

CF-4700 FFT Comparator Option

CF-0473 Amplitude Modulation Component

Extraction Function



About the CF-0473 Amplitude Modulation Component Extraction Function :

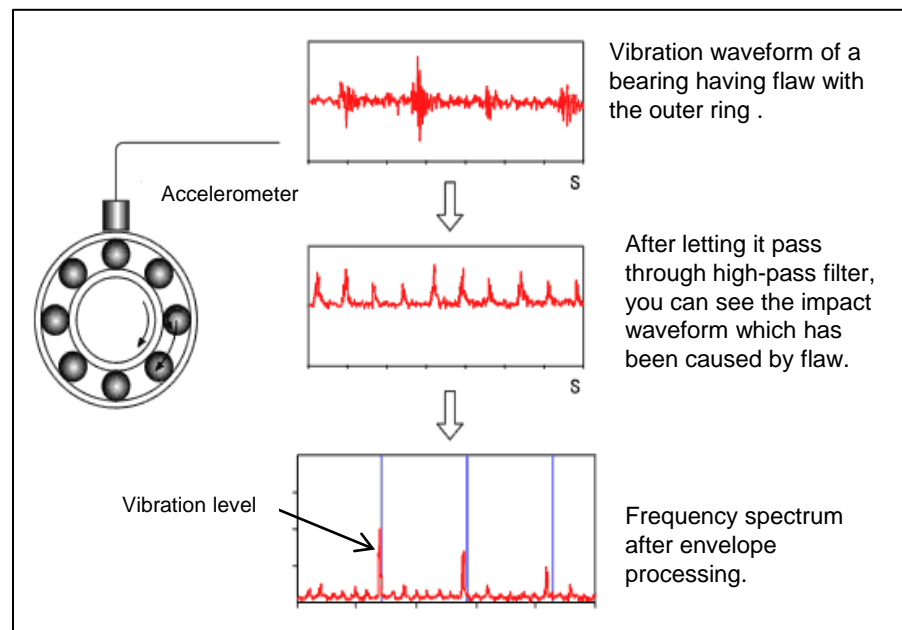
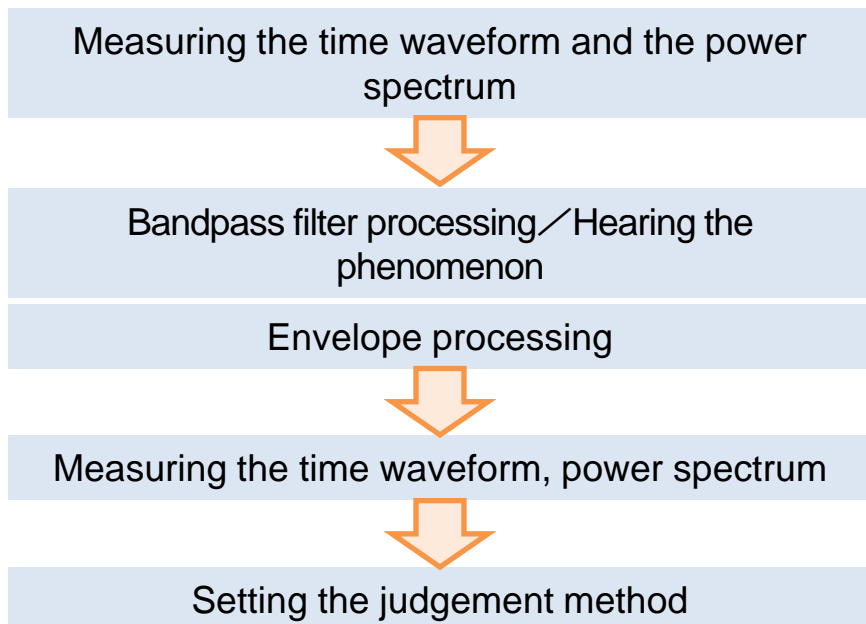
This option is to extract the amplitude modulation component by using the bandpass filter and the envelope processing function. The judgement is made from the amplitude modulation component.

For example, it is possible to

- ① measure the vibration waveform caused by a damaged bearing of a rotating body.
- ② to measure the cause of bearing damage and extent of damage while hearing the sound by filtering and envelope processing.

This procedure manual is a measurement example of the bearing vibration of a rotating body.

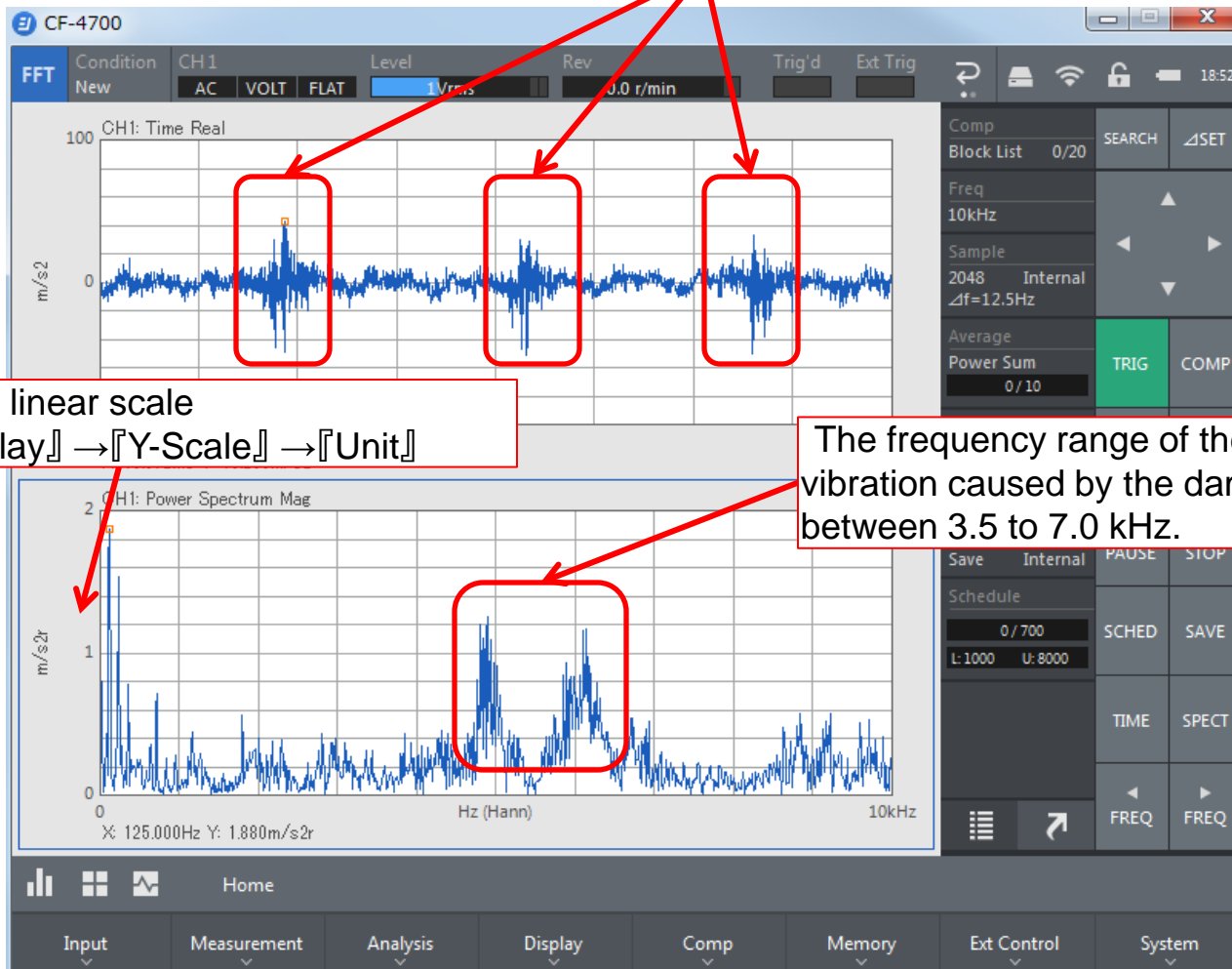
(Measurement flow)



1. Measuring the time waveform and the power spectrum

Turn on the power supply setting for the sensor (CCLD), set the calibration value, set the voltage and the frequency range. In the below measurement example, the frequency range was set to 10 kHz and the Y-axis of the power spectrum was set to linear scale.

Vibration waveform of a bearing with a damaged outer ring



Set the Y-axis to linear scale

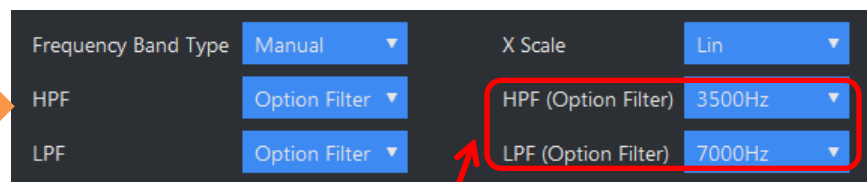
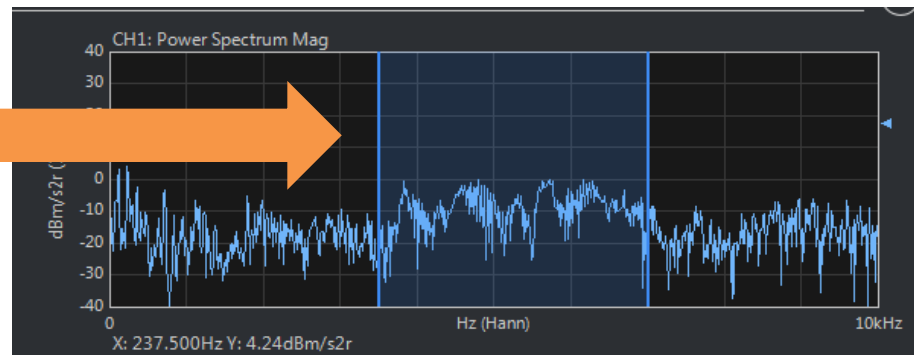
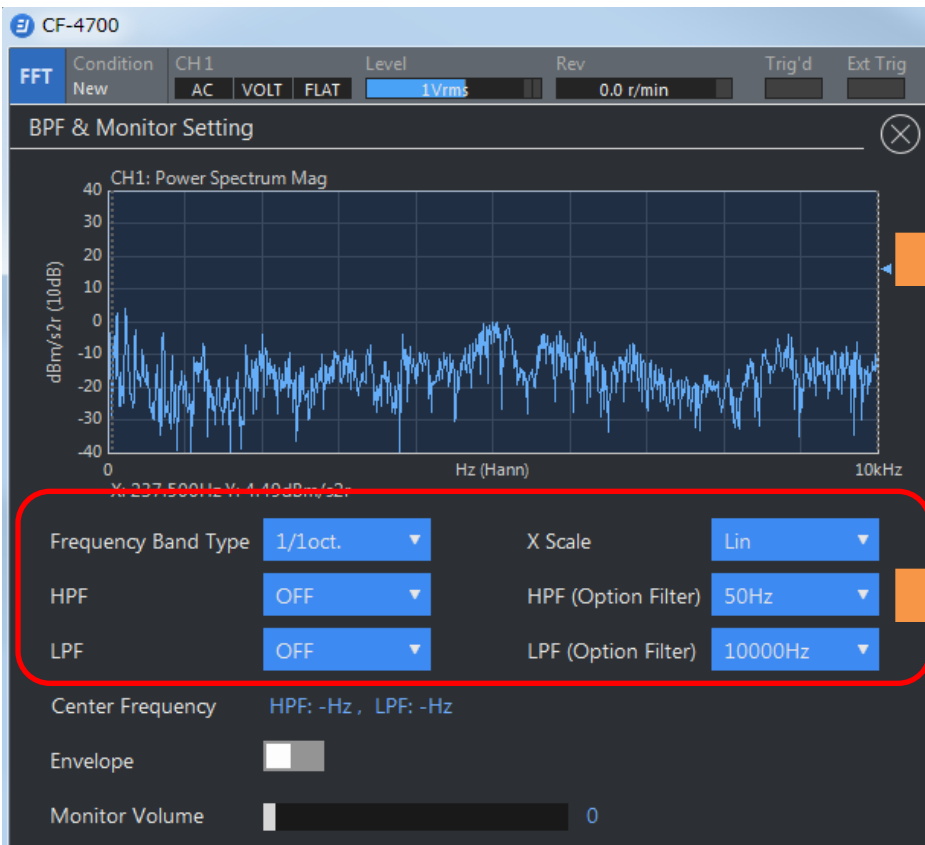
『Home』→『Display』→『Y-Scale』→『Unit』

The frequency range of the vibration caused by the damage is between 3.5 to 7.0 kHz.

2. Bandpass filtering and envelop processing

『Home』 → 『Input』 → 『BPF&Monitor』

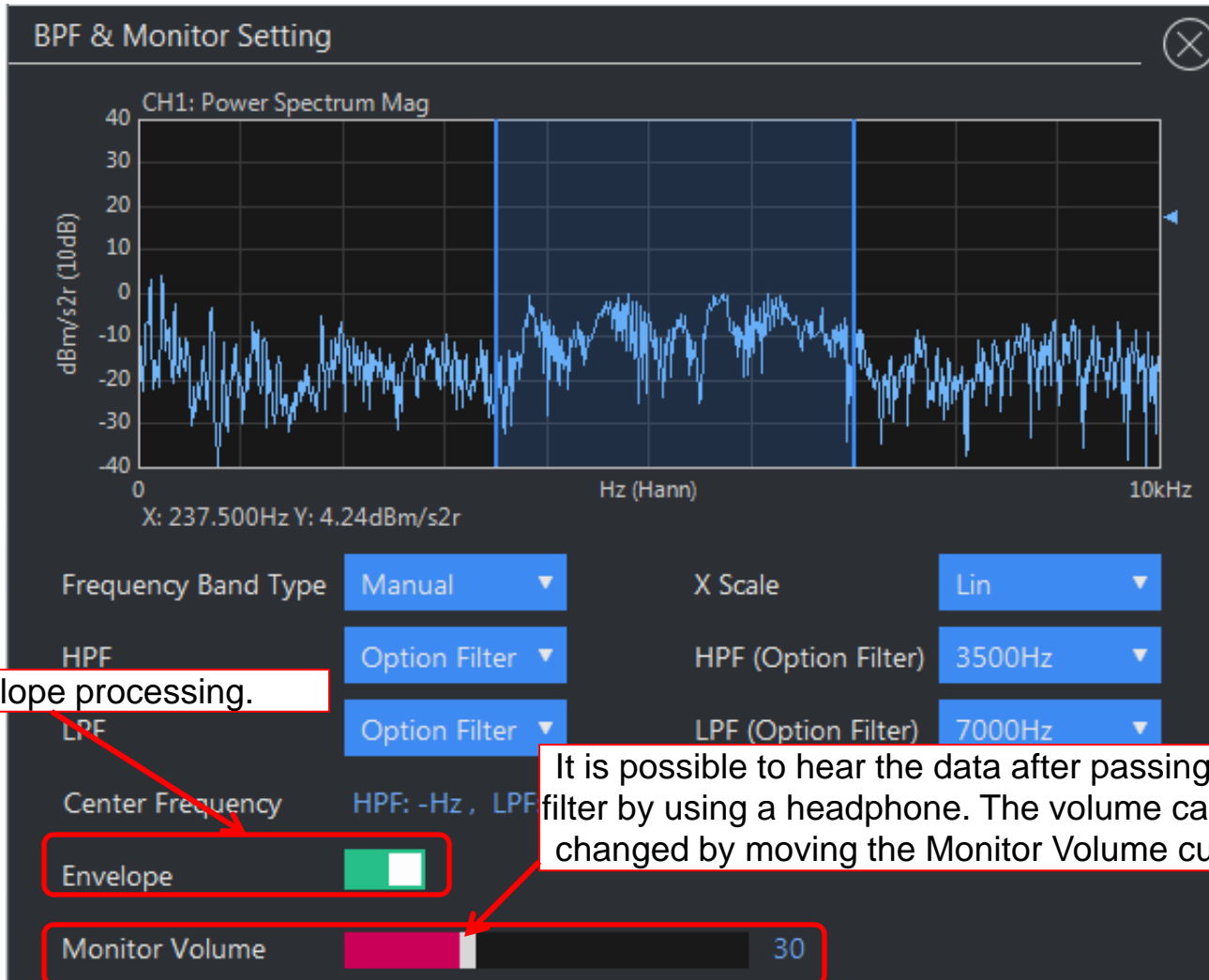
From the power spectrum waveform, the vibration waveform caused by the damaged bearing is found in the frequency range between 3.5 to 7.0 kHz. Cut off all other frequencies.



The frequency values can be set freely by using the option filter. Also the frequency width and range can be changed by touching the screen.

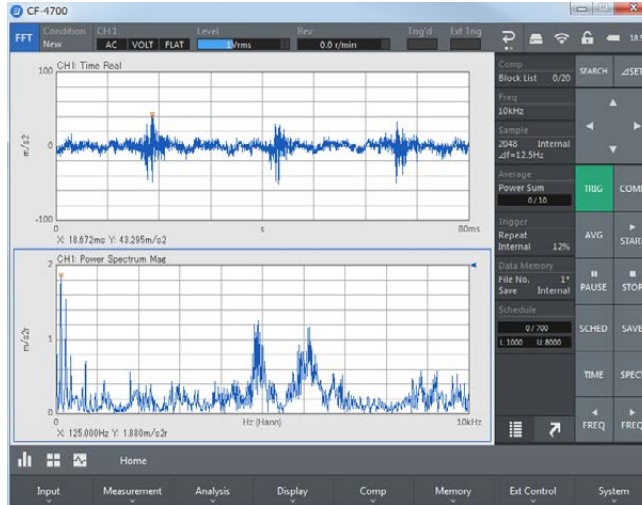
3. Envelope processing

Turn ON the envelope switch.

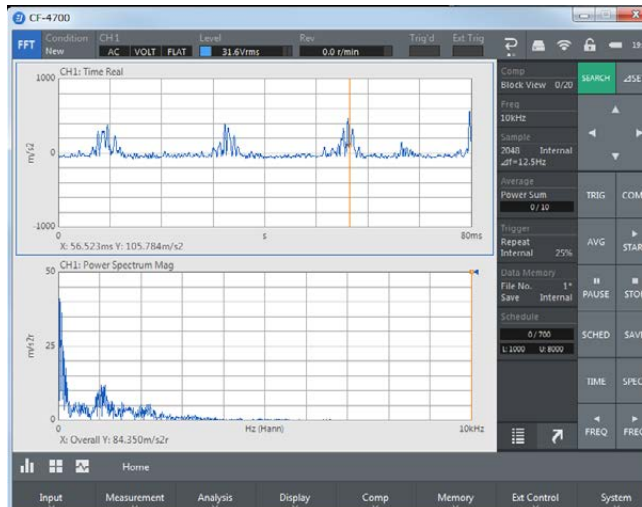


4. Analyzing the waveform after filtering or envelope processing

Original waveform



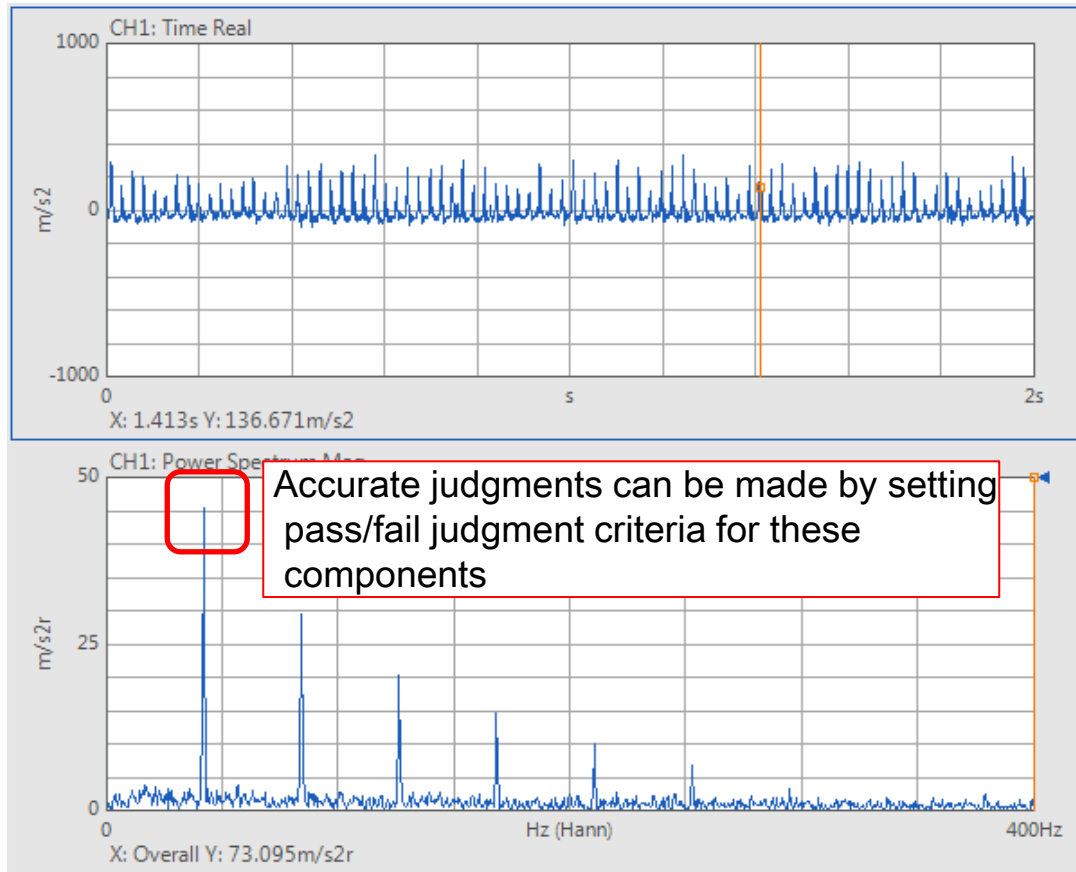
Waveform after processing



By performing a FFT analysis for the periods caused by the damaged bearing, the extent of the damage can be examined exactly.

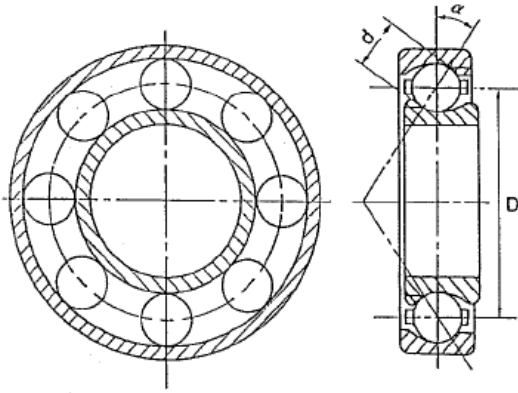
5. Determining the threshold value of the pass/fail judgment

Change the frequency range from 10 kHz to 400 Hz. By looking at the power spectrum, you can see that there is peak at 42 Hz. This vibration is caused by a damage of the inner ring of a rotating body (details on the next page). The CF-0473 Amplitude Modulation Component Extraction Function enables you to examine and determine the vibration frequency and the level caused by a damaged bearing of a rotating body.



Supplement: About the vibration frequency caused by a damaged bearing

The rotation speed of the rotating body is about 400 r/min. The following formula can predict and verify the frequency to be generated.



[Bearing specification]

- Pitch circle diameter (D) : 310
- Number of rolling elements (Z) : 15
- Rolling element diameter (d) : 50
- Contact angle (α) : 0
- Number of revolution (f_0) : 400 r/min \doteq 6.67 (Hz)

$$f_{in} = \frac{Z}{2} f_0 \left(1 + \frac{d}{D} \cos \alpha\right)$$

Vibration frequency generated by a damage of the inner ring

$$f_{out} = \frac{Z}{2} f_0 \left(1 - \frac{d}{D} \cos \alpha\right)$$

Vibration frequency generated by a damage of the outer ring

$$f_{ball} = f_0 \frac{D}{\alpha} \left\{1 - \left(\frac{d}{D}\right)^2 \cos^2 \alpha\right\}$$

Vibration frequency generated by a damage of the rolling elements

Reference URL

https://www.onosokki.co.jp/HP-WK/products/application/bearing_1.htm

[Vibration frequency generated by a damage of the outer ring]

$$f_{out} = \frac{Z}{2} f_0 \left(1 - \frac{d}{D} \cos \alpha\right) = \frac{15}{2} * 6.67 * \left(1 - \frac{50}{310}\right) = 41.95(\text{Hz})$$

The value is very close to the obtained experimental results.