Glossary of Terms

(May 21, 2025)

A

Active Graph: In the **three-graph format**. Either the **Point Grid** graphics area ***on the left side*** of the MEscope window, or the Data Block graphics on the **upper-*right*** or ***lower-right*** of the MEscope window.

Each graphics area is made active by ***touching it*** or by placing the mouse pointer on it and ***clicking*** the ***left mouse*** button. The ***upper*** graph always displays the **TWFs** extracted for a video. The ***lower*** graph displays **M#s *that are calculated*** from the **M#**s in the upper graphics area.

Animation Frame: Animation is created by displaying still pictures (frames) in succession in the **Point Grid** graphics area. There are three different types of animation: **sweep**, **sine dwell** and **stationary dwell**. The three types of animation are enabled by executing one of the commands in the Animate with menu at the top of the MEscope window.

Animation Source: Either the ***upper-right*** **TWFs** Data Block graphics area or the ***lower-right*** **DFTs** Data Block graphics area. An **ODS-FRFs** Data Block is also displayed in the **DFTs** Data block area. The animate source is switched to the ***upper-right*** or ***lower-right*** Data Block by ***touching it*** or by placing the mouse pointer on it and ***left-clicking.***

APS (Auto Power Spectrum): An Auto spectrum is calculated by multiplying the **DFT** of a signal by its own ***complex conjugate***. The Auto spectrum has ***magnitude only***. Its ***phase is zero***.

B

Band Cursor: One of the three types of cursors in a Data Block (**BLK**) graphics area. The Band Cursor is displayed as two vertical lines on each **M#** in a Data Block (**BLK**) graphics area. ***Click & drag inside*** the band to move the Band cursor. To widen or narrow the band, ***click & drag outside*** the band to move the nearest edge of the Band cursor.

Bitmap: A copy of the pixels used to draw the graphics in a window. Bitmaps are used in all Copy to Clipboard and Print commands that operate on graphics.

Block Size: The number of samples of data in each **M#** of a Data Block (**BLK**) graphics area. The Block Size of the **TWFs** that were extracted for a video equals the ***number of frames*** of the video from which the **TWFs** were extracted.

To view and edit the current Block Size, ***double click*** on the horizontal axis in the Data Block (**BLK**) graphics area. The Block size is displayed at the top of the MEscope window. Increasing the Block Size appends ***zero valued samples*** to each **M#**. Decreasing the Block Size ***removes higher time or frequency samples*** from each **M#**.

C

Complex Shape: A complex **ODS** can have shape components with ***phase angles other than 0 or 180 degrees***. During animation, complex shapes can exhibit a ***"traveling wave"*** motion. The magnitude & phase of the currently animated **ODS** are displayed next to a point in the **Point Grid** by executing the **Mag-Phase** command in the **Deflection** menu at the top of the MEscope window.

Contours: Areas of equal shape magnitude above or below the graphics surface in the **Point Grid** graphics area during shape animation. Contour colors are displayed ***only on the surfaces*** of a **Point Grid**. Color contours are also used to display **M#s** in a Data Block (**BLK**) graphics area.

To display and edit Contour Colors in the **Point Grid** graphics area, use the commands in the **Contours** menu at the top of the MEscope window.

Cross spectrum (XPS): A Cross spectrum is calculated by multiplying the Digital Fourier Transform (**DFT**) of an **M#** by the ***complex conjugate*** of the **DFT** of a **reference M#.** A Cross spectrum has ***magnitude & phase***.

Cross-channel Measurement: A measurement function that is calculated between two different ***simultaneously acquired*** signals. Examples are **XPS** or **ODS-FRF**.

Current Animation Source: Either the ***upper-right*** Data Block (**BLK**) graphics area of **TWFs** or the ***lower-right*** Data Block (**BLK**) graphics area of **DFTs** or **ODS-FRFs**. The animation source is switched to the ***upper-right*** or ***lower-right*** Data Block by ***touching it*** or placing the mouse pointer on it and ***left-clicking.***

D

Data Block (BLK) graphics area: One or more measurements (**M#s**) with a ***common time or frequency axis***. Time waveforms (**TWFs**) are ***real-valued***. Frequency domain measurements (**DFTs** or **ODS-FRFs**) are c***omplex-valued*** with a magnitude & phase or real & imaginary parts.

Each measurement has a unique measurement number (**M#**). **M#s** are displayed in the first column of the **M#s** spreadsheet in a Data Block (**BLK**) graphics area. **M#s** are used by the **M# Links** at each Point on the Rectangular **Point Grid** for displaying **M#** data from the ***current cursor position*** in the ***active*** Data Block (**BLK**) graphics area.

DFT: An acronym for **Digital Fourier Transform**. A **DFT** is the result of using the **FFT** algorithm to calculate the digital Fourier spectrum of a uniformly-sampled **TWF**. If a **TWF** has **N** real-valued samples, then its corresponding **DFT** will have (**N/2**) complex-valued samples. A **DFT** is also called a **Fourier spectrum** or a **Linear spectrum**.

DOF: An acronym for Degree-Of-Freedom. A **DOF** includes a Point number & direction of the motion at a point on the test article. A **DOF** is defined for each **M#** in a Data Block (**BLK**) graphics area.

DOFs are used to ***create*** **M# Link**s by linking **M#s** to matching Points & directions on the **Rectangular Point Grid** in the **Point Grid** graphics area.

E

EVA: An acronym for **Enhanced Video Animation**. After a raw video is processed using the **Video Wizard**, an **EVA** is begun. During an **EVA**, the **TWF**s extracted from the video and their corresponding **DFTs** are used to deflect the Points on a rectangular **Point Grid**. This is also called **ODS** animation.

During an **EVA**, frames from the original video are pasted onto the surface of the rectangular **Point Grid** so that a ***photo-realistic*** **ODS** animation is created when the Points are deflected. The amplitude and speed of the animation, along with several other parameters, can be changed to enhance the **ODS** animation.

F

FFT: An acronym for **Fast Fourier Transform**. The **FFT** algorithm transforms a ***uniformly sampled*** **TWF** into its corresponding **Digital Fourier Transform** (**DFT**). The Inverse **FFT** transforms the **DFT** back into its original **TWF**. The **FFT** algorithm in MEscope transforms any number of samples, not just powers of 2. Each sample of **TWF** data corresponds to a single frame of the video from which the **TWFs** were extracted.

Digital Fourier Transform (DFT): The result of applying the **FFT** to a uniformly sampled **TWF**. A **DFT** is also called a **Linear spectrum** or a **Fourier transform**. The Inverse **FFT** transforms the **DFT** back into its original **TWF**. Therefore, the **FFT** is called a ***one-to-one-and-onto*** mathematical transformation.

G

Graphics Format: Data can be displayed in the ***active*** Data Block (**BLK**) graphics area in several graphical formats. The display is switched between graphics formats by pressing the large left-pointing arrow on the right side of the Data Block (**BLK**) graphics areas to open the graphics display panel. **Chart Layout** and **Chart Data Format** contain multiple selections for formatting the graphics in the ***active*** area.

I

Input, Output, Both, Cross: These designations are used by the **ODS-FRF** calculation command. To calculate an **ODS-FRF**, each **TWF** must be designated as an **output** and a single reference **TWF** must be designated as a **Both**, meaning that it is both an **Input** and an **Output**. These choices are made in the **Input Output** column of the **M#s** spreadsheet in a Data Block (**BLK**) graphics area. When **Both** is chosen, that **TWF** will be used as ***both an*** **Input** ***and*** **Output** in the **ODS-FRF** calculations.

L

Line Cursor: One of the three types of cursors in a Data Block (**BLK**) graphics area. A Line cursor is displayed as a vertical line on each **M#** graph. The Line cursor is moved by ***clicking & dragging*** it on the graph. When it is displayed, the Line cursor is displayed at the touch or mouse pointer position when clicking on the graph.

Linear Spectrum: Another word used to describe a **DFT** or the square root of an **APS**.

M

M#: An abbreviation for **Measurement Number**. Each measurement function in a Data Block (**BLK**) graphics area has a **unique M#**.

To display shapes in animation each **M#** in the Animation Source must be linked to a **DOF** of the **Point Grid**. An **M# Link** is a ***weighted summation of* M#s** in the Source. During animation, each **M# Link** is evaluated to deflect each **DOF** of the **Point Grid**. Each measured **DOF** is animated using a **Measured M# Link** and each un-measured **DOF** is animated using an **Interpolated M# Link**.

M# Link: Each Point & direction (**DOF**) on a **Point Grid** can be either **Measured**, **Interpolated** (un-measured), or **Fixed**. To display shapes in animation, ***each* M#** in a connected Animation Source must be linked to a **DOF** of the **Point Grid** from which data was retrieved.

Measurement: A measurement refers is a **TWF**, **DFT** or **ODS-FRF**. Multiple **TWFs**, **DFTs** or **ODS-FRFs** are stored in a Data Block (**BLK**) graphics area. Each measurement has a ***unique Measurement Number*** (**M#**).

N

Node Line: A Node Line is a line on the surfaces of a **Point Grid** where ***all shape components are zero***. The Node Lines of a **normal mode shape** or a **normalized complex shape *do not move during animation***. Node lines of a complex-valued shape can move during **sine dwell** animation.

O

Octave: An Octave band is a frequency band where the highest frequency is ***twice the lowest frequency***. Acoustic measurements are often displayed using **1/1, 1/3, or 1/12** octave bands.

ODS: An acronym for **Operating Deflection Shape**. An **ODS** is the deflection of a **Grid Point** at ***two or more*** locations and/or directions due to its own operational forces and/or other applied forces. A **time-based ODS** characterizes the structural deflection at a specific time. A **frequency-based ODS** characterizes the structural deflection at a specific frequency. An **order-based ODS** characterizes the structural deflection at the running speed or a multiple of the running speed of a machine.

Each **ODS** is a ***summation of the mode shapes*** of the resonances being excited by the forces acting on the machine or **Point Grid**. Each mode shape will ***participate differently*** in an **ODS** depending on the mode shapes and where the excitation forces are applied to the test article.

ODS animation **(EVA):** During **ODS** animation, the **TWF**s extracted from the video and their corresponding **DFTs** are used to deflect the Points on a rectangular **Point Grid**. This is also called an **EVA**.

During an **EVA**, frames from the original video are pasted onto the surface of the rectangular **Point Grid** so that a ***photo-realistic* ODS** animation is created when the Points are deflected. The amplitude and speed of the animation, along with several other parameters, can be changed to enhance the **ODS** animation.

ODS-FRF: A cross-channel frequency domain measurement function that is calculated from operational (output-only) data. An **ODS-FRF** is created by adding the phase of the **XPS** between a Roving response and a fixed Reference response to the **APS** of the Roving response. **ODS's** can be displayed in animation directly from a set of **ODS-FRFs**. **OMA** mode shapes can be extracted from a set of **ODS-FRFs** by curve-fitting them.

ODS-FRFs *are unique* in that they can also be ***integrated or differentiated*** to change their response units between displacement, velocity, and acceleration units. An **ODS** obtained from a set of calibrated **ODS-FRFs** provides the ***true deflected motion*** of the **Point Grid**.

OMA: An acronym for **Operational Modal Analysis**. An **OMA** is performed when the excitation forces ***are not or cannot be measured***, and hence **FRF**s cannot be calculated. **XPS's** or **ODS-FRFs** are calculated instead of **FRF**s and can be curve fit to extract **OMA mode shapes**.

OMA Mode Shape: A set of **OMA** mode shapes is obtained by using **FRF**-based curve fitting on a set of **XPS's** or **ODS-FRFs** which have been windowed using a De-Convolution window. In MEscope, a De-Convolution window is automatically applied to a set of **XPS's** or **ODS-FRFs** before curve fitting them.

Operational Mode Shape: Another name for **OMA** mode shape.

Order-Based ODS: The **ODS** at the running speed (first order) or a multiple of the running speed (second order, third order, etc.) of a rotating machine. An **APS**, **XPS**, or **ODS-FRF** of an operating machine will typically exhibit a peak at each of its orders.

Overlap Processing: Overlap processing is done as part of spectrum averaging when **ODS-FRFs** are calculated from the **TWFs** in the ***upper*** Data Block (**BLK**) graphics area.

Overlap processing occurs when the number of samples of **TWF** data required to calculate several spectrum averages exceeds the number of samples available in the Data Block (**BLK**) graphics area. With overlap processing, some samples of **TWF** data are used over again to calculate each succeeding spectral estimate.

P

Peak Cursor: One of the three cursors in a Data Block (**BLK**) graphics area. A Peak cursor is displayed on each graph as a band with two vertical lines and a **red dot** indicating the peak in the middle of the band. ***Click & drag inside*** the band to move the Peak cursor. To widen or narrow the Peak cursor band, ***click & drag outside*** the band to move the nearest edge of the Peak cursor band.

Periodic Signal: With the **FFT** algorithm, it is assumed that the waveform to be transformed is periodic within its Transform window (the samples used by the **FFT**). Waveforms that are ***completely contained*** within the Transform window satisfy this requirement. Cyclical waveforms that ***complete an integer number of cycles*** within the Transform window also satisfy this requirement.

If a **TWF** is not periodic in its Transform window, its **DFT** or an **ODS-FRF** calculated from **TWF** data will have ***"leakage"*** (or distortion) in it. Using a **Hanning window** during spectrum averaging reduces the amount of leakage in an **ODS-FRF**.

Photo Realistic Model: A **Photo Realistic Model** is a **Point Grid** that has digital photographs attached to its surfaces. A Photo Realistic Model is created using third party software and is then imported into MEscope using the **OBJ** file format.

When the **Video Wizard** is used to process the raw video of a vibrating machine or **Point Grid**, a rectangular **Point Grid** is created and frames from the video are displayed on the surface of the **Point Grid** during **ODS** animation. This is another example of a **Photo Realistic Model.**

Point Grid: A rectangular grid of Points with surfaces between them. When the **Video Wizard** is used to process a raw video, the motions of the pixels between successive frames of the video are used to extract two **TWFs** for each **Point Grid**, one **TWF** for its horizontal motion and one for the vertical motion.

When **sweep** animation is conducted from the **TWFs** in the ***upper*** Data Block (**BLK**) graphics area, each frame of the video is attached to the surface of the **Point Grid**. When sine dwell animation is conducted from the **DFTs** or **ODS-FRFs** in the ***lower*** Data Block (**BLK**) graphics area, a single frame of the video is attached to the surfaces of the **Point Grid**.

Point Object: One of the Drawing Objects on a **Point Grid**. Points are used as end points for defining all other Drawing Objects in a **Point Grid** graphics area. Each Point has three global coordinates (**X, Y, Z**). The properties of the Points are displayed and edited by executing **Edit Point Grid** in the **hamburger** Menu on the left side of the MEscope window, and then pressing the **Points tab** on the bottom of the spreadsheet.

Each Point has **M# Links** that are used to animate the Point with shape data from the connected Animation Source, the ***active*** Data Block (**BLK**) graphics area.

Project File (.VTmax): All work in MEscope is done with data contained in a Project file. A Project file has **(.VTmax**) as the extension of its name. A Project file can contain ***multiple*** **Result Sets**. Each Result Set contains one **Point Grid** (**STR**) and two Data Block (**BLK**) files. ***Only one Project file*** can be opened at a time in MEscope.

Q

Quad View: A Quad View in a **Point Grid** graphics area displays four Views (**X View, Y View, Z View, & 3D View**) on a 3D model. ***Double-clicking*** on one of the single Views in a Quad View will display only that View. ***Double-clicking*** on the single View will return to the display of the Quad View.

R

Rectangular Point Grid: A rectangular grid of Points with surfaces between them. When the **Video Wizard** is used to process a raw video, the motions of the pixels between successive frames of the video are used to extract two **TWFs** for each **Point Grid**, one **TWF** for its horizontal motion and one for the vertical motion.

When **sweep** animation is conducted from the **TWFs** in the ***upper*** Data Block (**BLK**) graphics area, each frame of the video is attached to the surface of the **Point Grid**. When sine dwell animation is conducted from the **DFTs** or **ODS-FRFs** in the ***lower*** Data Block (**BLK**) graphics area, a single frame of the video is attached to the surfaces of the **Point Grid**.

Reference DOF: A Reference **DOF** defines a sensor that ***remains fixed*** during multi-channel data acquisition. A Reference **DOF** ***is required*** to calculate a **cross-channel** function such as an **XPS** or **ODS-FRF**. The **Input Output** property of the Reference **TWF** must be designated as either **Input** or **Both** to calculate an **XPS** or **ODS-FRF.**

Since all frames of a video are simultaneously acquired, the **TWF** of any Point in the **Point Grid** of an **EVA** can be designated as the **Input** or **Both**. Therefore, its **DOF** is the Reference DOF in the cross-channel functions.

All **cross-channel** functions have both a Roving and a Reference **DOF**. **DOFs** are listed in the **DOFs** column of the **M#s** spreadsheet. The **Roving DOF** ***precedes the colon*** **(:)** and the **Reference DOF** ***follows the colon*** **(:)** in the **DOF** of a cross-channel measurement.

S

Sampling Window: The **Sampling Window** is the block of **TWF** samples used by the **FFT** to calculate the **DFT** corresponding to the **TWF**. To create certain properties in its **DFT**, a special time domain windowing function (Hanning, Flat Top, Exponential, etc.) is often applied to the samples in the **Sampling Window** before they are transformed into a **DFT**. The **Sampling Window** is also called a **Transform Window**.

Shape: A Shape consists of ***two or more measured or calculated deflections*** at points & directions on a machine, or **Point Grid**. An Operating Deflection Shape (**ODS**), or mode shape is a shape function. Shape components can be Translational, Rotational, or Scalar. For correct shape animation, all shape components must have ***correct magnitude & phase values relative to one another***.

Sine Dwell: One of the three types of shape animation during an **EVA**. When **Sine Dwell** is enabled, each Point on the **Point Grid** is deflected by multiplying the **M#s** in the **Animation Source** that are linked to it by sine wave values that traverse a unit circle in equal increments from 0 to 360 degrees.

Single-channel measurement: A single-channel measurement is calculated using data from each acquired **TWF**. Examples are **DFTs** or **APS's**.

If **DFTs** are calculated from ***simultaneously acquired*** **TWFs**, **OMA** mode shapes can be extracted from them by curve-fitting. If **APS's** are calculated from ***simultaneously acquired*** **TWFs**, **OMA** mode shapes can be extracted from them by curve-fitting, but the phases of all the shape components will be zero.

Spectrum Averaging: Spectrum averaging is done to remove extraneous noise from **APS's** and **XPS's**. The most common type of averaging is called **Linear** or **Stable** averaging. Linear averaging is done by summing several spectral estimates together and dividing by the number of estimated. Stable averaging is done by adding each new weighted spectral estimate to a weighted average of the preceding estimates.

Stationary Dwell: One of the three types of animation during an **EVA**. When **Stationary Dwell** is enabled, each Point on the **Point Grid** is deflected with the **M#s** from the **Animation Source** that are linked to it, but without any modulation of the ODS data as with **Sine Dwell**. **Stationary Dwell** is most often used for displaying shapes using contour colors on **Point Grid** surfaces.

Point Grid graphics Area: The graphics area that contains the drawing Objects used to define the **Point Grid** used during an **EVA** to animate **ODS** data that was extracted from a video. The **Point Grid** used for displaying shapes in animation consists of rectangular grid of Points with Surface Quads connected between them.

Point Grid: The **Point Grid** in the **Point Grid graphics Area** is used for displaying Operating Deflection Shapes (**ODS's** in animation. A ***"stick model"*** consists of multiple ***Points with Lines between them***. A ***"surface model"*** has **Surve Triangles** and **Surface Quads** between Points. A ***"texture model"*** has textures added to its surfaces. A ***"photo realistic model"*** has digital photographs attached to its surfaces. A **Point Grid** has the frames of a digital video attached to its surfaces.

Surface Quad: A Surface Quad is a drawing Object that defines a surface ***between four Points*** on a **Point Grid**. Surfaces are used for hidden line displays, surface fills, surface textures, photo realistic models, and color contour displays. The properties of the Surface Quads on a **Point Grid** are displayed and edited by executing **Edit Point Grid** in the **hamburger** Menu on the left side of the MEscope window, and then pressing the **Surface Quads tab** on the bottom of the spreadsheet.

Surface Triangle: A Surface Triangle is a drawing Object that defines a surface ***between three Points*** on a **Point Grid**. Surfaces are used for hidden line displays, surface fills, surface textures, photo realistic models, and color contour displays. The properties of the Surface Triangles on a **Point Grid** are displayed and edited by executing **Edit Point Grid** in the **hamburger** Menu on the left side of the MEscope window, and then pressing the **Surface Triangles tab** on the bottom of the spreadsheet.

Sweep Animation: One of the three types of animation during an **EVA**. When **Sweep** is enabled, the cursor is moved through the samples of data from left to right, and the data at each cursor position is used to deflect each Point of the **Point Grid**. When **Sweep** is enabled, the video frame corresponding to the sample of data is also attached to the **Point Grid**.

T

Tool Tip: A Tool Tip is a brief description of each button (or Tool) on a Toolbar or Menu. A Tool Tip is displayed when the mouse pointer is hovered over a Toolbar or Menu.

Transform Window: The **Transform Window** is the block of **TWF** samples used by the **FFT** to calculate the **DFT** corresponding to the **TWF**. To create certain properties in its **DFT**, a special time domain windowing function (Hanning, Flat Top, Exponential, etc.) is often applied to the samples in the Transform Window before they are transformed into a **DFT**. The **Transform Window** is also called a Sampling Window.

Translational Data: The kind of shape data that is displayed in animation on a **Point Grid** modal in the . Examples are vibration and acoustic intensity. ***Each* Translational *measurement has a point & direction associated with it***. Measurement directions are defined by the **Measurement Axes** at each Point on the **Point Grid**. Shape data can be defined in ***up to three* Translational *directions*** at each Point.

Three-Graph Format: In the **three-graphs format**, the **Point Grid** graphics area is on the ***left side*** of the MEscope window, and the Data Block graphics are on the ***upper-right*** or ***lower-right side*** of the MEscope window.

The **TWFs** Data Block is displayed on the ***upper-right side*** and either **DFTs** Data Block or the **ODS-FRFs** Data Block is displayed on the ***lower-right side***.

Transmissibility (TRN): A Transmissibility is a cross-channel frequency domain measurement typically calculated from operational or output-only data. Transmissibility is defined as the ratio (**Output DFT / Input DFT**).

Operational mode shapes are obtained by saving the cursor values at a resonant frequency in a set of Transmissibility's. A set of **ODS-FRFs** is obtained by multiplying a single reference set of Transmissibility's by a reference Auto spectrum.

TWF: An acronym for **time waveform**. **TWFs** are extracted from a raw video of a vibrating machine or mechanical **Point Grid** using the **Video Wizard in MEscopeVIDEOS**.

TWFs Data Block: The **TWFs** that were extracted from a video using the **Video Wizard**.

U

UFF: UFF is an acronym for **Universal File Format**. **UFF** is a disk file format used for exchanging data between different structural testing & analysis systems. **Point Grid**s, mode shapes, **ODS's**, and time or frequency domain measurements can be imported & exported using **UFF** files. Typical **UFF** file name extensions are **.UFF**, **.UNV**, and **.ASC**.

V

Video ODS: A **Video ODS** is created when a high-speed video recording of a vibrating machine or **Point Grid** is post-processed to extract **TWF**s from it. The **TWF**s and their corresponding **DFTs** are then used to deflect the Points in a rectangular **Point Grid**.

During **ODS** animation, frames from the original video are pasted onto the rectangular surface of **Point Grid**s so that a ***photo-realistic* ODS** animation is created when the Points are deflected.

Video Wizard: A series of ***five steps*** that are carried out to extract the **TWFs** from frames of a video. Two **TWFs** are extracted for each point in a rectangular **Point Grid**, one **TWF** for ***vertical*** displacement of each point and one **TWF** for its ***horizontal*** displacement.

The five steps of the Video Wizard are **1) Adjust & Crop, 2) Frames & Elapsed Time, 3) Point Grids, 4) Scaling Distance, 5) TWF Magnitudes**.

X

XPS (Cross Power Spectrum): A Cross power spectrum is calculated by multiplying the Digital Fourier Transform (**DFT**) of an **M#** by the ***complex conjugate*** of the **DFT** of a **reference M#.** A **XPS** has both ***magnitude & phase***.

Z

Zoom-In, Zoom-Out: Zoom-In enlarges the display of the model in a **Point Grid** graphics area and **Zoom-Out** makes it smaller. **Zoom-In** displays fewer samples of data along the X-axis in a Data Block (**BLK**) graphics area and **Zoom-Out** displays more samples.