Detection of the Rotational Direction of a Shaft in SKF @ptitude Observer 9.1

Introduction

In some applications, it is important to control data collection with respect to the direction of the shaft rotation. This information is crucial in applications like rolling mills, shovels and draglines, since defects are more visible in a vibration spectra when the machine is under load. This kind of measurement can be complemented with gating (see application note CM3175, Gating Set up in SKF @ptitude Observer 9.1) to be able to collect vibration data when the machine is, for example, operating at a certain load and rotational speed.

To measure the rotational direction, we are going to use the time difference between two pulse measurements on a disc (see fig. 2). In this case, when the difference is positive, e.g., pulse 2 is later than pulse 1, the direction is forward. When the difference is negative, e.g., pulse 1 is later than pulse 2, the direction is reverse.

The result of the measurement can directly be used in a vibration measurement as a condition when to take the measurements.
Procedure

Step 1: Install two tachometers for measuring the rotational speed and one trigger point on the rotating disc. The two tachometers shall be close to each other. See the laboratory set up in fig. 2.

Step 2: Initiate an SKF Multilog IMx device and create two digital channels, and then create two measurement points for the rotational speed of the shaft.

1. Digital channels: Go to the main menu, in fig. 3a, and choose “On-line”, and then select “IMx/MasCon devices”. The window in fig. 3b will be opened. Then click the Initiate button in the area called “Digital channels” to create the two digital channels in figs. 4a and 4b. These channels are called “Rot. speed 1” and “Rot. speed 2”.

Fig. 3a. Select “IMx/MasCon devices” in the drop down menu.
The created IMx-S device called "IMx_1" is highlighted.

Press Initiate to create an IMx device.

Press Initiate to create a "Digital" channel for the rotational speed of the shaft.

**Fig. 3b.** The "IMx/MasCon devices" window for set up of an IMx device and channels.

**Fig. 4a.** Set up of digital channel 1 for the measurement point "Rot. Speed 1".

**Fig. 4b.** Set up of digital channel 2 for the measurement point "Rot. Speed 2".
2. Create a “Speed (IMx)” measurement point for each “Digital channel” in figs. 4a and 4b. Right-click on the machine “Fan 1” in fig. 3a. A drop down list will be visible. Then click on the option “Add” and select “Meas. Point” to view the window called “New meas. point” in fig. 6. Select the measurement point called “Speed”, which is marked with a green circle. The window in fig. 5a will then be opened. Add an IMx device and the earlier created digital channel “Rot. speed 1”. In this case, an IMx-S unit called “IMx_1” was selected. Repeat the procedure for the second measurement point called “Rot. speed 2.”

Note: See Step 5 to learn about which of the digital channels in the IMx that can be used for this application.

Fig. 5a. Set up of the rotational speed of the shaft on digital channel 1.

Fig. 5b. Set up of the rotational speed of the shaft on digital channel 2.
Step 3: Create and configure a "Time difference" measurement point (in red) to calculate the time difference between the two trig pulses from the tachometers (see figs. 6 and 7).

Fig. 6. Select the "Time difference" measurement point.

Fig. 7. Configuration of the "Time difference (IMx)" measurement point for the "Detection of the rotational direction of the shaft."
Step 4: A “Dynamic” vibration measurement point has to be created to be able to trend the “time difference”, see fig. 6. For this purpose, a vibration sensor has to be selected on the machine. This can be any vibration sensor on the machine. In this case, the dynamic measurement point “Motor NDE” was selected on the machine Fan 1 (see fig. 8).

- In the “Simultaneous measurements” section on the “Acquisition” tab (in blue), one of the “Rotational speed points” needs to be selected as a Speed meas. It doesn’t matter which one you select. In this case, the “Speed” measurement point called “Rotational speed – 1” was selected (see fig. 9).
- In the “Simultaneous measurements”, a process point called “Direction of rotational direction of the shaft” has to be selected as a Process meas. in the “Simultaneous measurements”. These two settings are marked with a red box in fig. 9.
- See also the necessary settings for the “Active range” on the “Operating and Storage Conditions” tab (in green) in fig. 10. In the example in fig. 10, the measurement data are only collected when the operating conditions are met. If the rotational direction point is included in the conditions, the collection of data will only take place in one of the directions.

Note: If the data also needs to be collected in the other direction, a second vibration measurement point must be created.

Fig. 8. Create a vibration measurement point.
Select a vibration point on your machine, and also select one of the rotational speed measurement points, plus the process measurement point, which in this case is called “Direction of rotational direction of the shaft”!

![Diagram of vibration point configuration](image)

**Fig. 9.** A vibration point is created for configuring of the "Active range" settings on the "Time difference" measurement point on the "Operating and Storage Conditions" tab.

- A frequency range and number of lines must be selected for the vibration spectra, even if it is not used for this application.
- The "Rotational speed 1" is selected as a simultaneous measurement, together with the "Process meas." called "Detection of rotational direction of shaft".

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In this case, the direction of rotation is counter clockwise, but if we configure as +2 to 0, the direction of the rotation would be in the clockwise direction.

In this case, data is collected in the speed range of 800 to 1100 RPM.

Fig. 10. An example of a condition when data is collected on the machine.
Step 5: Configure the hardware (HW) settings on the I/O board in the IMx-S device, for the sensor in fig. 2. In table 1, this sensor is called 'Tacho 2-wire'.

The digital inputs 1 to 4 (Dig 1 to Dig 4) can be configured via the DIP switches on the I/O board. The DIP switches for the sensors must be set according to table 1. The sensor that was used in fig. 2 is marked with a red box in table 1. This digital sensor input is called 'Tacho 2-wire'.

The digital inputs 5 to 8 are non-configurable inputs. They are only used for externally powered sensors, with a pulse level of 12 to 24 V; see the black box in table 2. Note: The shape of the signal has to be a square wave.

![Fig. 11. The digital inputs 1-8 on the IMx-S I/O board.](image)
<table>
<thead>
<tr>
<th>Signal</th>
<th>Terminal</th>
<th>DIP Settings position: 1234</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tacho 2-wire</td>
<td>+</td>
<td>A</td>
</tr>
<tr>
<td>(24 V internally powered, max 30 mA)</td>
<td>–</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>N.C.</td>
<td>0</td>
</tr>
<tr>
<td>Tacho 3-wire NPN</td>
<td>Brown (+24 V)</td>
<td>A</td>
</tr>
<tr>
<td>(24 V internally powered, max 30 mA)</td>
<td>Black (Signal)</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Blue (0 V)</td>
<td>0</td>
</tr>
<tr>
<td>Tacho 3-wire PNP</td>
<td>Brown (+24 V)</td>
<td>A</td>
</tr>
<tr>
<td>(24 V internally powered, max 30 mA)</td>
<td>Black (Signal)</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Blue (0 V)</td>
<td>0</td>
</tr>
<tr>
<td>Pulse 12-24 V</td>
<td>+</td>
<td>A</td>
</tr>
<tr>
<td>(external power)</td>
<td>–</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>N.C.</td>
<td>0</td>
</tr>
<tr>
<td>Pulse TTL</td>
<td>N.C.</td>
<td>A</td>
</tr>
<tr>
<td>(external power)</td>
<td>+</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 1. The IMx terminal list for the internally powered Digital inputs 1-4 DIP switch setting for digital sensors.

<table>
<thead>
<tr>
<th>Signal</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse 12-24 V</td>
<td>+</td>
<td>A</td>
</tr>
<tr>
<td>(external power)</td>
<td>–</td>
<td>B</td>
</tr>
</tbody>
</table>

Table 2. The IMx terminal list for the externally powered Digital inputs 5 to 8.

Note: Please also refer to the SKF Multilog IMx-S User Manual if needed.
Step 6: There is a positive and a negative time difference for this type of measurement (see fig. 12). For the set up in this example, a positive time difference corresponds to a clockwise direction of the shaft, and a negative time difference corresponds to a counter clockwise direction of the shaft.

**NOTE.** This observation of the rotational direction needs to be done by the person who set up the system. When you start up the system, you need to make a note which direction corresponds to the + or – sign in the trend.

![Fig. 12. The trend diagram for the time difference measurement point.](image)

In this case, the rotational direction of the shaft has a **positive (+)** time difference between the two trig pulses in fig. 2.

In the opposite direction, the time difference has **negative (–)** time difference between the two trig pulses.
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