

FLUKE®

Reliability

VIBXPERT® EX

db® PRÜFTECHNIK

**Operating Instructions
Balancing**

VIBXPERT[®] EX

Dual channel
FFT data collector and
signal analyzer with
intrinsic safety

'Balancing' Operating Instructions

Series: VIB 5.300 EX

Firmware: 2.3x

Edition: January 2017

Order no.: VIB 9.806.G

Translation of the german manual

LEGAL NOTES

Copyright

Both this manual and the product it describes are copyrighted. All rights belong to the publisher. The manual may not be copied, reproduced, translated or made accessible to a third party in any form, neither in its entirety nor as an excerpt.

Disclaimer

No liability may be claimed against the publisher regarding the product described in this manual. The publisher assumes no liability for accuracy of the manual contents. Furthermore, under no circumstances may the publisher be held liable for direct or indirect damage of any kind resulting from use of the product or the manual, even if the publisher has expressly indicated the potential for occurrence of such damage. The publisher assumes no liability for any product defects. This warranty and liability limitation applies to all distributors and sales partners as well.

Trademarks

The trademarks mentioned in this manual are generally noted as such and are the property of their owners. Lack of such designation does not imply, however, that names are not protected by trademark laws.

© Fluke Corporation, all rights reserved

Foreword

Congratulations! And thank you for choosing the dynamic balancing option in one or two planes to expand your VIBXPERT EX FFT data collector and signal analyzer*.

* Also called 'VIBXPERT EX' and 'measurement instrument' in this manual.

The balancing module is based on the well-known "influencing coefficients method" and is distinguished by its efficiency and ease of use. The measurement process implemented in the instrument has been optimized by a new knowledge-based algorithm. Perfectly matched measurement settings save time-intensive preparation and also enable the automation of recurrent tasks. Simple operation is guaranteed by intuitive graphic guidance which leads the user through the balancing procedure step by step. A number of methods are available to compensate rotor imbalance: free balancing, fixed weight, fixed location or tape measure balancing. If necessary, VIBXPERT EX can combine all mounted weights into a single new weight. If you do not wish to attach a balancing weight to the rotor, VIBXPERT EX will calculate the mass that should be milled from the rotor.

And just think! VIBXPERT EX even grows to meet your future requirements. The latest analysis and diagnostic functions are added on a regular basis and made available as an update. This ensures that you are always have the most modern equipment.

For further information visit us on the Internet at:

<http://www.pruftechnik.com>

About this manual

This manual describes the operation of the measurement device in the optional "Balancing" mode. The description of the measurement device and operation in the "Multimode" and "Route" modes appears in the VIBXPERT EX operating instructions (VIB 9.805.G).

If you do not have immediate access to this manual, direct help is contained in the device and can be opened with the HELP key.

This manual is valid for firmware version 2.3x and higher.

Contents

Safety and operating notes.....	5
Symbols.....	5
Intended use.....	5
General safety.....	6
Registration.....	7
Balancing on machines with rotating masses.....	11
Diagnosis.....	12
Preparatory activities.....	13
Assembly.....	13
Operation.....	17
Balancing in one plane.....	19
Measuring the initial imbalance.....	19
Trial run.....	20
Trim run.....	21
Undoing balancing runs.....	22
Balancing in two planes.....	23
Overview of the measurement procedure.....	23
Determining the measurement plane & balancing plane A.....	23
Measuring the initial imbalance in plane A and plane B.....	23
Trial run.....	24
Trim run.....	24
Saving the result.....	24
Evaluation of the data.....	25
Combining balancing weights.....	26
Options for balancing.....	27
Checking the measurement setting.....	27
Changing the correction mode.....	27
Removing the balancing weight.....	29
Checking functions.....	29
Entering the balancing radius and rotor mass later.....	30
Influence coefficient.....	30
Minimizing vibrations at the control plane.....	31
Display setup.....	32
Printing the balancing report.....	33
Setup parameters.....	34
Machine setup.....	34
Measurement setup.....	37
Balancing with a control plane.....	38
Balancing quality classes and groups of rigid balancing bodies.....	39
Messages during balancing.....	40
Emergency storage.....	42

Chapter 1: Introduction

Safety and operating notes

You must carefully read and understand the safety instructions in the VIBXPERT EX operating manual (VIB 9.805.G) as well as the following safety instructions for balancing before starting work with the measurement device.

Symbols



WARNING!

Danger to life and limb.



ATTENTION

Danger of improper operation which can cause damage.



NOTE

Tips on operation as well as important information about balancing.

Intended use

VIBXPERT EX is intended for use as a portable balancing device for the balancing of *stationary* machines equipped *solely with rotating components (rotors)*, e.g. turbine rotors, inductors, circulating pumps, centrifugal compressors, fans, etc. This does not include machines with oscillating components, e.g. all reciprocating machines.

VIBXPERT EX can be used without any restrictions for the balancing of rigid rotors. Elastic (soft) rotors may only be balanced with VIBXPERT EX at the resonant frequency ($\pm 25\%$) by an experienced user. The measurement instrument and its accessories may only be operated by authorized personnel.

PRÜFTECHNIK Condition Monitoring assumes no responsibility for any damage arising from improper use.

Conformity

The product complies with the relevant European directives. The declaration of conformity is available as a PDF and may be downloaded from the PRÜFTECHNIK homepage at:

www.pruftechnik.com/com/Know-How/Media-Center/Certificates-and-Material-Safety



General safety

- Observe the applicable safety regulations when performing measurements at the machine.
- When assembling measurement components, make sure that no holders, cables, etc. project into the range of movement of rotating machine parts.
- The respective manufacturer's instructions must be followed when mounting balancing weights.
Make sure that attachment points for balancing weights to be welded on are clean; clamp the ground electrode of the welding device onto the rotor and not onto the machine.
For balancing weights that need to be screwed on, the maximum permitted RPM of the motor must be observed.
- The machine must be disconnected in order to work on the rotor and must be secured against being switched on again in accordance with the applicable regulations.
- Before the first measurement (initial run), it is important to ensure that the preparatory activities have been carried out correctly and completely. In addition to the assembly of measurement components, particular attention must be paid to the correct input of parameters in the machine setup. If an incorrect rotor mass is entered, a trial weight that is too large may be calculated as a result. This could have serious consequences for personnel and machine!
- No one is allowed to remain in the radial vicinity of the rotor during balancing runs. This area must be properly secured against unauthorized entry. If the trial weight of the rotor on a running machine detaches, there is a risk of fatal injury in this area!
- If the rotor is in a protective housing, any gaps in the housing must be closed before switching on the machine.
- The permitted switch-on frequency of the machine may not be exceeded. Otherwise, the motor could be damaged.
- The cause of the imbalance must be determined before balancing, and must be corrected if necessary (e.g. remove any caking on the rotor, weld any cracks on the impeller or replace the impeller).

Registration

The balancing software is already contained in the instrument and must be activated by entering a password. Changes to the instrument or the loading of additional software are not necessary.

Entering the password

The password is given on the password certificate.

- Click on "Device Setup" in the start screen.
- Click on "Registration" in the "Device Setup" screen (see below).
- Click on the "Balancing - not registered" in the "Registration" screen and enter the registration password in the text editor.

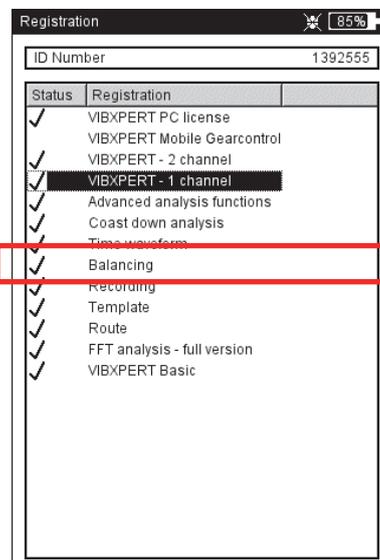
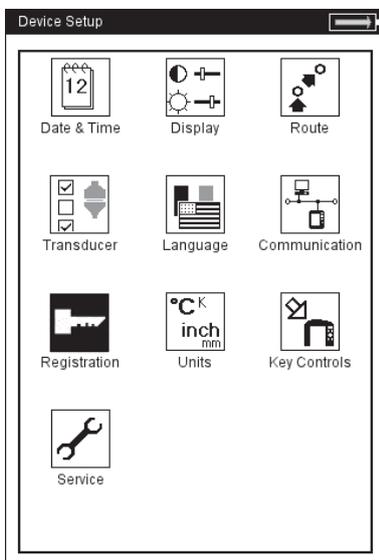
Registration is now complete and the new operating mode now appears on the start screen.



Device Setup



Balancing



Device Setup - Registration

Registering 'Balancing'

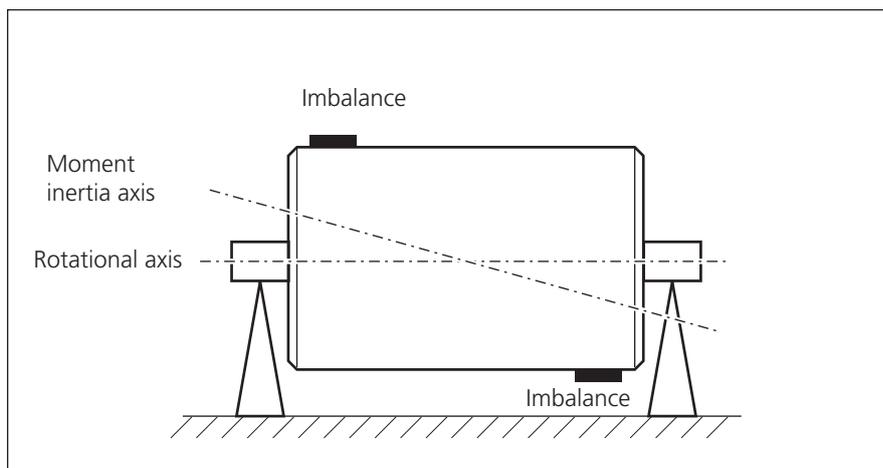
Chapter 2: Balancing

Increased vibrations on machines are undesirable phenomena. They impair product quality, place additional strain on components and, last but not least, reduce operational safety. The most frequent cause for these increased vibrations is imbalance. The high centrifugal forces that result lead to premature wear of machine components such as bearings and seals, for example. Thus, the objective of balancing rotors is to limit bearing forces and shaft deformations to acceptable values.

VIBXPERT EX enables imbalance to be reliably detected and quickly corrected. The balancing results are automatically compared with the evaluation yardsticks of DIN ISO 1940 for the balancing condition of rotating rigid bodies.

Imbalance

If a rotor is correctly balanced and this rotor is placed on balancing rollers, any additional mass placed on the rotor will cause this mass to immediately move downwards. This process is called 'roll off'.



Couple (dynamic) imbalance

If this rotor is now turned with the balancing RPM, a centrifugal force is caused perpendicular to the rotational axis by the displacement of the center of gravity.

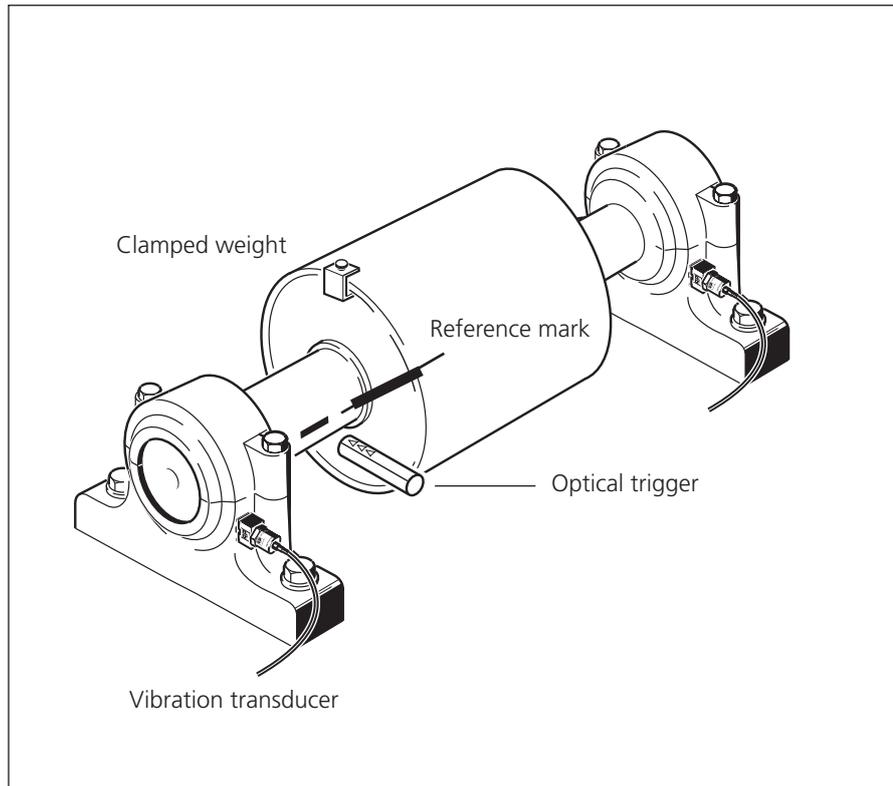
A static imbalance has to be corrected using 1-plane balancing because the planes of imbalance and center of gravity coincide. Considered from the measurement plane, the imbalance is static at a single location.

If two equally heavy masses are attached to a completely balanced rotor so that they lie exactly opposite in two separately lying radial planes, this is called a couple imbalance (or a dynamic imbalance). The center of gravity of the rotor remains on the rotational axis. The imbalances cause a centrifugal torque that gives rise to opposing forces of the same size in the bearings. Such imbalances can only be balanced using two-plane "dynamic" balancing - one-plane balancing would not bring any improvement.

If an individual imbalance which does not lie on the center of gravity is added to a completely balanced rotor in one plane, it is called a quasi static imbalance. It corresponds to the combination of a static imbalance and a couple imbalance and is usually compensated in two planes.

Basically, the consideration of whether to carry out balancing in one or two planes depends on the specific machine situation, i.e. on the balancing behavior of the rotor and the vibration behavior of the machine. Simultaneous balancing in two planes is quicker and more precise than successive balancing measurements in each of two individual planes. Residual errors that are accumulated in sequential balancing are therefore prevented. The distance/diameter ratio of the balancing planes is normally an important decision criterion.

Two-plane balancing under operating conditions using an optical trigger and two vibration transducers.



Balancing on machines with rotating masses

The VIBXPERT EX balancing module is based on the well-known 'influence coefficients method':

First, VIBXPERT EX measures the vibration amplitude and phase angle and the vibration caused by the imbalance or so-called 'initial imbalance'. A defined trial weight* is then attached and the instrument measures the resulting change in amplitude and phase. VIBXPERT EX calculates the influence coefficients from the difference between both vibrations according to magnitude and phase which precisely indicates the location and magnitude of the balancing weight with regard to the position and size of the trial weight. In the case of two-plane balancing, the calculation of the influence of the mass is also taken into account in the other plane. All so-called 'rigid' rotors are balanced using this method.

A rigid rotor mainly exhibits proportional vibration behavior if the balancing weight and angle change. In the case of fixed rotational speed, weaknesses or resonances in the mounting have no influence on the vibration behavior. If the machine rotates at a variable speed, it frequently exhibits different vibration behavior for each revolution and, therefore, has to be balanced several times over the range of low-speed to high-speed running.

Soft rotors do not exhibit the expected proportional behavior with the calculated balancing weight, and the coefficients method does not apply. Such rotors can normally only be balanced in balancing machines using a force measuring procedure.

* VIBXPERT EX calculates the weight and location for the required trial mass in such a manner that it usually results in a reduction in the existing imbalance and in the associated vibration load. This has the added advantage that the trial mass does not have to be removed again but can remain on the machine indefinitely.

Diagnosis

Before beginning the balancing procedure, first make sure that the cause for the adversely affected smooth running of the rotors is actually an imbalance. Furthermore, a vibration diagnosis indicates which balancing method is the most suitable.

A series of coordinated measurement tasks are available for the diagnosis of an imbalance:



Balancing

- Click on "Balancing" in the start screen and open the 'Diagnosis' tab (see below):

Overall value - vibration velocity



Records the broadband vibration of the machine in order to document the actual condition before and after balancing. This also makes it possible to determine the measurement location with the highest vibration values where the sensors should be mounted.

RPM



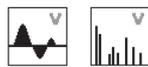
Measures the rotor RPM. If a machine setup is used for balancing, this parameter is required in order to calculate the resulting centrifugal forces.

Phase measurement - one / two planes



Records the amplitude and phase angle of the RPM-synchronous vibration signal. This allows, for example, the type of imbalance (static / dynamic) to be determined.

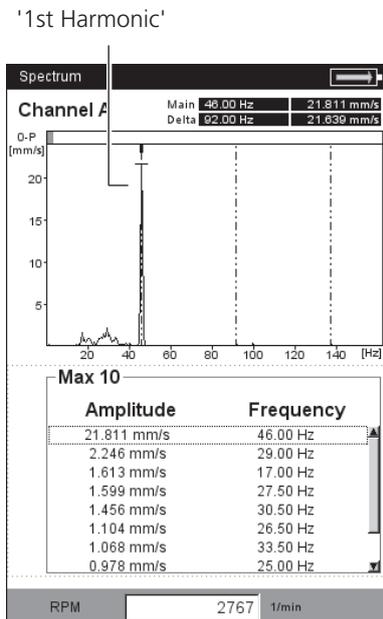
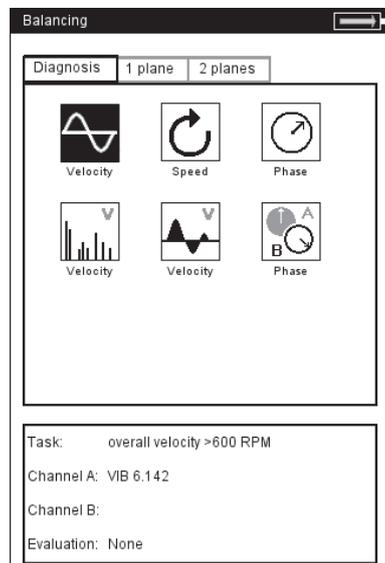
Spectrum & Time waveform - vibration velocity



Measures the FFT spectrum and time waveform. If the 1st harmonic dominates the spectrum, an imbalance is probably the cause for the poor running.

Left:
Diagnosis measurement

Right:
FFT spectrum for diagnosis
1st RPM harmonic
vibration dominates -> imbalance



Preparatory activities

The preparations include the mounting of the measurement components.

The machine must be disconnected before carrying out any work on the machine and it must be protected against being switched on again inadvertently!



WARNING!

Assembly

1. Try to find out the cause of the imbalance visually and fix it if possible. Example: Remove any coatings from the impeller, fasten any loose balancing weights or tighten any loose screws on the foundation.

If the machine cannot be balanced in-situ, it must be firmly mounted on a rigid foundation (directly on frames or on vibration isolators).



Note

2. Determine the measurement and balancing planes (see figure on next page). Mount the vibration transducer on the bearing housing at the measurement location with the highest vibration values. Note that:

- The measurement plane should be in the middle of the bearing and close to the balancing plane and the plane of the center of gravity (e.g. impeller side, rotor).
- Vibrations are transferred via the outer ring of a bearing in a radial direction. Thus, mount the transducer on the side (horizontal) or on the top of the bearing (vertical). Find suitable measurement locations by searching for positions with the highest vibration values using a hand-held probe.
- The transducer should be attached as close as possible to the bearing. Prevent signal attenuation due to excessively long transmission paths or bearing covers or similar. The direction of measurement must correspond to the main direction of vibration (mostly horizontal). If the measurement direction is horizontal, mount the transducer on the lower half of the bearing housing.
- Wherever possible, use transducers which are screwed onto the machine or attach the transducer using a magnetic holder (VIB 3.420). The transducer should not be attached to components with intrinsic vibrations, e.g. covers.
- Hand-held probes are not suitable for balancing!
- Only for balancing in two planes: Determine the second plane (B) in the same way.
TIP: Plane B should be on the rigid drive side near to the coupling and plane A on the soft output side away from the coupling (see figure on next page).

3. Assess the machine smoothness.

Measure the vibration velocity and record an FFT spectrum if the measurement values are too high (see DIN ISO 10816-3). If high vibration signals appear at the rotational frequency, there is an imbalance that must be corrected by balancing.

Save the measured values in order to be able to compare them later with the values measured after the balancing procedure.



Note

High axial amplitudes indicate a large imbalance of torque which cannot be balanced using the methods described here.

4. Attach reference mark on the shaft for the trigger sensor.

- Use reflective tape VIB 3.306 and place this perpendicular to the direction of rotation.

TIP: Place the mark as close as possible to the groove of the adjusting spring. The mark should be easy to find and the measurement results can be reproduced more easily.

- Angle convention: the angular reference mark lies at 0° ; the fixing angle ϕ for the balancing weight is counted against the direction of shaft rotation.

TIP: Number the fan blades corresponding to the counting direction of the fixing angle. Blade no. 1 is taken as the 0° position.

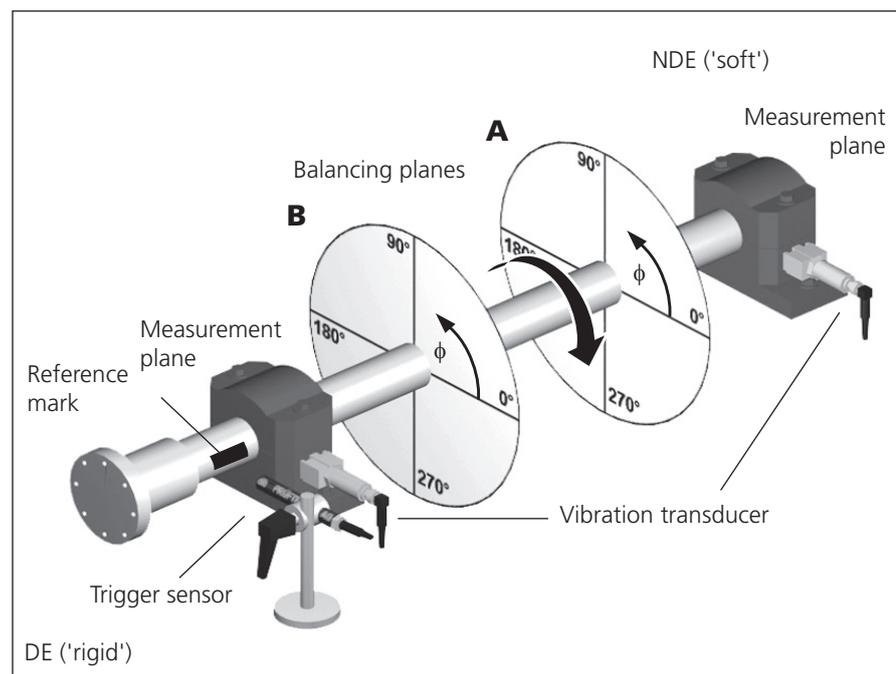
- Active edge: Define whether the edge of the incoming trigger mark or outgoing trigger mark on the shaft is to be used as the reference signal. The setting can be made under 'Transducer/Keyphaser' in the Device Setup.

Note for SYSTEM 2 user:

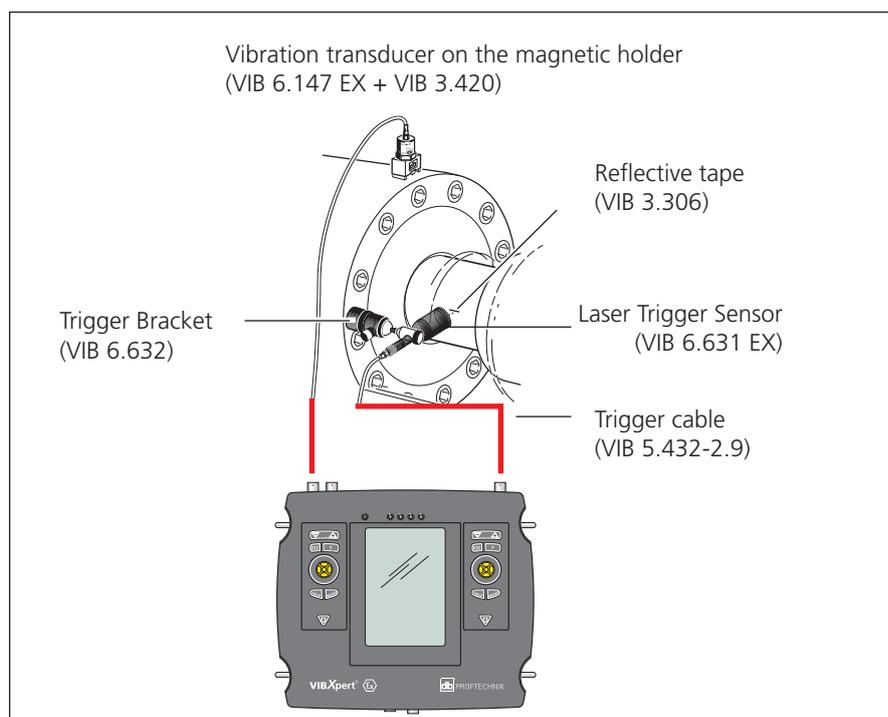
The angle is counted IN the direction of rotation of the shaft when using the SYSTEM 2 VIBROSPECT® FFT balancing instrument.

Typical assembly:

Measurement and balancing plane A & B, reference marks, fixing angle ϕ



5. Mount the laser trigger sensor with the trigger bracket (VIB 6.632).
6. Connect the vibration transducer and the trigger sensor to the measurement instrument.



After completing the preparatory activities, ensure the following:

- The balancing RPM should lie as close as possible to the operating RPM. If this is not possible due to high vibration values, start at a lower RPM and approach the operating RPM step-by-step in several balancing runs.
Minimum balancing RPM: 30 cpm. (= 0,5 Hz)
- Pay attention to potential resonance points and, if there is any doubt, perform a coast down measurement!
- The RPM must remain constant during a balancing run! Otherwise, the balancing run must be restarted.
- The rotor must reach operating temperature during the measurement (e.g. if the rotor works in a hot air stream).
- Often the static imbalance is dominant at vibration values above 10 mm/s. First, compensate this using 1-plane balancing before proceeding with 2-plane balancing.
- Before starting the initial balancing run, check again that all measurement components have been correctly installed.
- If a machine setup is used for the balancing procedure, check the specified parameters. Incorrect rotor data may result in the calculation of excessive trial weights under certain circumstances!



Note

Operation

If you are not yet familiar with operation in balancing mode, please note the following instructions:

Settings

All settings necessary for the measurement and evaluation of a balancing run are made in setup menus:

- Measurement setup: measurement settings
- Transducer setup: parameters of the transducer in use
- Machine setup: data on rotor and balancing-related settings

These three setup menus are contained in the measurement task manager. The settings can only be changed before a balancing run is begun. The settings in the following two setup menus can also be changed during a balancing run:

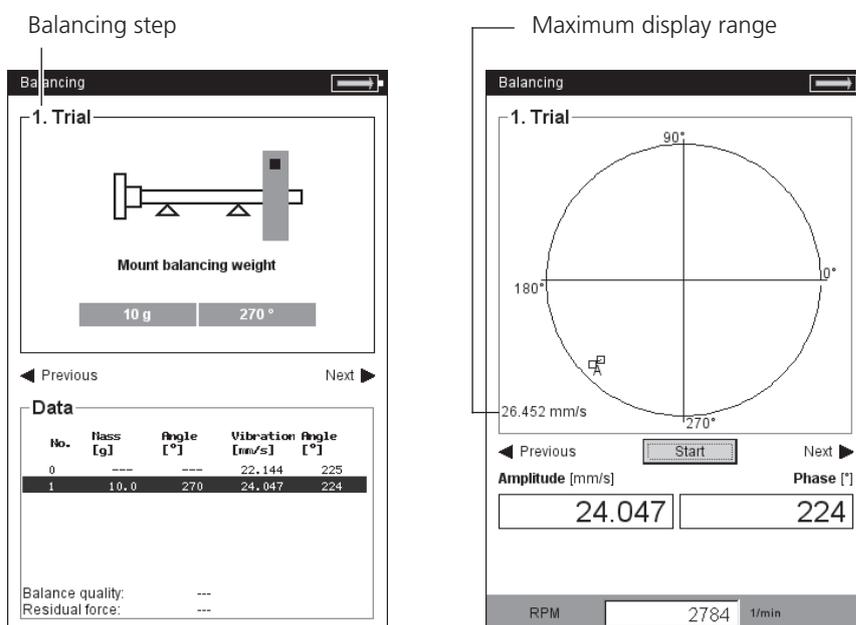
- Display setup: display settings.
- Tools: balancing-related settings and parameters that can be changed during a balancing run.

Display

In each balancing run, two main screens appear:

The *data screen* shows the balancing weights and their positions on the rotor in the upper half of the screen. The lower half contains the measurement data and balancing weights of all completed runs. If a machine setup is used, it shows the balancing quality attained and the resulting centrifugal force on the rotor.

In the *measurement screen*, the measurement values (amplitude and phase angle) are displayed and the imbalance pointer is shown in a polar diagram.



The respective balancing step appears on the upper left of both screens:

- *0. Initial imbalance*: Measurement of the original imbalance; if the vibration values are within the tolerance range, the rotor is balanced. Otherwise, the balancing weights must be placed on the rotor according to the following balancing steps.
- *1st trial run*: The influence of the attached trial weights is measured and the resulting balancing weight is calculated.
- *2. Trim to ..N. Trim*: Trim runs for reduction of rotor imbalance.

The initial imbalance pointer represents the starting point of the balancing procedure.



Zoom with '+/-'

Zoom

VIBXPERT EX automatically scales the display range with respect to the last two balancing runs. To magnify the view, press the "+" button repeatedly. If the initial imbalance moves out of the display range, the maximum range is also given as a percentage of the initial imbalance.

Navigation

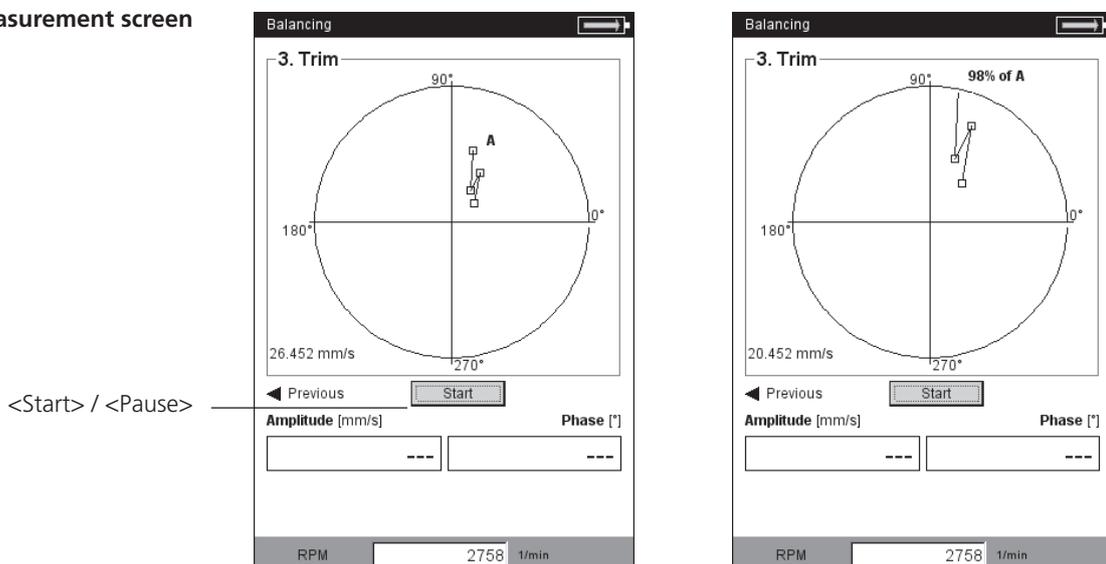
To scroll forwards and backwards, move the joystick repeatedly to the left or right.



Starting / stopping the measurement

Press on the joystick in the measurement screen.

Zooming the measurement screen



Balancing in one plane

On the basis of an example, the next section illustrates the steps that are needed to balance in one plane:

Requirements

- In the following example, the machine setup is not used.
- The default settings in the 'Tools' menu item are not changed:
 - Correction mode: free
 - "Add" balancing weights
 - Check that the functions are all active, except for the coefficients calculation which is inactive.
 - 'Use different radii' option: inactive

Activating the balancing mode

1. Switch on VIBXPERT EX.
2. Click on the "Balancing" icon in the start screen.

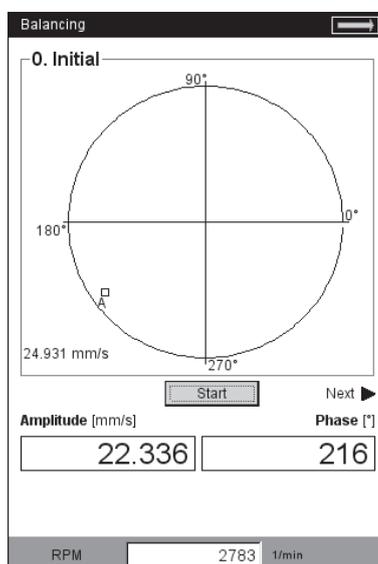
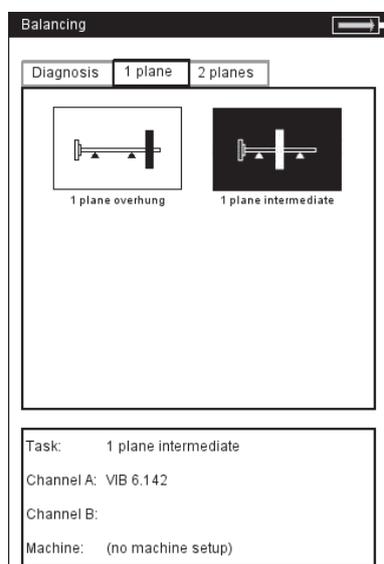


Selecting the task

1. Open the '1-plane' tab.
2. Highlight the rotor graphic which corresponds to the rotor type.
3. Check and change the current measurement task beforehand if necessary. (MENU - Task Manager - Setup)
4. Click on the rotor graphic to open the measurement screen

Measuring the initial imbalance

1. Switch the machine on. Wait until the machine has reached the balancing RPM and operating temperature if necessary.
2. Press the joystick to start the measurement.



Left:
Selection screen

Right:
Start 'Initial' run

First, VIBXPRT EX records the RPM. The green LED flashes with each trigger pulse. If the RPM varies too much, a warning message appears.

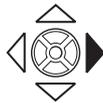
Finally, the instrument measures the amplitude and phase of the RPM synchronous vibration. If the values are unstable, the average is automatically increased.



3. If the measurement values are stable, press the joystick to stop the measurement (see previous page).

To repeat the measurement, press the joystick again.

4. Switch the machine off.

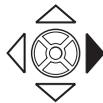


Trial run

1. Move the joystick to the right to open the data screen for the trial run.

2. Enter the mass and fixing angle for the trial weight.

- Click on the mass or angle field under the rotor graphic. The active field is highlighted in black.
- Enter the respective value in the number editor and confirm the entry with MENU - 'OK'.



3. Move the joystick to the right until the next screen appears.

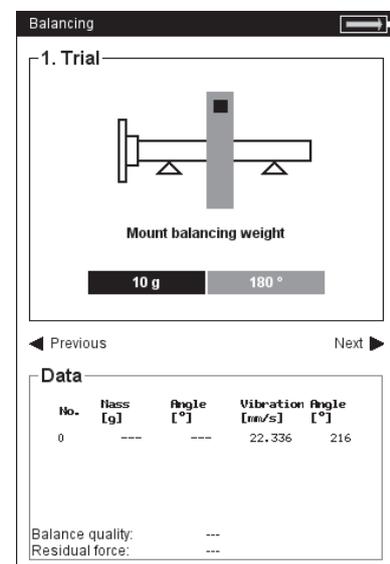
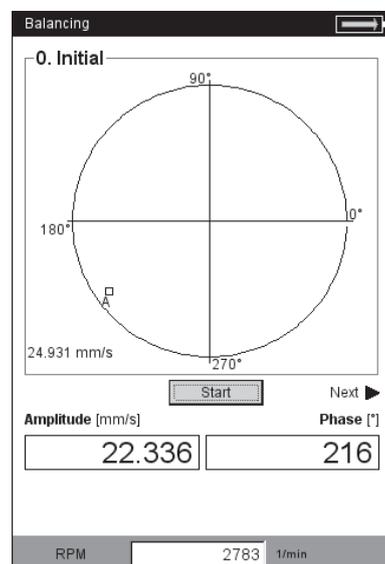


If the trial mass is applied at random, there is a risk of increased imbalance and thus an increased vibration load. Especially if vibration loads are already very high, this may result in further machine damage.

4. Switch the machine on.

Left:
Measure 'Initial' run

Right:
Enter mass and angle for trial run



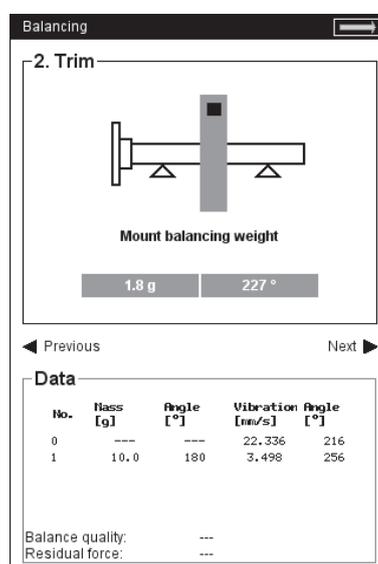
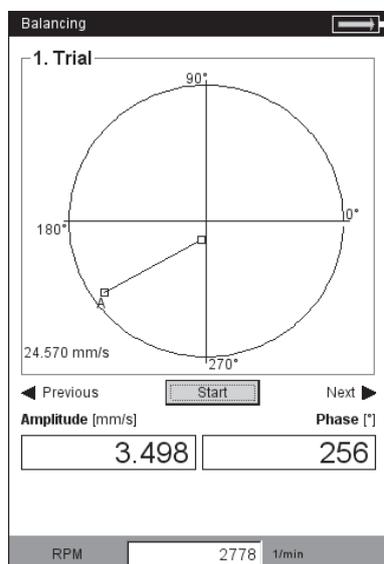
5. Press the joystick to start the measurement.
6. If the measurement values are stable, press the joystick to stop the measurement.
7. Switch the machine off.



In the trial run the imbalance should change enough to steadily reduce the residual imbalance in the subsequent balancing runs. If the imbalance changes only slightly, increase the trial weight. If the imbalance has more than doubled, use a smaller trial weight. If necessary, scroll back in the data screen of the trial run, change the mass accordingly and repeat the trial run.

Trim run

1. Move the joystick to the right to close the measurement screen of the trial run and to open the data screen of the first trim run.
Depending on whether the trial weight resulted in an improvement or not, it can be left on the rotor or taken off. Respond to the resulting prompt in the screen accordingly.
2. Attach the recommended mass at the specified position on the rotor. If necessary, also change the values.
3. Move the joystick to the right until the next measurement screen appears.
4. Switch on the machine.
5. Press the joystick to start the measurement.
6. If the measurement values are stable, press the joystick to stop the measurement.
7. Switch off the machine.



Left:
Measure trial run

Right:
Trim run data screen

In the following trim runs VIBXPRT EX checks whether the imbalance has sufficiently reduced from one run to the next. If this is not the case, the following message appears: 'No Improvement'. The run concerned must be repeated with a different balancing weight.



Note

Start again if the vibration values worsen and the balancing weights do not become smaller.

8. Move the joystick to the right and continue the balancing with the next trim run.

The balancing procedure is complete as soon as the vibration values have reached an acceptable value. When working with "Machine Setup", the calculated balancing quality is the criterion for terminating the balancing procedure. A 'smiley' appears in the measurement screen if the balancing quality has reached the tolerance range.



Undoing balancing runs

If the measurement results worsen after a trim run, you can return to a run that was acceptable and continue balancing with different weights from there.

- Navigate to the data screen of the trim run at which you wish to continue the procedure.
- Press the MENU button and click on 'Undo' (see below).
- Confirm the next query with 'Yes!'. All subsequent trim runs are deleted.
- Remove the balancing weights that you attached during the deleted trim runs.

Left:
Balancing quality achieved
(balancing with machine setup)

Right:
Undoing balancing runs

4. Trim

Mount balancing weight

0.7 g 301 °

Previous Next

No.	Mass [g]	Angle [°]	Vibration [mm/s]	Angle [°]
0	---	---	22.336	216
1	10.0	180	3.498	256
* 2	1.8	227	5.964	311
3	2.0	100	1.484	331

Balance quality: 2.403
Residual force: 5.59 N

* = Trim weight was removed

3. Trim

Tools
Data
Save
Print
Undo
Restart
Task Manager
Display setup

80 ° #13: 22.5 g

Pr Next

No.	Mass [g]	Angle [°]	Vibration [mm/s]	Angle [°]
0	---	---	3.240	104
1 R+	1.0	1	3.171	264
1 B	---	---	3.227	104
* 2 R+	109.7	261	3.161	264
2 B	---	---	3.214	104
3 R+	48.6	172	2.022	250
3 B	---	---	1.754	73

Balance quality: 133.6
Residual force: 313.52 N

Balancing in two planes

In principle, the process here corresponds to the previous section. Therefore, only the specific features of balancing in two planes are described in the following section:

Overview of the measurement procedure

Plane A? : Determination of the measurement and balancing plane A.

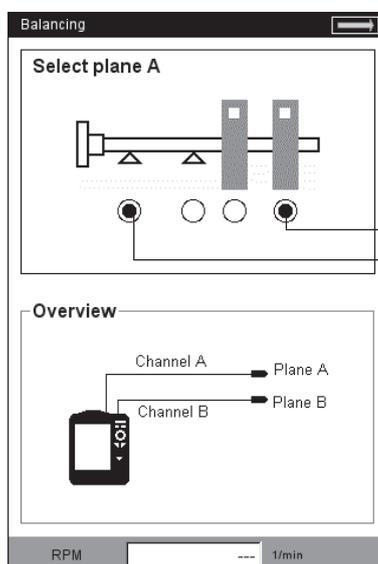
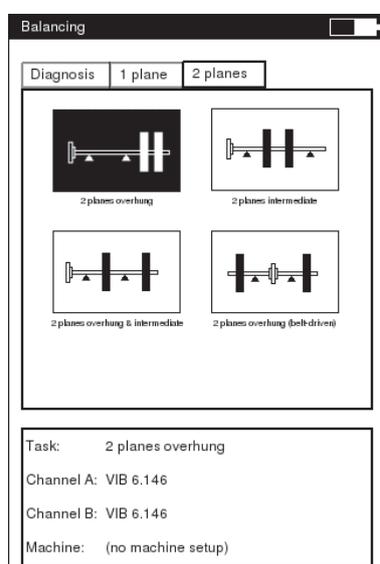
0. Initial imbalance: Measurement in plane A and plane B
- 1A. Trial run: Recommendation for trial weight in plane A; measurement in plane A and plane B with trial weight in plane A
- 1B. Trial run: Recommendation for trial weight in plane B; measurement in plane A and plane B with trial weight in plane B
2. Balancing run: Recommendation for balancing weight in plane A and plane B; measurement in plane A and plane B
-
- N. Balancing run ...

Determining the measurement plane & balancing plane A

1. Activate the balancing mode and open the "2 planes" tab.
2. Click on the rotor graphic which corresponds to the rotor type.
3. Select plane A:
 - Next connect the transducer which is mounted in measurement plane A to measurement channel A (see "Overview").

Measuring the initial imbalance in plane A and plane B

1. Switch the machine on and start the initial run.



Left:
Selection screen - rotor type

Right:
Setting of plane A

Balancing plane A
Measurement plane A

Trial run

The trial run is divided into two parts which are marked in the main screen as "1A" or "1B":

1A: The trial weight is attached in plane A and its influence is measured in both planes.

1B: The trial weight is attached in plane B and its influence measured in both planes.

Trim run

Enter the balancing weights for both planes in the data screen of the trim run (see next page). Move the joystick to the right to mark the input fields of the series.

Continue the trim run until the residual imbalance is within the tolerance range.

Saving the result

- Press the MENU button in the data screen.
- Click on 'Save' to open the text editor.
- Enter a name.
- Finally press the MENU button and click on 'OK'.

Left:
Input of trial weight in plane B

Right:
Trial run 1B
Imbalance in planes A and B
with trial weight in plane B

Current balancing plane
is marked in black

'AA': Result in **plane A**
'AB': Result in **plane B**
(trial weight always in plane A)

No.	Mass [g]	Angle [°]	Vibration Amplitude [mm/s]	Vibration Angle [°]
0 A	---	---	22.864	220
0 B	---	---	15.090	78
1 AA	10.0	0	6.725	293
1 AB	---	---	15.005	81

Ch.	Amplitude [mm/s]	Phase [°]
Ch. A	3.440	219
Ch. B	1.292	166

RPM: 2775 1/min

Evaluation of the data

The following data are listed in the data screen for each completed balancing run:

- MASS: Mass of the balancing weight
- ANGLE: Fixing angle
- VIBRATION: Vibration overall values (RMS)
- ANGLE: Phase angle

If you entered the rotor mass and the balancing radius, the achieved balancing quality and the centrifugal force on the rotor are also calculated. If the balancing quality is within the range of tolerance, the "smiley" appears and indicates the end of the balancing procedure.

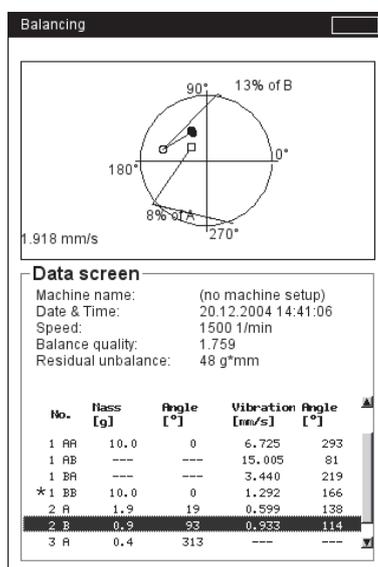
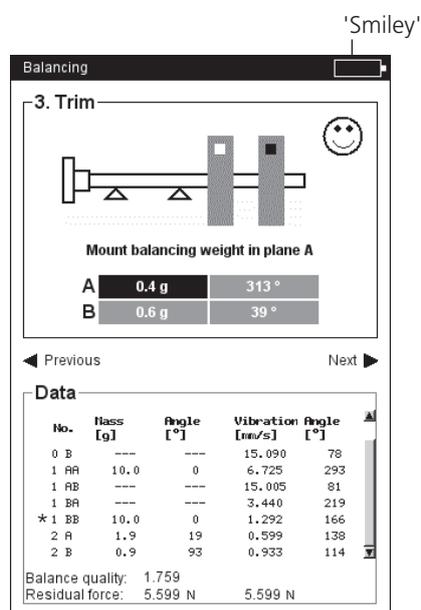
Data View

- Press the MENU button in the data screen and click on "Data". The "Data View" screen appears.

Here you can combine the balancing weights to a single weight and display the following information:

- MACHINE NAME: Name of the machine setup if used
- DATE & TIME: Date and time of the last balancing run
- SPEED: Shaft rotational speed that is selected in the machine setup
- BALANCE QUALITY: Balance quality after the last balancing run
- RESIDUAL UNBALANCE: Imbalance after the last balancing run

The individual balancing runs can be activated in the list. The marked run is highlighted in black in the polar diagram. A star (*) marks the balancing runs in the list where the attached balancing weight was removed again from the rotor after the measurement (e.g. trial run with weight in plane B: ('1BB'), see figure below).



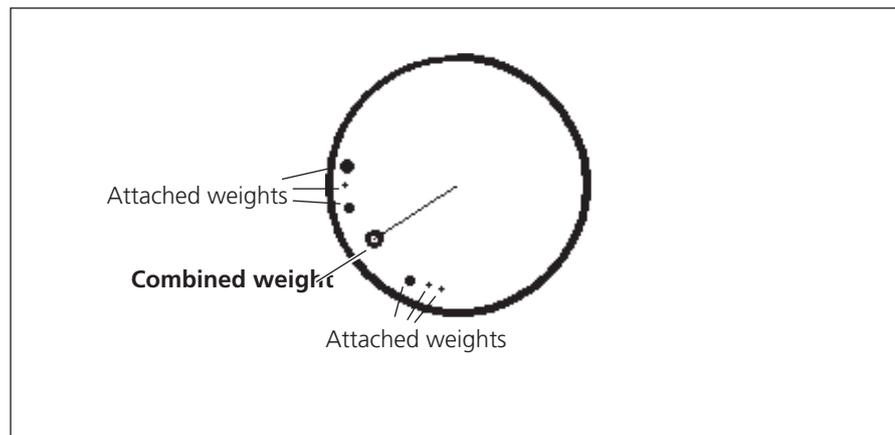
Left:
Data screen
Balancing quality OK

Right:
Data View screen

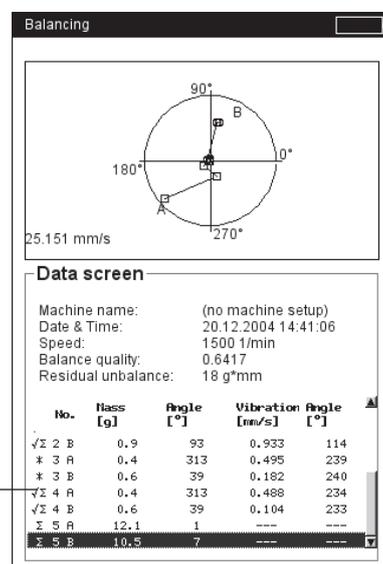
Combining balancing weights

If several weights have already been placed on the rotor, they can be combined into one single weight. VIBXPERT EX vectorially adds the weights of the completed balancing runs and displays the resulting weight and fixing angle in the 'Data' screen and the 'Data View' screen.

- Press the MENU button in the Data View screen.
- Click on "Combine":
The newly calculated balancing weight appears in the list in the line for the next balancing run. All combined runs are marked with a sum symbol ('Σ').
- Then press the MENU button and click on "OK" to accept the combination of the balancing weights.
- Before continuing with the next balancing run, remove the weights that were already attached and attach the newly calculated balancing weight to the rotor.



Combined weights



'A': Result in plane A
'B': Result in plane B

The weights from runs '1' to '4' were combined:
Run '5' is carried out with the newly calculated weight .

Options for balancing

The following options are available in the trial run and the trim runs:

Checking the measurement setting

- Press the MENU button and click on "Task Manager".
- Mark the respective setup, press the MENU button and click on "Show" to display the specified parameters.

Changing the correction mode

The correction mode describes how the balancing weight is attached to the rotor. Normally the correction mode is set to 'Free & add', i.e. the weight can have any mass and be placed at any angular position.

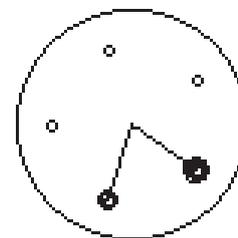
- Press the MENU button in the data screen and click on "Tools".

The following correction modes are available additionally:

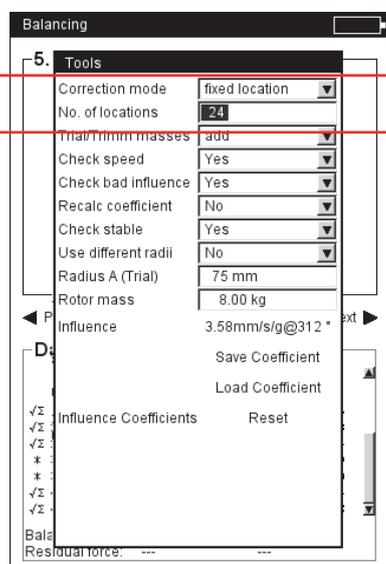
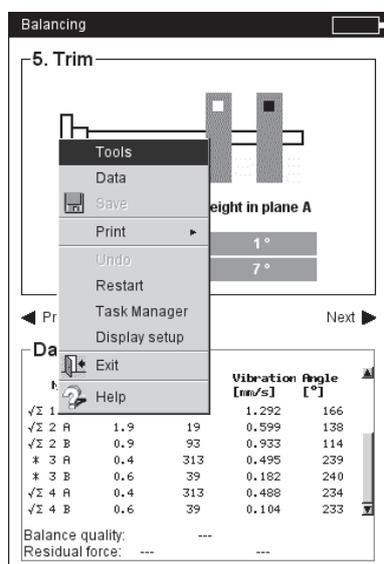
- Fixed location
- Fixed weight
- Meas. tape

Fixed location

To attach the balancing weight only at specific positions on the rotor (e.g. on the blade of a ventilator), select the "Fixed location" correction mode. Then enter the "Number of locations" on the rotor. VIBXPERT EX calculates two masses in the balancing runs which are to be placed at two of the permanently specified positions. Position or blade #1 corresponds to the 0° position and should be selected as a reference mark for the trigger. In the data screen, the angular position is displayed for each fixed location.



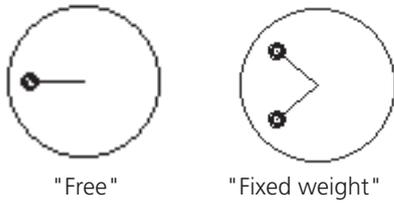
"Fixed location" correction mode



Left:
Changing correction mode in "Tools"

Right:
"Fixed location"
Setting the number of fixed locations

Balancing: Options



Note

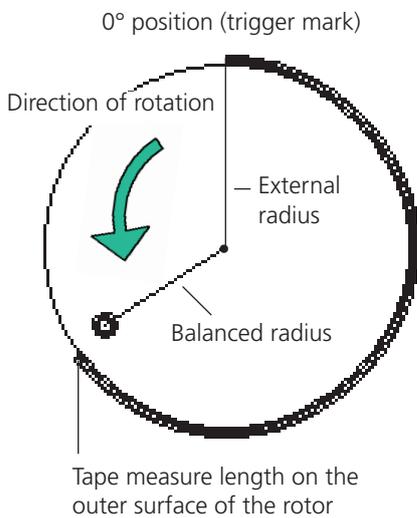
Fixed weight

Activate the "Fixed weight" option if only specific masses (e.g. 2g, 5g, 10g) are available for balancing. Then enter the mass of the "Fixed weight". VIBXPERT EX calculates two angular positions at which the two equal weights must be placed.

Select the "Trial/ Trim masses -> Add" option in the "Tools" menu.

The fixed weight m_{fix} must meet the following requirements relative to the variable weight m_{free} :

$$0.5 \times m_{free} \leq m_{fix} \leq 3 \times m_{free}$$



Note

Measuring tape

The correction mode can determine the position of the balancing weights with the measuring tape without having to consider a reference system with angular divisions.

Enter the outer diameter of the rotor in plane A and plane B. The distance on the outer surface of the rotor is calculated in millimeters (or inches) from the trigger mark (0° position) and measured counter to the direction of rotation. Place a tape measure around the rotor and place the balancing weight at the specified position (i.e. length).

The distance of the balancing weight from the rotational axis is the balancing radius. This is usually smaller than the outer radius.

In all three correction modes, the calculated specified values can be changed afterwards. However, the changes should not deviate significantly from the specified values.

The list in the "Data" field always shows the balancing weights for the 'Free' correction mode.

Left:
"Fixed weight" correction mode

Right:
"Meas. tape" correction mode

5. Trim

Mount balancing weight in plane A

A	10 g:	308 °	10 g:	54 °
B	10 g:	309 °	10 g:	66 °

◀ Previous Next ▶

Data

No.	Mass [g]	Angle [°]	Vibration [mm/s]	Angle [°]
√Σ 1 BB	10.0	0	1.292	166
√Σ 2 A	1.9	19	0.599	138
√Σ 2 B	0.9	93	0.933	114
× 3 A	0.4	313	0.495	239
× 3 B	0.6	39	0.182	240
√Σ 4 A	0.4	313	0.488	234
√Σ 4 B	0.6	39	0.104	233

Balance quality: ---
Residual force: ---

5. Trim

Mount balancing weight in plane A

A	12.1 g	2 mm
B	10.5 g	10 mm

◀ Previous Next ▶

Data

No.	Mass [g]	Angle [°]	Vibration [mm/s]	Angle [°]
√Σ 1 BB	10.0	0	1.292	166
√Σ 2 A	1.9	19	0.599	138
√Σ 2 B	0.9	93	0.933	114
× 3 A	0.4	313	0.495	239
× 3 B	0.6	39	0.182	240
√Σ 4 A	0.4	313	0.488	234
√Σ 4 B	0.6	39	0.104	233

Balance quality: ---
Residual force: ---

Removing the balancing weight

If the balancing weights cannot be attached to the rotor by clamping, welding, screwing or similar, the imbalance can also be compensated by grinding material off the rotor. To do this, select the "Trial/ Trim masses -> remove" option in "Tools" menu (see below). VIBXPERT EX then calculates the "Balancing weights" as negative masses.

Checking functions

In order to ensure that the balancing procedure provides reliable and usable results, VIBXPERT EX has the following check functions in the "Tools" menu:

CHECKING SPEED

Before each measurement VIBXPERT EX checks whether the measured RPM is stable. An appropriate error message appears if the RPM varies excessively.

CHECKING BAD INFLUENCE

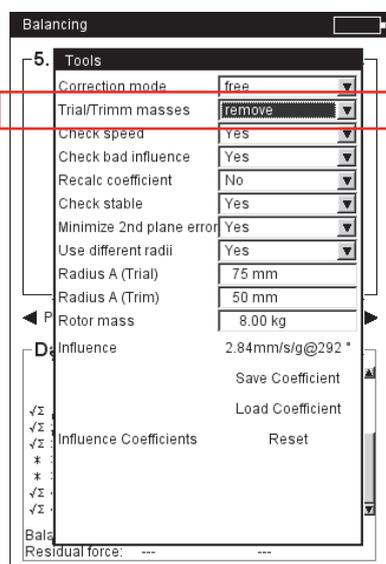
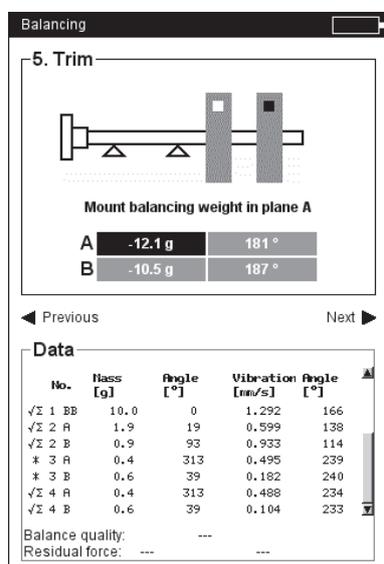
The change of the imbalance indicator is checked; if the change is too large/too small, an appropriate message appears. Return to the previous balancing run and reduce or increase the weight used.

RECALCULATING THE COEFFICIENT

The coefficient for calculating the balancing weight can be taken over from the trial run (setting: "No") or from the previous balancing run (setting: "Yes").

CHECKING STABILITY

The stability of the imbalance indicator is checked during the measurement. If the imbalance indicator is unstable and the 'Auto-average' option is active, VIBXPERT EX automatically increases the selected number of averages in the measurement setup. An appropriate message appears if the maximum number of averages is reached.



"Remove balancing weight"
Grinding off rotor material

Entering the balancing radius and rotor mass later

You can enter the balancing radius and the rotor mass later in the Tools menu to have the achieved balancing quality and the centrifugal force calculated. In this way, these values will be available to you if you start the balancing procedure without the machine setup.

Optionally, you can enter different balancing radii for the trial run and the balancing runs. To do so, activate the 'Use different radii' option.

Influence coefficient

After the test run, VIBXPRT EX calculates the influence coefficient that is used to calculate the balancing weights.

If you wish to use the influence coefficient from a previous balancing measurement, you have the following options:

1. Manual entry via the number editor:

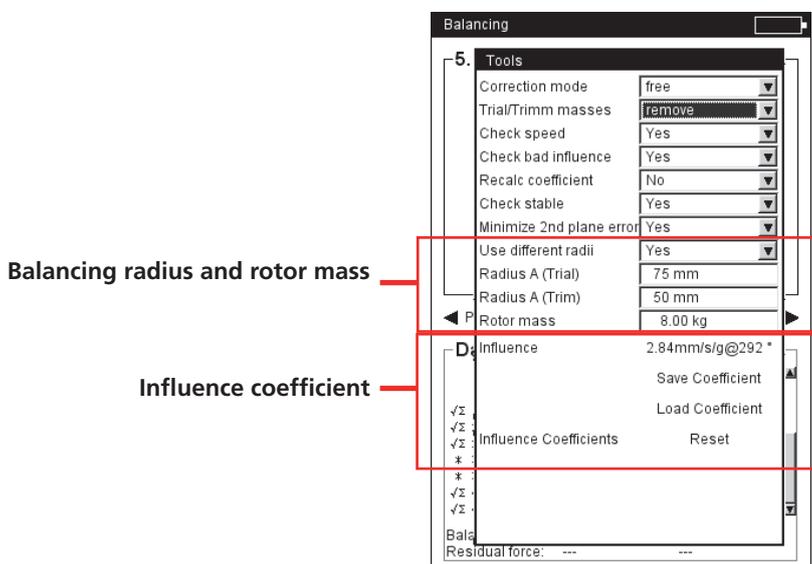
- In the Tools menu, click on 'Value mm/s/g@angle°'
- First enter the amplitude.
- Press the MENU button and click on 'OK'.
- Enter the angle.

2. Load the coefficient from the file:

- Click on the 'Load coefficient' value.
- Select the coefficient file.

3. Use the coefficient from the file:

- Open the balancing file.
- Navigate to the last balancing step (measurement or data screen).



- Press the MENU button and click on 'Restart'.
A warning appears. Click on 'OK'.
- Start the balancing measurement ('Initial imbalance').

In variant 2, the coefficient must be stored after the trial run of the particular balancing measurement.



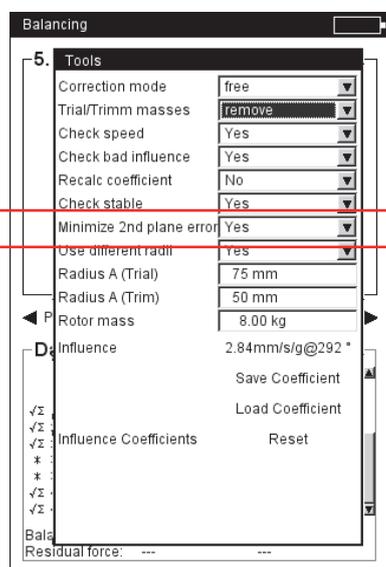
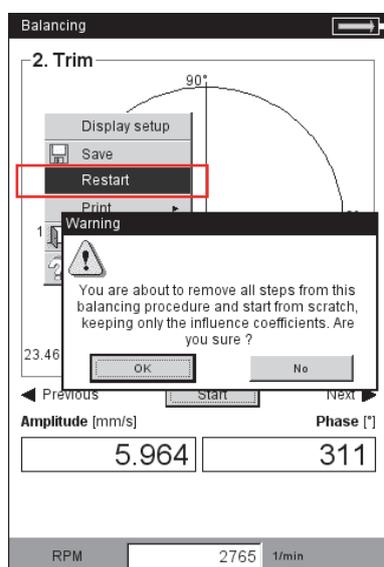
Note

To delete the influence coefficients in a file, click on 'Reset' in the Tools menu.

Minimizing vibrations at the control plane

This option is only available when balancing in one plane with vibration monitoring in a control plane. The monitoring option is activated in the machine setup.

When balancing in one plane, the vibration usually increases in the control plane. When this option is activated, VIBXPERT EX calculates the balancing weights in such a way that the vibration is minimized in both planes.



Left:
Adopting the influence coefficient by restarting

Right:
Minimizing the vibration in the control plane

Display setup

In the display setup, you can define the display settings for the data screen and measurement screen. The display setup can be called up on every screen:

- Press the MENU button and click on 'Display setup'.

ZOOM: Speed or step size when zooming.

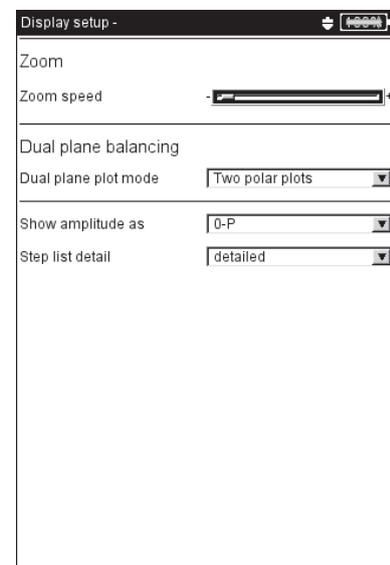
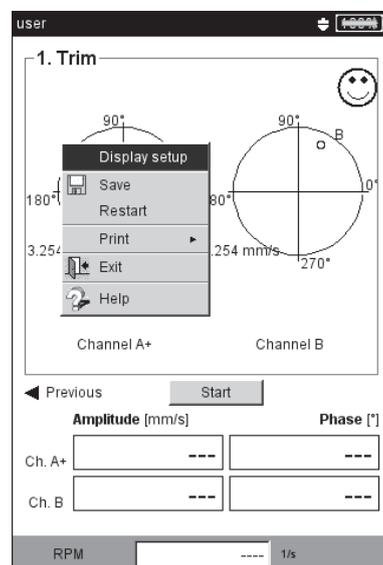
DUAL PLANE BALANCING, PLOT MODE: The imbalance pointers of the two planes can be displayed separately in *two polar plots* or together in *one polar plot*.

AMPLITUDE: The vibration amplitude can be specified in RMS, 0-p or p-p.

STEP LIST DETAIL: Select 'detailed' if you would like all balancing runs to appear in the data and measurement screen. The 'short' option only shows the first run (initial imbalance) and the last completed balancing run.

Left:
Opening the display setup

Right:
Parameter in the display setup



Printing the balancing report

Two different report types are available for documenting the balancing measurements:

- *Screenshot*: Printout of the current screen
- *Report printouts*: Detailed report printout with general measurement data and balancing-related data.

A report printout can be started from the measurement or data screen:

Screenshot:

- Press the MENU button and click on 'Print > Screenshot'.
- Select the printer, press the MENU button and click on 'Print'.

Report printouts:

- Press the MENU button and click on 'Print > Report printouts'.
- Check and, if necessary, change the report configuration.
- Select the printer.
- Press the MENU button and click on 'Print'.

The balancing-related report content is found on the 'Measure Info' tab:

POLAR PLOT: The balancing report contains a polar plot showing the completed balancing steps.

STEP LIST DETAIL: The balancing report contains all balancing steps ('detailed') or only the first and last steps ('short').

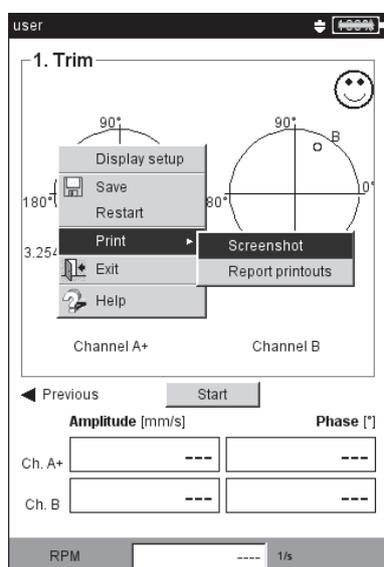
BALANCE QUALITY / IMPROVEMENT: The balancing report contains the balance quality (setpoint and actual value) if balancing was performed with the machine setup. If a machine setup was not used, the improvement in the vibration values is shown in percent.

Details on preparing and configuring a report printout can be found in the VIBXPERT EX operating manual.



Note

Starting a report printout



Balancing-related report content



Balancing report

Prüftechnik Condition Monitoring GmbH		PRUFTECHNIK	
Dateiname: U_sbaov			
Gedruckt am: 25.11.2008 08:22:14			
Gedruckt von: 25.11.2008 07:53:43			
Messaufgabe: user			
Aufnehmer Setup: VIB 6.146			
Polar-Diagramm			
Auswertungsschritte			
Nr.	Massa [g]	Winkel [°]	Schwing. [mm/s]
0	—	—	2.746
1	1.0	9	3.935
2	1.2	137	2.075
3	0.7	208	—
Maschinen Info			
Maschinen Name: user			
Maschinen Drehzahl: 45.000 1/s			
SOQL Auswertgröße: 2.50			
IST Auswertgröße: 4.085			
© 2008 PRUFTECHNIK AG			
V2.20(505)			
1 / 1			

Setup parameters

This section describes the measurement settings that you generally can only edit before beginning a balance measurement. The parameters are contained in the 'Setup menu':

- Machine setup (see below)
- Measurement setup
- Transducer setup

Machine setup

A 'machine setup' contains the machine data and information on the measurement setup. VIBXPERT EX uses these data to calculate a suitable trial weight and, after each balancing run, the remaining imbalance, centrifugal force and the attained balancing quality. To create a machine setup, proceed as follows:

- Mark a rotor type in the selection screen.
- Press the MENU button and click on "Task manager".
- Mark the "Machine setup" field.
- Press the MENU button and click on "New" or on "Edit":

PLANES: *One / Two*. Number of balancing planes; cannot be changed because the rotor type is selected in the selection screen.

CORRECTION MODE*: *Free / fixed location / fixed weight / meas. tape*; takes into account restrictions on the machine (fixed locations, e.g. for ventilator blades) or local circumstances (tape measure). Depending on the selection, the following parameters can be selected:

- Number of locations: 3-100. Usually the number of ventilator blades.
- Fixed weight: Mass of the available balancing weight.
- Outer diameter: The tape measure can be used to determine the position of the balancing weight without a reference angle.

*This parameter can be changed in each balancing run (MENU - Tools)

Machine setup	
user	user
Planes	1
Correction mode	fixed location
No. of locations	24
Trial/Trimm masses	remove
Balance quality	2.5
Foundation	flexible
Use different radii	Yes
Radius A (Trial)	75 mm
Radius A (Trim)	50 mm
Rotor mass	8.00 kg
Trigger angle A	90 °
RPM	25.000 1/s
Check speed	Yes
Control 2nd plane	Yes

TRIAL/TRIM MASSES*: *add / remove*; in general, an imbalance is corrected by affixing weights to the rotor. If this is not possible, VIBXPERT EX calculates how much mass must be ground off the rotor ('negative mass').

* This parameter can be changed in each balancing run (MENU - Tools)

BALANCE QUALITY: 0 - 4000; evaluation of the residual imbalance using quality grades according to DIN ISO 1940. If the calculated balancing quality is smaller than the selected value, the 'smiley' symbol appears in the data screen and the balancing run is complete. Select the value "0" to work without evaluation of the residual imbalance.



FOUNDATION: *Flexible / rigid*; type of foundation according to DIN ISO 10816. With the same excitation, a machine oscillates more strongly on a flexible foundation than on a rigid foundation. The permissible vibration limit values can therefore be higher on a flexible foundation. The balancing weights are smaller for a flexible foundation than for a rigid foundation.

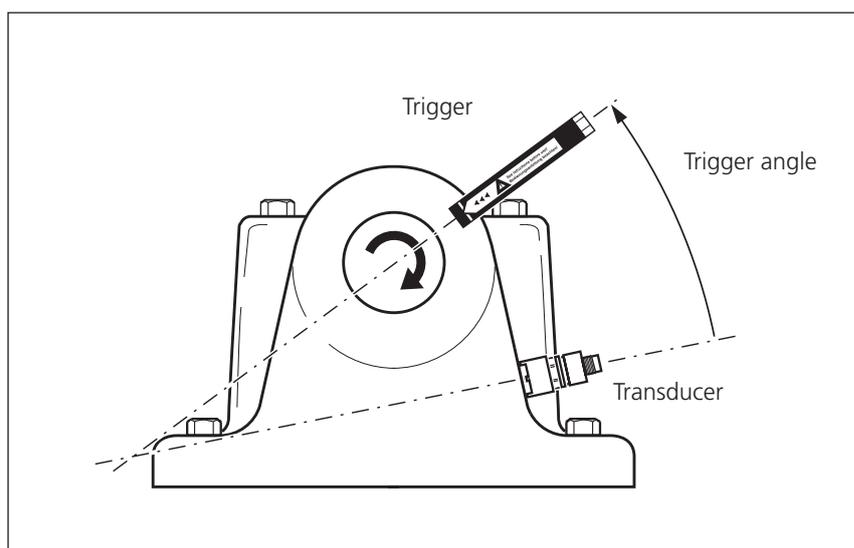
USE DIFFERENT RADII: *Yes / No*; the trial weights can be attached at a different radius than the balancing weights.

RADIUS: *Balancing radius*; distance of the balancing weight from the rotational axis; the larger the balancing radius, the smaller the balancing weight for the same RPM.

ROTOR MASS: The mass of the rotor is taken into consideration in the calculation of the trial weight.

TRIGGER ANGLE: Angle between transducer and trigger; the trigger angle is taken into account in the calculation of the trial weight and is calculated counter to the direction of rotation of the rotor.

RPM: *Balancing RPM*; should be as close as possible to the operating RPM. When balancing with the factory-set RPM setup, only one trigger pulse is processed per revolution. Ensure that only one trigger mark is placed on the shaft.



Trigger angle:

Angle between transducer and trigger is calculated counter to the direction of rotation of the rotor

Balancing: Machine setup

* This parameter can be changed in each balancing run (MENU - Tools)

CHECK SPEED*: *Yes / No*; see "Checking functions".

CONTROL 2ND PLANE: *Yes / No*; when balancing in a plane, the vibration in a second plane can be recorded and displayed as well.

MINIMIZE ERROR IN 2ND PLANE*: *Yes / No*; generally, the vibration in the control plane increases. Activate this option to calculate the balancing weights in such a way that the vibration in both the balancing plane and the control plane are minimized.

AUTO AVERAGE: *Yes / No*; with a strongly varying imbalance pointer, VIBXPERT EX automatically increases the selected number of averages in the measurement setup. This option works only in combination with the 'Checking stability' option.

CHECK BAD INFLUENCE*: *Yes / No*; see "Checking functions",

RECALCULATING COEFFICIENT*: *Yes / No*; see "Checking functions".

AUTO TRIAL MASS: *Yes / No*; VIBXPERT EX calculates a trial weight from the machine data and recommends this in the trial run. If this option is deactivated, the trial weight attached to the rotor must be entered in the data screen of the trial run.

CHECK STABILITY*: *Yes / No*; see "Checking functions".

FREE-RUN: *Yes / No*; the free-run mode abbreviates the balancing procedure. In this mode, only the measurement screen appears. The weight and the position of the balancing weights is not displayed. In the machine setup, all options that are used to calculate the balancing weights are deactivated. This mode should only be used by balancing experts.

Parameters in the machine setup

Machine setup	
user	
Radius A (Trial)	75 mm
Radius A (Trim)	50 mm
Rotor mass	8.00 kg
Trigger angle A	90 °
RPM	25.000 1/s
Check speed	Yes
Control 2nd plane	Yes
Minimize 2nd plane error	No
Auto average	Yes
Check bad influence	Yes
Recalc coefficient	No
Auto trial mass	No
Check stable	Yes
Free-run	No

Measurement setup

When creating a new measurement setup, the following parameters can be edited:

FILTER: *0.5 / 1 / 2 / 10 Hz*; select "10 Hz" as the lowest frequency if the machine RPM is more than 600 RPM and the machine is placed on a flexible foundation.

AVERAGING: *1 - 20*; the number of averages is automatically increased to the maximum value if the indicator shows strongly varying imbalance.

TIME SYNCHRONOUS AVERAGING: In this type of averaging, the time signals of each individual rotation are averaged to reduce non-synchronous components in the signal. The calculated phase values are likewise averaged to increase the stability of the phase vector. The parameters for the phase averaging correspond to the settings under "Average type / Number of measurements" (see above). The number of time synchronous averages is either RPM-dependent, user-defined or unrestricted:

'Auto': Time synchronous number of averages is a function of the rpm*.

'Manual': Time synchronous number of averages can be entered (max. 254).

'Unrestricted': Each individual measurement is averaged with the preceding individual measurement. The longer the measurement takes, the more stable the final result. This average type is generally used for balancing. The measurement must be stopped using the joystick.

ORDER: *1 - 5*; order filters enable the balancing at RPM harmonics of a higher order; these special cases can occur in special machine configurations.

MEASUREMENT RANGE: The measurement range for the analog channel (A/B) can be automatically matched to the input signal ('Auto') or set to fixed. When set to '[Value] / Auto-Up', the measurement range is automatically increased when the upper limit is exceeded.

Measurement setup	
user balancing	
Meas. quantity	Velocity
Lower frequency	2.00 Hz
No. of measurements	5
Timesync. averages	Infinite
Order	1
Measurement range	Auto

Parameters in the measurement setup

Balancing with a control plane

While balancing in one plane, the vibration pointer in a second plane - the control plane - can be recorded and displayed as well.

Activating the control plane

You can activate recording of the vibration and phase values for the control plane.

Measurement channel

Connect the transducer in the *balancing plane* to the channel that is selected in the measurement task manager. Connect the transducer in the *control plane* to the other channel.

Display

In the measurement and data screen, the balancing plane is marked with a plus sign (+) (plane A in the example below).

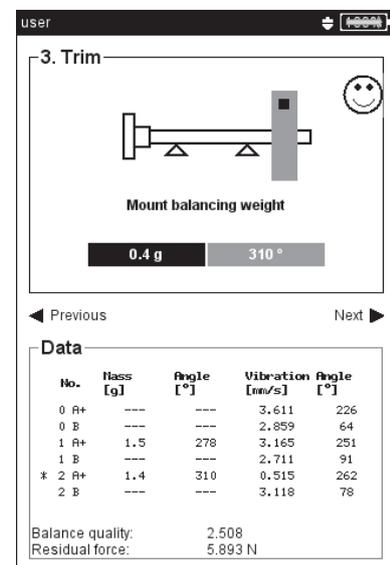
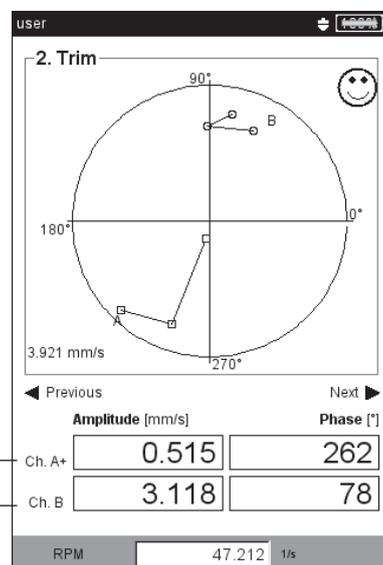
Reducing vibration in the balancing and control planes

Vibration in the control plane generally increases with each balancing run since VIBXPRT EX calculates the balancing weights for the balancing plane. To reduce the vibrations in both planes as far as possible, you can include the measurement values from the control plane in the calculation of the balancing weights. Activate 'Minimize 2nd plane error' - either in the machine setup before beginning the balancing procedure, or during balancing in the 'Tools' menu.

Single plane balancing with control plane

Balancing plane is indicated by a '+'

Control plane



Chapter 3: Appendix

This section contains the following information:

- Overview of the quality classes according to DIN ISO 1940. This enables the user to set up the balancing quality in the machine setup.
- Messages that may appear during the balancing procedure.

Balancing quality classes and groups of rigid balancing bodies (excerpt from DIN ISO 1940)

Qty. class	Examples of balancing bodies or machines
630	Crank gear rigidly assembled four-stroke engines and elastically mounted ships diesel engines
250	Crank gear rigidly mounted, high-speed 4-cylinder diesel engines
100	Crank gear rigidly mounted, high-speed diesel motors with six and more cylinders
40	Automobile wheels, rims, wheelsets, drive shaft crank gear elastically mounted, high-speed four-stroke engines with six and more cylinders
16	Crank gear components of automobile, truck and locomotive engines, crank gear of six and more cylinder engines with special requirements
6.3	Fans, flywheels, centrifugal pumps, machine construction and machine tool construction parts
2.5	Impellers of jet power plants, gas and steam turbines, turboblowers and generators
1	Tape recorder and phono drives, grinding machine drives
0.4	Precision grinding machine anchorages, shafts and disks, gyroscopes

Messages during balancing

Insufficient improvement

The vibration values are greater than 1 mm/s and have not sufficiently improved. Check whether the cause is actually an imbalance.

One-plane balancing is recommended

The dynamic portion of the calculated imbalance is larger than the static portion. The results will not be significantly improved if you proceed to balance in two planes.

Remove balancing weight?

You can leave the balancing weight on the rotor or remove it after each balancing run. Answer the question with YES or NO.

RPM measurement

VIBXPERT EX measures the RPM before each balancing run. The green LED lights up if the RPM sensor sends a pulse.

Please check trigger sensor!

There is no signal from the trigger / RPM sensor. Possible causes: signal path is interrupted, poor light conditions, incorrect orientation of the trigger optics for the reference mark, ...

Initializing

The measurement amplifier is adjusted (Autorange)

Speed fluctuates. Results can be influenced!

The RPM variation is too large or deviates too much from the measured RPM of the preceding balancing run. Wait until the machine has reached the balancing RPM before starting the measurement.

Vibration pointer unstable

The magnitude and/or the phase of the vibration pointer is changing too much. VIBXPERT EX automatically increases the selected number of averages until the signal is stable or the maximum number of averages (20) is reached.

Maximum number of averages reached

VIBXPERT EX has set the number of averages to 20. If the vibration pointer has stabilized, the balancing runs can be continued.

Balancing planes cannot be separated (2-plane balancing)

The influences of the balancing weights in the other plane are the same or are adjusted so that they increase at the same time. Under these conditions, the results for the subsequent balancing runs cannot be used. Balancing in one plane is recommended.

Pointer change too large

The vibration pointer in the trial run has changed too much in magnitude and phase in comparison to the initial imbalance run.

Pointer change too small

The vibration pointer in the trial run has not changed enough in magnitude and phase in comparison to the initial imbalance run.

If the change is too large, the trial weight must be reduced. If it is too small, the trial weight must be increased.

Restart is recommended (1-plane balancing)

If the vibration values increase and the balancing weights increase from one balancing run to the next, no further improvement can be expected. The entire balance measurement must be restarted.

Masses combined.**Remove previously attached masses!**

The previously attached balancing weights are added together (vectorially) to form a single weight. Attach the weight calculated in the data screen to the rotor, and remove all previously attached balancing weights. Start the next balancing run. In comparison to the last run, the balanced state should not change substantially.

Emergency storage

If the balancing procedure is stopped prematurely (e.g. battery discharged), the data are stored in a recovery file. When the device is switched on again, the balancing procedure can be continued with the aid of this recovery file.

Opening the recovery file

- Switch on the measuring device.
- In the start screen, click on the 'Balance' symbol.
- Open the tab in which the interrupted balancing procedure was started (e.g. '1 plane').
The recovery file is labeled with a warning symbol.
- Click on the recovery file to open the recovery dialog box. It shows information on when the emergency storage took place and the number of balancing steps (see below).
- Click on 'Restore' to open the file and continue the balancing procedure, or to save the data properly.
Click on 'Discard' to clear the data in the recovery file and start a new measurement.
Use 'Exit' to leave the recovery dialog box without deleting the recovery file.



Continuing the balancing procedure after emergency storage

Balancing [RECALL]

Diagnosis 1 plane 2 planes

Balancing

Measurement was interrupted. Do you want to reload it and close it correctly?

Date	27.11.2008
Time	07:15:35
Number of balancing runs	4

Task: user

Channel A: VIB 6.146

Channel B:

Machine: user

Productive maintenance technology

Fluke Deutschland GmbH
Freisinger Str. 34
85737 Ismaning, Germany
+ 49 89 99616-0
www.pruftechnik.com

Printed in Germany VIB9.806.01.2017.0G