Orbit Magazine

Visualizing Anomalies

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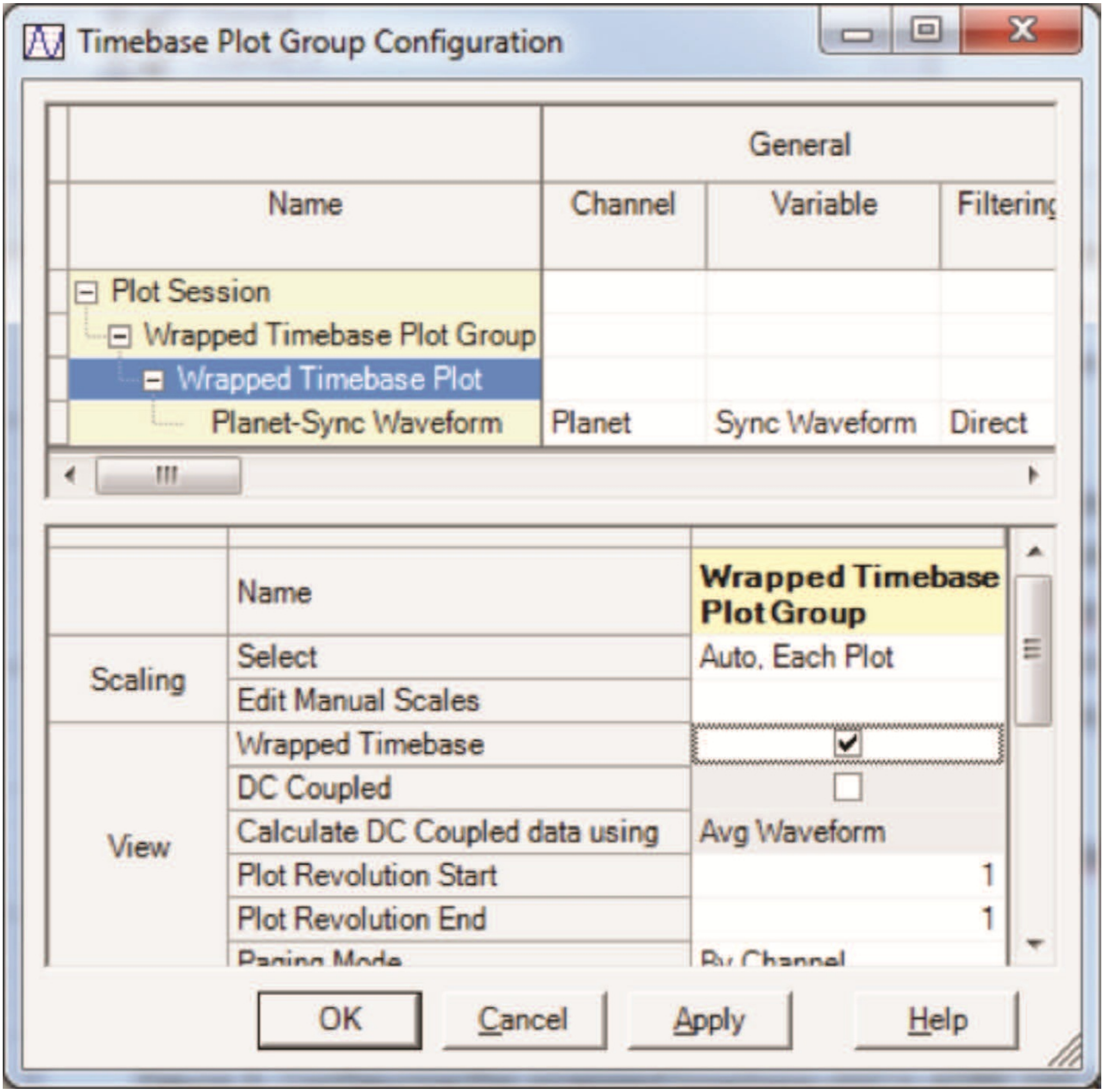


Visualizing Anomalies with the Wrapped Timebase Plot in

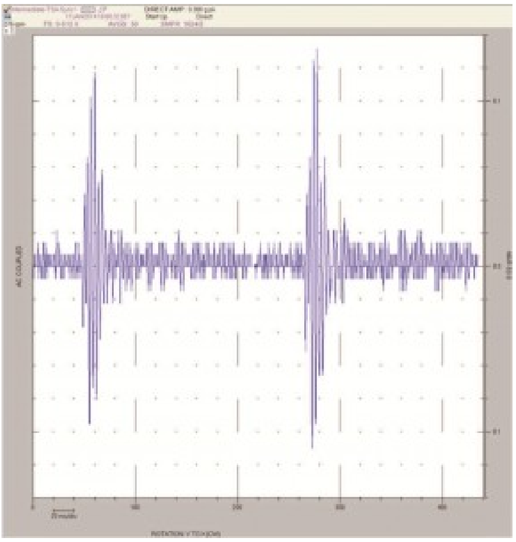
ADRE* Sxp 3.0 Software

RELEASED IN JANUARY 2014, ADRE Sxp 3.0 contains a new Wrapped Timebase plot feature. This new view of the timebase waveform is useful for visualizing how periodic anomalies as seen from a single vibration probe relate to the angular position of the rotor during its rotation. These circular waveform plots make repeatable anomalies show up more clearly when using synchronous sampling. Examples include a damaged tooth (or teeth) on a gear and wear in a fixed outer bearing race (especially if it is located in the load zone.)

Recall: A timebase plot is a presentation of the instantaneous amplitude of a signal as a function of time. When the instantaneous digital values are connected, the recreated waveform corresponds to a classic oscilloscope trace of the signal as seen in the time domain. Timebase plots are very commonly used to display vibration data in software such as ADRE Sxp and System 1*.

An example timebase plot is shown in Figure 1. In this example, synchronous data collection settings were established to create waveform records based on collecting 1024 instantaneous samples per revolution for a total of two revolutions in each record. 50 such waveform records were collected, and averaged together to create this TSA timebase plot.

A “wrapped timebase” plot in Sxp software displays the waveform data in a circular format, rather than an x-y plot. Figure 2 shows an example where this same waveform record (from 17JAN14, 10:00:32:857) is shown as a “wrapped” timebase. Each revolution of the monitored rotor is represented by a full circle. The full scale range of the vibration signal (0.28 g) is represented graphically by the distance between the inner and outer circles. The accelerometer signal is shown as “+” (toward the sensor) and “-“ (away from the sensor) about the dashed circle that represents the “0” value.



Note: One way to visualize why the angular values increase in the direction opposite to shaft rotation is to imagine the plot axes being printed on a piece of paper, which represents the rotor divided up into 360 degrees. As the shaft rotates, the probe stays in its fixed location – in this case at the true vertical orientation on top of the machine casing. In this example, the shaft (represented by the paper plot) turns clockwise. So relative to the vertical probe, the measured angle starts with 0 degrees, and counts upwards through 90, 180, 270, and then 360/0 degrees for each rotation of the shaft.

FIGURE 1: This example shows a Time Synchronous Averaged (TSA) vibration waveform record captured from an accelerometer on a wind turbine gearbox. The total time period shown on the x-axis is just under half a second which corresponds to the time required for the rotor to make two complete rotations. This familiar horizontal format mimics the traditional CRT trace on an analog oscilloscope. Red arrows indicate location of the Keyphasor* marks.

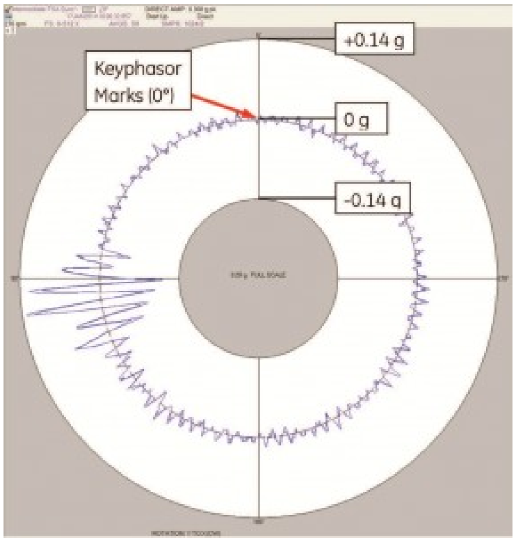


FIGURE 2: In this example, the same data from Figure 1 is shown in a wrapped timebase plot. The accelerometer is mounted vertically on the top of the monitored gearbox, where the 0 degree reference mark is shown on the plot. Rotation is clockwise, so, starting with the Keyphasor event, time increases (degrees of shaft rotation increase) in the counterclockwise direction around the outer circle of the plot. With machine speed of 276 rpm, each complete revolution takes about 0.217 seconds.

The data shown in Figures 1 and 2 is from a wind turbine gearbox shaft that carries an 82 tooth gear. The higher frequency oscillation at 82 times the shaft rotation frequency is caused by this gear. Viewing it in the wrapped timebase plot, we can see how the vibration relates to the shaft rotation angle. In this case we can see that there is an anomaly related to broken gear teeth at about 90 to 95 degrees phase lag from the Keyphasor triggering feature.

The data shown in Figures 1 and 2 is collected with Time Synchronous Averaging (TSA). TSA can filter out non-synchronous vibration from the waveform, leaving only vibration information that is synchronous with shaft rotation. Since the wrapped timebase shows vibration as it relates to the revolution of a shaft, it is useful to filter out non-synchronous vibration, and only show synchronous vibration. When TSA is used, a single revolution shown on the plot represents many actual revolutions of the shaft averaged together.

Configure a timebase plot as a wrapped timebase in the timebase plot group configuration by selecting the Wrapped Timebase option as shown in Figure 3.

Note: The Wrapped Timebase Plot only applies to synchronous waveforms. Asynchronous waveforms in a plot group configured for wrapped timebase will simply be shown as traditional timebase plots.

* Denotes a trademark of Bently Nevada, Inc., a wholly owned subsidiary of General Electric Company.