K WAVE FILES IN SVAN 956, SVAN 957, SVAN 959 and SVAN 958 INSTRUMENTS

K.1 Wave recording in SVAN 956, SVAN 957 and SVAN 959 instruments

In order to record wave files in the SVAN 956, SVAN 957 and SVAN 959 instruments, please follow the steps given below:

1. Connect the USB flash drive to the instrument.
2. Go to **SETUP** / **USB-HOST PORT**, choose **WAVE RECORDING** and press the **<ENTER>** push-button. The window **DIRECTORY** will apear on the display with the name of the directory the data will be saved in. You may edit the name of the directory using **<◄>, <►>** push-buttons for selection of field to be changed and **<SHIFT>** and **<▲>**or **<SHIFT>** and **<▼>** to select proper character. The paper sheet icon in the top corner of the display will indicate the connection of the USB flash drive. Press **<ENTER>**.
3. **WAVE PARAMETER** window will appear on the display. Choose **FORMAT** of files (PCM or EXTENSIBLE). Choose **AUDIO SAMPLING** frequency (12, 24 or 48 kHz). The selection of the lower sampling rate enables one to save memory, but the measurement will be more precise in the case of higher sampling frequency. Choose **BITS PER SAMPLE** parameter (16 or 24). In the case of 16 bits per sample selection **SIGNAL GAIN** parameter will appear on the display which enables the signal amplification up to 40 dB. Press **<ENTER>** for confirmation.
4. There is also possibility to trigger wave recording- it is used when the user need to record not all the signal but exemplary only those parts which are overpassing the selected level (e.g. in case of short time high level noise or vibration). In order to specify trigger conditions the user has to enter the **RECORDER TRIGGER** window.(INPUT/ TRIGGER SETUP/ RECORDER TRIGGER) and select trigger mode (SLOPE+, SLOPE-, LEVEL +, LEVEL -, EXT I/O), level of the signal, **REC. TIME** and **PRE TRIGGER**.

   The trigger may be caused by arising or falling slope of the signal (**TRIGGER: SLOPE+, SLOPE-**), by overpassing the level in plus or in minus (**TRIGGER: LEVEL+, LEVEL-**). The wave recording will be triggered according to the level of the signal set in the **LEVEL** position.The triggering is also possible by signal from extended I/O socket of the instrument (**TRIGGER: EXT. I/O**).

   The result taken as a source for triggering purpose is RMS result from the first profile (**SOURCE: RMS (1)**).

   The time of signal recording after its triggering is set in **REC. TIME** position and the instrument will wait for overpassing of signal level till the end of measurement. Each event will trigger record which last time set in **REC. TIME** position (for each event is created a separate file). If next trigger conditions fullfilment will have place before last recording time is over the audio event record will be longer. For example: lets assume the REC.TIME is equal to 10s. After 7 s from first overpassing the next one has place. To the end of the record will be in 3 s, but in case when second overpassing has place the record will take 17 s. In SvanPC+ it will be presented as one 17 s record.

   It is also possible to record the signal directly before triggering of the record (**PRETRIGGER**). Pretrigger is equal to 1 s, 2 s or 4 s (respectively for 48 kHz, 24 kHz and 12 kHz s sampling rate). Pretrigger time is additional to the recording time.
5. Set up all other required parameters of the measurement (like integration period, measurement cycles, etc.).
6. Start the measurement. The wave files will be recorded on the USB flash drive. The measurement results and logger results will be saved in the internal memory of the instrument. During the measurement the paper sheet icon will be flashing.

K.2 Wave recording in SVAN 958 instrument

In order to record wave files in the SVAN 958 instrument please follow given steps:

1. Connect the USB flash drive to the instrument.
2. Go to **FUNCTION** / **MEASUREMENT FUNCTION** and choose **WAVE RECORDER**. Press the **<ENTER>** push-button for confirmation of made selection.
3. The **USB DIRECTORY** window will appear on the display. Select the directory the files will be saved or select **CREATE NEW** option in **ACTION** position and create new directory for wave recording purpose. Press **<ENTER>** for confirmation.
4. Go to **SETUP** / **WAVE PARAMETERS** and choose channels from which the wave files will be recorded. The sampling rate is equal to 48 kHz. The number of recorded bits per sample is equal to 24. It is possible to reduce number of recorded bits per sample to 16. It enables to save memory but the measurement will not be as precise as in the case of 24 bits per sample. In the case of 16 bits per sample selection choose also the value of **SIGNAL GAIN** - the too high value of this parameter may cause saturation (clipping) of the recorded signal. Press **<ENTER>** for confirmation
5. It is also possible to trigger wave recording- it is used when the user need to record not all the signal but exemplary only those parts which are overpassing the selected level (e.g. in case of short time high level noise or vibration). In order to specify trigger conditions the user has to enter the **INPUT** / **TRIGGER SETUP**/ **WAVE TRIGGER** window and enable wave triggering option by ticking **ENABLED**, set **REC. TIME** (recording time) and (in order to save samples directly before fulfilment of triggering conditions.) tick **PRETRIGGER** position.

   In order to specify detailed triggering conditions the user has to enter the **TRIGGER EVENTS SETUP (MENU/INPUT/ TRIGGER SETUP/ TRIGGER EVENTS SETUP)**, select respectively channels and set trigger conditions for each channel the wave recording is to be performed in **TRIGGER EVENT 1** and **TRIGGER EVENT 2** windows (it is possible to set two conditions for triggering purpose e.g. 95 dB and 100 dB).

   The trigger may be caused by overpassing the level in plus or in minus (**TRIGGER**: **LEVEL+**, **LEVEL-**), by arising or falling slope of the signal (**TRIGGER**: **SLOPE+**, **SLOPE-**) or by increasing or falling down gradient of the signal (**TRIGGER**: **GRAD-**, **GRAD+**). The wave recording will be triggered according to the level of the signal set in the **LEVEL** position. The result taken as a source for triggering purpose may be **PEAK**, **MAX**, **MIN** or **RMS** result from selected profile in case of sound measurements. In case of vibration measurements it may be **PEAK**, **P-P**, **MAX**, **MIN**, **RMS**, **VDV** result from the first profile.

   The user has to specify also integration time of the result from which the recording will be started. It is made in **INTEGR.** position.

   Next the user has to open **ACTION SETUP** window and tick WAVE position. In the **WAVE EVENTS** window (INPUT/ TRIGGER SETUP / WAVE RECORDING/ SELECT SOURCES) will appear sources selected in **TRIGGER EVENT** window and it is possible to switch on/off set those sources (conditions) witout going through **TRIGGER EVENTS SETUP** menu.
7. Set up all other required parameters of the measurement (like integration period, measurement cycles, etc.)
8. Start the measurement. The paper sheet icon will be flashing. The wave files will be recorded on the USB flash drive. The measurement results and logger results will be saved in the internal memory of the instrument.

K.3 Wave files description

Wave file's structure: the wave file consists of the header in PCM or in EXTENSIBLE format, block with samples and the marker of the end of the block.

Field		Length (bytes)	Contents
WaveHeader		44 - PCM, 80 - EXTENSIBLE	Standard header of the wave file which describes basic parameters of the data contained in a file like: signal sampling frequency, width of sample word, number of channels, number of samples
WaveData	SamplesInfo		Signal Samples
	Samples		
WaveEnd			End block

K.4 WaveHeader

The header may be saved in PCM format or may content a little more information while saved in EXTENSIBLE format.

Some programs do not restore wave files saved with PCM header, in which the signal samples are stored in 24 bits word. In such a case the file should be saved using the EXTENSIBLE format.

Independently from header type, the recorded time-domain signal has the same format.

K.5 PCM

Field	Length (bytes)	Contents
ChunkID	4	"RIFF"
ChunkSize	4	WaveHeader size + WaveData size
WaveID	4	"WAVE"
FormatID	4	"fmt "
ChunkSize	4	16 - size of chunk
FormatTag	2	1 - PCM format
Channels	2	Number of channels
SamplesPerSec	4	Number of samples per second
BytesPerSec	4	Number of bytes per second
BlockAlign	2	Samples block size
BitsPerSample	2	Bits per sample (16 or 24)
DataID	4	"data"
ChunkSize	4	WaveData size

K.6 EXTENSIBLE

Field	Length (bytes)	Contents
ChunkID	4	"RIFF"
ChunkSize	4	WaveHeader size + WaveData size
WaveID	4	"WAVE"
FormatID	4	"fmt "
ChunkSize	4	40 - size of chunk
FormatTag	2	0xFFFE - EXTENSIBLE format
Channels	2	Number of channels
SamplesPerSec	4	Number of samples per second
BytesPerSec	4	Number of bytes per second
BlockAlign	2	Samples block size
BitsPerSample	2	Bits per sample (16 or 24)
ExtensionSize	2	22 - size of extension
ValidBitsPerSample	2	Valid bits per sample (16 or 24)
ChannelMask	4	0
GUIsubFormat	16	0x00 ,0x00, 0x00, 0x00, 0x10, 0x00, 0x80, 0x00, 0x00, 0xAA, 0x00, 0x38, 0x9B, 0x71
ChunkID	4	"fact"
ChunkSize	4	4 - size of chunk
SampleLength	4	Total number of samples
DataID	4	"data"
ChunkSize	4	WaveData size

K.7 WaveData

The block contents audio signal samples. In order to avoid the loss of signal quality, the samples are not scaled during their recording in the instrument. However, in order to be able to refer the counted parameters to the physical quantities, in the place of the first four samples the additional information about the measured signal has been inscribed. In this documentation those samples are called as SamplesInfo block.

K.8 SamplesInfo

The additional information, which is needed for obtaining the physical quantities on the base of time-domain signal, is saved in the SamplesInfo block. The block is inscribed in the place of the first 4 samples of time-domain signal. Information in this block is recorded in the binary form and should be treated as the integer numbers. Independently from the word-width dedicated for time-signal record (16 bits or 24 bits), in the place of one sample one information is recorded.

Sample:	Contents
1	Channel number in which the recording was executed
2	Unit flag, meaning of the bits (it is possible that only one bit is set up): 0 - µPa, nominal reference level, equal to 20 µPa 1 - µm/s^2, nominal reference level, equal to 1 µm/s^2 2 - nm/s, nominal reference level, equal to 1 nm/s 3 - pm, nominal reference level, equal to 1 pm
3	Range value expressed in 0.01 dB
4	Reference level value, expressed in 0.01 dB, related to reference level described in a flag field

The range value is the interval in which the signal may change to be recorded in a file. It is the greatest or the lowest reachable value of the signal.

K.9 Example 1 - Header interpretation and computation of range value

Signal measured in one channel, 24 bits per sample.

Parameters of the signal				Samples		
Sample(1)	Sample(2)	Sample(3)	Sample(4)	Sample(5)	Sample(6)	Sample(7)
0x000001	0x000001	0x00396F	0x000000	0x003456	0x123456	0x012233

Sample(1): 0x000001, recording was executed in the 1st channel of the instrument
Sample(2): 0x000001, zero bit is set up, so the sound signal for which the nominal reference level is equal to 20 µPa was recorded
Sample(3): 0x00396F, equal to decimal 14703, so range value is equal to 147.03 dB related to reference level
Sample(4): 0x000000, the reference level is equal to 0 dB, so it must be equal to 20 µPa

Re-count of range value into linear value:
R - range value expressed in physical units
P - reference level expressed in physical units, which is equal to $20 * 10^{-6}$ Pa
RdB - range value in dB, which is equal to 147.03 dB
$R = P * 10^{(Rdb/20)} = 20 * 10^{-6}$ Pa $* 10^{(147.03/20)} = 449.29$ Pa

Exemplary calculation of physical value for a sample based on the range value:

Sample(5): 0x003456 = 0.001597 => 0.001597 * 449.29 Pa = 0.7176 Pa
Sample(6): 0x123456 = 0.001597 => 0.1422 * 449.29 Pa = 63.899 Pa

K.10 Example 2 - Interpretation of the header in multi-channel file

Signal measured in two channels, 16 bits per sample.

Parameters of the signal								Samples		
Sample (1)	Sample (2)	Sample (3)	Sample (4)	Sample (5)	Sample (6)	Sample (7)	Sample (8)	Sample (9)	Sample (10)	Sample (11)
0x0001	0x0003	0x0001	0x0002	0x396F	0x4911	0x0000	0x0576	0x3456	0x1234	0x0122

- Samples from the 1st channel are marked with orange colour
- Samples from the 2nd channel are marked with yellow colour

Sample(1): 0x0001, record of the file from the 1st channel was executed in the 1st channel of the instrument
Sample(2): 0x0003, record of the file from the 2nd channel was executed in the 3rd channel of the instrument
Sample(3): 0x0001, zero bit is set up, so sound signal for which the nominal reference value is equal to 20 µPa, was recorded
Sample(4): 0x0002, the first bit is set up, so the signal comes from the acceleration transducer, for which the nominal value of the reference level is equal to 1m/s^2
Sample(5): 0x396F, equal to decimal 14703, the range value is equal to 147.03 dB related to reference level
Sample(6): 0x4911, equal to decimal 18705, the range value is equal to 187.05 dB related to reference level
Sample(7): 0x0000, the reference level is equal to 0 dB, so it must be equal to 20 µPa
Sample(8): 0x0576, equal to decimal 1398, the reference level is equal to 13.98 dB related to 1 µm/s^2.

In this example, the range value for the signal in the 2nd channel may be counted in two ways, because given level is relative:

The first way:

1. Firstly, we count physical reference level
   P - reference level expressed in physical units
   PdB - reference level in dB, which is equal to 13.98 dB
   Pn - nominal reference level equal to 1 µm/s^2
   $P = Pn * 10^{(Pdb/20)} = 1\ \mu m/s^2 * 10^{(13.98/20)} = 5\ \mu m/s^2$

2. We count the range value
   R - range value expressed in physical values
   P - reference level expressed in physical units, which is equal to 5 µm/s^2
   Rdb - range value in dB, which is equal to 187.05 dB
   $R = P * 10^{(Rdb/20)} = 5\ \mu m/s^2 * 10^{(187.05/20)} = 11259\ m/s^2$

The second way:

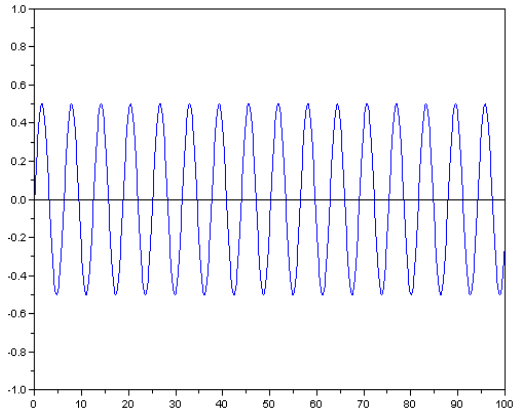
1. At first, we add reference level expressed in dB to range value expressed in dB related to 1 µm/s^2
   Pdb = 187.05 dB + 13.98 dB = 201.03 dB

2. We count the range value
   R - range value expressed in physical values
   P - reference level expressed in physical units, which is equal to 1 µm/s^2
   Rdb - range value in dB, which is equal to 201.03 dB
   $R = P * 10^{(Rdb/20)} = 1\ \mu m/s^2 * 10^{(201.03/20)} = 11259\ m/s^2$

Sample(9): the 1st sample from the 1st channel
Sample(10): the 1st sample from the 2nd channel
Sample(11): the 2nd sample from the 1st channel

K.11 Example 3 - range value in calculations

The range value and the reference level recorded in the file are expressed in dB. Thanks to that in very easy way, after counting the required parameters on the base of the signal samples from the wave file, it is possible to present them in dB, assuming generally accepted reference levels like 20 µPa for sound or 1 µm/s^2 for vibrations.



Let's assume that the range value read from the file is equal to 134.32 dB, and the reference level related to 20 µPa is equal to 11.2 dB. For example, let's take under consideration a signal with the amplitude equal to 0.5 as on the picture.

RMS of such signal is equal to 0.35. RMS, expressed in dB is equal to 20*log(0.5) = -0.602 dB. In order to obtain RMS value (in dB) related to the reference value of 20 µPa it is sufficient to add to the calculated value the range value in dB and the reference level value (also in dB).

RMS = -0.602 dB + 134.32 dB + 11.2 dB = 139.5 dB

K.12 Samples

The samples represent the time-domain signal. They are recorded as 16-bit or 24-bit numbers, depending on the settings of the instrument.

K.13 WaveEnd

The header contains the same data as block SamplesInfo, but those data are inscribed into the text block. Additionally, the block contains type and the serial number of the instrument the recording was done and the date and time of the recording.

The information field was defined according to the RIFF format, slightly modified because of the lack of the proper fields in it. For that reason some fields have other meanings than it was defined in standard.

Field	Length (bytes)	Contents
LIST_ID	4	"LIST"
LIST_Size	4	Size of data from block "LIST"
INFO_ID	4	"INFO"
INAM_ID	4	"INAM"
INAM_Size	4	Size of data from block "INAM"
INAMtext	INAM_Size	Type of the instrument and its serial number
ICRD_ID	4	"ICRD"
ICRD_Size	4	Size of data from block "ICRD"
ICRDtext	ICRD_Size	Date of the beginning of the recording
ICMT_ID	4	"ICMT"
ICMT_Size	4	Size of data from block "ICMT"
ICMTtext	ICMT_Size	Recorded signal parameters for each channel and time of the beginning of the recording

Exemplary header in the hexadecimal format and in the text format is presented in the table below.

Hexadecimal	Text
4C 49 53 54 58 00 00 00 49 4E 46 4F 49 4E 41 4D 11 00 00 00 53 56 41 4E 20 39 35 39 20 53 4E 3A 34 30 30 30 00 49 43 52 44 0B 00 00 00 32 30 30 38 2D 31 32 2D 30 31 00 49 43 4D 54 16 00 00 00 43 68 2E 31 3A 20 31 34 37 2E 30 33 64 42 2C 20 32 30 75 50 61 00 20 30 30 3A 31 39 3A 31 32 00	LIST INFOINAM SVAN 959 SN: 4000 ICRD 200 8-12-01 ICMT Ch.1: 147.03dB, 20uPa 00:19:12

The recording was executed with the use of SVAN 959 instrument with the serial number equal to 4000. The recording was started on the 1st of December 2008 at 00:19:12 o'clock. The signal from the 1st channel was recorded. The full range of the samples is equivalent to 147.03 dB referenced to the level of 20 µPa.