Appendix 6

NDAS Converter

User Manual

Version 02

NDAS converter setup

Run the furnished 'converter setup.exe' file. The installation procedure is standard. After that you can execute converter by opening start menu and finding 'NDAS converter' in it.

General description

The application is designed to convert SIVY files to a number of common formats. These formats include seismic formats (SEGY, MINISEED, SAC), binary and spreadsheet format ('txt' flag). In binary format the data is stored in file as successive float32 values.

The NDAS converter can process single file or multiple files placed in one directory. In the latter case, every time a new station or time gap is encountered, new output files will be generated (so each output file presents uninterrupted data chunk from a single channel of one station).

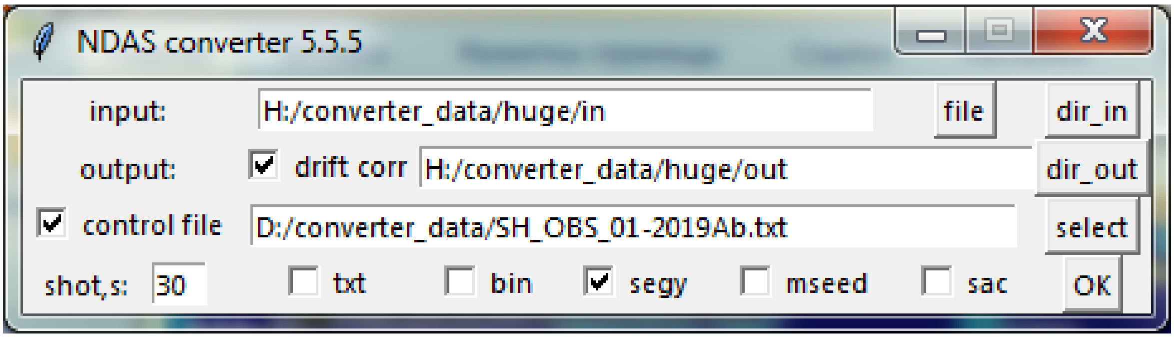

Figure 1. Selecting of the output format

The converter can function in control file mode, in which case it extracts data only from the gaps specified in control file. This mode is mainly used with SEGY format and is mostly used in reflection seismology experiment in which shots take place. Then the times of shots (with some forestalling) are specified in control file.

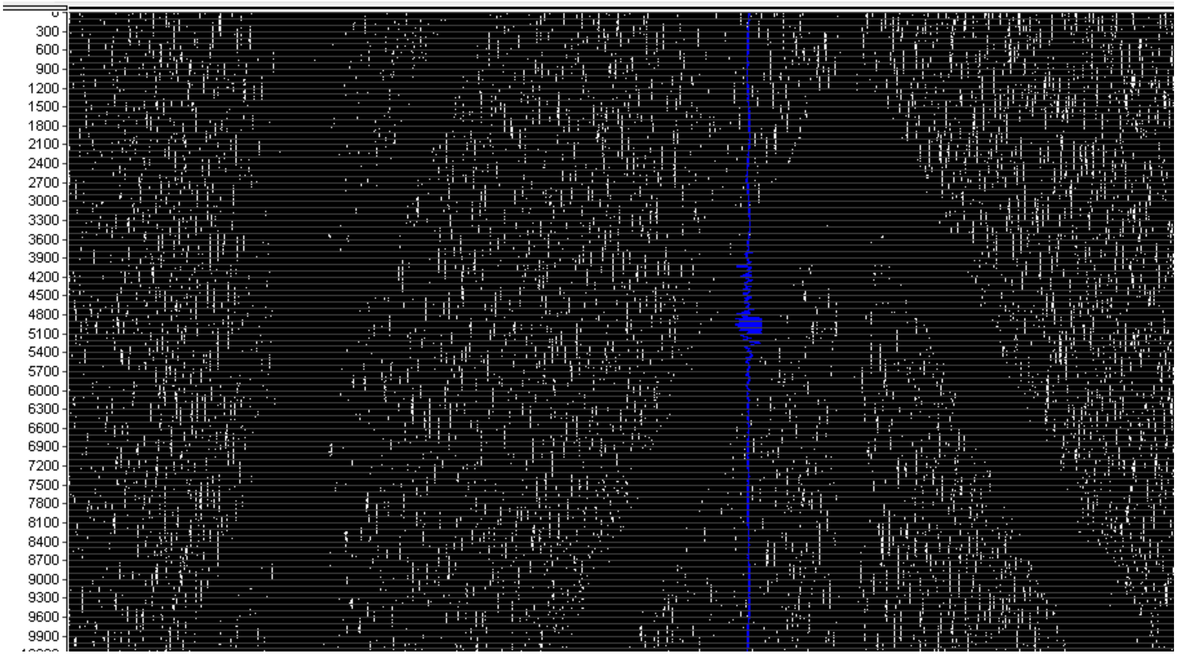

Figure 2. Seismic profile obtained after processing with control file

Also make note, that converter uses disk space in a considerable way. So at least three times of the original data size free space is required.

If you check 'bin' flag, besides *.bin files the spreadsheet CSV file will be generated. The spreadsheet file contains the following additional data for each one-minute frame.

Table 1. Spreadsheet (csv) file columns

Column	Value	Description
Sample time	ns *	Recording start time of a minute block according to the data logger's clock
GPS time	ns *	Time of the latest drift measurement on the GPS clock
Drift	ns *	The drift of the clock measured in the GPS time point is given as a difference between a true time on GPS and a time on the data logger's clock: d = tGPS – tLocal
Acc (Z, X, Y)	mg	Indications of the three-axis accelerometer (available not in all models of devices!)
Comp (Z, X, Y)	mG	Indications of the three-axis magnetometer (available not in all models of devices!)
Press_reg	Pa	Indications of the pressure sensor (available not in all models of devices!)
Power_reg	V	Value of main supply voltage (Valid only when the device powered via main power source; if powered via USB, the voltage measurements read zero)
Temper_reg	°C	The data logger's temperature
h	m	Height above the sea level – according to the GPS receiver
lat	°	Width – in degrees
lon	°	Longitude – in degrees
Sample rate	1/s	Sampling rate of a signal
Sample time	s	Recording start time of a minute block on the data logger's clock given in a format which is clear to a user

Control file mode

The control file mode is turned on with the corresponding flag. The control file should be selected.

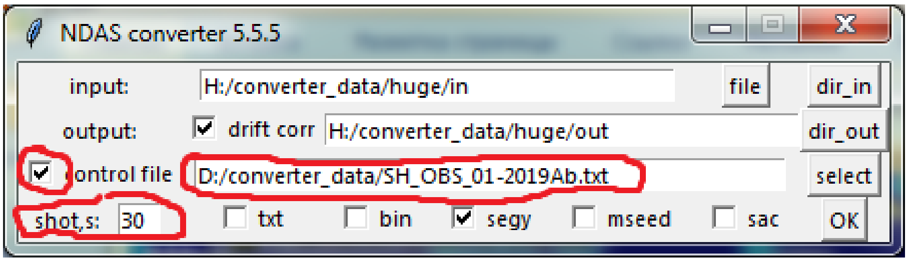

Figure 3. Turning on control file mode

The control file format is as follows.

101 00:07:44.555 30/7/2017 0.000000 0.000000 0.000000

102 00:08:45.724 30/7/2017 0.000000 0.000000 0.000000

The columns are: shot number, time, date in dd/mm/yyyy format, longitude and latitude in degrees, height in meters.

The length of each extracted chunk is set in seconds by 'shot' field (see Figure 3. Turning on control file mode). SEGY trace can contain up to 32 000 points. If you need longer traces, SEGY traces will be divided, so MINISEED is recommended, since MINISEED supports longer traces. For example, if your measurements were taken at 1kHz and you set shot length 40s, you will have two 20s traces for each shot if you will still be using SEGY.

Other formats -- bin, sac and txt – do not suit well for using with control file. However, you can still generate them. Then you will get a number of files, since the portion of data for each shot will be stored in a separate file.

R-sensors LLC
8A Zhukovskogo street, Dolgoprudny, Moscow region, 141700, Russia
Tel.: (498) 744-69-95

Drift correction and interpolation

When GPS is present the internal time and sample rate of the device are corrected regularly. However, during some experiment, GPS may be absent for a long amount of time and reoccur only at the end of the experiment. So the factual time and sample rate will differ from the supposed ones considerably. You can restore the set sample rate and interpolate values with the converter if you have measurements before GPS gone and after GPS reappears. The combined process of frequency restoring and interpolation is called 'drift correction'. To perform it you should set flag 'drift corr'.

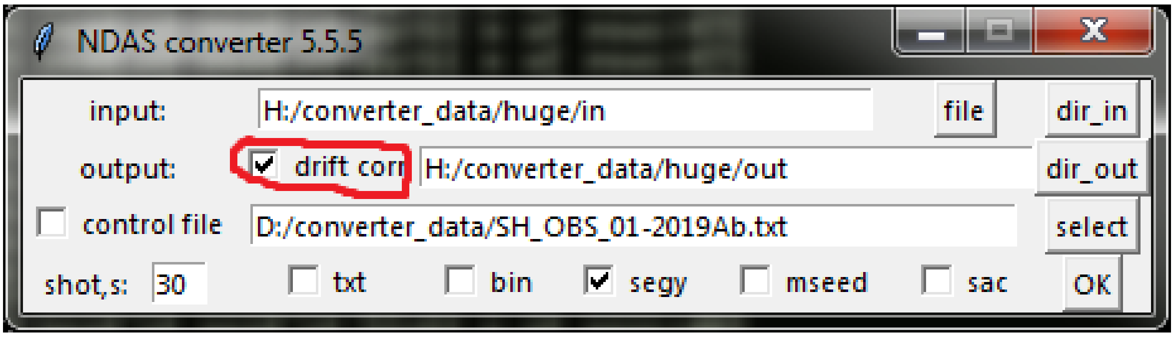

Figure 4. Drift correction

Besides the values and time in the output files, you can see the result of drift correction in a convenient form if you check the 'bin' flag. Then, apart from bin files, the spreadsheet (CSV) file will be generated. In the last two columns – 'line' and 'temper' – you can see drifts calculated with different algorithms – line drift and temperature drift (see

Figure 5. Line drift and temperature drift,

U	V	W
starttime	line	temper
2018-10-30T12:31:50.000000Z	20120	-470
2018-10-30T12:32:50.000000Z	20317	-335
2018-10-30T12:33:50.000000Z	20495	-219
2018-10-30T12:34:50.000000Z	20529	-242
2018-10-30T12:35:50.000000Z	20585	-243
2018-10-30T12:36:50.000000Z	20867	-14
2018-10-30T12:37:50.000000Z	20915	-16
2018-10-30T12:38:50.000000Z	20925	-54

Figure 5. Line drift and temperature drift

Below are the details of drift calculation and interpolation.

As it was noted, two kinds of drifts are calculated: linear and temperature dependent. The temperature drift is experimental at the moment and used only in subsidiary CSV file. Drift calculation and interpolation is executed in any considerable gap (>~3min) where the GPS is present only on the margins. Linear drift is considered to spread uniformly through the gap. For example, if the GPS was absent during 200 minutes and in the end of the gap accumulated drift equals 2 000 ns, then each minute frame will be changed so that its start time will have a minute and 10 ns offset relatively to the previous frame start time. After changing start times of the frames, each frame will have individual sample rate. That sample rates will be slightly different from one frame to another. To correct this, the interpolation to the preset sample rate is performed. During the interpolation the 'lanczos' method is used.

Temperature drift

Temperature drift is calculated based on the assumption that the sample rate instability is conditioned by the temperature offsets. So sample rate offset at a given moment is proportional to the temperature offset. Let's denote u the coefficient for the sample rate change. So if at a given moment the temperature offset is dt1 and the original sample rate is n, then the sample rate at the moment n1 is as follows.

n1 = n + u * dt1

Now let's suppose that n1 is the sample rate of the first frame, n2 – that of the second frame, and nN – that of the last frame, tm – cumulative time of the experiment. Then we can derive the following.

tm=60 * ((n+u*dt1)/n + (n+u*dt2)/n + (n+u*dt3)/n +…+(n+u*dtN)/n)

tm=60*n*N + 60*u/n * (dt1 + dt2 + … dtN)

From the last expression we can see that the drift is proportional to the sum of temperature offsets.

drift ~ dt1 + dt2 + … dtN

Make note that the temperature offsets are offsets from the start temperature t0 and not between adjacent frames.

dt1 = t1 – t0

dt2 = t2 – t0

…

dtN = tN – t0

So the temperature drift is calculating as follows. Sum of temperature offsets is taken and the coefficient of proportionality is deduced. Then the sum of offsets of each frame is taken and with the calculated coefficient the current drift is calculated

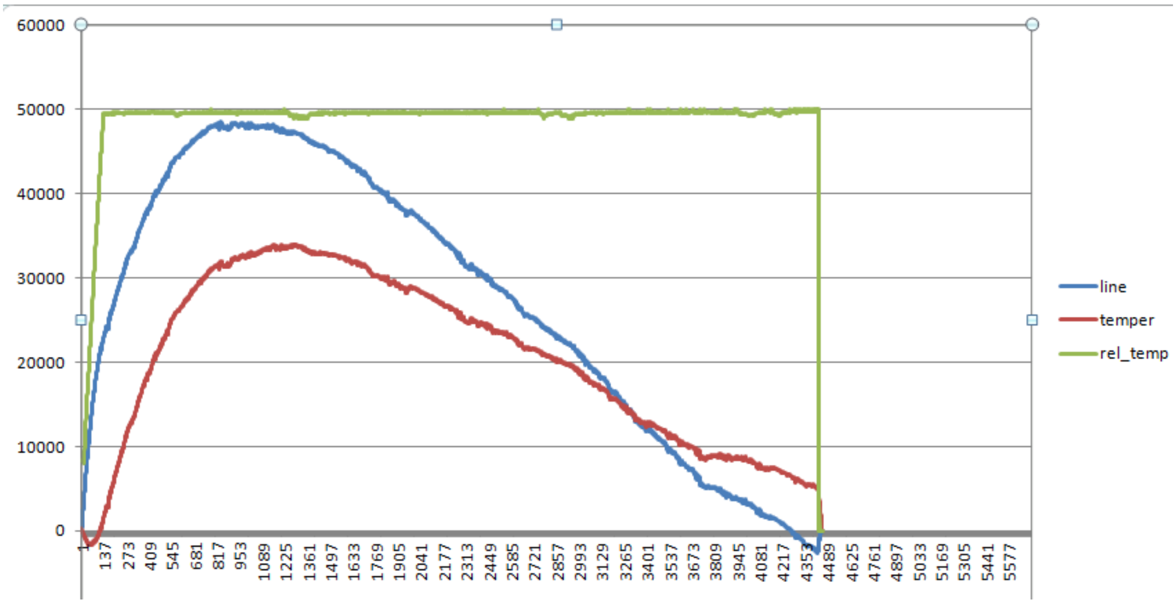

Figure 6. Differences between real drift, line drift and temperature drift

You can see the comparison between line drift (blue) and the temperature drift (red) on the picture. The temperature offset is rendered by the green graph and is presented in conventional relative units.

The difference between line drift and temperature drift is not considered substantial, while calculating temperature drift is more complicated. So the temperature drift is experimental and is not used in the output signal files (only in CSV file).

Notes

Output file names consist of the device serial name, time of the first sample and channel name with underscore '_' delimiters. Channel names are ch1, ch2, ch3, ch4, … for binary files. And BHZ, BHN, BHE, ch4, … for other file formats. The time is in format YYMMDD_HHmmSS.

So, for example, if you have a device with serial 0210311101, and the start time is 2018-10-30 10:49.50, then the bin files may be:

0210311101_181030_104950_ch1.bin

…

0210311101_181030_104950_ch4.bin

And SEGY files will be:

0210311101_181030_104950_ BHZ.segy

0210311101_181030_104950_ BHN.segy

0210311101_181030_104950_ BHE.segy

0210311101_181030_104950_ ch4.segy

Device name, contained in SIVY header is used in MINISEED header. However, since device name is 10 symbols length, while MINISEED field can have only 5 symbols, only 5 last symbols of device name length are placed in MINISEED header.