# 1 What is Presto ?

# 2 Overview

# 3 Functions description

## 3.1 CompensateDelayAndFreqShift

**Signature** [So]=CompensateDelayAndFreqShift(S,zeros,plotflag)
**Return-Values**
*So*: S enriched with informations about completion and compensation. The frequency data of So are compensated
**Entries**
*S*: The mesured data to be compensated, contained in the fields *freq* and *value* of the S-strucutre S.
*zeros=DVC.CDAFS.zeros_at_inf*: Number of zeros at infty for $S_{1,2}$ and $S_{2,1}$. This information is used during the computation of a completion for those elements.
*plotflag=DVC.CDAFS.plot_flag*: If plotflag is diff of 0 the result is ploted
**Constants**
*DVC.CDAFS.sign_in_zero_trans_12*: The constant frequency shift applied to $S_{1,2}$ and $S_{2,1}$ is defined up to $\pi$. This constant fixes the sign of the imaginary part of $S_{1,2}$ at the zero frequency (at the measurment point nearest to zeros). Poss. values {-1,1}. **Important**: the identified coupling matrices corresponding to those nomalizations can be deduced from one an other by a change of sign of certain couplings.
*DVC.CDAFS.delay_range*: Range of possible delay compensation to be considered.
*DVC.CDAFS.poly_order*: Degree of the $1/s$ polynomial used to compute completion.
*DVC.CDAFS.omega_lim*: For $|w| > w_{lim}$ the $1/s$ polynomial defining the completion, should fit the data as good as possible. In other words the users believes that for $|w| > w_{lim}$ a $1/s$ expansion of degree DVC.CDAFS.poly_order is a good approximation of the frequency behaviour of the filter. **Important**: the number of selected data points should be enough so that a meaningfull approximation can

be computed, i.e $card(|w_k| > w_{lim}) >> poly\_order$.

*DVC.CDAFS.error_lim*: If the error between the data (with best compensation) and the $1/s$ expansion (on the data points with $|w| > w\_lim$) is greater than error_lim a warning message is released.

*DVC.CDAFS.causal_bound(1,1)*: Bound for the distance to causal systems for the completion of $S_{1,1}$. This bound is expressed in percent.

*DVC.CDAFS.causal_bound(2,2)*: Same as prev. but for $S_{2,2}$.

*DVC.CDAFS.modulus_factor(1,1)*: The modulus of the completion is controled so as to be less than: $modulus\_factor * max_w(|S_{1,1}|)$.

*DVC.CDAFS.modulus_factor(2,2)*: Same as prev. but for $S_{2,2}$.

*DVC.CDAFS.number_of_control_points*: Number of (equaly spaced on the sub-arc of the unit circle where the completion is defined) control points used to control the modulus of the completion. This number should be choosen in regards of DVC.CDAFS.poly_order (good results seems to be obtained with $number\_of\_control\_points \geq 5 * .poly\_order$).

*DVC.CDAFS.number_of_fourier_coeffs*: Number of Fourier coeffs. used to estimate non-causal part of completed data.

*DVC.CDAFS.iso_flag*: Indicates which kind of isometry is used when passing to the disk to evaluate the non-causal part of completed data. Possibilities are $L^\infty$ or $L^2$ isometry which are obtained resp. for the values {0,1} of the flag.

**Description**

The function proceeds roughly in three steps: first the delay components of $S_{1,1}$ and $S_{2,2}$ are estimated and compensated, then completions are determined for all entries and finally constant frequency shifts are applied so as to ensure $Imag(S_{1,1}) = Imag(S_{2,2}) = 0$. A frequency shifts on the diagonal terms is also estimated by using the hypothesis that in the ideal case the system is lossless.

**Delay determination:** For $S_{1,1}$ and $S_{2,2}$ the delay component is estimated in the following way. Let $K = \{k, |w_k| > w_{lim}$ the selected measurement points. Given $\tau \in [delay\_range]$ we define

$$\psi(\tau) = \min_{(a_0,a_1\ldots)\in\mathbb{C}^{poly\_order+1}} \sum_{k\in K} |S_{1,1}(w_k)e^{i\tau w_k} - \sum_{l=0}^{poly\_order} \frac{a_l}{(w_k)^l}|^2.$$

The 'optimal' delay compensation $\tau_{opt}$ is defined by,

$$\psi(\tau_{opt}) = \min_{\tau\in[delay\_range]} \psi(\tau)$$

**Completions:** We recall that $I_2$ and $I_\infty$ are respectively the $L^2$ and $L^\infty$ isometries definied as in **??**. Let $p$ be a polynomial defining a possible completion of the measured data we denote by $S_{i,j} \vee p$ the extended function defined on the whole imaginary axes (note that between two measurement points, $S_{i,j}$ is defined by spline interpolation, so that it can be considered as a function on the interval $[\min(w_i), \max(w_i)]$). The constrained optimisation problem we adress to determine a completion of our data (for $iso\_flag = 0$) is the following:

$$! \min_{p \in \mathbb{C}^{poly\_order}[x]} \sum_{k \in K} |S_{i,j}(w_k) - p(\frac{1}{w_k})|^2$$

under the following constraints

$$||P_{H_0^2}(I_\infty(S_{i,j}) \vee p)||_2 \leq ||I_\infty(S_{i,j})||_2 . causal\_bound(i,j)$$
$$\forall w \in [control\_points] \quad |p(\frac{1}{w_c})| \leq modulus\_factor(i,j). \max_k(|S_{i,j}(w_k)|)$$

If there is no element $p$ satisfying those constraints then the following relaxed problem is solved,

$$! \min_{p \in \mathbb{C}^{poly\_order}[x]} ||P_{H_0^2}(I_\infty(S_{i,j}) \vee p)||_2^2$$

under the following constraint

$$\forall w \in [control\_points] \quad |p(\frac{1}{w_c})| \leq modulus\_factor(i,j). \max_k(|S_{i,j}(w_k)|)$$

for which $p = 0$ is a feasable point. For $iso\_flag = 1$ the $L^2$ isometry is used instead (the value at infinity is substracted, so as to ensure that $S_{i,j} \vee p - p_0$ is $L^2$ integrable).

## 3.2 PlotS

**Signature** PlotS(S, g_t, l_f)
**Return-Values** none
**Entries**

*S*: The S structure to be ploted

*g_t=DVC.PS.graphic_type_flag*: indicates if a Nyquist or a Bode plot is expected. Possible value are {b,n}

*l_f=DVC.PS.legend_flag*: indicates if a legend should appear for each curve (data, compl., rat. app.). Possible values are {0,1}

**Constants** none

**Description**

The PlotS function plots a Nyquist or Bode diagram of a given S-structure. Depending of what fields are present in S, data, completion and rational approximation are plotted

## 3.3 CompFourierCoeffs

**Signature** [So]=CompFourierCoeffs(Si)

**Return-Values**

*So*: Si enriched with the Fourier coefficients of each channel

**Entries**

*Si*: S-structure for which completion to infty exists

**Constants**

*DVC.CFC.n_Fourier*: Number of Fourier coefficients to be computed

*DVC.CFC.n_comp*: Number of points taken in completion evaluation

*DVC.CFC.n_spline*: Number of points taken after splines (interpolating data and completion) have been computed. Those evaluation points are used in the to evaluate integrals for Fourier coeffs. computation.

**Description**

The procedure computes positive and negative indexed Fourier coefficients. The positive ones are added to the S-structure, the negative ones are used to compute the "distance" to causality see [3.1].

## 3.4 RatApp

**Signature** [SS]=RatApp(S,n,Is_type,solver)

**Return-Values**

*SS*: S enriched with the computed rational approximation

**Entries**

$S$: S-structure for which completion and Fourier coeffs. have been computed

$n$: Target MacMillan degree

*Is_type=DVC.RA.divide_by_z_minus_one*: Type of isometry used to pass to the circle. $L^2$ and $L^\infty$ isometries are available. For the $L^2$ isometry the value at $\infty$ for $S_{1,1}$ and $S_{2,2}$ is first subtracted. Possible values are 0 for $L^\infty$ and 1 for $L^2$.

*solver=DVC.RA.solver_flag*: Specifies which rational approximation engine to use, i.e RARL2 [**??**] and hyperion [**??**] are available. The corresponding argument values are {'RARL2','HARL2'}

**Constants** none

**Description**

The engine hyperion is only available under linux.