ERT System

Polares32

Overview of proprietary formats

GPD file format

The GPD format (Geophysics Pasi Data) is the proprietary format used by the PASI Polares32 system for the storage and export of electrode geometric data and measured electrical data related to a measurement session and saved to file. The characteristics of the protocol are described below with the objective of enabling the reading of measurement session result files produced by Polares32 and their processing with third-party analysis systems.

The GPD format is the only proprietary output format of the files produced by the Polares32 instrument for which Pasi undertakes to provide a formal definition. Therefore, any instrument or software intending to provide analysis functions for data produced by Polares32 must operate on files generated in GPD format.

During normal operation of the Polares32 instrument, the results obtained from measurements are stored in proprietary binary files with extension BPD (Binary Pasi Data), for which no documentation is provided. To obtain a GPD format file suitable for export to third-party analysis systems, the following procedure must be followed:

- From the main page, press the “Measurement Session” button and open the BPD file to be exported;
- Press the “Save Session” button;
- Navigate to the directory where the output file is to be saved, enter the desired output file name, select the GPD format from the drop-down menu, and press the “Ok” button.

The GPD format is described below in its Version 2.

NOTE: It is recommended not to manually modify GPD files using a text editor, as this may render the file unreadable and therefore unusable.

General structure

The GPD format is an ASCII text file composed of lines terminated by a line feed character (Line Feed, hexadecimal 0A). Each line consists of strings separated by horizontal tab characters (Horizontal Tab, hexadecimal 09).

Information is provided in the format:

- “Parameter Name” – “Parameter Value”,

or, in the case of tabular information, in the format:

- “Row containing the parameter names for each column” – “Rows containing the parameter values for each table element”.

The file can therefore be viewed using a standard text editor and is readable by a human operator.

The GPD file consists of five sections:

- A start-of-file line containing the string “*** Do not manually edit the GPD file ***”;
- A header containing information related to the entire measurement session;
- An “Electrodes” table containing the identifier and position of the electrodes used to perform the session measurements;
- A “Measurements” table containing the information related to each individual measurement scheduled during the session, including references to the identifiers of the involved electrodes, the measured electrical parameters (if the measurement was executed), and additional information related to the measurement;
- An end-of-file line containing the string “*** End of GPD file ***”.

The separation between parameter name and parameter value is performed using the Tab character. The separation between lines is performed using the line termination character.

The three main parts of the file are described in detail below.

File header

The file header has the following structure:

- **“Format”** followed by the string **“Geophysics_PASI_Data_Format_GPD”**.
- **“GPD_version”** followed by a number, indicating the version of the GPD format used to write the file. This document describes version 2 of the format.
- **“Creation_date”** followed by the file creation date in the format “yyyy-mm-dd”.

- **“Last_modification_date”** followed by the date of last modification of the file in the format “yyyy-mm-dd”.
- **“Type”**, indicating which type of electrical measurement is contained in the tabular part of the file. It can be set to **“Automatic”** or **“Manual”**.
- **“Method”** identifies the method with which the table was initially built with regard to electrode positions. It is set at the moment the table is created and is not modified if subsequent manual changes are made by the operator to electrode positions. It is followed by one of the following strings depending on the value of the *Type* field.

For **Type = “Automatic”** it may be:

  - “TOM - Wenner Alfa”;
  - “TOM - Wenner Beta”;
  - “TOM - Wenner Gamma”;
  - “TOM - Wenner-Schlumberger”;
  - “TOM - Dipole-Dipole”;
  - “TOM - Pole-Dipole”;
  - “TOM - Pole-Pole”;
  - “TOM - From Custom File”;
  - “Self Potential Only”.

For **Type = “Manual”** it may be:

  - “VES – Wenner”;
  - “VES – Schlumberger Fixed”;
  - “AMNB Generic”.

- **“Electrodes_sequence”** identifies the order of the electrodes placed on the ground as a consequence of the selected measurement method. The string may assume the following values:

  - “ABMN”;
  - “AMNB”;
  - “AMBN”;

    - “AMN”;
    - “AM”;
    - “MN”.
- **“Standard_electrodes_position”** followed by the string “Standard” or “Not Standard”, indicates whether the operator has maintained the electrode positions according to the standard algorithm selected during measurement configuration, or whether modifications were made.
- **“Measures_number”** followed by a string containing the number of measurements planned and reported in the measurements table.
- **“Measures_done”** followed by a string containing the number of measurements performed and whose results are stored in the measurements table.
- **“Measurements_unit”** followed by the string “[m]”.
- **“Latitude_O”** followed by the decimal degrees of latitude of the origin point of the session. North latitude degrees are reported as positive numbers; south latitude degrees as negative numbers. If not populated, the value must be “TBD”.
- **“Longitude_O”** followed by the decimal degrees of longitude of the origin point of the session. East longitude degrees are reported as positive numbers; west longitude degrees as negative numbers. If not populated, the value must be “TBD”.
- **“Altitude_O [m]”** followed by the altitude in meters of the origin point of the session. If not populated, the value must be “TBD”.
- **“Azimut_X”** followed by the angular value expressed in decimal degrees measured between the North direction and the direction of the reference X-axis for the electrode positions reported in the subsequent measurements table. If not populated, the value must be “TBD”.
- **“Electrodes_distance [m]”**: automatic measurements only. Distance between two adjacent electrodes in a tomography session. If not applicable, the parameter is set to “NA”.
- **“Levels_number”**: automatic measurements only. Maximum number of levels to be performed in a tomography session. If not applicable, the parameter is set to “NA”.
- **“n value”**: automatic measurements only. Maximum value of parameter *n* to be applied in a tomography session. If not applicable, the parameter is set to “NA”.
- **“Electrodes_number”**: number of electrodes involved in the execution of a tomography session. If not applicable, the parameter is set to “NA”.

- **“Topological_Information”**: automatic measurements only. Indicates the choice made by the operator for electrode positioning on the ground. It may be:
    - “Linear X”;
    - “Linear Y”;
    - “Linear Z”;
    - “Custom”;
    - “From template/operator”.
- **“Measures_per_decade”**: manual measurements only. Number of measurements to be performed within an electrode spacing interval corresponding to a factor of 10 in meters, used to calculate electrode positions.
- **“Note”**: followed by a free-text notes field (must not contain line feed or horizontal tab characters) of 255 characters. If absent, it is set to “TBD”.
- **“Spare_x”**: values reserved for future use, set to “NA”.
- **“Max_voltage”**: automatic measurements only. Maximum voltage value during execution of the measurements (not used).
- **“Infinite_electrode”**: automatic measurements only. Reference to the electrode(s) placed at infinity in pole-dipole or pole-pole measurements. It may be:
    - "First electrode/s";
    - "Last electrode/s";
    - "Before mpx".
- **“Sigma_max”**: maximum Sigma value (standard deviation) expressed as a percentage, calculated over the repetitions of the single measurement, below which the average of the measurements is considered reliable.
- **“Frequency”**: frequency, in Hertz, at which the measurements were performed. It may assume the following values: 10, 5, 3, 2.
- **“Max_retry”**: maximum number of repetitions for the single measurement. If the maximum Sigma percentage value is reached, repetitions are stopped. It may assume values from 3 to 10.
- **“Max_phase”**: maximum phase value. It may assume the following values: 45, 20, 5.

- **“Multiple_acquisition”**: automatic measurements only. Indicates whether the session includes multiple acquisitions, i.e., the possibility of repeating the same measurements at regular intervals. It may assume the values “true” or “false”.
- **“Multiple_interval”**: automatic measurements only. If *Multiple_acquisition* is set to true, indicates the repetition interval value in seconds. It may assume an integer value.
- **“Multiple_number”**: automatic measurements only. If *Multiple_acquisition* is set to true, indicates the number of multiple repetitions to be performed. It may assume an integer value.

Below is an example of a GPD file header for an automatic measurement:

```
*** Do not manually edit the GPD file ***
Format  Geophysics_PASI_Data_Format_GPD
GPD_version  2
Creation_date     2020-02-15 18:53
Last_modification_date2020-02-15 18:53
Type    Automatic
Method  TOM - Wenner Alfa
Electrodes_sequence    AMNB
Standard_electrodes_position     Standard
Measures_number   55
Measures_done     0
Measurements_unit [m]
Longitude_O  TBD
Latitude_O   TBD
Altitude_O   TBD
Azimut_X     TBD
Electrodes_distance [m]     5.0
Levels_number     2
n  2
```

```
Electrodes_number 32
Topological_Information    From template/operator
Note    TBD
Spare_1 NA
Spare_2 NA
Max_voltage 100
Infinite_electrode    First electrode/s
Sigma_max    5
Frequency    10
Max_retry    10
Max_phase    20
Multiple_acquisition   false
Multiple_interval 120
Multiple_number   10
```

Below is an example of a GPD file header for a manual measurement:

```
*** Do not manually edit the GPD file ***
Format  Geophysics_PASI_Data_Format_GPD
GPD_version  2
Creation_date    2025-03-23 16:43
Last_modification_date 2025-03-23 16:52
Type    Manual
Method  AMNB Generic
Electrodes_sequence    AMNB
Standard_electrodes_position    Standard
Measures_number   25
Measures_done    0
```

```
Measurements_unit [m]
Latitude_O   TBD
Longitude_O  TBD
Altitude_O   TBD
Azimut_X     TBD
Measures_per_decade    10
Electrodes_number 4
Note    TBD
Spare_1 NA
Spare_2 NA
Spare_3 NA
Spare_4 NA
Spare_5 NA
Sigma_max    5
Frequency    10
Max_retry    10
Max_phase    20
```

Electrodes table

The electrode table is present within the GPD file only in the case of automatic measurements. It has the following structure:

- A title line containing the string: **“Logical - Physical electrodes mapping”**.
- A line indicating, for each column of the table, which data is reported. It contains the string: **“Logical_id Mux_id Electrodes_id X_position Y_position Z_position”**.

Below are the values of the table header and the formats for each corresponding field:

- **“Logical_id”**: logical identifier of the electrode. It will be used as a value within the measurements table, in the columns “A”, “B”, “M” and “N”, to indicate which logical electrode performs each role in the given measurement. It assumes an integer value starting from 1.

- **“Mux_id”**: identifier of the physical multiplexer (mpx) associated with the logical electrode. It assumes an integer value starting from 1.
- **“Electrodes_id”**: identifier of the physical electrode associated with the logical electrode. It assumes an integer value.
- **“X_position”**: value of the X component, expressed in meters, of the position of the logical electrode within a relative Cartesian coordinate system. It assumes a positive or negative decimal numeric value.
- **“Y_position”**: value of the Y component, expressed in meters, of the position of the logical electrode within a relative Cartesian coordinate system. It assumes a positive or negative decimal numeric value.
- **“Z_position”**: value of the Z component, expressed in meters, of the position of the logical electrode within a relative Cartesian coordinate system. It assumes a positive or negative decimal numeric value.

Below is an example of the file portion containing the electrode table for 8 electrodes:

```
Logical - Physical electrodes mapping

Logical_id   Mux_id    Electrodes_id  X_position     Y_position
   Z_position

1  1    1    0.00 0.00 0.00

2  1    2    5.00 0.00 0.00

3  1    3    10.00     0.00 0.00

4  1    4    15.00     0.00 0.00

5  1    5    20.00     0.00 0.00

6  1    6    25.00     0.00 0.00

7  1    7    30.00     0.00 0.00

8  1    8    35.00     0.00 0.00
```

Automatic measurements table

The measurements table, in the case of automatic measurements, has the following structure:

- **“Measures_list”**: indicates the beginning of the measurements table.
- A header line indicating, for each column of the table, which data is reported and with which unit of measurement. It contains the string:

“# A B M N R[Ohm] Rho[Ohm/m] Sigma[%] dVmn[V] Iab[A] SP[V] IP[ms] K Time Latitude Longitude Altitude Frequency”.

- A sequence of lines (equal in number to the value reported in the parameter “Measures_number”) containing string values, one line for each measurement to be performed or already performed. These lines report measurement-related data and measured values. Undefined values, either because absent or because the measurement was not executed, are filled with the string “-”.

Below are the header values and the formats for each corresponding field:

- **“#”**: progressive integer identifying the row and therefore the measurement.
- **“A”, “B”, “M”, “N”**: logical identifiers of the four electrodes that, in the given measurement, assume each role. The identifier “0” is used to indicate that no electrode is associated with that role. Values are integer strings.
- **“R[Ohm]”**: measured resistance value. Reported as a positive decimal number.
- **“Rho[Ohm/m]”**: resistivity value calculated from the resistance measurement and the geometric constant K. Reported as a positive decimal number.
- **“Sigma[%]”**: root mean square deviation calculated over the repetitions of the measurement, expressed as a percentage of the measured value itself. Reported as a positive integer written as “xxx” or “xxx*”. Measurements accepted despite having a Sigma value higher than that set by the operator are marked with an asterisk “*”.
- **“dVmn[V]”**: potential difference measured between electrodes M and N. Reported as a positive or negative decimal number.
- **“Iab[A]”**: electric current intensity measured between electrodes A and B. Reported as a positive or negative decimal number.
- **“SP[V]”**: spontaneous potential measured between electrodes A and B. Reported as a positive or negative decimal number.
- **“IP[ms]”**: measured induced polarization value. Reported as a positive decimal number.
- **“K”**: geometric constant calculated based on electrode positions. Reported as a positive decimal number.
- **“Time”**: date and time of measurement execution. Reported in the format “yyyy-mm-dd hh:mm”.
- **“Longitude”**: string of decimal degrees of longitude of the measurement point. East longitude degrees are positive, west longitude degrees are negative.

- **“Latitude”**: string of decimal degrees of latitude of the measurement point. North latitude degrees are positive, south latitude degrees are negative.
- **“Altitude”**: altitude of the measurement point expressed in meters.
- **“Frequency”**: frequency value used for the execution of the individual measurement.

Below is an example of the file portion containing the electrode table for 8 electrodes, no measurements results are present jet:

```
Measures list

#  A    B    M    N    R[Ohm]    Rho[Ohm/m]     Sigma[%]  dVmn[V]
   Iab[A]    SP[V]     IP[ms]    K    Time Longitude Latitude
   Altitude  Frequency

1  1    4    2    3    -    -    -    -    -    -    -    31.430
                -    -    -    -

2  2    5    3    4    -    -    -    -    -    -    -    31.430
                -    -    -    -

3  3    6    4    5    -    -    -    -    -    -    -    31.430
                -    -    -    -

4  4    7    5    6    -    -    -    -    -    -    -    31.430
                -    -    -    -

5  5    8    6    7    -    -    -    -    -    -    -    31.430
                -    -    -    -

6  6    9    7    8    -    -    -    -    -    -    -    31.430
                -    -    -    -

7  7    10   8    9    -    -    -    -    -    -    -    31.430
                -    -    -    -

8  8    11   9    10   -    -    -    -    -    -    -    31.430
                -    -    -    -
```

Below is an example of the file portion containing the electrode table for 8 electrodes, measurements results are present:

```
Measures list 8

#     A    B    M    N    R[Ohm]    Rho[Ohm/m]     Sigma[%]  dVmn[V]
      Iab[A]    SP[V]     IP[ms]    K    Time Longitude Latitude
      Altitude  Frequency
```

```
1    1    2    3    4    2.9  82.06          2.115     733.4     -
0.141     0.56 28.29     2020-12-22 09:37    0.0  0.0  0.00 31.20
2    2    3    4    5    2.6  73.25          1.595     620.0
     0.057     0.58 28.29     2020-12-22 09:37    0.0  0.0  0.00
     31.20
3    3    4    5    6    1.8  51.44          1.169     647.1     -
0.019     0.61 28.29     2020-12-22 09:37    0.0  0.0  0.00 31.20
4    4    5    6    7    4.4  124.86         2.735     623.9
     0.078     0.60 28.29     2020-12-22 09:18    0.0  0.0  0.00
     31.20
5    5    6    7    8    4.2  117.79         2.754     665.9
     0.157     0.59 28.29     2020-12-22 09:18    0.0  0.0  0.00
     31.20
6    6    7    8    9    2.0  56.24          1.218     617.2
     0.005     0.61 28.29     2020-12-22 09:18    0.0  0.0  0.00
     31.20
7    7    8    9    10   5.3  150.05         3.170     602.8
     0.015     0.66 28.29     2020-12-22 09:18    0.0  0.0  0.00
     31.20
8    8    9    10   11   6.8  191.57         4.401     654.8
     0.069     0.63 28.29     2020-12-22 09:18    0.0  0.0  0.00
     31.20
```

Manual measurements table

The measurements table in the case of manual measurements has the following structure:

- **“Measures_list”**: indicates the beginning of the measurements table.
- A header line indicating, for each column of the table, which data is reported and with which unit of measurement. It contains the string: “# AM_dist [m] MN_dist [m] NB_dist [m] OO1_dist [m]AM_heigth [m] MN_heigth [m] NB_heigth [m] OO1_heigth [m] R[Ohm] Rho[Ohm/m] Sigma[%] dVmn[V] Iab[A] SP[V] IP[ms] K Time Latitude Longitude Altitude Frequency”.
- A sequence of lines (equal in number to the value reported in the parameter “Measures_number”) containing string values, one line for each measurement to be performed or performed. Undefined values are filled with the string “-”.

Below are the header values and the formats for each corresponding field:

- **“#”**: progressive integer identifying the row and therefore the measurement.

- **“AM_dist [m]”, “MN_dist [m]”, “NB_dist [m]”**: distances in meters between electrodes A–M, M–N, and N–B respectively. Values are signed decimal numeric strings.
- **“OO1_dist [m]”**: distance in meters between the origin of the measurement series and the origin of the single measurement. Used to retain information for measurements where electrodes are not symmetrically positioned with respect to a measurement center. Values are signed decimal numeric strings.
- **“AM_heigth [m]”, “MN_heigth [m]”, “NB_heigth [m]”**: differences in height of positioning of the respective electrodes. Values are signed decimal numeric strings.
- **“OO1_height [m]”**: difference in height between the origin of the measurement series and the origin of the single measurement. Values are signed decimal numeric strings.
- **“R[Ohm]”**: measured resistance value. Reported as a positive decimal number.
- **“Rho[Ohm/m]”**: resistivity value calculated from resistance and geometric constant K. Reported as a positive decimal number.
- **“Sigma[%]”**: root mean square deviation calculated over the repetitions of the measurement, expressed as a percentage. Reported as “xxx” or “xxx*”.
- **“dVmn[V]”**: potential difference between electrodes M and N. Positive or negative decimal number.
- **“Iab[A]”**: current intensity between electrodes A and B. Positive or negative decimal number.
- **“SP[V]”**: spontaneous potential between electrodes A and B. Positive or negative decimal number.
- **“IP[ms]”**: induced polarization value. Positive decimal number.
- **“K”**: geometric constant. Positive decimal number.
- **“Time”**: date and time in format “yyyy-mm-dd hh:mm”.
- **“Longitude”**: decimal degrees of longitude (east positive, west negative).
- **“Latitude”**: decimal degrees of latitude (north positive, south negative).
- **“Altitude”**: altitude in meters.
- **“Frequency”**: frequency used for the individual measurement.

Below is an example of the file portion for 8 electrodes, no measurements results are present jet:

Measures list

#	AM_dist [m]	MN_dist [m]	NB_dist [m]	OO1_dist [m]								
	AM_heigth [m]	MN_heigth [m]	NB_heigth [m]	OO1_heigth [m]								
	R[Ohm]	Rho[Ohm/m]	Sigma[%]	dVmn[V]	Iab[A]	SP[V]						
	IP[ms]	K	Time	Latitude	Longitude	Altitude	Frequency					
1	0.67	0.67	0.67	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	4.21	-	0.0	0.0	0.00	0.000
2	0.84	0.84	0.84	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	5.28	-	0.0	0.0	0.00	0.000
3	1.06	1.06	1.06	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	6.66	-	0.0	0.0	0.00	0.000
4	1.33	1.33	1.33	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	8.36	-	0.0	0.0	0.00	0.000
5	1.67	1.67	1.67	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	10.50	-	0.0	0.0	0.00	
	0.000											
6	2.11	2.11	2.11	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	13.26	-	0.0	0.0	0.00	
	0.000											
7	2.65	2.65	2.65	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	16.66	-	0.0	0.0	0.00	
	0.000											
8	3.34	3.34	3.34	0.00	0.00	0.00	0.00	0.00	0.000		0.00	-
	0.000		0.0	0.000		0.00	20.99	-	0.0	0.0	0.00	
	0.000											

PASI data file format (PAS)

The PASI Data PAS format is a proprietary format developed by Pasi that allows exporting data from a manual measurement session in text format.

It consists of:

- A header
- A measurement table

Parameter names and values are separated by a Tab character, while lines are separated by a line termination character.

The header contains the following information:

- **“Format DAT PASI”**: start-of-file string.
- **“Last modification date:”**: date of last file modification in format YYYY-MM-DD hh:mm.
- **“Method:”**: manual measurement method, which can be one of the following:
  - “VES – Wenner”
  - “VES – Schlumberger Fixed”
  - “AMNB Generic”
- **“Electrodes sequence:”**: electrode sequence used during measurement; always “AMNB”.
- **“Measures number:”**: total number of measurements planned for the session (sum of completed and pending measurements).

The following example shows a PAS file containing 20 planned measurements, of which the first 15 were completed:

```
   Format DAT PASI
Last modification date:  2025-03-25 18:59
Method:   VES - Wenner
Electrodes sequence:     AMNB
Measures number:    20

Index      AM [m]    MN [m]    NB [m]    OO' [m]    V [V]      I [mA]
1    0.67 0.67 0.67 0.00 5.275     349.8
2    0.84 0.84 0.84 0.00 5.496     364.4
```

3	1.06	1.06	1.06	0.00	5.331	353.2
4	1.33	1.33	1.33	0.00	5.393	357.1
5	1.67	1.67	1.67	0.00	5.568	369.3
6	2.11	2.11	2.11	0.00	5.618	372.6
7	2.65	2.65	2.65	0.00	5.717	379.3
8	3.34	3.34	3.34	0.00	5.824	386.6
9	4.21	4.21	4.21	0.00	5.733	382.0
10	5.30	5.30	5.30	0.00	5.894	392.9
11	6.67	6.67	6.67	0.00	5.955	397.1
12	8.39	8.39	8.39	0.00	5.924	395.0
13	10.57	10.57	10.57	0.00	5.950	396.8
14	13.30	13.30	13.30	0.00	5.941	396.2
15	16.75	16.75	16.75	0.00	5.786	385.6
16	21.08	21.08	21.08	0.00	0.000	0.0
17	26.54	26.54	26.54	0.00	0.000	0.0
18	33.41	33.41	33.41	0.00	0.000	0.0
19	42.06	42.06	42.06	0.00	0.000	0.0
20	52.96	52.96	52.96	0.00	0.000	0.0