: CTD mode (mandatory Pressure Sensor)	0
Acquisition_frequency	float	Hz	Acquisition frequency (maximum value)	2
Frames_per_bloc	integer	frame	Nb of frames to accumulate and synthesize to send	1
Pressure_for_auto_start	integer	decibar	When in CTD mode (PT_mode= 3), pressure value to automatically start the acquisition	0
Pressure_difference_for_auto_stop	integer	decibar	When in CTD mode (PT_mode= 3), pressure drop from deepest value to automatically stop the acquisition	0
Result_sending	boolean		0/false: results are never sent - 1/true: synthesized results are sent through RS232 after each bloc	1

Save_synthetic_data_for_delayed_request	boolean		0/false: do not save - 1/true: save synthetic data for a potential delayed request (usefull only for troubleshooting)	0
Save_images	integer		How to save Images -> 0: don't save, 1: save whole raw image, 2: save selected vignettes only	2
Vignetting_lower_limit_size	integer	µM	When saving vignettes (Save_images= 2), minimum object size (ESD) to save vignette, utilizes Aa and Exp, (default : 645)	645
Appendices_ratio	float		When saving vignettes (Save_images= 2), vignette size to actual object size ratio (default : 1.5)	1,5
Interval_for_measuring_background_noise	integer	bloc	Background noise measured every 'interval' (bloc acquired without flashing). Disabled if zero	40
Image_nb_for_smoothing	integer	frame	Nb of images to measure temperature (for safety stop) and average particle abundance for the analog output	10
Analog_output_activation	boolean		Activation of the particle abundance analog output : 0/false: disabled - 1/true	0
Gain_for_analog_out	integer	object	Smoothed number of counted objects for 5 volts analog output voltage	1000
Maximal_internal_temperature	integer	°C	Maximum internal temperature to cause a security stop	60
Operator_email	email		Identification of the operator filling this configuration table	marc.picheral@obs-vlfr.fr
Taxo_conf	text		Taxonomic classification configuration for this acquisition (let it empty to disable embedded recognition)	NO_RE
Aux_mode	integer		Auxiliary output activation mode (0 : disabled, 1 : enabled all sequence, 2 : enabled during Aux_param_1 at the start of the acquisition and before the start of the sequence, during Aux_param_2 after the sequence and before the end of the acquisition and 3 : enabled and no image processed during the sequence)	0
Aux_param_1	Integer		Duration of activation for mode 2 at the start of the aquisition	20
Aux_param_2	integer		Duration of activation for mode 2 at the end of the aquisition	
Remaining_memory	integer	MB	SD card remaining memory at the start of the acquisition	383008

TAXOconf variable name	**Type**	**Unit**	**Explanation**	**Example**
			frame name	AXO_CONF

Configuration_name	text		Name used to set this configuration into the field Taxo_conf, from the Acquisition configuration file	TAXO_NKE_0
Model_reference	text		Taxonomic classification model to be used. Automatically filled during model creation/export	MODEL_geom
Max_size_for_classification	integer	pixel	Maximum vignette size to perform the embedded classification	65535
Model_nb_classes	integer		Number of classes used by the classification model. Automatically filled during model creation/export	8
Taxo_ID_for_class_00	integer		Ecotaxa taxonomic unique identifier for model's class 00	94022
Taxo_ID_for_class_01	integer		Ecotaxa taxonomic unique identifier for model's class 01	84963
Taxo_ID_for_class_02	integer		Ecotaxa taxonomic unique identifier for model's class 02	85050
Taxo_ID_for_class_03	integer		Ecotaxa taxonomic unique identifier for model's class 03	85079
Taxo_ID_for_class_04	integer		Ecotaxa taxonomic unique identifier for model's class 04	94024
Taxo_ID_for_class_05	integer		Ecotaxa taxonomic unique identifier for model's class 05	94023
Taxo_ID_for_class_06	integer		Ecotaxa taxonomic unique identifier for model's class 06	94021
Taxo_ID_for_class_07	integer		Ecotaxa taxonomic unique identifier for model's class 07	94020
Taxo_ID_for_class_08	integer		Ecotaxa taxonomic unique identifier for model's class 08	0
Taxo_ID_for_class_09	integer		Ecotaxa taxonomic unique identifier for model's class 09	0
Taxo_ID_for_class_10	integer		Ecotaxa taxonomic unique identifier for model's class 10	0
Taxo_ID_for_class_11	integer		Ecotaxa taxonomic unique identifier for model's class 11	0
Taxo_ID_for_class_12	integer		Ecotaxa taxonomic unique identifier for model's class 12	0
Taxo_ID_for_class_13	integer		Ecotaxa taxonomic unique identifier for model's class 13	0
Taxo_ID_for_class_14	integer		Ecotaxa taxonomic unique identifier for model's class 14	0
Taxo_ID_for_class_15	integer		Ecotaxa taxonomic unique identifier for model's class 15	0
Taxo_ID_for_class_16	integer		Ecotaxa taxonomic unique identifier for model's class 16	0
Taxo_ID_for_class_17	integer		Ecotaxa taxonomic unique identifier for model's class 17	0
Taxo_ID_for_class_18	integer		Ecotaxa taxonomic unique identifier for model's class 18	0
Taxo_ID_for_class_19	integer		Ecotaxa taxonomic unique identifier for model's class 19	0
Taxo_ID_for_class_20	integer		Ecotaxa taxonomic unique identifier for model's class 20	0
Taxo_ID_for_class_21	integer		Ecotaxa taxonomic unique identifier for model's class 21	0
Taxo_ID_for_class_22	integer		Ecotaxa taxonomic unique identifier for model's class 22	0
Taxo_ID_for_class_23	integer		Ecotaxa taxonomic unique identifier for model's class 23	0
Taxo_ID_for_class_24	integer		Ecotaxa taxonomic unique identifier for model's class 24	0

Taxo_ID_for_class_25	integer		Ecotaxa taxonomic unique identifier for model's class 25	0
Taxo_ID_for_class_26	integer		Ecotaxa taxonomic unique identifier for model's class 26	0
Taxo_ID_for_class_27	integer		Ecotaxa taxonomic unique identifier for model's class 27	0
Taxo_ID_for_class_28	integer		Ecotaxa taxonomic unique identifier for model's class 28	0
Taxo_ID_for_class_29	integer		Ecotaxa taxonomic unique identifier for model's class 29	0
Taxo_ID_for_class_30	integer		Ecotaxa taxonomic unique identifier for model's class 30	0
Taxo_ID_for_class_31	integer		Ecotaxa taxonomic unique identifier for model's class 31	0
Taxo_ID_for_class_32	integer		Ecotaxa taxonomic unique identifier for model's class 32	0
Taxo_ID_for_class_33	integer		Ecotaxa taxonomic unique identifier for model's class 33	0
Taxo_ID_for_class_34	integer		Ecotaxa taxonomic unique identifier for model's class 34	0
Taxo_ID_for_class_35	integer		Ecotaxa taxonomic unique identifier for model's class 35	0
Taxo_ID_for_class_36	integer		Ecotaxa taxonomic unique identifier for model's class 36	0
Taxo_ID_for_class_37	integer		Ecotaxa taxonomic unique identifier for model's class 37	0
Taxo_ID_for_class_38	integer		Ecotaxa taxonomic unique identifier for model's class 38	0
Taxo_ID_for_class_39	integer		Ecotaxa taxonomic unique identifier for model's class 39	0

6.2. UVP6 to platform or vector LPM data L0

One rs232 data frame is transmitted per block of images. All the images of the block are not necessarily used (in case of overexposed). For each pixel class size, the total number of objects of the bloc is transmitted, as well as the average per object of their grey level.

The number of fields of the LPM data frame is always the same.

LPM_DATA,P,date,time,IMG,T,Nbi,Nbi+1,...GGj,GGj+1 [...] ;

Where :

- P : pressure (float)

- Date : date in YYYYMMDD

- Time : time in HHMMSS

- IMG : number of images used. (integer 0-255)

- T : internal temperature (float)

- Nbi : number of objects of the category i (integer 0-4294967295 or 65535 for category higher than 12)

- GGi : average Grey level of the objects i (integer 0-255)

All fields are delimited by ",".

“i” the number of categories goes from 1 to 18.

The frame ends with a “;”.

Example :

LPM_DATA,4.42,20220607,133012,1,26.88,3375,81,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,34,32,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0;

One frame, at pressure 4.42 bars, the 07/06/2022 at 13h30min12s UTC. The internal temperature of the UVP is 26.88°C. There are 3375 objects of one pixel, with an average level of grey of 34.

6.3. UVP6 to vector black data L0

The rs232 black data frame is the same as the LPM data frame but starting by “BLACK_DATA” and not ‘LPM_DATA”. The only difference is there is no information on grey level.

Example :

BLACK_DATA,1555.81,20220223,040453,1,24.19,42,0,5,0,1,0,1,1,0,0,0,0,0,0,0,0,1,3;

One frame, at pressure 1555.81 bars, the 23/02/2022 at 04h04min53s UTC. The internal temperature of the UVP is 24.19°C. There are 42 objects of one pixel.

6.4. UVP6 to platform or vector taxo data L0

One rs232 data frame per block of images contains 25 objects per frame maximum. All the images of the block are not necessarily used (analysis of the images stops after 25 objects). For each detected and identified object, the predicted category, the spherical equivalent volume of the object and the average grey level are transmitted.

The number of fields of the taxo frame is variable depending on the number of identified objects. Metadata are transmitted in the lpm data frame.

TAXO_DATA,IMG,NNi,VVi,GGi,NNi+1,VVi+1,GGi+1 [...] ;

Where:

- IMG : number of images in which the taxo was performed. (integer 0-255)

- NNi : N° of the category of the object i (integer 0-39)

- VVi : Volume of the object i (integer 0-65535 ??? 1.2620e+07 ??? TBD)

- GGi : Grey level of the object i (integer 0-255)

All the fields are delimited by ",". All fields are integers.

The frame ends with a “;”.

Example :

TAXO_DATA,1,8,65,39,8,43,41,9,175,61;

One image, 3 objects, 2 of category 8 and 1 of category 9.

TAXO_DATA,5,8,37,42;

Five images, 1 object of category 8

TAXO_DATA,3;

Three images analysed containing no object to be identified.

7. Reduction process by the piloting platform or vector

7.1. Description

In order to reduce the transmitted data and transmission time, it is recommended to aggregate the LPM and TAXO data by depth slices. This process must be conducted by the vector along an uvp acquisition or sample (i.e. profile). The black data are never aggregated because of the low data quantity and because of the need to keep a detailed monitoring of this data.

A similar (by time) aggregation process can be applied for time series.

The typical depth slices used depends on the precision needed, so on the depth. It is possible to reduce the transmitted data using different depth slices for the LPM and the Taxo data. Here is an example:

Depth slices aggregation by the vector		
Depth ranges	**LPM depth slice size**	**TAXO depth slice size**
0 – 2 m	Raw data	Raw data
2 – 100 m	5 m	5 m
100 – 500 m	10 m	10 m
500 – 1000 m	20 m	20 m
1000 – XXXX m	20 m	40 m

It is also recommended to select the ACQ frequency and bloc sizes plus the slice width to keep the theoretical number of images constant for all slices. The consquence is that a lower acquisition rate implies a wider depth (or time) slice. The ascending or descending speed, if not constant can also be taken in consideration when setting these parameters.

For each depth slice, the aggregation is a compression of all the bloc data from the slice. Different operations must be conducted on the different fields.

- DateTime, (latitude and longitude) are taken from the first bloc of images
- The numbers of images are summed

- The pressures and the temperature are averaged over the blocs (can be weighted by the real number of processed images per bloc)
- The number of particles and the number of taxo objects are summed for all the images of the slice. The taxo number of objects must be enumerated by the vector.
- The grey and volume should be an average per objects. Since the uvp6 already send an average per object in a bloc (L0), the reduction process of the vector must be a weighted average per object across the different blocs.

Some of the divisions could be conducted on land in order to transmit only integers.

The different reduction processes are summarized here, for each final expected on-land variable:

Columns header	**Format**	**Description**	**Vector's aggregation operation**
DATE_TIME	YYYYMMDDThhmmss	Date and time of the slice	From first bloc
PRES_decibar	Float	Average pressure of the slice	Average per bloc
LATITUDE_decimal_degree	Float	Latitude, if available	From first bloc
LONGITUDE_decimal_degree	Float	Longitude, if available	From first bloc
IMAGE_NUMBER_PARTICLES	Int	Number of uvp images in the slice	Sum over all blocs
TEMP_PARTICLES	Float	Average uvp temperature of the slice	Average per bloc
Particles data			
NB_SIZE_SPECTRA_PARTICLES_class_#	Int	Average number of particles per image of class #	Sum over all blocs
GREY_ SIZE_SPECTRA_PARTICLES_class_#	Int	Average grey level per particles of class #	Weighted average per number of objects
Taxo data			
NB_OBJECTS_class_#	Int	Average number of objects per image of class #	Sum over all blocs
VOLUME_OBJECTS_class_#	Int	Average volume per object of class #	Average per number of objects
GREY_OBJECTS_class_#	Int	Average grey level per object of class #	Average per number of objects

7.2. LPM data example

To better understand the example, the reduction process is divided into two operations: sum or weighted sum, then division for the average.

The number of particles is just summed.

The grey level is multiplied by the number of particles in the bloc then summed together, and finally divided by the total number of particles in the slice.

L0 (L1a) format send by the uvp6:

LPM_DATA,4.42,19050926,120000,1,26.88,1010,1020,…,5,18,…

LPM_DATA,5.43,19050926,120002,4,26.88,4000,4000,…,10,8,…

LPM_DATA,6.45,19050926,120004,2,26.88,0,0,…,0,0,…

Sum operations:

LPM_DATA**,16.3,19050926,120000,7,80.64,5010,5020,…,45050,50360,…**

Division operations for the average:

LPM_DATA**,5.43,**19050926,120000,7**,26.88,**5010,5020**,…,8.99,10.03,…**

7.3. Taxo data example

To better understand the example, the reduction process is divided into three operations: counting the objects, sum or weighted sum, then division for the average.

The counting operation counts and adds the number of objects in each category. The volume and grey are simply summed at the same time.

The number of objects is then summed over the blocs.

The volume and the grey level are summed and then divided by the total number of objects in the slice.

L0 (L1a) format send by the uvp6:

TAXO_DATA,1,1,1010,11,8,1020,12,…

TAXO_DATA,4,1,1030,13,1,1050,15…

Counting operation:

TAXO_DATA,1,1**,1**,1010,11,8,**1**,1020,12,…

TAXO_DATA,4,1**,2**,**2080,28,…**

TAXO_DATA,0;

Sum operations:

TAXO_DATA**,5,**1,**3,3090,39,**8,**1,1020,12,…**

Division operations for the average:

TAXO_DATA,5,1,3**,1030,13**,8,1**,1020,12,…**

Remark: the slice metadata has to be recovered from the corresponding slice particles data.

8. Changes from older versions

This document is for more recent version than ver2022.01. Older versions have changes in configuration frames. Functioning and data frame stay the same, unless the missing embedded classification for the older versions than 2022.01.

On-land L2 data and metadata should be adapted.

The changes are listed in this section for information.

8.1. Version 2022.01

The 2022.01 version has small changes in the HWconf frame and the ACQconf frame compared to more recent versions. It misses the *Firmware_version* variable in the HWconf frame and the *Aux_mode, Aux_param_1* and *Aux_param_2* variables in the ACQconf frame.

HWconf variable name	**Type**	**Unit**	**Explanation**	**Example**
	text		frame name	HW_CONF
Camera_ref	text		UVP6 serial number (XXXXXXXX)	000176LP
Acquisition_mode	integer		0: SUPERVISED mode, 1: AUTONOMOUS mode (including CTD mode), 2: TIME-programmed mode	1
Default_acquisition_configuration	text		Name of the acquisition configuration automatically launched when Acquisition_mode = 1	ACQ_CAL_FULL
Delay_after_power_up_on_time_mode	integer	min	Optional delay before starting image acquisition when Acquisition_mode = 1 (AUTONOMOUS)	0
Light_ref	text		Light unit serial number	000178VE2
Correction_table_activation	boolean		Selection of the lighting correction LUT -> 0: no correction, 1: light unit correction #1, 2: light unit correction #2 (default : 1)	1

Time_between_lighting_trigger_and_acquisition	integer	µS	Delay between light unit trigger and image sensor shutter	250
Pressure_sensor_ref	text		Pressure sensor serial number (empty if no sensor installed)	
Pressure_offset	float	M	Vertical distance between the image plan and the pressure measurement point (>0 if pressure sensor above image field, if undefined, set 999)	0,6
Storage_capacity	integer	MB	SD card storage capacity, automatically updated by UVP6 when parameters are modified, do not edit	393857
Minimum_remaining_memory_for_thumbnail_saving	integer	MB	Minimal memory remaining in the SD card to keep saving images or vignettes, do not edit	10000
Baud_Rate	integer		UVP6 RS232 baud rate selection -> 0: 9600 bauds, 1: 19200 bauds, 2: 38400 bauds	2
Black_level	integer	12 bits gray level	Image sensor black level parameter	0
Shutter	integer	µS	Image sensor integration time (shutter)	64
Gain	integer	dB	Image sensor gain, do not edit	6
Threshold	integer	8 bits gray scale	Threshold for image segmentation (pixels <= Threshold are considered background)	20
Aa	integer	µM²	Calibration parameter (corresponding area in the scene represented by each pixel)	2300
Exp	integer		Calibration parameter (adjusting for specular reflections)	1,136
Pixel_Size	integer	µM	Uncalibrated pixel size (side of the pixel in the image field)	73
Image_volume	float	L	Image volume	0,55
Calibration_date	date	YYYYMMDDHHMM	Calibration date for the values in this table	20220504
Last_parameters_modification	date	YYYYMMDDHHMM	Automatically updated by UVP6 when hardware parameters are modified	2,02206E+11
Operator_email	email		Identification of the operator filling this configuration table	alice.pierret@imev-mer.fr
Min_esd_class_01	float	µM	Lower Equivalent Spherical Diameter for class 01	50,8
Min_esd_class_02	float	µM	Lower Equivalent Spherical Diameter for class 02	64
Min_esd_class_03	float	µM	Lower Equivalent Spherical Diameter for class 03	80,6
Min_esd_class_04	float	µM	Lower Equivalent Spherical Diameter for class 04	102
Min_esd_class_05	float	µM	Lower Equivalent Spherical Diameter for class 05	128

Min_esd_class_06	float	µM	Lower Equivalent Spherical Diameter for class 06	161
Min_esd_class_07	float	µM	Lower Equivalent Spherical Diameter for class 07	203
Min_esd_class_08	float	µM	Lower Equivalent Spherical Diameter for class 08	256
Min_esd_class_09	float	µM	Lower Equivalent Spherical Diameter for class 09	323
Min_esd_class_10	float	µM	Lower Equivalent Spherical Diameter for class 10	406
Min_esd_class_11	float	µM	Lower Equivalent Spherical Diameter for class 11	512
Min_esd_class_12	float	µM	Lower Equivalent Spherical Diameter for class 12	645
Min_esd_class_13	float	µM	Lower Equivalent Spherical Diameter for class 13	813
Min_esd_class_14	float	µM	Lower Equivalent Spherical Diameter for class 14	1020
Min_esd_class_15	float	µM	Lower Equivalent Spherical Diameter for class 15	1290
Min_esd_class_16	float	µM	Lower Equivalent Spherical Diameter for class 16	1630
Min_esd_class_17	float	µM	Lower Equivalent Spherical Diameter for class 17	2050
Min_esd_class_18	float	µM	Lower Equivalent Spherical Diameter for class 18	2580

ACQconf variable name	**Type**	**Unit**	**Explanation**	**Example**
			frame name	ACQ_CONF
Configuration_name	text		Name used to launch this configuration	ACQ_NKE_0
PT_mode	integer		0: Triggered by vector, 1: Asks for pressure and time, 2: Use UVP6 Acquisition_frequency, 3: CTD mode (mandatory Pressure Sensor)	0
Acquisition_frequency	float	Hz	Acquisition frequency (maximum value)	2
Frames_per_bloc	integer	frame	Nb of frames to accumulate and synthesize to send	1
Pressure_for_auto_start	integer	decibar	When in CTD mode (PT_mode= 3), pressure value to automatically start the acquisition	0
Pressure_difference_for_auto_stop	integer	decibar	When in CTD mode (PT_mode= 3), pressure drop from deepest value to automatically stop the acquisition	0
Result_sending	boolean		0/false: results are never sent - 1/true: synthesized results are sent through RS232 after each bloc	1
Save_synthetic_data_for_delayed_request	boolean		0/false: do not save - 1/true: save synthetic data for a potential delayed request (usefull only for troubleshooting)	0
Save_images	integer		How to save Images -> 0: don't save, 1: save whole raw image, 2: save selected vignettes only	2

Vignetting_lower_limit_size	integer	µM	When saving vignettes (Save_images= 2), minimum object size (ESD) to save vignette, utilizes Aa and Exp, (default : 645)	645
Appendices_ratio	float		When saving vignettes (Save_images= 2), vignette size to actual object size ratio (default : 1.5)	1,5
Interval_for_measuring_background_noise	integer	bloc	Background noise measured every 'interval' (bloc acquired without flashing). Disabled if zero	40
Image_nb_for_smoothing	integer	frame	Nb of images to measure temperature (for safety stop) and average particle abundance for the analog output	10
Analog_output_activation	boolean		Activation of the particle abundance analog output : 0/false: disabled - 1/true	0
Gain_for_analog_out	integer	object	Smoothed number of counted objects for 5 volts analog output voltage	1000
Maximal_internal_temperature	integer	°C	Maximum internal temperature to cause a security stop	60
Operator_email	email		Identification of the operator filling this configuration table	marc.picheral@obs-vlfr.fr
Taxo_conf	text		Taxonomic classification configuration for this acquisition (let it empty to disable embedded recognition)	NO_RE
Remaining_memory	integer	MB	SD card remaining memory at the start of the acquisition	383008

8.2. Version 2021 and older

This section is valid for ver2021 and older.

The 2020 firmware version is the first stable version of the UVP6 firmware and has been widespread with the first functioning unit. It has been simplified and improved to optimized the interaction with autonomous vectors. It has the same missing variables as the ver2022.01 with additional variables: *Time_between_lighting_power_up_and_trigger* and *IP_adress* for the HWconf; *Blocs_per_PT, Limit_lpm_detection_size, Minimum_object_number* and *Taxo_flag* for the ACQconf.

This version does not have any embedded classification option. No taxonomic configurations and frames exist.

HWconf variable name	**Type**	**Unit**	**Explanation**	**Example**
	text		frame name	HW_CONF
Camera_ref	text		UVP6 serial number (XXXXXXXX)	000176LP
Acquisition_mode	integer		0: SUPERVISED mode, 1: AUTONOMOUS mode (including CTD mode), 2: TIME-programmed mode	1

Default_acquisition_configuration	text		Name of the acquisition configuration automatically launched when Acquisition_mode = 1	ACQ_CAL_FULL
Delay_after_power_up_on_time_mode	integer	min	Optional delay before starting image acquisition when Acquisition_mode = 1 (AUTONOMOUS)	0
Light_ref	text		Light unit serial number	000178VE2
Correction_table_activation	boolean		Selection of the lighting correction LUT -> 0: no correction, 1: light unit correction #1, 2: light unit correction #2 (default : 1)	1
Time_between_lighting_power_up_and_trigger	integer	µS	Delay between light unit powering and trigger	150
Time_between_lighting_trigger_and_acquisition	integer	µS	Delay between light unit trigger and image sensor shutter	250
Pressure_sensor_ref	text		Pressure sensor serial number (empty if no sensor installed)	
Pressure_offset	float	M	Vertical distance between the image plan and the pressure measurement point (>0 if pressure sensor above image field, if undefined, set 999)	0,6
Storage_capacity	integer	MB	SD card storage capacity, automatically updated by UVP6 when parameters are modified, do not edit	393857
Minimum_remaining_memory_for_thumbnail_saving	integer	MB	Minimal memory remaining in the SD card to keep saving images or vignettes, do not edit	10000
Baud_Rate	integer		UVP6 RS232 baud rate selection -> 0: 9600 bauds, 1: 19200 bauds, 2: 38400 bauds	2
IP_adress	text		UVP6 IP address for Ethernet communication	193.49.112.100
Black_level	integer	12 bits gray level	Image sensor black level parameter	0
Shutter	integer	µS	Image sensor integration time (shutter)	64
Gain	integer	dB	Image sensor gain, do not edit	6
Threshold	integer	8 bits gray scale	Threshold for image segmentation (pixels <= Threshold are considered background)	20
Aa	integer	μM^2	Calibration parameter (corresponding area in the scene represented by each pixel)	2300
Exp	integer		Calibration parameter (adjusting for specular reflections)	1,136
Pixel_Size	integer	µM	Uncalibrated pixel size (side of the pixel in the image field)	73
Image_volume	float	L	Image volume	0,55

Calibration_date	date	YYYYMMDDHHMM	Calibration date for the values in this table	20220504
Last_parameters_modification	date	YYYYMMDDHHMM	Automatically updated by UVP6 when hardware parameters are modified	2,02206E+11
Operator_email	email		Identification of the operator filling this configuration table	alice.pierret@imev-mer.fr
Min_esd_class_01	float	µM	Lower Equivalent Spherical Diameter for class 01	50,8
Min_esd_class_02	float	µM	Lower Equivalent Spherical Diameter for class 02	64
Min_esd_class_03	float	µM	Lower Equivalent Spherical Diameter for class 03	80,6
Min_esd_class_04	float	µM	Lower Equivalent Spherical Diameter for class 04	102
Min_esd_class_05	float	µM	Lower Equivalent Spherical Diameter for class 05	128
Min_esd_class_06	float	µM	Lower Equivalent Spherical Diameter for class 06	161
Min_esd_class_07	float	µM	Lower Equivalent Spherical Diameter for class 07	203
Min_esd_class_08	float	µM	Lower Equivalent Spherical Diameter for class 08	256
Min_esd_class_09	float	µM	Lower Equivalent Spherical Diameter for class 09	323
Min_esd_class_10	float	µM	Lower Equivalent Spherical Diameter for class 10	406
Min_esd_class_11	float	µM	Lower Equivalent Spherical Diameter for class 11	512
Min_esd_class_12	float	µM	Lower Equivalent Spherical Diameter for class 12	645
Min_esd_class_13	float	µM	Lower Equivalent Spherical Diameter for class 13	813
Min_esd_class_14	float	µM	Lower Equivalent Spherical Diameter for class 14	1020
Min_esd_class_15	float	µM	Lower Equivalent Spherical Diameter for class 15	1290
Min_esd_class_16	float	µM	Lower Equivalent Spherical Diameter for class 16	1630
Min_esd_class_17	float	µM	Lower Equivalent Spherical Diameter for class 17	2050
Min_esd_class_18	float	µM	Lower Equivalent Spherical Diameter for class 18	2580

ACQconf variable name	**Type**	**Unit**	**Explanation**	**Example**
			frame name	ACQ_CONF
Configuration_name	text		Name used to launch this configuration	ACQ_NKE_0
PT_mode	integer		0: Triggered by vector, 1: Asks for pressure and time, 2: Use UVP6 Acquisition_frequency, 3: CTD mode (mandatory Pressure Sensor)	0
Acquisition_frequency	float	Hz	Acquisition frequency (maximum value)	2

Frames_per_bloc	integer	frame	Nb of frames to accumulate and synthesize to send	1
Blocs_per_PT	integer	bloc	Nb of blocs to acquire before a new acquisition or asking for a new pressure information	1
Pressure_for_auto_start	integer	decibar	When in CTD mode (PT_mode= 3), pressure value to automatically start the acquisition	0
Pressure_difference_for_auto_stop	integer	decibar	When in CTD mode (PT_mode= 3), pressure drop from deepest value to automatically stop the acquisition	0
Result_sending	boolean		0/false: results are never sent - 1/true: synthesized results are sent through RS232 after each bloc	1
Save_synthetic_data_for_delayed_request	boolean		0/false: do not save - 1/true: save synthetic data for a potential delayed request (usefull only for troubleshooting)	0
Limit_lpm_detection_size	integer	µM	Minimum size (ESD) to count and analyze objects, utilizes Aa and Exp	10
Save_images	integer		How to save Images -> 0: don't save, 1: save whole raw image, 2: save selected vignettes only	2
Vignetting_lower_limit_size	integer	µM	When saving vignettes (Save_images= 2), minimum object size (ESD) to save vignette, utilizes Aa and Exp, (default : 645)	645
Appendices_ratio	float		When saving vignettes (Save_images= 2), vignette size to actual object size ratio (default : 1.5)	1,5
Interval_for_measuring_background_noise	integer	bloc	Background noise measured every 'interval' (bloc acquired without flashing). Disabled if zero	40
Image_nb_for_smoothing	integer	frame	Nb of images to measure temperature (for safety stop) and average particle abundance for the analog output	10
Analog_output_activation	boolean		Activation of the particle abundance analog output : 0/false: disabled - 1/true	0
Gain_for_analog_out	integer	object	Smoothed number of counted objects for 5 volts analog output voltage	1000
Minimum_object_number	integer	object	Smoothed minimum number of objects to cause a security stop (not implemented)	0
Maximal_internal_temperature	integer	°C	Maximum internal temperature to cause a security stop	60
Operator_email	email		Identification of the operator filling this configuration table	marc.picheral@obs-vlfr.fr
Taxo_flag	boolean		Taxonomic classification flag for this acquisition (not implemented)	0
Remaining_memory	integer	MB	SD card remaining memory at the start of the acquisition	383008