Functionalities Provided by the BPA/PNNL DSI Toolbox: A Tabular Summary

WAMS Working Note

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1. Summary

This document provides a tabular summary of functionalities provided by the Dynamic System Identification (**DSI**) Toolbox. Additional information is provided in [1,2,3,4,5] .

2. Main Processing Options Provided by the DSI Toolbox

Table 1. Primary menu of processing options presented by the DSI Toolbox

```
Select processing type: Options are
    1  Batch Plots
    2  Angle/Freq Refs
    3  Filter/Decimate
    4  Backload Filtered
    5  Fourier
    6  Histograms
    7  Ringdown GUI
    8  Ringdown Utilities
    9  AutoCorrelations
   21  ModeMeter
   22  EventScan
   41  Phasor Utilities
   42  Backload Phasor Results
   51  Special Displays
   94  DownSelect Signals
   95  Load new data
   96  save results
   97  keyboard
   98  Defaults on/off
   99  end case

   Indicate processing type - enter number from list above [1]:
```

3. Summary of Functionalities Provided by the DSI Toolbox

3.1 DSI Toolbox File Reading Formats

- **PDC**- Phasor data concentrator (BPA format)
- **PPSM**- Portable Power System Monitor (BPA format)
- **SWX**- Various ASCII formats related to BPA Swing Export
  - PSMT ASCII-Standard ASCII format for data export from PSM Tools and DSI Toolbox. (Excel compatible, with special header)
  - PSLF/PSDS- GE software output
  - PTI PRNT- PTI software output
  - PTI RAWC- PTI software output
  - DFR Comtrade (Digital Fault Recorder)
- **PDC Special**- Mimics intermediate export from PDC. Provided for AEP and others.
- **PMU**- Phasor measurement unit- Macrodyne A, Macrodyne B, VA Tech, Arizona Public Service. Involves several legacy formats that are no longer in active service.
- **DCU**- Data Capture Unit. PNNL device similar to PPSM. Data saved as .mat files.
- **PSAM**- Power System Analysis Monitor (BPA legacy system)
- **Special-** Special options under keyboard control
- **PSMT**- Standard Matlab format for data export from PSM Tools and DSI Toolbox.
- **PSDM**- Power System Disturbance Monitor (BPA legacy system)
- **F08**- ASCII data exported from FORTRAN predecessor to DSI Toolbox.
- **PPSM Special**- Portable Power System Monitor. BPA's high speed point on wave. Similar to digital fault recordings, but stored as Matlab data.

3.2 DSI Toolbox File Writing Formats

- **PSMT**- Standard PSM Tools format used in DSI Toolbox workspace. Files to be merged must first be translated into this format.
- **SWX**- Excel compatible ASCII format, with header information developed at BPA for Swing Export.

3.3 DSI Toolbox Features for Merging Files

PSMreload (matching files together and then merging)

- T**imestamp editing-** Manual signal alignment. Important for merging mismatched files covering the same event
- **Signal resampling-** Required before merging files, adjusting timesteps etc.
- **Automatic renaming of signals to facilitate sorting-**
- **Parallel merging of multiple files**
- **Saving merged data**

3.4 DSI Toolbox Modules for Phasor Data Processing and Analysis

Table 2. DSI Toolbox Modules for Phasor Data Processing and Analysis

Operation	Module
1	**Batch Plots**- Plot all or selected signals, control axes, send to printer, save to file, manipulate, etc. Can plot any signal against any other, including sample number.
2	**Angle/Freq Refs**- Select angle or frequency signal as reference, and subtract from all other signals of that type; estimate frequency from angle signals. At user option, data from this operation overstore or are appended to original data.
3	**Filter/Decimate**- Input data are filtered and/or decimated. Filter types include high-pass, low-pass, and band-pass Butterworth, several kinds of moving average, the BPA "activity filter" for oscillation detection, and filters defined by the user under keyboard control.
4	**Backload Filtered**- Data from the filter operation overstore or are appended to present data. Decimated data must overstore present data, due to change in sample rate.
5	**Fourier**- Fast Fourier Transforms (FFT), Inverse FFT, windowing, autospectra vs. frequency, coherency vs. frequency, waterfall plots, calculate transfer function using non-parametric gain and phase vs. frequency.
6	**Histograms**- Provides statistical information concerning signal activity within their frequency bands. One or more cycles of bandpass filtering are done first.
7	**Ringdown GUI**- Calculate mode frequencies, damping ratios, mode shapes, and transfer functions from ringdown signals using Prony analysis.
8	**Ringdown Utilities**- Provides tabular and graphical display for Ringdown GUI, constructs linear models for control system design.
9	**AutoCorrelations**- Time domain counterpart to the Fourier processing option. Experimental code seeks modes and damping from system noise response.
21	**ModeMeter**- Custom codes for estimating mode frequencies, damping ratios, mode shapes, and transfer functions from ambient noise and other signals. Several codesets under development by universities in DOE/EPSCoR project, BPA, PNNL, perhaps others. Some codesets build upon proprietary codes distributed by the Math Works, other National Laboratories, and the NASA Langley Research Center.
22	**EventScan**- Custom codes that open and scan long file sequences for dynamic events. None have been integrated into the DSI Toolbox as yet.
41	**Phasor Utilities**- Custom codes for deriving phasors from point-on-wave signals. Undocumented toolset for expert users.
42	**Backload Phasor Results**- Replaces original point-on-wave signals by derived phasors.
51	**Special Display**s- Custom display codes provided by or for special users. Experimental versions are under development at BPA, perhaps elsewhere.
94	**DownSelect Signals**- Sorts and/or downselects the signals in active memory.
95	**Load new data**- Loads a new data set for analysis, with optional restart of the automatic processing log.

96 **Save results**- Saves analysis results and processing log to output file. User can reduce data time span, select between PSMT and SWX output formats; future option will provide extended .dst format compatible with PDC utilities.

97 **Keyboard**- Provides direct access to MATLAB Command Window (MCW) during a DSI toolbox session.

98 **Defaults on/off**- Toggles the default settings that customize processing for efficient performance of pre-defined task sequences.

99 **End case**- Terminates execution of the DSI Toolbox.

4. Glossary of Terms

DSM	Dynamic System Monitor
PDC	Phasor Data Concentrator
PMU	Phasor Measurement Unit
PPSM	Portable Power System Monitor
PSM	Power System Monitor (primary definition)
"	Power System Measurements (secondary definition)
WAMS	Wide Area Measurement System
DMWG	Disturbance Monitoring Work Group of the WECC
M&VWG	Monitoring & Validation Work Group of the WECC
WECC	Western Electricity Coordinating Council
EIPP	Eastern Interconnection Phasor Project

5. References

[1] **A User Guide to PSM Tools: Utilities for Matlab Processing of Power System Response Records**, J. F. Hauer and J. M. Johnson. Prepared for the U.S. Department of Energy Transmission Reliability Program by the Consortium for Electric Reliability Solutions (CERTS), February 2001. (Available at ftp.bpa.gov/outgoing/WAMS%20Information/)

[2] **DSItools User Manual for the Ringdown Analysis Tool**, J. M. Johnson and D. J. Trudnowski. Battelle Memorial Institute, 1998

[3] **DSItools Application Guide for the Power System Modal Analysis,** D. J. Trudnowski, J. F. Hauer, and G. J. Rogers. Battelle Memorial Institute, 1998.

[4] **Expanded Version of the BPA/PNNL GUI for Integrated Prony and Fourier analysis of Ringdown Signals**, J. F. Hauer, Zhenyu (Henry) Huang, and J. M. Johnson. WAMS Outreach documentation slides prepared for the U.S. Department of Energy Transmission Reliability Program by the Consortium for Electric Reliability Solutions (CERTS), June 27, 2003.

[5] **WSCC Plan for Dynamic Performance and Disturbance Monitoring**, prepared by the WECC Disturbance Monitoring Work Group, October 4, 2000. (At ftp.bpa.gov/outgoing/WAMS%20Information/ and/or http://www.wecc.biz/committees/JGC/DMWG/documents/)