Polarimetric Data Standard Format

Description:

This help file describes the different and specific PolSARpro v2.0 compatible raw binary data formats.
PolSARpro v2.0 can process polarimetric or partially polarimetric data sets under many different formats. A polarimetric data set is composed of **Binary files** characterized by a **Configuration Text File** and located in a given **Data Directory.**

Configuration Text File:

A Configuration text file, indicating the considered image dimensions and polarimetric type is required by PolSARpro. Configuration files are automatically created by the different data processing applications proposed in PolSARpro and by any conversion from sensor specific format data.
PolSARpro offers the possibility to directly process polarimetric data binary files. In this case, users have to provide a configuration text file named config.txt and formatted as follows:

Nrow
Image number of rows

Ncol
Image number of columns

PolarCase
monostatic or bistatic or intensities

PolarType
full or pp1 or pp2 or pp3 or pp4 or pp5 or pp6 or pp7

Note: PolSARpro is Case Sensitive.

Binary Data Files:

In order to be correctly interpreted by PolSARpro, binary data files have to be built according to a compatible format.

- A Nrow by Ncol image is read by PolSARpro on a row by row basis, i.e. Ncol pixels are read in a single thread and are then assigned to one of the rows of a Nrow by Ncol matrix as shown in the following illustration.

$$\overbrace{\begin{matrix} \\ Nrow \end{matrix}}^{Ncol} \left\{ \begin{bmatrix} P_{1,1} & \dots & P_{1,j} & \dots & P_{1,Ncol} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ P_{i,1} & \dots & P_{i,j} & \dots & P_{i,Ncol} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ P_{Nrow,1} & \dots & P_{Nrow,j} & \dots & P_{Nrow,Ncol} \end{bmatrix} \right.$$

- Binary data associated to real (not complex) variables are coded under the form of 4-bytes (i.e. 32 bits) float numbers. A Nrow by Ncol image of a real variable (e.g T11) contains Nrow*Ncol*4 bytes, i.e. Nrow*Ncol*32 bits.
- Binary data associated to complex variables are coded under the form of interlaced float numbers representing real and imaginary parts.
  A Nrow by Ncol image of a complex variable (e.g S11) contains Nrow*Ncol*2*4 bytes, i.e. Nrow*Ncol*2*32 bits.

$$\begin{matrix} \{ \; T_{i,1}, & \dots, & T_{i,j}, & \dots, & T_{i,Ncol} \; \} \\ \{ \; \Re(S_{i,1}), \Im(S_{i,1}), \dots, \Re(S_{i,j}), \Im(S_{i,j}), \dots, \Re(S_{i,Ncol}), \Im(S_{i,Ncol}) \; \} \end{matrix}$$

Schematic description of row of Ncol real (T11) and complex (S11) values

(2x2) complex Sinclair [S2] data format:

A (2x2) complex Sinclair **[S2]** matrix is a coherent polarimetric representation relating incident and scattered Jones vectors. In a general case, it is composed of four complex elements and becomes symmetric in monostatic configurations.

$$[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$$

The (2x2) complex Sinclair **[S2]** raw binary data files have to be located in a Main Directory (MD) and described by a text configuration file.

Contents of Main Directory (MD)

- MD / .
- MD / ..
- MD / config.txt
- MD / s11.bin
- MD / s12.bin
- MD / s21.bin
- MD / s22.bin

Important Note: PolSARpro requires distinct s12.bin and s21.bin data files, even in monostatic configurations. Some polarimetric data sets only present a single cross-polarization channel, e.g. s12.bin. Users have then to create a second cross-polarization channel, e.g. copy s12.bin to s21.bin.

Config.txt file
If the (2x2) complex Sinclair **[S2]** matrix is symmetric: PolarCase = monostatic
If the (2x2) complex Sinclair **[S2]** matrix is not symmetric: PolarCase = bistatic
PolarType = full

(3x3) complex Coherency [T3] data format:

A (3x3) Coherency **[T3]** matrix is an incoherent polarimetric representation relating to second order statistics of scattering matrix elements. This matrix is hermitian semi-definite positive.

$$[T_3] = \begin{bmatrix} T_{11} & T_{12} & T_{13} \\ T_{12}^* & T_{22} & T_{23} \\ T_{13}^* & T_{23}^* & T_{33} \end{bmatrix}$$

The (3x3) Coherency **[T3]** matrix is constructed from a three-element unitary target vector, obtained from the projection of a Sinclair matrix onto a reduced and modified Pauli spin matrix set. An outter product leads the to the definition of the corresponding (3x3) Coherency matrix **[T3]** relating to second order statistics.

$$\underline{k}_{3P} = \frac{1}{\sqrt{2}} \begin{bmatrix} S_{11} + S_{22} & S_{11} - S_{22} & S_{12} + S_{21} \end{bmatrix}$$

$$\Longrightarrow \qquad [T_3] = \langle \underline{k}_{3P} . \underline{k}_{3P}^{\dagger} \rangle$$

Where < > denotes an eventual incoherent averaging operation.

The (3x3) Coherency **[T3]** raw binary data files have to be located in a Main Directory / T3 (MD / T3) and described by a text configuration file.

Contents of Main Directory (MD / T3)

- MD / T3 / .
- MD / T3 / ..
- MD / T3 / config.txt
- MD / T3 / T11.bin
- MD / T3 / T12_real.bin
- MD / T3 / T12_imag.bin
- MD / T3 / T13_real.bin
- MD / T3 / T13_imag.bin
- MD / T3 / T22.bin
- MD / T3 / T23_real.bin
- MD / T3 / T23_imag.bin
- MD / T3 / T33.bin

Note: Txy_real.bin and Txy_imag.bin denote respectively real and imaginary parts of a coherency matrix complex element..

Config.txt file

PolarCase = monostatic
PolarType = full

(4x4) complex Coherency [T4] data format:

A (4x4) Coherency **[T4]** matrix is an incoherent polarimetric representation relating to second order statistics of scattering matrix elements. This matrix is hermitian semi-definite positive.

$$[T_4] = \begin{bmatrix} T_{11} & T_{12} & T_{13} & T_{14} \\ T_{12}^* & T_{22} & T_{23} & T_{24} \\ T_{13}^* & T_{23}^* & T_{33} & T_{34} \\ T_{14}^* & T_{24}^* & T_{34}^* & T_{44} \end{bmatrix}$$

The (4x4) Coherency **[T4]** matrix is constructed from a four-element unitary target vector, obtained from the projection of a Sinclair matrix onto a reduced and modified Pauli spin matrix set. An outter product leads the to the definition of the corresponding (4x4) Coherency matrix **[T4]** relating to second order statistics.

$$\underline{k}_{4P} = \frac{1}{\sqrt{2}} \left[\begin{array}{cccc} S_{11} + S_{22} & S_{11} - S_{22} & S_{12} + S_{21} & j(S_{12} - S_{21}) \end{array} \right]$$

$$\Longrightarrow \quad [T_4] = \langle \underline{k}_{4P} . \underline{k}_{4P}^{\dagger} \rangle$$

Where < > denotes an eventual incoherent averaging operation.

The (4x4) Coherency **[T4]** raw binary data files have to be located in a Main Directory / T4 (MD / T4) and described by a text configuration file.

Contents of Main Directory (MD / T4)

- MD / T4 / .
- MD / T4 / ..
- MD / T4 / config.txt
- MD / T4 / T11.bin
- MD / T4 / T12_real.bin
- MD / T4 / T12_imag.bin
- MD / T4 / T13_real.bin
- MD / T4 / T13_imag.bin
- MD / T4 / T14_real.bin
- MD / T4 / T14_imag.bin
- MD / T4 / T22.bin
- MD / T4 / T23_real.bin
- MD / T4 / T23_imag.bin
- MD / T4 / T24_real.bin
- MD / T4 / T24_imag.bin
- MD / T4 / T33.bin

- MD / T4 / T34_real.bin
- MD / T4 / T34_imag.bin
- MD / T4 / T44.bin

Note: Txy_real.bin and Txy_imag.bin denote respectively real and imaginary parts of a coherency matrix complex element..

Config.txt file
PolarCase = bistatic
PolarType = full

(3x3) complex Covariance[C3] data format:

A (3x3) Covariance **[C3]** matrix is an incoherent polarimetric representation relating to second order statistics of scattering matrix elements. This matrix is hermitian semi-definite positive.

$$[C_3] = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{12}^* & C_{22} & C_{23} \\ C_{13}^* & C_{23}^* & C_{33} \end{bmatrix}$$

The (3x3) Covariance **[C3]** matrix is constructed from a three-element unitary target vector, obtained from the projection of a Sinclair matrix onto a reduced and modified Pauli spin matrix set. An outter product leads the to the definition of the corresponding (3x3) Covariance matrix **[C3]** relating to second order statistics.

$$\underline{k}_{3L} = \begin{bmatrix} S_{11} & S_{12}.\sqrt{2} & S_{22} \end{bmatrix}$$
$$\Longrightarrow \quad [C_3] = \langle \underline{k}_{3L}.\underline{k}_{3L}^{\dagger} \rangle$$

Where < > denotes an eventual incoherent averaging operation.

The (3x3) Covariance **[C3]** raw binary data files have to be located in a Main Directory / C3 (MD / C3) and described by a text configuration file.

Contents of Main Directory (MD / C3)

- MD / C3 / .
- MD / C3 / ..
- MD / C3 / config.txt
- MD / C3 / C11.bin
- MD / C3 / C12_real.bin
- MD / C3 / C12_imag.bin
- MD / C3 / C13_real.bin
- MD / C3 / C13_imag.bin
- MD / C3 / C22.bin
- MD / C3 / C23_real.bin
- MD / C3 / C23_imag.bin
- MD / C3 / C33.bin

Note: Cxy_real.bin and Cxy_imag.bin denote respectively real and imaginary parts of a Covariance matrix complex element..

Config.txt file
PolarCase = monostatic
PolarType = full

(4x4) complex Covariance [C4] data format:

A (4x4) Covariance **[C4]** matrix is an incoherent polarimetric representation relating to second order statistics of scattering matrix elements. This matrix is hermitian semi-definite positive.

$$[C_4] = \begin{bmatrix} C_{11} & C_{12} & C_{13} & C_{14} \\ C_{12}^* & C_{22} & C_{23} & C_{24} \\ C_{13}^* & C_{23}^* & C_{33} & C_{34} \\ C_{14}^* & C_{24}^* & C_{34}^* & C_{44} \end{bmatrix}$$

The (4x4) Covariance **[C4]** matrix is constructed from a four-element unitary target vector, obtained from the projection of a Sinclair matrix onto a reduced and modified Pauli spin matrix set. An outter product leads the to the definition of the corresponding (4x4) Covariance matrix **[C4]** relating to second order statistics.

$$\underline{k}_{4L} = \begin{bmatrix} S_{11} & S_{12} & S_{21} & S_{22} \end{bmatrix}$$
$$\Longrightarrow \qquad [C_4] = \langle \underline{k}_{4L} . \underline{k}_{4L}^{\dagger} \rangle$$

Where < > denotes an eventual incoherent averaging operation.

The (4x4) Covariance **[C4]** raw binary data files have to be located in a Main Directory / C4 (MD / C4) and described by a text configuration file.

Contents of Main Directory (MD / C4)

- MD / C4 / .
- MD / C4 / ..
- MD / C4 / config.txt
- MD / C4 / C11.bin
- MD / C4 / C12_real.bin
- MD / C4 / C12_imag.bin
- MD / C4 / C13_real.bin
- MD / C4 / C13_imag.bin
- MD / C4 / C14_real.bin
- MD / C4 / C14_imag.bin
- MD / C4 / C22.bin
- MD / C4 / C23_real.bin
- MD / C4 / C23_imag.bin

- MD / C4 / C24_real.bin
- MD / C4 / C24_imag.bin
- MD / C4 / C33.bin
- MD / C4 / C34_real.bin
- MD / C4 / C34_imag.bin
- MD / C4 / C44.bin

Note: Cxy_real.bin and Cxy_imag.bin denote respectively real and imaginary parts of a Covariance matrix complex element..

Config.txt file
PolarCase = bistatic
PolarType = full

Partial Polarimetric Coherent (Sxx, Sxy) data format:

A Partial Polarimetry **ppX** representation (with X equal to 1,2 or 3) consists of two coherent polarimetric channels acquired in a reduced polarimetry configuration.

ppX binary data files have to be located in a directory located at the same level than a MD directory and described by a text configuration file.

Contents of **pp1** Main Directory (MD)
- MD / .
- MD / ..
- MD / config.txt
- MD / s11.bin
- MD / s21.bin

Contents of **pp2**Main Directory (MD)
- MD / .
- MD / ..
- MD / config.txt
- MD / s12.bin
- MD / s22.bin

Contents of **pp3** Main Directory (MD)
- MD / .
- MD / ..
- MD / config.txt
- MD / s11.bin
- MD / s22.bin

Config.txt file
PolarCase = monostatic
According to the two coherent polarimetric channels combination:
PolarType = pp1 or pp2 or pp3

(2x2) complex Covariance[C2] data format:

A (2x2) Covariance **[C2]** matrix is an incoherent polarimetric representation relating to second order statistics of partial polarimetric scattering matrix elements. This matrix is hermitian semi-definite positive.

$$[C_2] = \begin{bmatrix} C_{11} & C_{12} \\ C_{12}^* & C_{22} \end{bmatrix}$$

The (2x2) Covariance **[C2]** matrix is constructed from a two-element unitary target vector. An outter product leads the to the definition of the corresponding (2x2) Covariance matrix **[C2]** relating to second order statistics.

$$\underline{k}_{PX} = \begin{bmatrix} S_{11} & S_{22} \end{bmatrix}$$
$$\Longrightarrow \quad [C_2] = \langle \underline{k}_{PX} . \underline{k}_{PX}^{\dagger} \rangle$$

Where < > denotes an eventual incoherent averaging operation.

The (2x2) Covariance **[C2]** raw binary data files have to be located in a Main Directory / C2 (MD / C2) and described by a text configuration file.

Contents of Main Directory (MD / C2)

- MD / C2 / .
- MD / C2 / ..
- MD / C2 / config.txt
- MD / C2 / C11.bin
- MD / C2 / C12_real.bin
- MD / C2 / C12_imag.bin
- MD / C2 / C22.bin

Note: C12_real.bin and C12_imag.bin denote respectively real and imaginary parts of a Covariance matrix complex element..

Config.txt file
PolarCase = monostatic
According to the two coherent polarimetric channels combination:
PolarType = pp1 or pp2 or pp3

Partial Polarimetric Incoherent (Ixx, Ixy) data format:

A Partial Polarimetry **ppX** representation (with X equal to 4, 5, 6 or 7) consists of two or three incoherent polarimetric channels (intensities) acquired in a reduced polarimetry configuration.

ppX binary data files have to be located in a directory located at the same level than a MD directory and described by a text configuration file.

Contents of **pp4** Main Directory (MD)

- MD / .
- MD / ..
- MD / config.txt
- MD / I11.bin
- MD / I12.bin
- MD / I22.bin

Contents of **pp5** Main Directory (MD)

- MD / .
- MD / ..
- MD / config.txt
- MD / I11.bin
- MD / I21.bin

Contents of **pp6**Main Directory (MD)

- MD / .
- MD / ..
- MD / config.txt
- MD / I12.bin
- MD / I22.bin

Contents of **pp7** Main Directory (MD)

- MD / .
- MD / ..
- MD / config.txt
- MD / I11.bin
- MD / I22.bin

Config.txt file

PolarCase = intensities

According to the two or three incoherent polarimetric channels combination:

PolarType = pp4 or pp5 or pp6 or pp7