Application Note

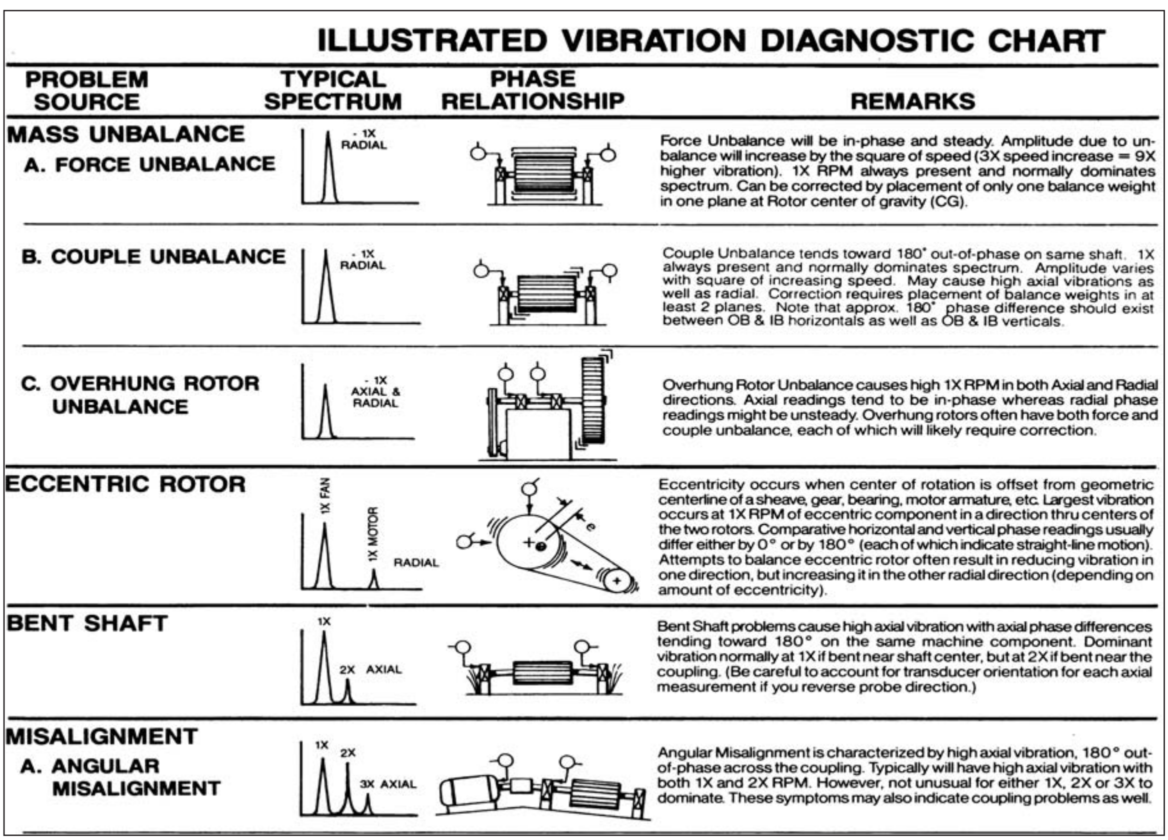
Phase Analysis

Phase Measurements in the SKF Microlog Series

Phase analysis

Phase analysis is vitally important when diagnosing problems in rotating machinery. Correct diagnosis of a machine condition will often depend on the information phase gives us. The chart in **Figure 1** denotes some typical machine faults and, as you can see, the relative phase changes with different fault types:

The SKF Microlog series of instruments uses two different techniques to calculate the cross channel phase.



ILLUSTRATED VIBRATION DIAGNOSTIC CHART

PROBLEM SOURCE	TYPICAL SPECTRUM	PHASE RELATIONSHIP	REMARKS
MASS UNBALANCE A. FORCE UNBALANCE	- 1X RADIAL		Force Unbalance will be in-phase and steady. Amplitude due to unbalance will increase by the square of speed (3X speed increase = 9X higher vibration). 1X RPM always present and normally dominates spectrum. Can be corrected by placement of only one balance weight in one plane at Rotor center of gravity (CG).
B. COUPLE UNBALANCE	- 1X RADIAL		Couple Unbalance tends toward 180° out-of-phase on same shaft. 1X always present and normally dominates spectrum. Amplitude varies with square of increasing speed. May cause high axial vibrations as well as radial. Correction requires placement of balance weights in at least 2 planes. Note that approx. 180° phase difference should exist between OB & IB horizontals as well as OB & IB verticals.
C. OVERHUNG ROTOR UNBALANCE	- 1X AXIAL & RADIAL		Overhung Rotor Unbalance causes high 1X RPM in both Axial and Radial directions. Axial readings tend to be in-phase whereas radial phase readings might be unsteady. Overhung rotors often have both force and couple unbalance, each of which will likely require correction.
ECCENTRIC ROTOR	1X FAN, 1X MOTOR, RADIAL	e	Eccentricity occurs when center of rotation is offset from geometric centerline of a sheave, gear, bearing, motor armature, etc. Largest vibration occurs at 1X RPM of eccentric component in a direction thru centers of the two rotors. Comparative horizontal and vertical phase readings usually differ either by 0° or by 180° (each of which indicate straight-line motion). Attempts to balance eccentric rotor often result in reducing vibration in one direction, but increasing it in the other radial direction (depending on amount of eccentricity).
BENT SHAFT	1X, 2X AXIAL		Bent Shaft problems cause high axial vibration with axial phase differences tending toward 180° on the same machine component. Dominant vibration normally at 1X if bent near shaft center, but at 2X if bent near the coupling. (Be careful to account for transducer orientation for each axial measurement if you reverse probe direction.)
MISALIGNMENT A. ANGULAR MISALIGNMENT	1X, 2X, 3X AXIAL		Angular Misalignment is characterized by high axial vibration, 180° out-of-phase across the coupling. Typically will have high axial vibration with both 1X and 2X RPM. However, not unusual for either 1X, 2X or 3X to dominate. These symptoms may also indicate coupling problems as well.

Figure 1. Illustrated Vibration Diagnostic Chart (extract by permission of Technical Associates of Charlotte).

Route mode phase analysis – single channel with tachometer

When collecting single channel phase data in a route, a tachometer such as the CMAC 5030-K is required to be connected to the trigger channel of the SKF Microlog. The tachometer is left in the same position for the entire machine route collection.

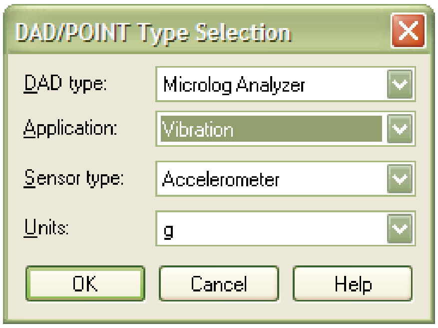


Figure 2. Point type setup for single channel.

In the **POINT Properties** Setup tab, make sure the **Freq. type** is set to **Order track** and **Save data** is set to **FFT and phase**:

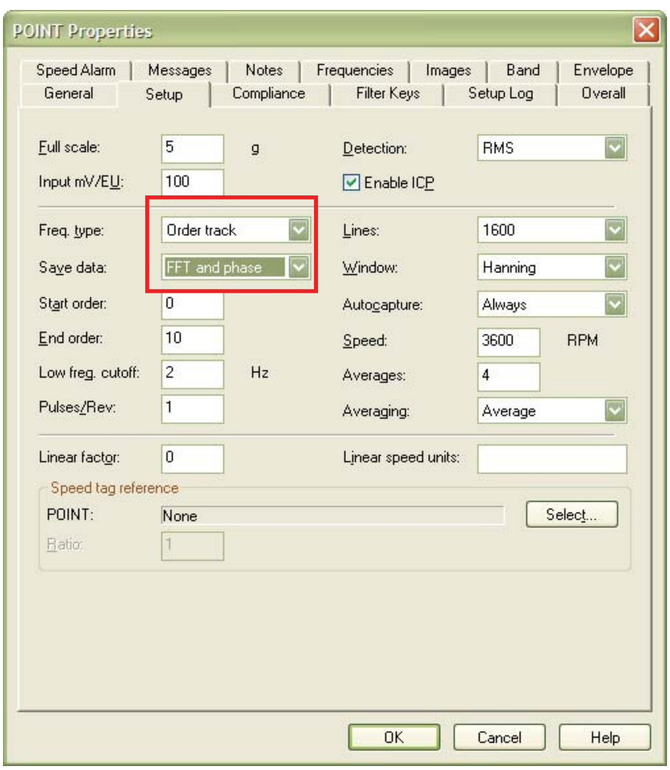


Figure 3. POINT Properties Setup tab.

When the data has been collected for a measurement point, you can review the information. The spectrum and the first eight orders are shown on the screen.

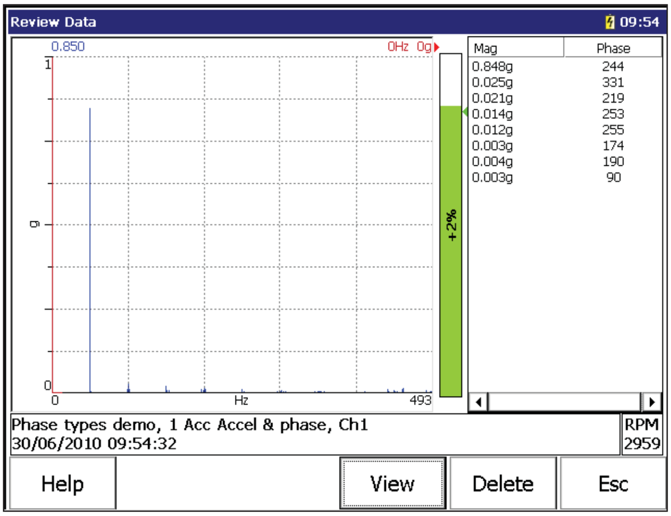


Figure 4. Review Data screen.

Note: The phase angle shown is calculated in relationship with the position of the tachometer, and on its own it has no meaning. A second reading from another point on the machine must be acquired so a cross channel calculation can be made.

In **Figure 5**, the phase is captured during the first route point and shows a phase angle of 244°. The phase of the second route point (**Figure 6**) is 349°.

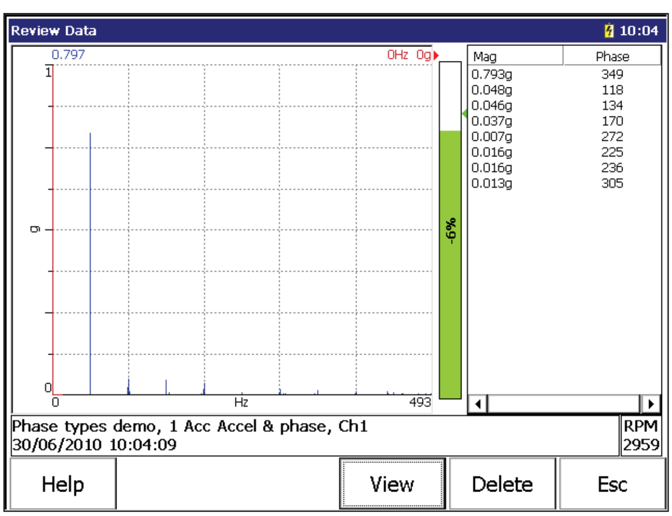


Figure 5. Review Data screen.

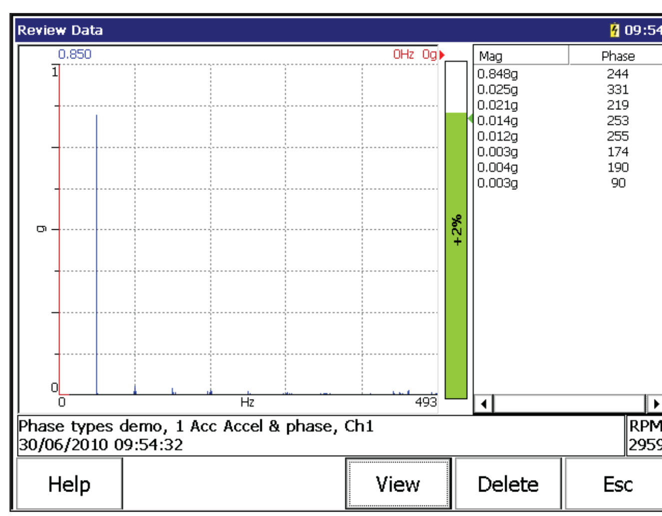


Figure 6. Review Data Screen.

In **Figure 7** you can see that the phase difference between the two is 90°.

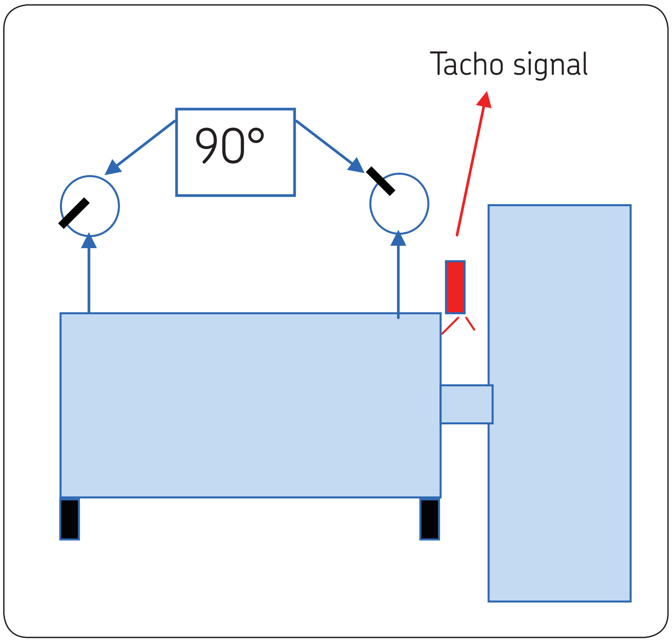


Figure 7. Phase difference is 90°.

Route mode phase analysis – two channel without tachometer

When collecting two channel phase data in a route, a tachometer is not required; the cross channel phase is calculated between the two accelerometers.

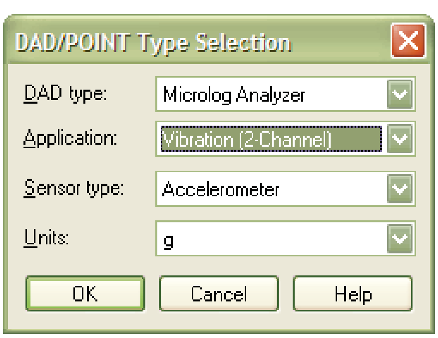


Figure 8. Point type setup for two channel.

In the POINT Properties Setup tab, make sure the **Freq. type** is set to **Order track** and **Save data** is set to **FFT and phase**.

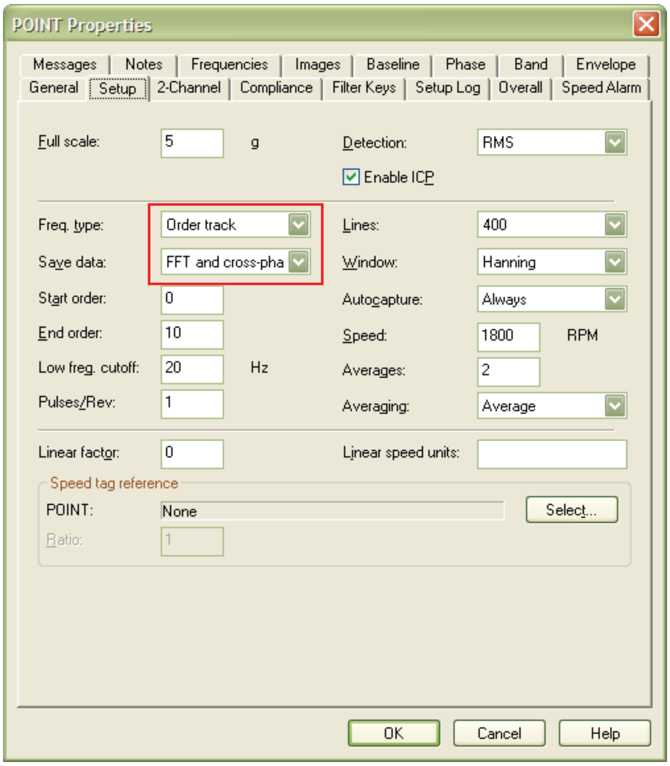


Figure 9. POINT Properties Setup tab.

When collecting cross channel phase from two accelerometers, the first thing required is to set the machine speed by either typing it in manually (use **TYPE IN** function key) or locate the 1X peak from the spectrum (use **Spec** function key). Once the data has been captured, you can review it.

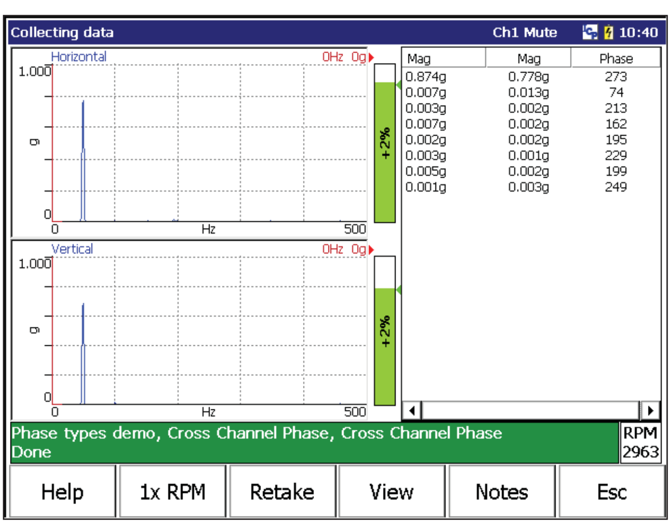


Figure 10. Collecting Data screen.

In the next example the cross channel phase is calculated between the two accelerometer channels. The phase of the first eight orders are shown in **Figure 11**.

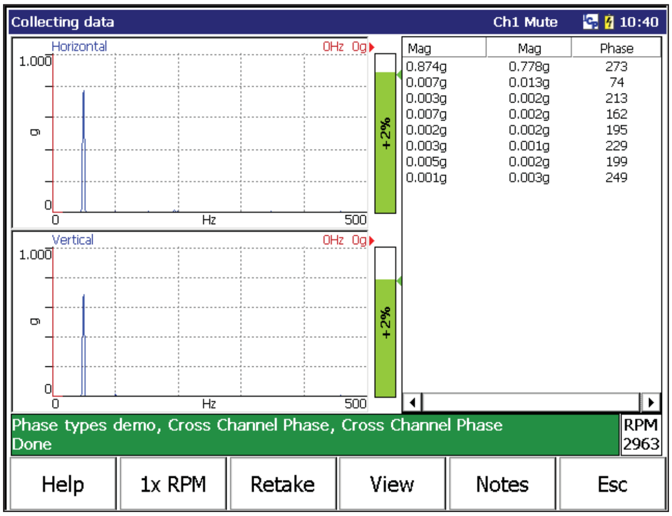


Figure 11. Collecting Data screen.

In this case, the phase of channel 1 is normalized to the 0° position as the reference channel. The phase difference of channel 2 is then calculated. As can be seen, the difference is 273°.

When drawn, as shown in **Figure 12**, the machine shows a 90° difference between the channels (the same 90° as when using a single channel and a tachometer).

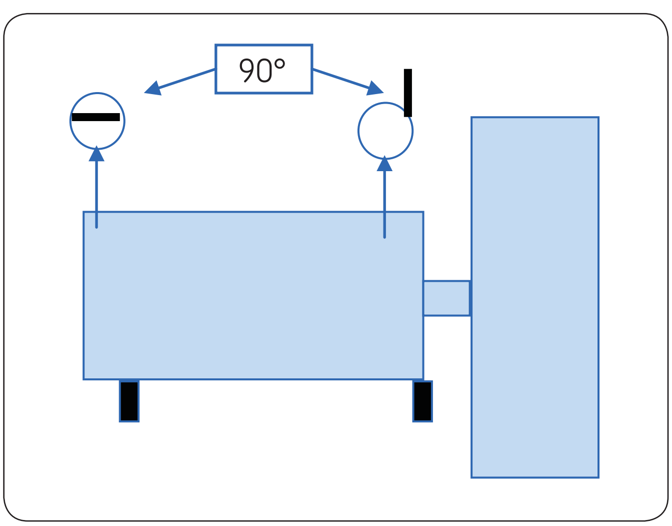


Figure 12. 90° difference between channels.

The advantage here is that we have not had to stop the machine to attach tape from where the tachometer will work.

Non-route mode phase analysis – single channel with tachometer

When collecting single channel phase data in a non-route, a tachometer such as the CMAC 5030-K is required to be connected to the trigger channel of the SKF Microlog.

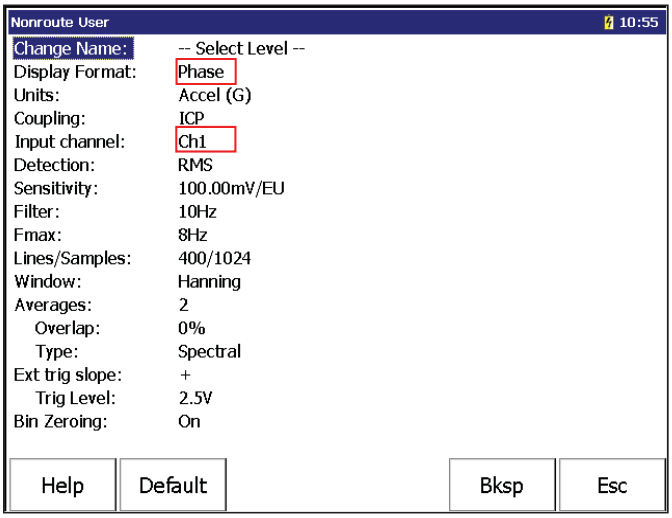


Figure 13. Non-route user settings.

Non-route mode phase analysis – two channel without tachometer

When collecting two channel phase data in a non-route, a tachometer is not required. The cross channel phase is calculated between the two accelerometers.

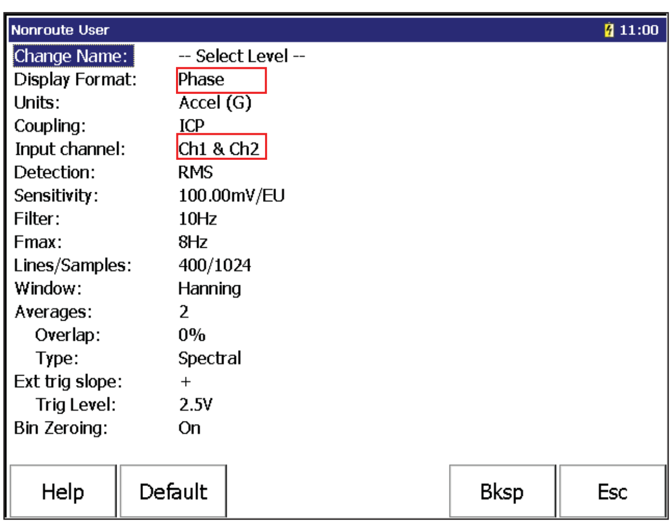


Figure 14. Non-route user settings.

Phase analysis – two channel without tachometer – analyzer module

When collecting two channel phase data in the Analyzer module, a tachometer is not required. The cross channel phase is calculated between the two accelerometers.

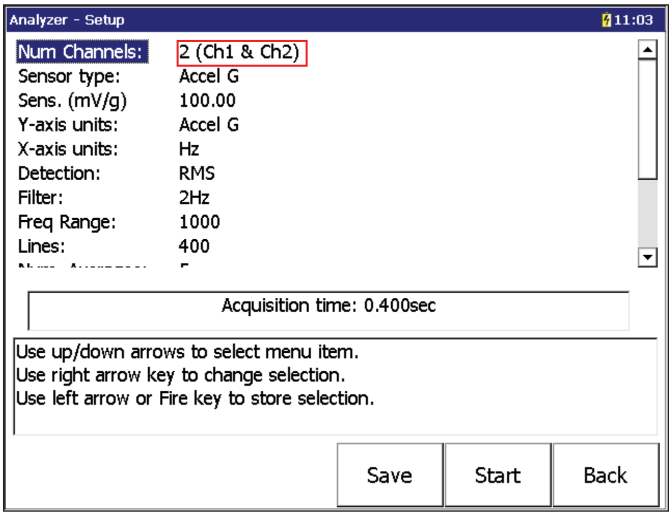


Figure 15. Analyzer – Setup screen (top half).

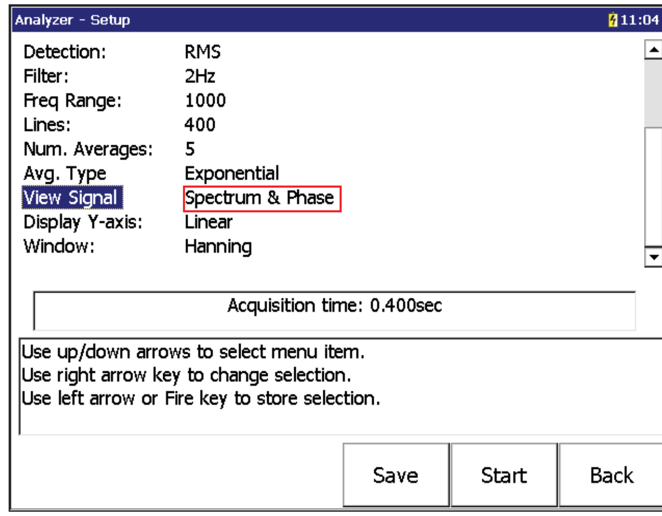


Figure 16. Analyzer – Setup screen (lower half).

In the Analyzer module, the cross channel phase is shown in the top left-hand corner of the screen as a vector and numerically. It is also shown numerically in the info box at the bottom of the screen.

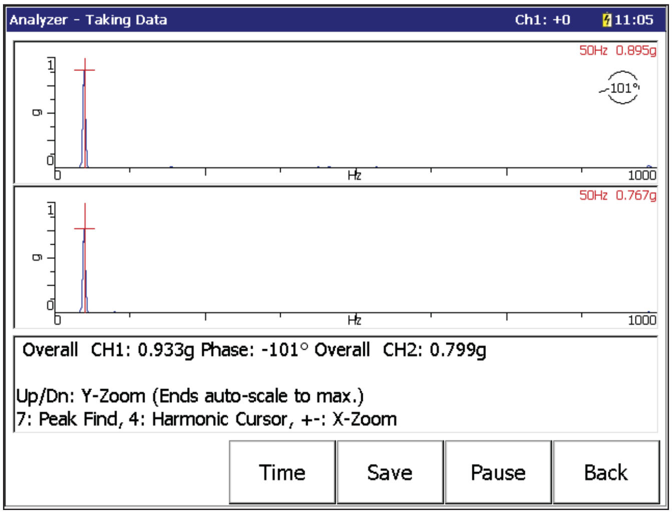


Figure 17. Analyzer – Taking Data screen.

Note: The cross channel phase indication is synchronized with the cursor. You **must** place the cursor on the running speed or a multiple to correctly indicate the cross channel phase.

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