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Weir DMA

User's Manual and Specifications

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2. Introduction

Release Jan. 19,2005 Version 2

2.1 Product Scope

Weir PW™, Weir PSFM and Weir DM are components of the Weir Wavefront Engineering Suite of process optimization tools. Weir PSFM provides advanced tools for aerial image wavefront plotting and focus uniformity modeling across the wafer and scanned image.

Weir PW™ addresses the need for an advanced suite of tools capable of importing and modeling any form of metrology used in semiconductor lithographic image evaluations. A single user interface provides statistical analysis of raw data as well as models for substrate, optics, and electro-mechanical scan image aberration measurement.

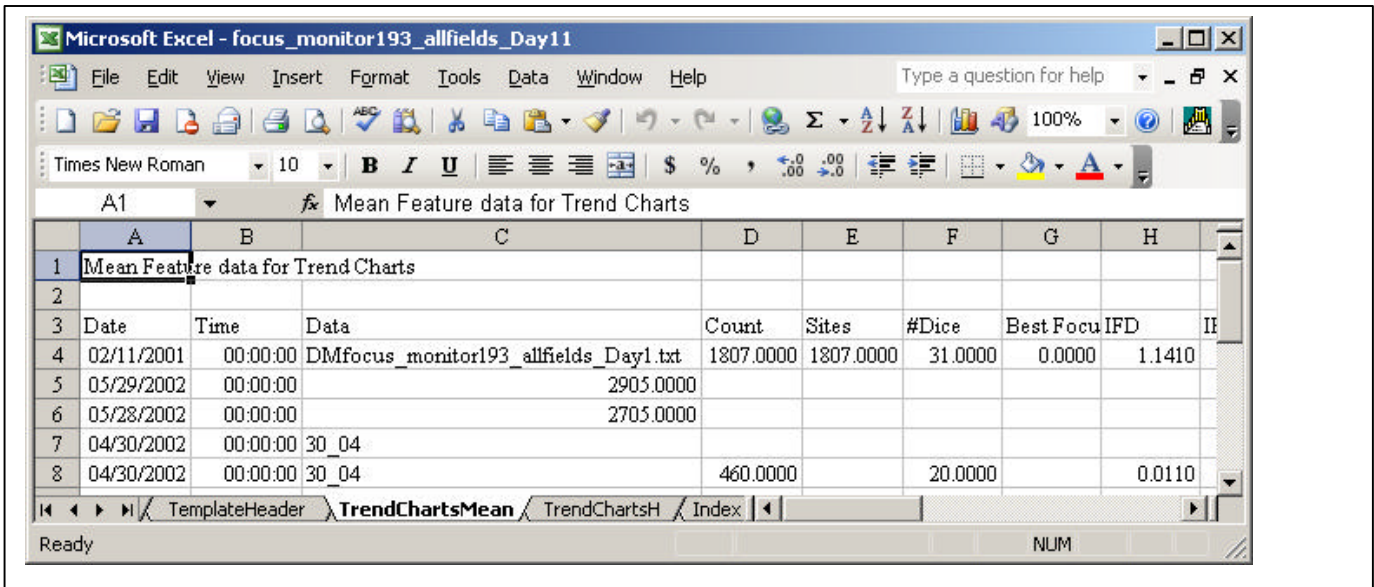
Weir DM is an automation interface for Weir PW and Weir PSFM providing automated analysis encapsulation into control templates and data storage for trend charting of user-selected variables.

This document addresses the use and application of Weir DM in the form of an automated version called Weir DMA. The product enhancements allow Weir DMA to:

- ☞☞ Start an instance from an external script or program call
- ☞☞ Run a process defined by a Weir DM Template to perform one of the following:
 - ☞☞ PSFM calibration,
 - ☞☞ PSFM conversion of registration metrology to focus
 - ☞☞ Analysis of Raw (input) data, or
 - ☞☞ Model raw data as instructed by the template
- ☞☞ Save the results in either an Excel workbook (*.XLS) or comma-delimited file (*.csv) located in a directory of the user's choice, see section .

2.2 Weir DM operational mode

- ☞☞ Weir DM is a user interactive program.
- ☞☞ The user selects a data file from a sorted list of files in the data source directory.
- ☞☞ User selects a template to use for the analysis.
 - ☞☞ Template defines the type of analysis, graphics and variables calculated.
- ☞☞ Weir DM performs the analysis and then stores the new data results in a new row in one of three worksheets in the template "XLT" File
 - ☞☞ "TrendChartsH"
 - ☞☞ "TrendChartsV"
 - ☞☞ "TrendChartsMEAN"
- ☞☞ The "TemplateHeader" worksheet details the type of analysis and variables to calculate.



3. Weir DMA Description

3.1 Operational Calling

- ☞☞ Update the user interface so that a file and template can be specified by an external program.
- ☞☞ Allow the passing of command line arguments to specify the file path and template.

Example:

“WeirDailyMonitor.exe -f D:\ICOData\newLensPSFM.dat -t ICOtemplates.XLT”

Where

“-f” specifies the data source file path,

“-t” specifies the template to use.

“-“ designates a new parameter.

Spaces are permitted in the path.

?? the variable may be enclosed with quotes:

?? WeirDailyMonitor.exe -f “d:\ICO data\New Lens PSFM.dat”

Options for the call

If “-t” is not given, then the default template is used.

The default template is set up in the Weir DM options interface.

If “-f” is not given, then the newest data file in the template’s specified data-source directory will be used.

That data file may be an ascii format or Weir spreadsheet format file.

The software uses the file’s Modified Date attribute to decide the latest date.

Option “-o”,

Specifies an output path to a directory for storage of an ASCII format, comma delimited file of the same name as the data input file but ending in “_WeirDMA.csv”

?? Path can optionally end with a “\” completing “\” or it may be omitted.

?? Output files of the same name will be overwritten

Output file will contain a two column ASCII file with one line for each user-selected output variable in the trend charts. Column 0 = the variable name, column 1 = value.

Option “-x”

Specifies an output path to a directory for storage of an Excel Workbook file of the same name as the data input file but ending in “_WeirDMA.XLS”

?? Path may optionally end with an “\”

?? Outputs of the same name will be overwritten

Worksheets

?? Workbook will contain one Worksheet of the same name as the input data.

?? The “Results” worksheet contains the output variables.

?? Worksheet will contain variable names in column A and values in column B, one row for each variable specified in the template

Batch calling is not supported. Only one file may be submitted at a time.

Email notifications of out-of-control or warning levels are not supported.

3.2 Analysis Results

Results are output into either an excel workbook or an ASCII

File folder locations are specified with either the “-x” or “-o” switches

Variable names are stored in the first column, values in column #2

Delimiters

- Each section contains a heading enclosed in square brackets such as [Results]
- The end of the section is marked by a square bracket delimiter and the “END” keyword: [EndResults]

Data Sections

Data

- Contains information about the template, data file, date, tool and wafers used for the analysis.

Header

- Summary of Weir DM Template specified analysis steps

Results

- Reports the variables specified in the template’s Display Statistics Section
- The metrology variable name is included in subsection brackets prior to reporting the calculated statistics and model results. For example [FV_Slope] signifies the start of the measured slope reporting.
- When overlay or Focus (PSFM Reticle) data analysis and modeling is reported, this section may contain up to three (3) sub-sections of variables. Each subsection contains the calculated values for that variable
 - ?? [X-focus] – for X overlay analysis of vertical feature edges
 - ?? [Y-focus] – for Y overlay analysis of horizontal feature edges
 - ?? [Z-Mean] – for mean
- User-specified names for each variable axis are entered into the template in the “Data Reporting Axes” section of the “Statistics Display” tab of the “Daily Monitor Setup” interface.
 - ?? Daily Monitor Setup is reached from the Weir PW/PSFM Tools menu.

Example:

| | | |
|-----------------|----------|----------------------------------|
| [Results] | | Start of results section |
| [X (Slit)] | | Start of “X” focus variables |
| IFD: | 0.0600 | Modeled statistics and variables |
| BF(Fitted): | -0.0640 | |
| X Tilt(urad): | -0.9110 | |
| Y Tilt(urad): | 0.4620 | |
| Curv(nm/cm2): | -13.9400 | |
| IFDresid(um): | 0.0450 | |
| StDEVresid(um): | 0.0140 | |
| Mean: | -0.0780 | |
| Maximum: | -0.0640 | |
| Minimum: | -0.0960 | |
| Range: | 0.0320 | |
| [Y (Scan)] | | Start of “Y” focus variables |
| IFD: | 0.1110 | |
| BF(Fitted): | 0.0240 | |
| X Tilt(urad): | 3.4880 | |
| Y Tilt(urad): | 0.4620 | |

4. Weir DMA License Basis

4.1 License Basis

- ☞☞ Weir DMA software licenses are purchased on a single-fab license.
 - ☞☞ The number of licenses available are set by estimated capacity of the fab
 - ☞ Recommend one license for every two metrology tools.
 - ☞☞ One license and instance per CPU
 - ☞ A separate license for Weir DMA is set from the Weir DM “Tools/License Maintenance” menu.
 - ☞☞ CPU should be Windows 2000 with a Pentium 4, 1+ Gigahertz and 256 meg RAM

4.2 License Installation

2.4.1 Accessing the License Maintenance Interface

- ☞☞ Start a stand-alone version of Weir DM
 - ☞☞ DO NOT enter Weir DM from the Weir PSFM/PW interface.
- ☞☞ Select the “Tools/License Maintenance” menu item.
- ☞☞ The License Maintenance interface will appear along with two fields for “Weir DM” and “Weir DMA” Confirmation ID’s

2.4.2 Obtaining a license

- ☞☞ Send an email with the “Installation ID A:” screen value shown to:
 - ☞☞ info@TEAsystems.com
- ☞☞ A license will be returned to you containing the Weir DM and Weir DMA Confirmation ID’s.
 - ☞☞ Note that you will be able to start Weir DM 10 times without a license.
- ☞☞ After you receive the license values, enter them into the Weir DM and Weir DMA fields and then press the “**Enter Confirmation**” button.

5. Product Test Plan

5.1 Associated Documents and Files:

- ☞☞ Weir DMA Getting Started.ppt
PowerPoint example of a typical test sequence
- ☞☞ WeirDMAresults.zip
Data Files and RemoteCall.log file
Typical files for testing
Use is reported in “Weir DMA Getting Started.ppt”
- ☞☞ Data_Macro.zip
Weir format data files used
Weir DM Macro used for testing
- ☞☞ WeirDMcall.bat

A DOS Batch file designed to automatically call and analyze all of the raw BioRad data files of the test.

☞☞ WeirDMA Test Files.zip

- 1) Seven, BioRad Raw data files (ending in ".txt")
- 2) A copy of the "WeirDMcall.bat" file to automatically call Weir DMA for each of the test files from a DOS prompt.
- 3) A copy of the Weir DM macro, "DS1_FF_DMteplate.xlt"

5.2 Overview

A Weir DM or DMA analysis has four key elements that must be setup. The first is the Weir DM macro that contains all of the remaining element information with the exception of the data import filter. These elements are:

Weir DM macro

Defines the analysis program sequence and files

Contains all of the following information ...

Stored in the applications "Templates" sub-folder as Excel files ending in ".XLT"

Weir PSFM Calibration template

Defines the calibration values for converting PSFM Reticle overlay data to focus data.

Stored in the applications "Templates" sub-folder in file "WEIRpsfm.tpl"

Data directory path

Data import filter type to use

NOTE: This filter is NOT currently stored in the Weir DM macro

Must be set from the Weir DM "Tools/Options" menu.

5.3 Test Sections

3.5.1 Weir DM Fixed-Focus Macro Setup

☞☞ This analysis assumes:

☞☞ Focus uniformity across the wafer and field are to be examined

☞☞ A PSFM Focus calibration template exists for the exposure-dose, NA and sigma of the tool.

☞☞ Open a data file, exposed at fixed-focus, that will be typical of the format of the analysis

☞☞ Fill in the exposure layout and centering for the file

?? Note that the WAFER layout and exposure are not critical for a Fixed-Focus macro

?? The FIELD layout, that is the number of sites-per-field and their locations, are critical **ONLY IF** you specify the "All Sites", "Center Row" or "Center Column" PSFM conversion methods.

?? Site locations are **NOT** critical if you specify the "Center" site conversion method or if you do not select a PSFM Focus Conversion Template

☞☞ Select the "Tools/Daily Monitor Setup" menu

- 4) Specify the final Weir DM macro name in the "Save As" field.
- 5) Select the "Data Directory"
- 6) Select "Fixed Focus", the PSFM Focus Conversion template and the method of Focus Conversion ("All Sites", Center, Center Row or Center Column)
- 7) Check the "Model Data" check box

- 8) In the “Models” tab
 - a) Select the appropriate models
- 9) Findally, select the display and statistics for display and trend charting using the remaining tabs on the interface.
- 10) Save the DM Macro using the “Save Template” command button

3.5.2 Weir DM Focus/Expo macro Setup

☞☞ This analysis assumes:

☞☞ A focus matrix exposure of the field will be exposed.

☞☞ All subsequent Weir DM/ Weir DMA test wafers will have the same layout, focus range and focus stepping between exposure fields.

☞☞ Weir DM/DMA will perform a PSFM focus calibration, calculate Best Focus and model the Best Focus field for each subsequent test wafer analyzed by the macro.

☞☞ Open a data file, exposed with a **focus matrix**, that will be typical of the format of the analysis

☞☞ Fill in the exposure layout and centering for the file

?? Note that the WAFER layout and exposure **are critical** for a Focus/Expo macro

?? The FIELD layout, that is the number or sites-per-field and their locations are not critical

?? Only one exposure-dose can be specified for the matrix.

☞☞ Select the “Tools/Daily Monitor Setup” menu

11) Specify the final Weir DM macro name in the “Save As” field.

12) Select the “Data Directory”

13) Select “Focus/Expo” analysis format

14) Optionally specify a focus range using the Maximun and Minimum drop-down controls in the “Focus Range” frame.

15) Optionally, check the “Model Data” check box

16) In the “Models” tab

a) Select the appropriate field model

17) Findally, select the display and statistics for display and trend charting using the remaining tabs on the interface.

18) Save the DM Macro using the “Save Template” command button

3.5.3 Validate the Weir DM Macro

☞☞ Startup Weir DM

☞☞ Select the Weir DM Macro of the previous section

☞☞ Select a data file

☞☞ Press the “Run Daily Monitor” command button.

Ensure that the data displays correctly as specified in the previous step

Ensure that the new data is entered into the trend charts

3.5.4 Test Run Weir DMA

☞☞ Setup a data directory with data files that are the same exposure, format and layout as specified in section 3.1

☞☞ Call Weir DM from the command line prompt using calls of the format

1. "C:\Program Files\Weir Wavefront Engineering\WeirDailyMonitor.exe" -t "C:\Program Files\Weir Wavefront Engineering\Templates\DS1_FF_DMtemplate.XLT" -d 040615210805.txt -o D:\TEMP -x D:\TEMP

Note: if the Weir DM executable is in your call path, you do not have to specify the full program or template path

See the Weir DMA documentation for command switches and functions in calling Weir DMA

☞☞ Repeat Weir DMA calling for at least four (4) data files.

5.4 Simulating Calls to Weir DMA from other programs

☞☞ Use files contained in "WeirDMA Test Files.zip"

☞☞ This Zip file contains:

- 19) Seven, BioRad Raw data files (ending in ".txt")
- 20) A copy of the "**WeirDMcall.bat**" file to automatically call Weir DMA for each of the test files from a DOS prompt.
- 21) A copy of the Weir DM macro, "DS1_FF_DMteplate.xlt"

4.5.1 Overview

The objective of this section is to simulate the manner in which a factory control or APC program would call Weir DMA and obtain results from the analysis. The "**WeirDMcall.bat**" batch file is used to simulate this call by running Weir DMA from calls within a DOS prompt window.

The batch files contains seven lines of code similar to:

```
call WeirDailyMonitor.exe -t DS1_FF_DMtemplate.XLT -d 040525153141.txt -o c:\TEMP -x c:\TEMP
```

where each line differs on by the data file specified after the "-d" switch. The call starts the DMA program using the DS1_FF_DMtemplate.XLT file.

Notice that the template and data files do not contain full path names. Full path names are not needed if the files are located in the default directories specified in the Weir DM options. This call outputs two summary files to the "c:\temp" directory.

4.5.2 Setup

- 1) Unzip all of the files in "WeirDMA Test Files.zip" into a temporary directory.
- 2) Weir DM Macro Setup/Customization
 - a) Copy the "DS1_FF_DMteplate.xlt" macro into the Weir DM templates sub-directory. This directory is typically in the path:
"C:\Program Files\Weir Wavefront Engineering\Templates"
 - b) Start Weir PSFM/PW and enter the "Tools/Daily Monitor Setup" interface
 - c) Select the "DS1_FF_DMteplate.xlt" macro from the "Source File" combo field.
 - d) Setup the proper **Data Directory** location.
 - i) The macro defaults to "C:\ DMA Testing All\Testing"
 - ii) Either re-specify the proper data directory or create a new folder at this location.
 - e) Select the proper "PSFM Focus Conversion" template from the combo field.
 - i) This entry will convert the BioRad data from offsets to focus
 - ii) The template defaults to "PSFM_FOCUS MATRIX_DATA"

- iii) If you do not have this template on your computer, select one from the choices presented.
 - (1) For this testing it is not necessary to have a proper PSFM template since we are only testing software functionality, not setting up a process.
 - f) Select "Center" as the method for template-focus conversion.
 - i) This selection combo is located immediately to the right side of the PSFM template combo.
 - g) Save the template and exit the interface.
 - h) Exit Weir PSFM.
- 3) Data File Setup
- a) Copy the seven (7) BioRad data files into the Data Directory that you specified in step 1.d above.
- 4) Batch File Setup
- a) Copy the "**WeirDMcall.bat**" file into your Weir DM program directory, typically:
"C:\Program Files\Weir Wavefront Engineering"
- 5) Weir DM Options Setup
- a) This setup is needed to provide a known location for the "RemoteCall.LOG" text file. This text file provides analysis status and aids for use in debugging the Weir DMA software. Calls are written to the log file only when Weir DMA is called or when the "Log Data Results" check box is selected on the main screen of Weir DM. *Note that when this log file is being written, it's folder-path will appear below the check box.*
 - i) Start Weir DM
 - ii) Select the "Tools/Options" menu
 - iii) Select the "DMA" tab
 - iv) Type in a folder location for the log file.
 - b)

4.5.3 Running the Weir DMA Simulation

- 1) Exit all Weir interfaces.
- 2) Open a Windows Explorer window.
- 3) Open the Weir program folder:
Ex: "C:\Program Files\Weir Wavefront Engineering"
 - a) And find the "**WeirDMcall.bat**" batch file.
- 4) Double-click on the batch file to start the analysis.
- 5) You will see a DOS window open and the each call to WeirDMA will be shown.
- 6) The window will close automatically after completion.

4.5.4 Analyzing the results

- 1) Verification of data analysis
 - a) Start the Weir DM interface
 - b) Select the "**DS1_FF_DMtemplate.XLT**" macro from the Analysis Macro combo.
 - c) Select the "Trend" tab.
 - d) View the results on the trend charts created for each variable.
- 2) Validation of output file integrity

- a) Open the output folder, specified with the “-o” switch in the batch file, using Windows Explorer:
 - i) By default this was “C:\Temp”
 - b) Use a text-file viewer, such as Notepad.exe, to view the format and contents of each “csv” and “xls” file.
 - c) There should be two output files for each data file analyzed.
 - d) Insure that the files correspond to the format specified in the “Analysis Results”, section 2.2, of the “WeirDMA User Manual”.
- 3) Validation of analysis steps.
- a) Open the “RemoteCall.Log” file using any text editor
 - i) See a sample in Appendix I
 - b) Insure that the file statements do not list any errors and each analysis ends with the lines:

```
run DM successful  
Weir DMA Analysis End: 2004-11-18 09:16:58  
+++++ END +++++
```

Appendix I: Sample "RemoteCall.LOG" file

The following text is generated for each successful analysis call. The information documents the calls, data analyzed and, if any errors occur, the error type and it's location in the code.

```
+++++START+++++
_____ Weir DMA Auto-Run Logging _____
Start DMA: 2004!~8#31# #U#È 09:16:45
Weir DMA: ver: 3.9.9
System ID: 5CE5169A
Analysis Start: 2004!~8#31# #U#È 09:16:46
Cmd: -t DS1_FF_DMtemplate.XLT -d 040724125824.txt -o c:\TEMP -x c:\TEMP
runDM Start: #U#È 09:16:46
cmdLineParse Start: #U#È 09:16:46
DMA Start: #U#È 09:16:46
Opening Template 2004!~8#31# #U#È 09:16:46 chk: 2
Template Folder: D:\Program Files\Weir Wavefront Engineering\Templates
Template: D:\Program Files\Weir Wavefront Engineering\Templates\DS1_FF_DMtemplate.XLT
Import(OpenExcelWorksheet): Begin open/save function ___ #U#È 09:16:46
Header information. chk:1
Workbook already exists. chk:3
Workbook successfully loaded/saved. #U#È 09:16:46 chk: 12
Import(OpenExcelWorksheet): Exit#U#È 09:16:46 chk: 99
_____
Opening Data: 2004!~8#31# #U#È 09:16:46 chk: 5
Data Storage Directory:
Data: C:\DMA TESTING ALL\DMATesting\040724125824.txt
Import: ImportBioRadQ6res
Output: C:\DMA TESTING ALL\DMATesting\040724125824.XLS
Import(ImportRawData): Begin import of raw data. chk:1
#U#È 09:16:46
Import(SaveData): BEGIN....Save data into Workbook. chk:1
#U#È 09:16:47
Header information. chk:4
Open/Create Excel workbook. chk:8
C:\DMA TESTING ALL\DMATesting\Q040724125824.XLS
Import(OpenExcelWorksheet): Begin open/save function ___ #U#È 09:16:47
Header information. chk:1
Create new workbook. chk:6, 'C:\DMA TESTING ALL\DMATesting\Q040724125824.XLS'
```

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xlApplication started... chk:6.2

Saveas Workbook: C:\DMA TESTING ALL\DMATesting\Q040724125824.XLS chk: 6.2

File Checked, now create..: C:\DMA TESTING ALL\DMATesting\Q040724125824.XLS chk: 6.3

Save Workbook properties. chk: 9.1

Workbook successfully loaded/saved. 09:16:47 chk: 12

Import(OpenExcelWorksheet): Exit 09:16:47 chk: 99

Save successful!. chk:15

Import(SaveData): Program exit. chk:16

Import(ImportRawData): Analysis Successful. chk:3

09:16:48

Import(OpenExcelWorksheet): Begin open/save function ____ 09:16:49

Header information. chk:1

Workbook already exists. chk:3

Workbook successfully loaded/saved. 09:16:49 chk: 12

Import(OpenExcelWorksheet): Exit 09:16:49 chk: 99

Analysis Format: 2004~8 09:16:49 chk: 8

Analysis Format: Fixed Focus

Fixed Focus: 2004~8 09:16:49 chk: 9

Focus Template: PSFM_Focus_Matrix_Data

LotConversionMethod = 1

DataName: 040724125824.txt

Models: 2004~8 09:16:49 chk: 12.3

Field Model: Full Field chk: 12.3

runDMoutput Start: 09:16:57

Output: C:\TEMP\040724125824_WeirDMA.csv

Output 58 statistics.

OutputXLS: C:\TEMP\040724125824_WeirDMA.xls

Output 58 statistics.

run DM successful

Weir DMA Analysis End: 2004~8 09:16:58

+++++ END +++++