Rolling Bearing Defect Frequencies (BPFO, BPFI, BSF, FTF)

Outer race, inner race, ball spin and cage frequencies of a rolling element bearing from shaft speed, number of balls, ball and pitch diameters and contact angle.

Method: Rolling-bearing kinematics (Harris and Kotzalas, Rolling Bearing Analysis)

Input parameters

Unit system: SI

Parameter	Value	Unit
Shaft speed	1,480.0	rpm
Number of rolling elements	9.0000	
Rolling element diameter	12.700	mm
Pitch diameter	71.500	mm
Contact angle	0	°

Calculated results

Parameter	Value	Unit
Ball pass frequency, outer race	91.284	Hz
Ball pass frequency, inner race	130.72	Hz
Ball spin frequency	67.245	Hz
Fundamental train (cage) frequency	10.143	Hz

Notes for this case

- Kinematic frequencies with no slip; real peaks lie within a few per cent. Results in Hz; multiply by 60 for cycles per minute.

Formula and method

$$BPFO = \frac{n}{2} f_r \left(1 - \frac{d}{D}\cos\varphi\right), \quad BPFI = \frac{n}{2} f_r \left(1 + \frac{d}{D}\cos\varphi\right)$$

$$BSF = \frac{D}{2d} f_r \left[1 - \left(\frac{d}{D}\cos\varphi\right)^2\right], \quad FTF = \frac{f_r}{2}\left(1 - \frac{d}{D}\cos\varphi\right)$$

Variables

f_r	Shaft speed	1/s
n	Number of rolling elements	-
d	Rolling element diameter	m
D	Pitch diameter	m
φ	Contact angle	rad
$BPFO$	Ball pass frequency, outer race	1/s
$BPFI$	Ball pass frequency, inner race	1/s
BSF	Ball spin frequency	1/s
FTF	Fundamental train (cage) frequency	1/s

Method and standards

Rolling without slip.

Assumptions and limits

- No slip, outer race fixed.
- Rotating outer race with a fixed inner race (some wheel hubs and idlers) is not offered: there the cage turns at f_r/2 (1 + d/D cos

φ) and the race frequencies change accordingly.
- The number of rolling elements must be a whole number.

References
- Rolling-bearing kinematics (Harris and Kotzalas, Rolling Bearing Analysis)

Report details

Report reference	FCC-4Q9H-ZSQ4 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online
https://calc.firecad.com/instrumentation/vibration-noise/bearing-defect-frequencies

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Reopens the calculator with the inputs of this report.