Automotive
Energy & Power Analysis
Field Service
Environmental
Research & Development

Rotor Balancer

Technical reference manual

ISO9001

... the precision signal conditioning company

worldwide
DEWETRON
www.dewetron.com

1 Table of contents

2 Balancing procedures

In general, balancing involves two separate actions:
- Measuring the unbalance
- Correcting the unbalance

According to rotor nature, it can be balanced with single or dual plane balancing procedure.

Single plane balancing is used when rotor has only 'static component' of unbalance. This type of balancing is only sufficient for narrow rotors (fans…)

More advanced balancing is made with dual plane balancing procedure. This procedure corrects both static and dynamic components of unbalance and can be also called 'dynamic balancing'. The typical example for dynamic balancing is long rotors (the length is higher than the diameter).

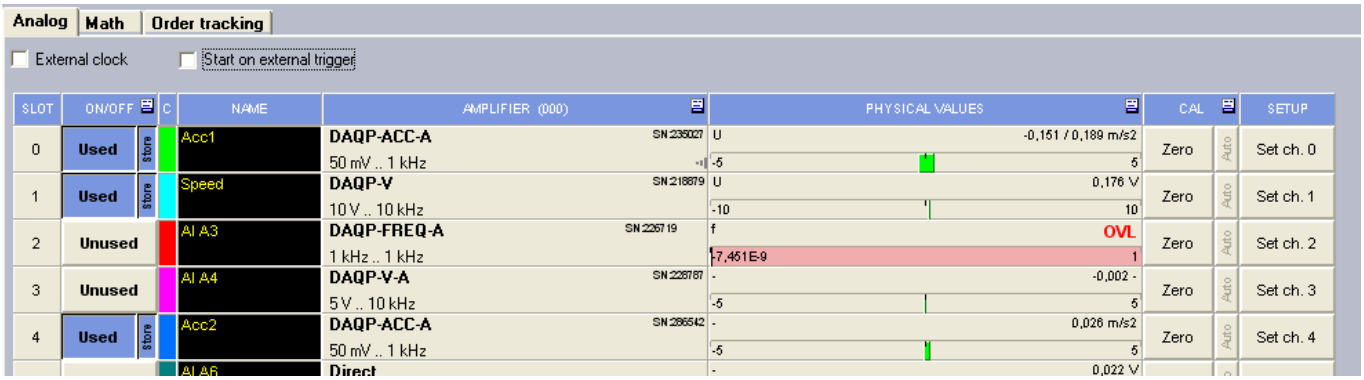
3 Setup

3.1 Hardware setup

Hardware needed for single plane balancing:
- Acceleration sensor (for measuring vibrations)
- Encoder or optical probe (for rpm)

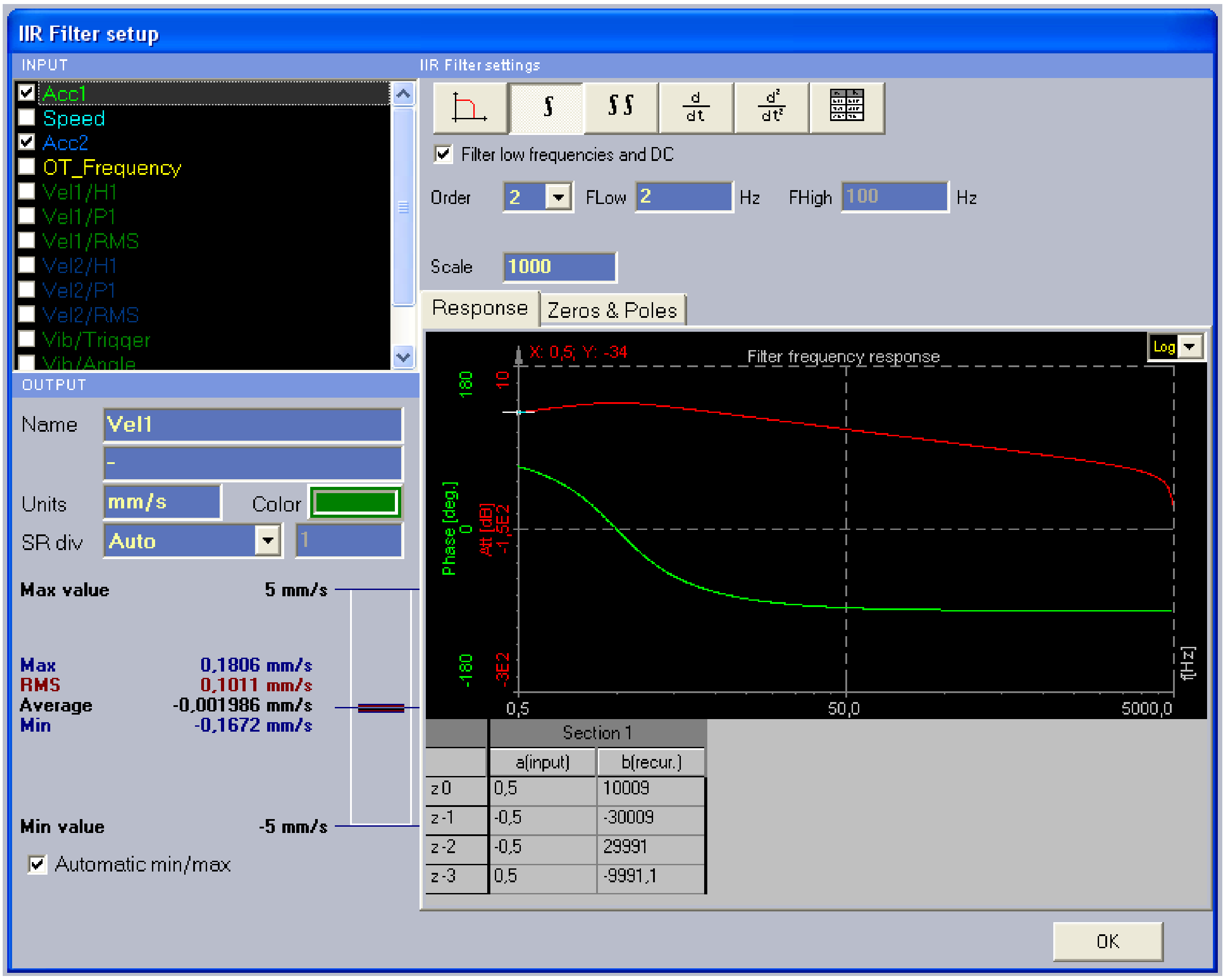
Hardware needed for two plane balancing:
- 2 x Acceleration sensor (for measuring vibrations on each plane)
- Encoder or optical probe (for rpm)

Channel setup (for dual plane procedure) should look similar to lower image. We need three channels, one for each sensor. Please take care that vibration sensors are correctly calibrated.



3.2 Math filters

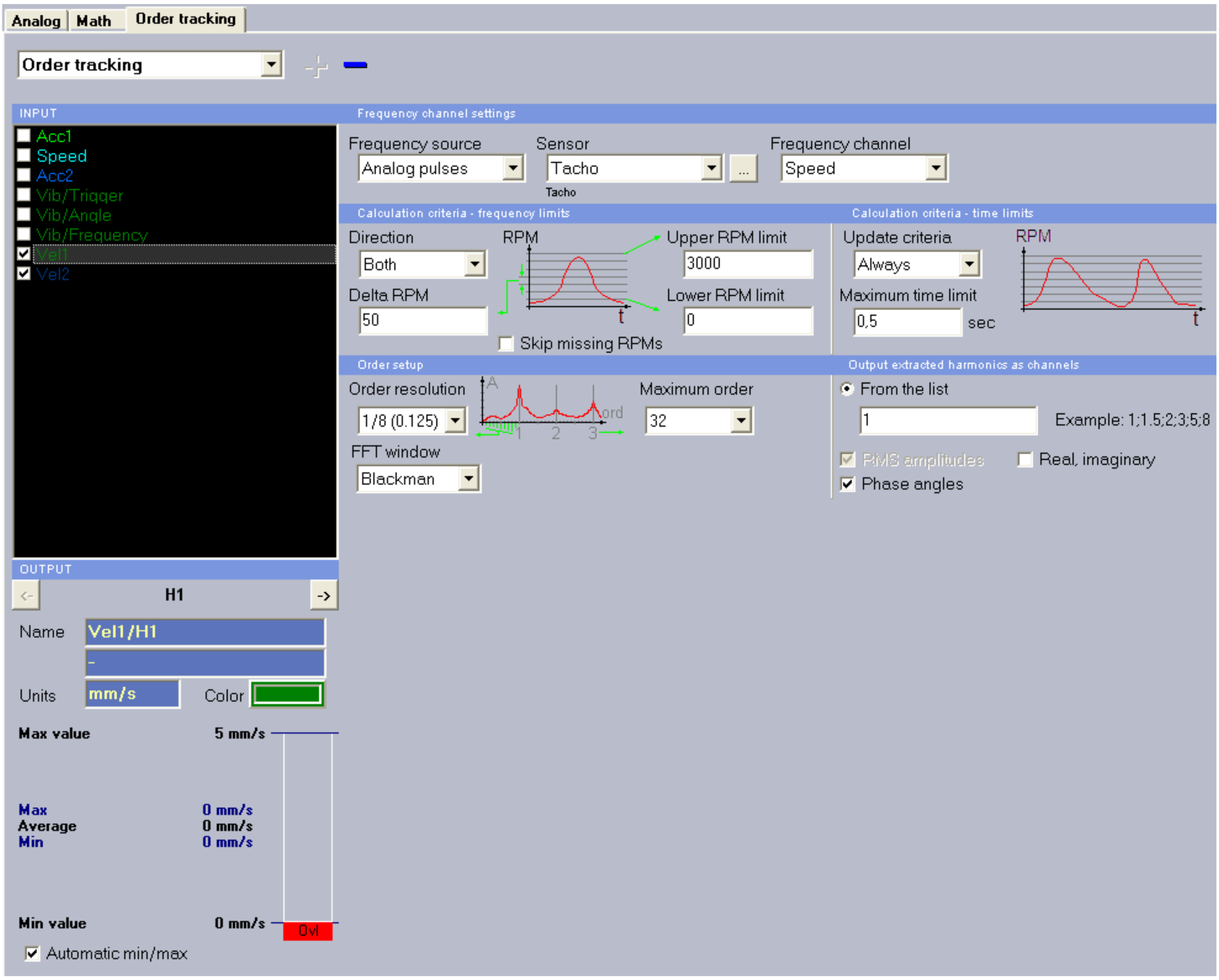
It is recommended to use vibration velocity instead of acceleration for balancing.
For this the integration mode of IIR Filter is used as shown in the lower image. Please consult Dewesoft user’s manual for more details. Please note that we have measured acceleration in m/s2 and the converted to mm/s and therefore a factor of 1000 is used.



3.3 Order tracking

Inputs for order tracking are the velocity channels from filters.
From order tracking, we need to get phase angle (P1), frequency [RPM] and first harmonic (H1) for each plane.

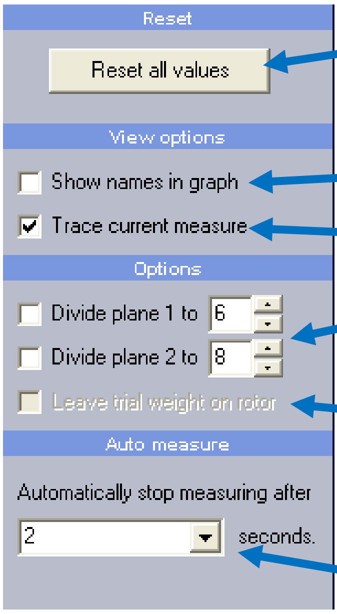
Your setup should look similar to lower image. More details about order tracking are described in the Dewesoft order tracking manual and tutorial. Please note that three ellipsis button near the Sensor field allow you to set the angle sensor, which could be attached to analog channel or the counter channel (if the output of the sensor is digital).



4 Balancing window description

The balancing window is a visual control, where you need to add the RotorBalancer.vc to the Addons folder of Dewesoft. The new visual control will appear in the design mode of the display window. Adding the visual control will result in a having a window shown below.

4.1 Left window



Clears all values (except system characteristics) and returns view to first step

Enable/Disable point names in vibration graph

Enable/Disable trace points in vibration graph

Choose wheter to divide each plane into equal parts (for example: divide if rotor has predefined attachments for weights)

Check if you want to leave trial weight on the rotor (only in single plane balancing)

Select, after how many seconds should the measure automatically stop

4.2 Main window

Short instructions

Green arrows show previous steps and red arrow shows current one

Navigation trough procedure

Measure button

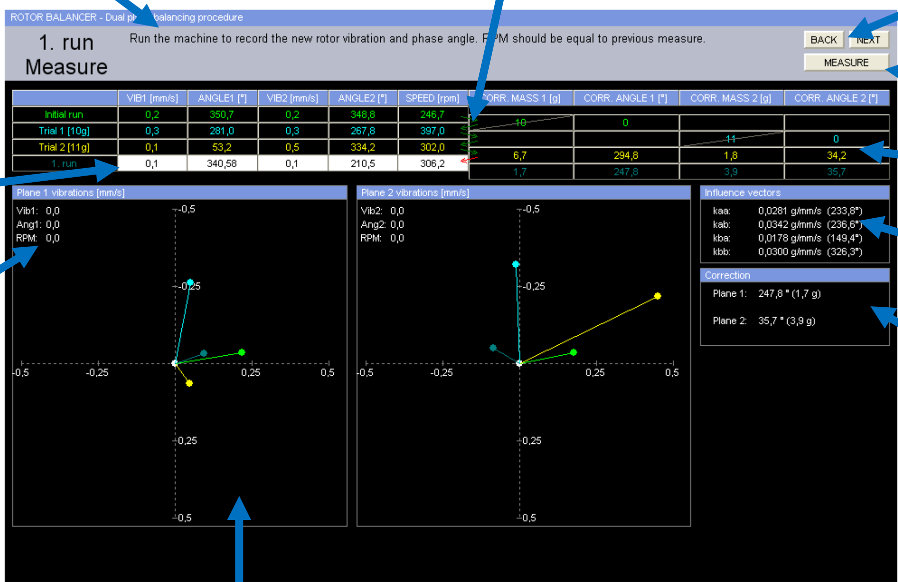
Input boxes for manual measuring

Corrections

Calculated influence vectors

Current values

Needed correction



Vibration graphs for both planes

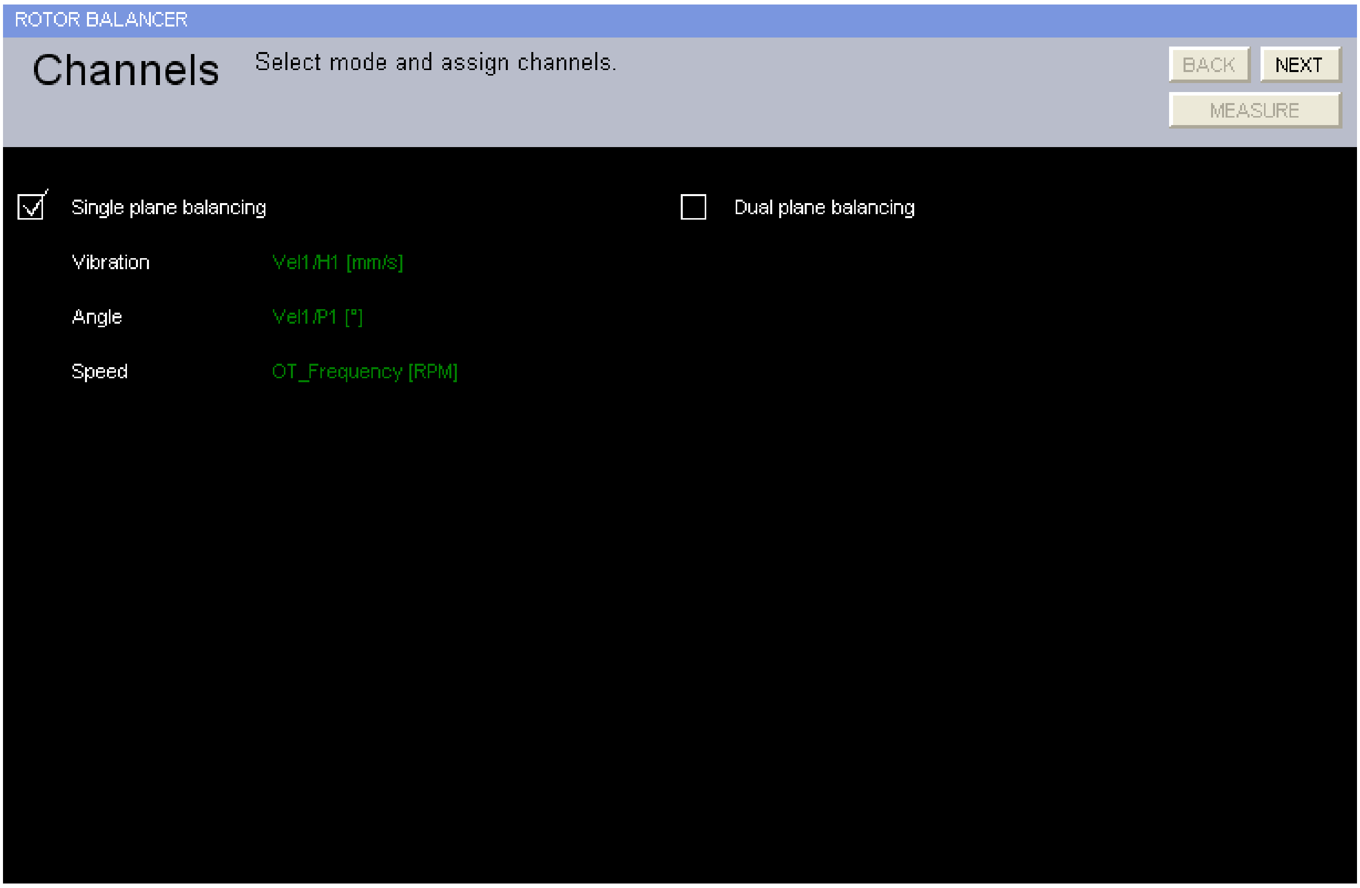
5 Single plane balancing procedure

The procedure contains next steps:
1. Measure initial unbalance
2. Attach trial weight
3. Measure unbalance
4. Detach trial weight (optional)
5. Attach calculated correction weight
6. Measure unbalance
7. Repeat steps 5 and 6 until you are happy with results.

5.1 Assign channels

First thing you must do is to select the channels. Channels are retrieved from order tracking and must be selected in specific order:
1. Vibration (H1)
2. Phase angle (P1) – unit must be in degrees
3. Speed (Frequency) – in RPM unit

First screen will show you which channels you have assigned. When you assign all 3 channels, press the button 'NEXT'.



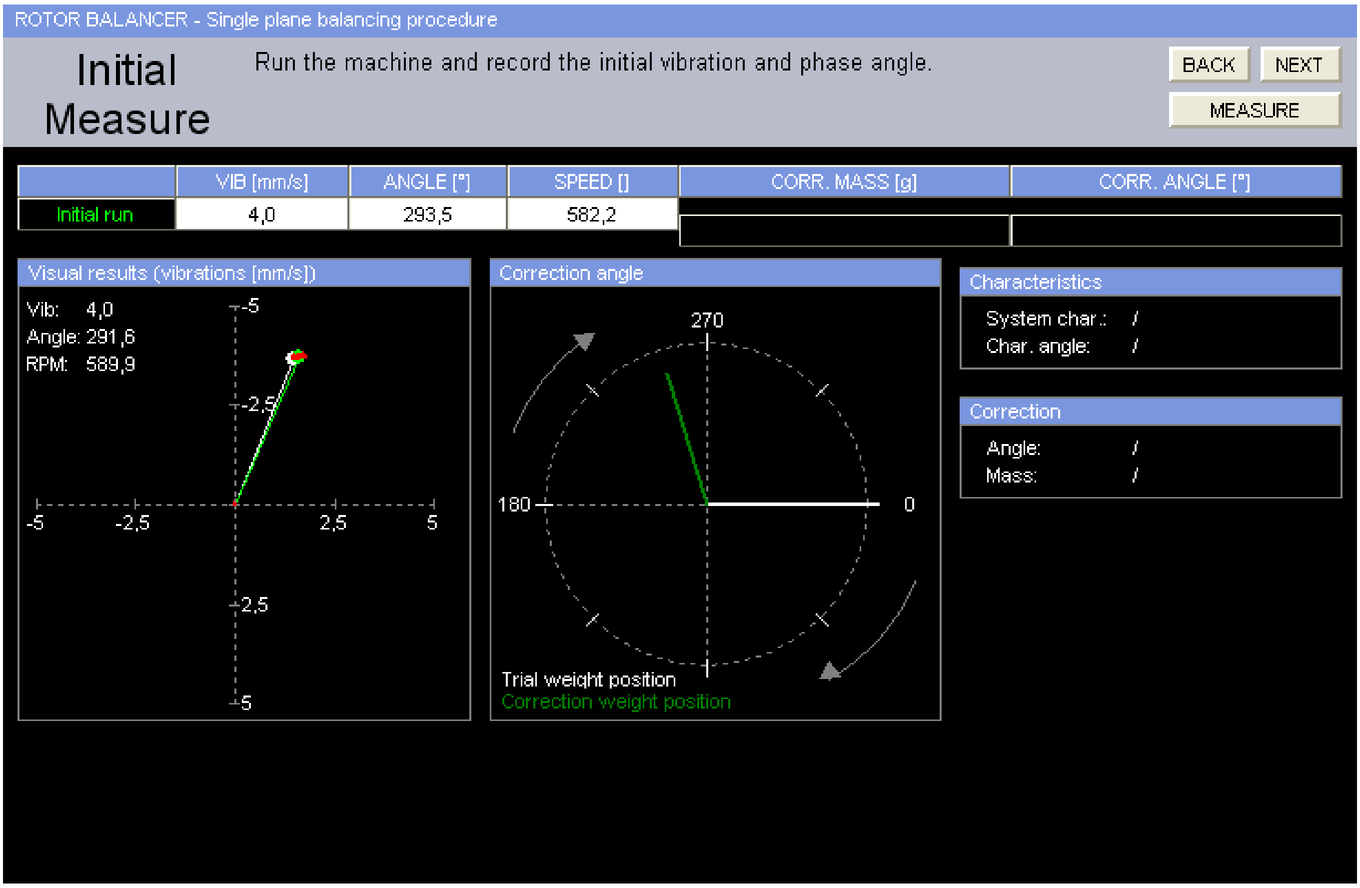
5.2 Measure initial vibration

Run the machine and wait until it reaches its operating speed (rpm). Due to difference force applied from unbalance and differences in dynamic behavior at different speeds, speed should be the same in all measurements.

If you check the ‘Trace current measure’ option, red dots will show the history of vibration movement.
Now, you can click ‘MEASURE’ button, and program will measure and average the current vibration. Measure length can be changed in the left window and can be stopped manually with second click on the ‘MEASURE’ button.

If you are not happy with measured results, you can enter values (vibration, angle and rpm) manually by clicking on the table cells.

When you are finished with initial measurement, press button next and stop the rotor.



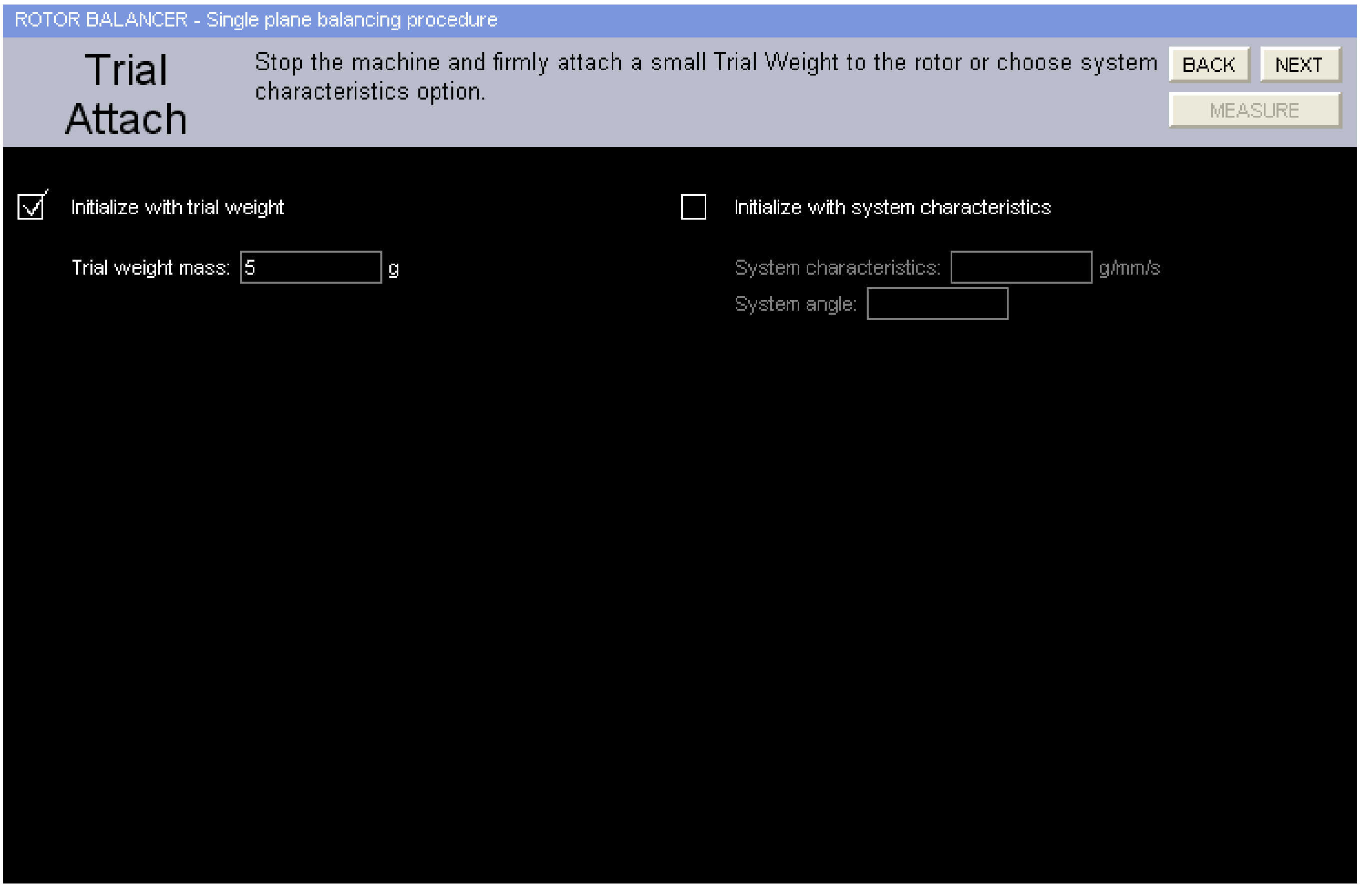
5.3 Attaching the trial weight

Option 'Initialize with system characteristics' is described later in the chapter 5.7.

In this step, you will have to attach the trial weight to the rotor. The mass selection of the trial weight depends on the rotor mass and its operating speed.
If the trial mass is too light, the second measurement will make almost no difference to the first measurement and calculations will not be accurate. The program will warn you if the difference is too small. However, if the trial mass is too heavy, rotor unbalance will be too big and this could lead to rotor damage. You should stop the measure procedure if you notice too much unbalance after the trial mass.

Be sure that all weights are firmly attached to the rotor so they don't fall off when the rotor reaches its operating speed.

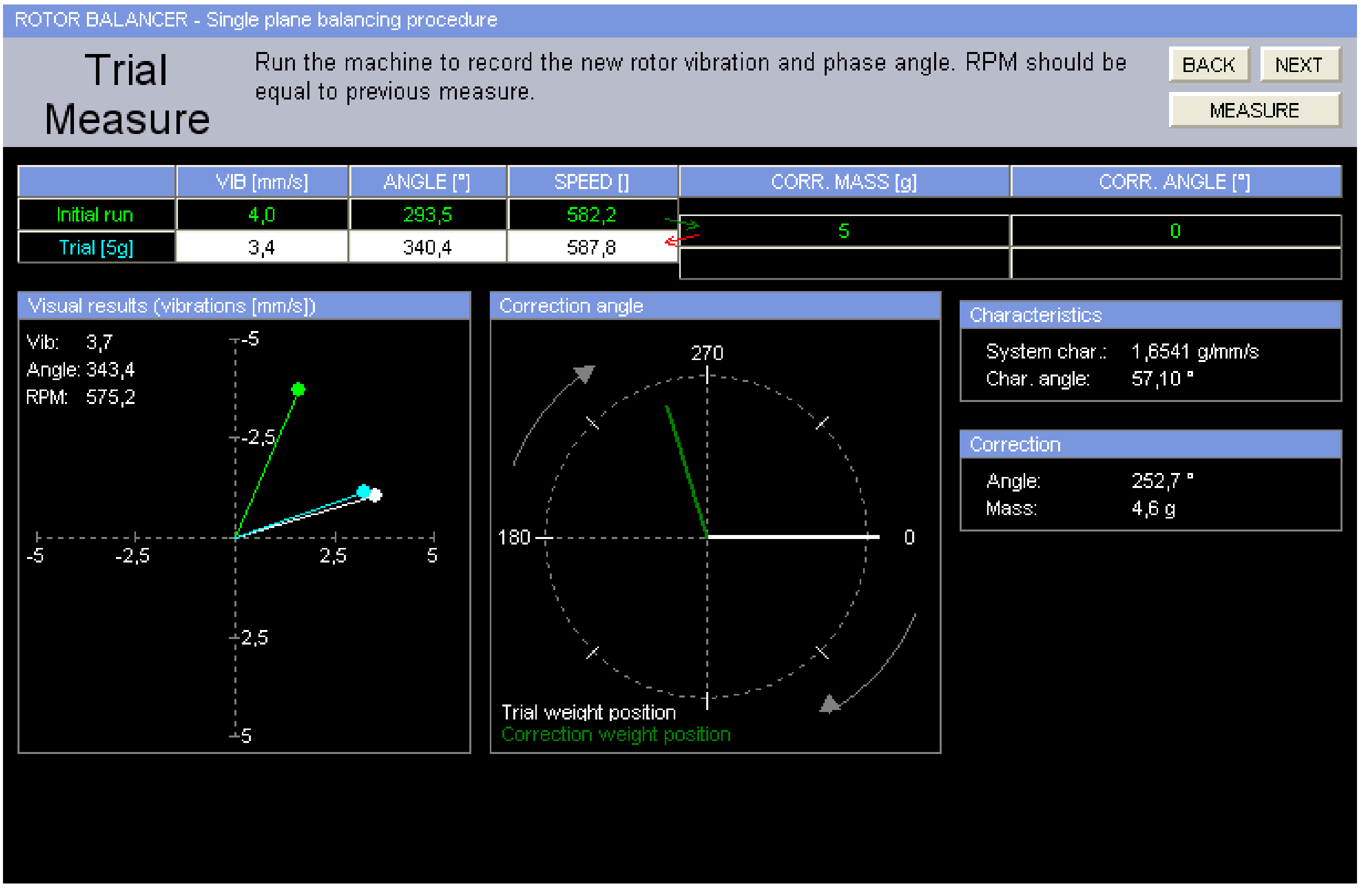
Firmly attach the trial weight to the rotor and remember its position because this will present the initial position (0 degrees) in further corrections. Enter trial weight mass in the proper field and press button 'NEXT' to proceed.



5.4 Trial weight measure

Remeasure the rotor with trial weight in the same way as you did in the ‘Initial measure’ step. Rotor speed should be the same as in the initial measure.

As you can see on display, program informed you that you made the correction (in this case) of 5 grams weight on 0 degrees.
When the measurement is done, press the button ‘NEXT’.

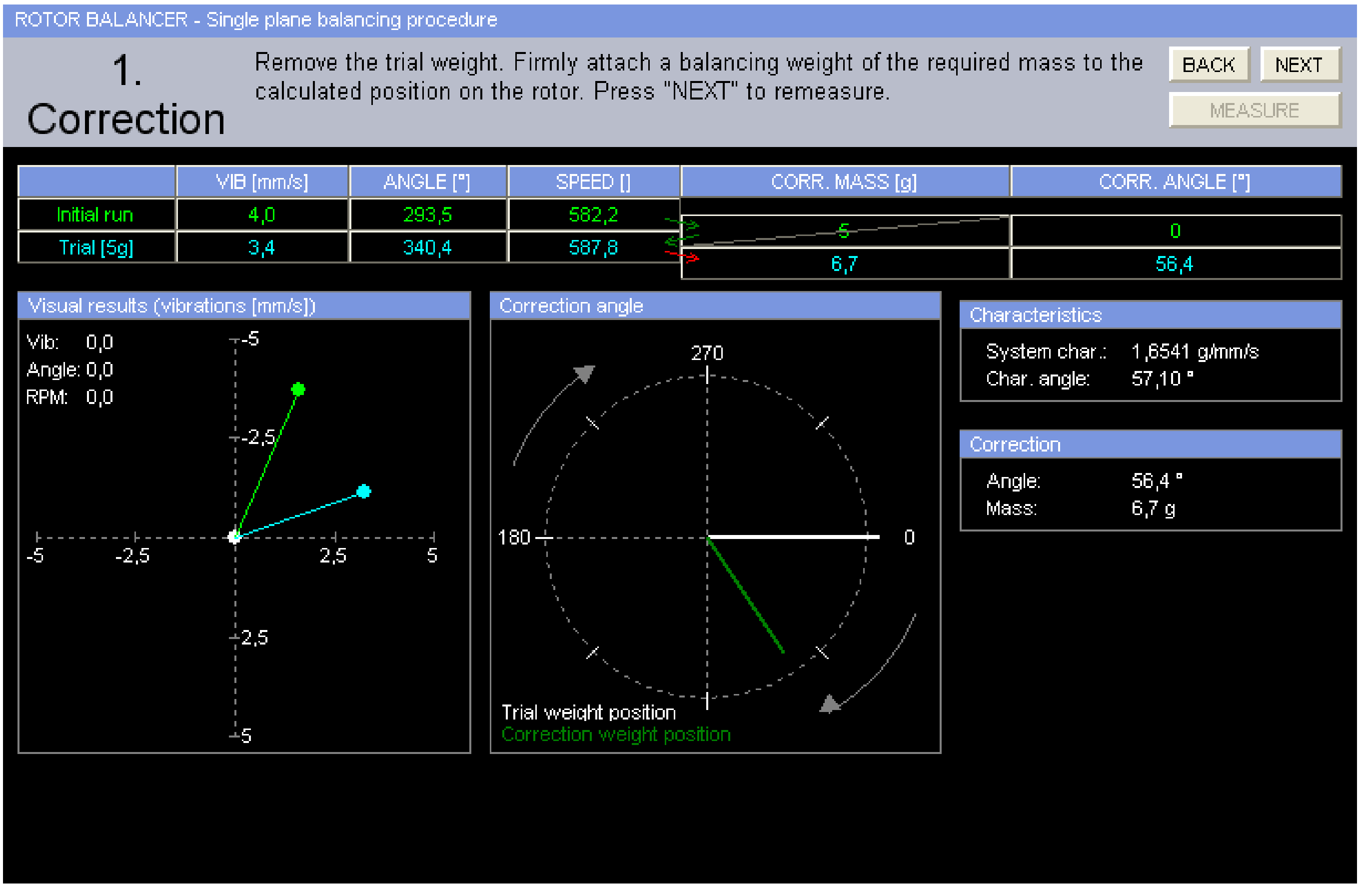


5.5 First correction

After the trial weight is measured, program will calculate the corrections and system characteristics (which can be used for later balancing of the same rotor).
In most cases, the trial weight should be removed from the rotor after measuring (see the crossed 5 grams in the table), but if the trial weight already gave good results, you can leave it on. In this case, you have to check the option ‘Leave the trial weight on’ in the left window, so the program will give you proper correction.

When attaching the correction weight, you can also choose to divide the plane into more pieces if you have pre-prepared holes for adding the weight or if you cannot put (because of the rotor nature) the correction weight on the calculated position. In this case, check the ‘Divide plane 1’ in the left window and choose number of divisions. Program will calculate new correction masses and display them in the table and correction window.

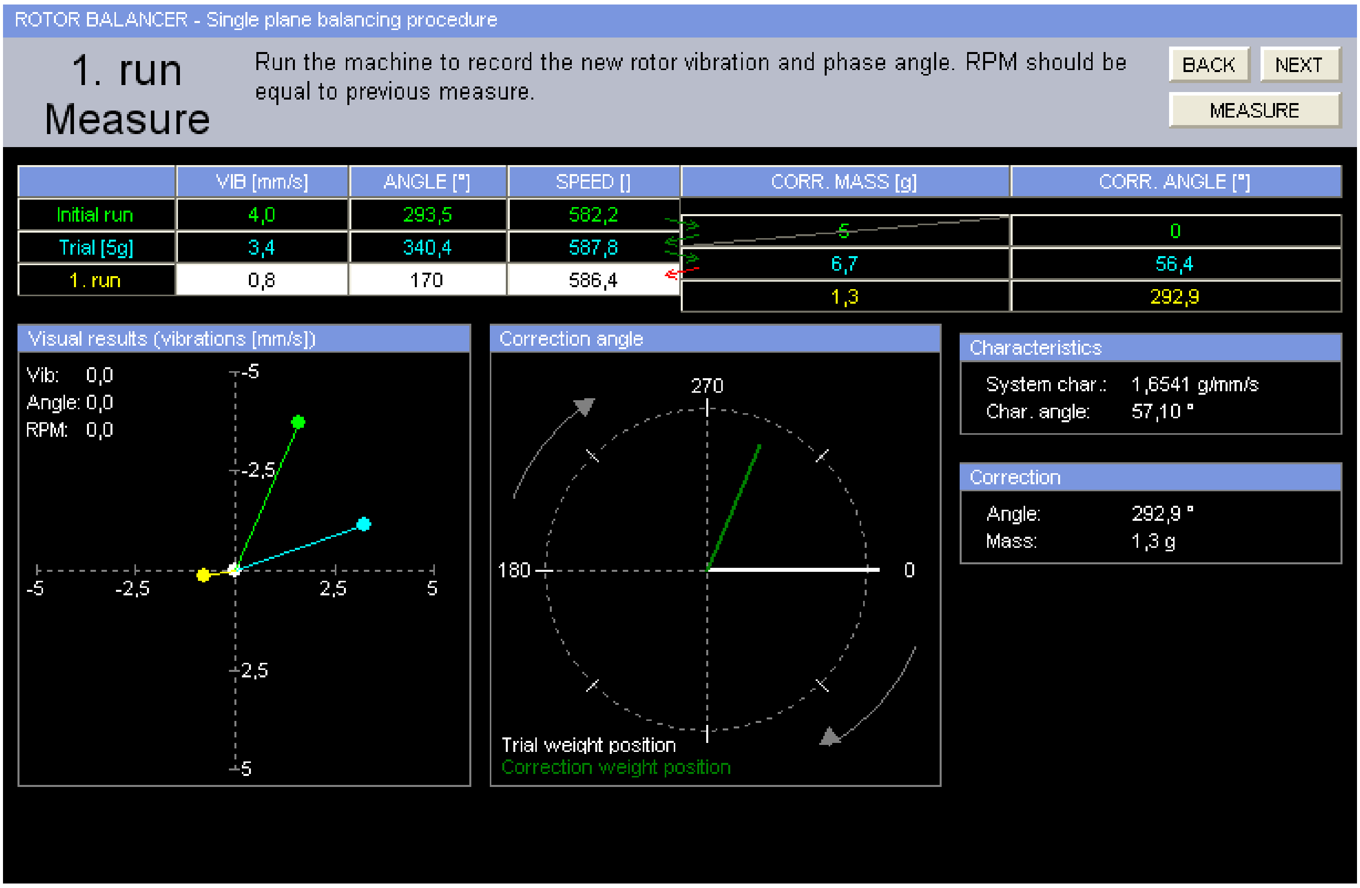
The correction angle graph shows you where to put your correction weight. The gray arrows show the rotor rotation direction.
For example, if the correction is 40deg, be sure to put the correction weight 40 degrees forward in the rotor rotation direction.



5.6 First measure

After the correction weight was attached, you must remeasure the rotor to see the progress made. Measuring is described in the chapter 5.2.

If you are happy with result, you can stop balancing at this point. Otherwise, just click the 'NEXT' button and repeat procedures described in chapters (5.5 and 5.6).



5.7 Rebalancing the rotor with system characteristics

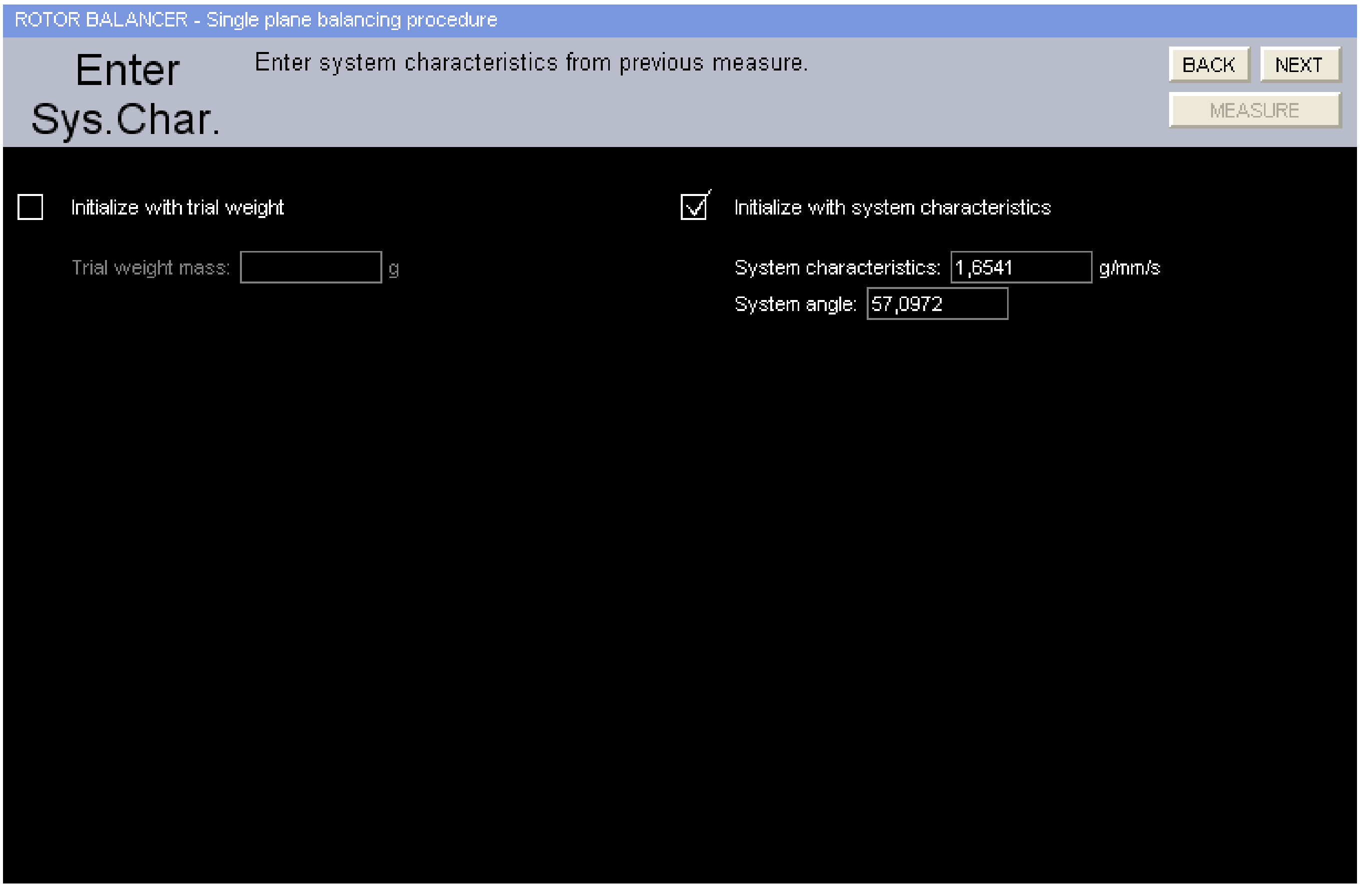
Rebalancing with system characteristics is only possible when all these requirements are met:

- Rotor was previously balanced with trial mass
- Rotor characteristics were not changed
- Position of the first trial mass must be known
- Reflection badge position must stay the same
- Optoprobe and vibration sensors must maintain the same angle to each other

If you have saved the setup of previous measure, system characteristics were stored in the setup file. You can open saved setup and click the button ‘Reset values’ in the left window.
Program will return to the channel selection (chapter 5.1). Everything should be fine here, so just click button ‘NEXT’.

Next thing you will have to do is to measure the initial rotor vibration (see chapter 5.2) and click button ‘NEXT’.

Now in this window, you should choose the ‘Initialize with system characteristics’ option. As you will see, the characteristics from previous measure will be already written in the fields, so you should just click button ‘NEXT’ and the program will give you the proper correction (see chapter 5.5). Of course, you can manually write the system characteristics in the fields.



6 Dual plane balancing procedure

Dual plane balancing procedure is similar to one plane balancing.

The procedure contains next steps:

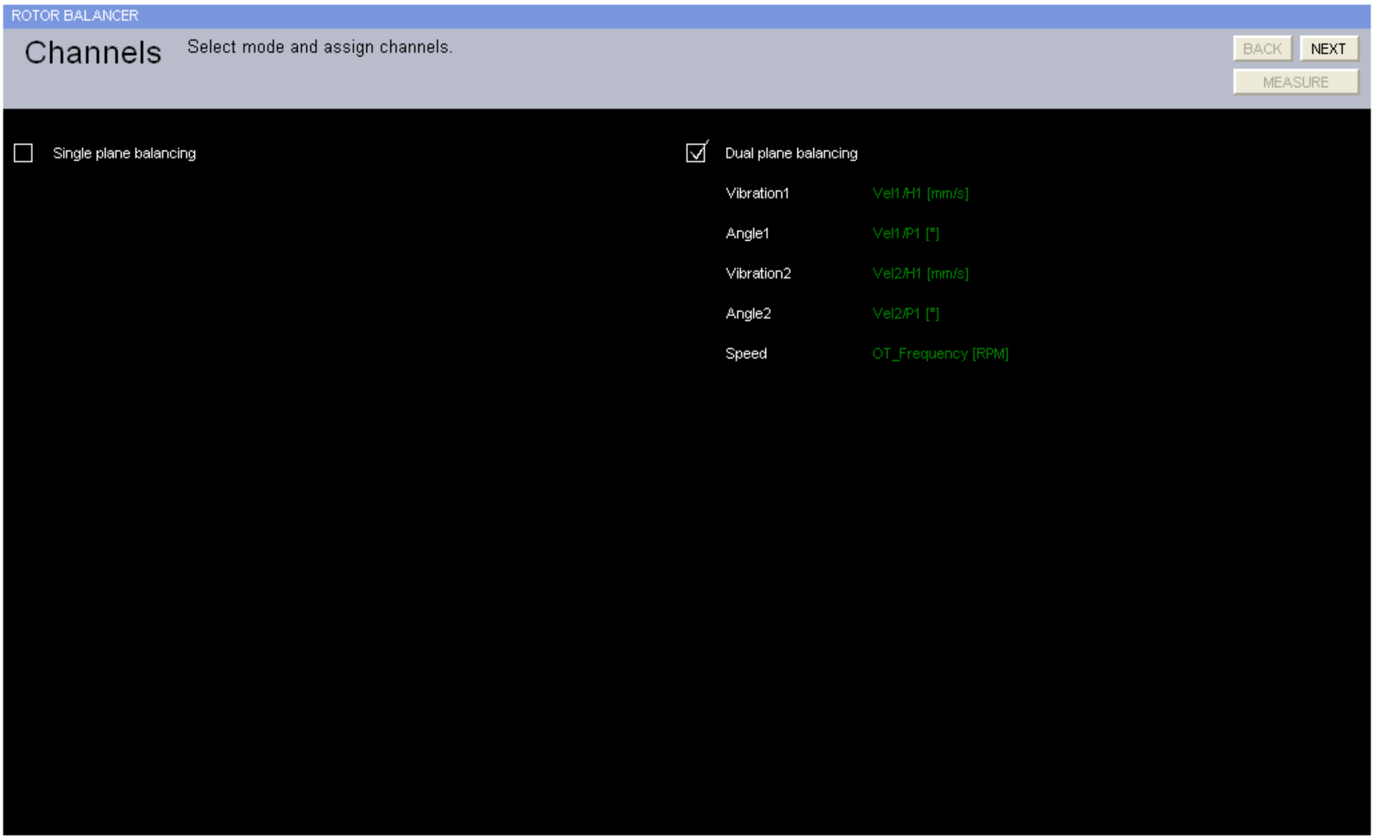
1. Measure initial unbalance
2. Attach trial weight on plane 1
3. Measure unbalance
4. Detach first trial weight
5. Attach trial weight to plane 2
6. Measure unbalance
7. Detach second trial weight
8. Attach calculated correction weights on each plane
9. Measure unbalance
10. Repeat steps 8 and 9 until you are happy with results.

6.1 Assign channels

In dual balancing procedure, you must select 5 channels:

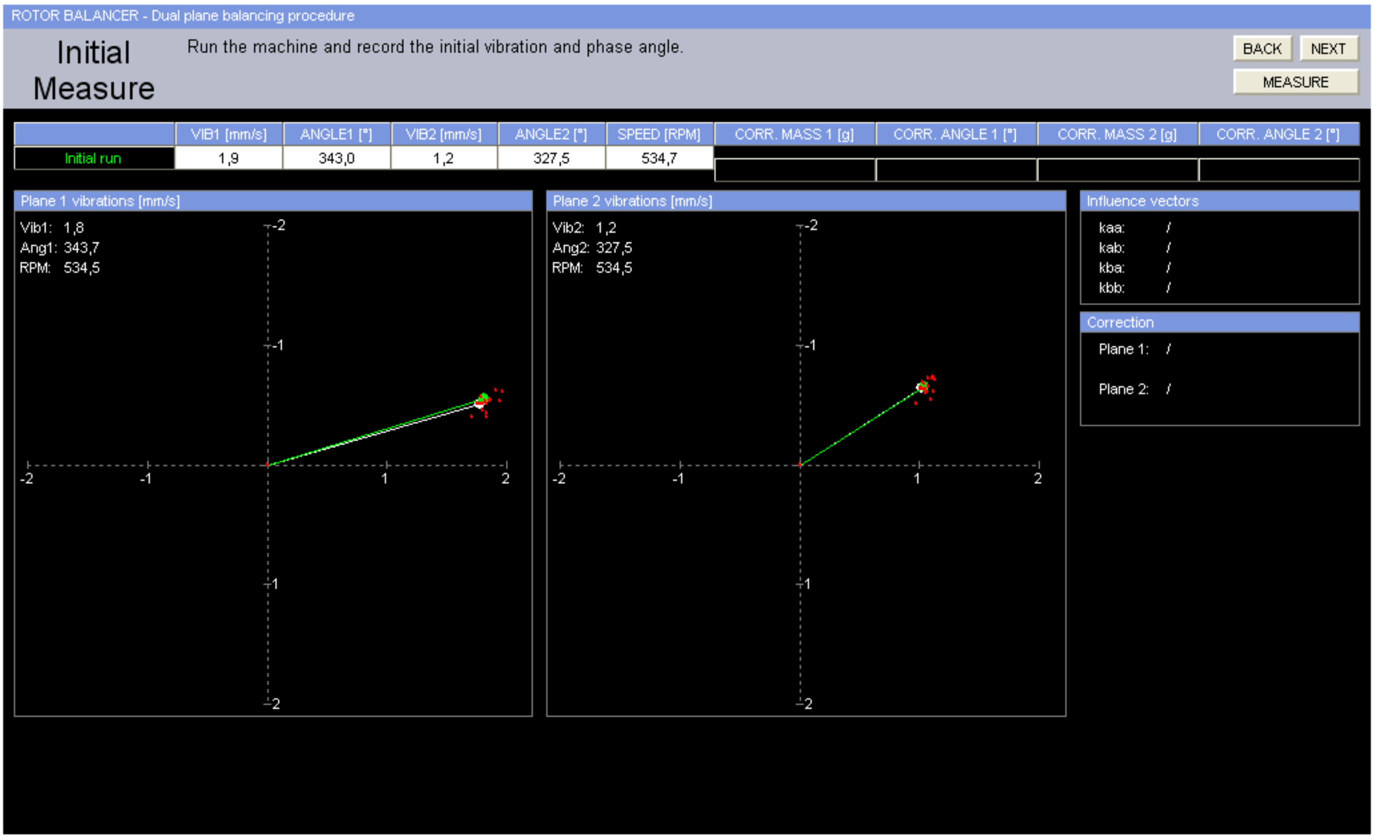
- Plane 1 vibration
- Plane 1 phase angle
- Plane 2 vibration
- Plane 2 phase angle
- Speed (rpm)

It is important that the vibrations on both planes have the same unit.



6.2 Measure initial vibration

Measurements are made in the same way as in one plane balancing. The speed must be equal in all measurements. In measure mode, only vibration graphs are shown for both planes. See chapter 5.2 for measurement procedure.

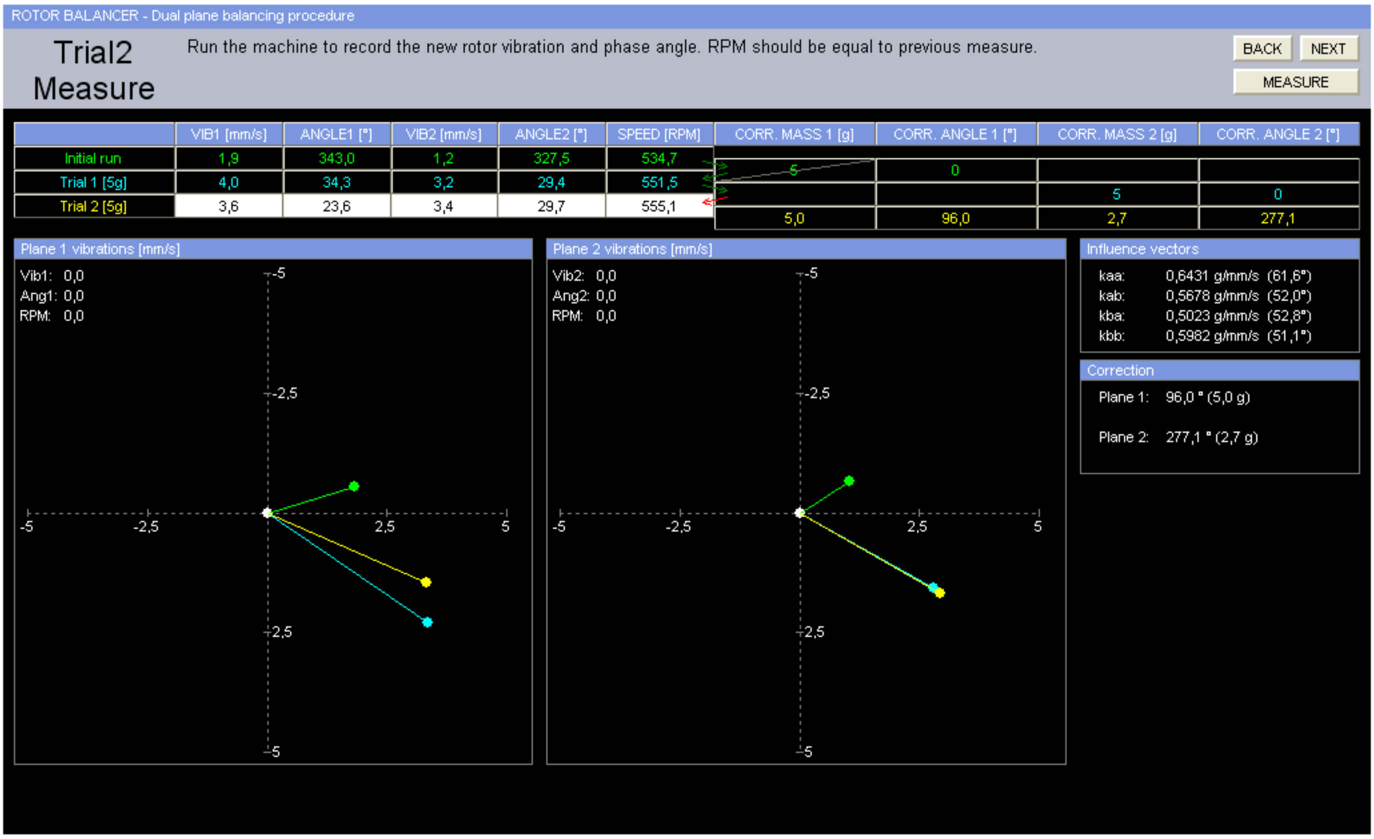


6.3 Attaching and measuring the weights

Trial weights represent initial position (0 degrees) on each plane.

If the trial weights are too light, program will warn you. On the other hand, if the trial weights are too heavy and rotor vibration becomes too big, you should immediately stop the rotor and repeat the procedure with lighter weight.

First you will have to attach trial weight to plane 1 and remember its position. After new vibration is measured, you must detach first weight and attach second trial weight to plane 2. After you measure vibration with second trial weight, system will calculate system characteristics (influence vectors) and calculate correction weights.

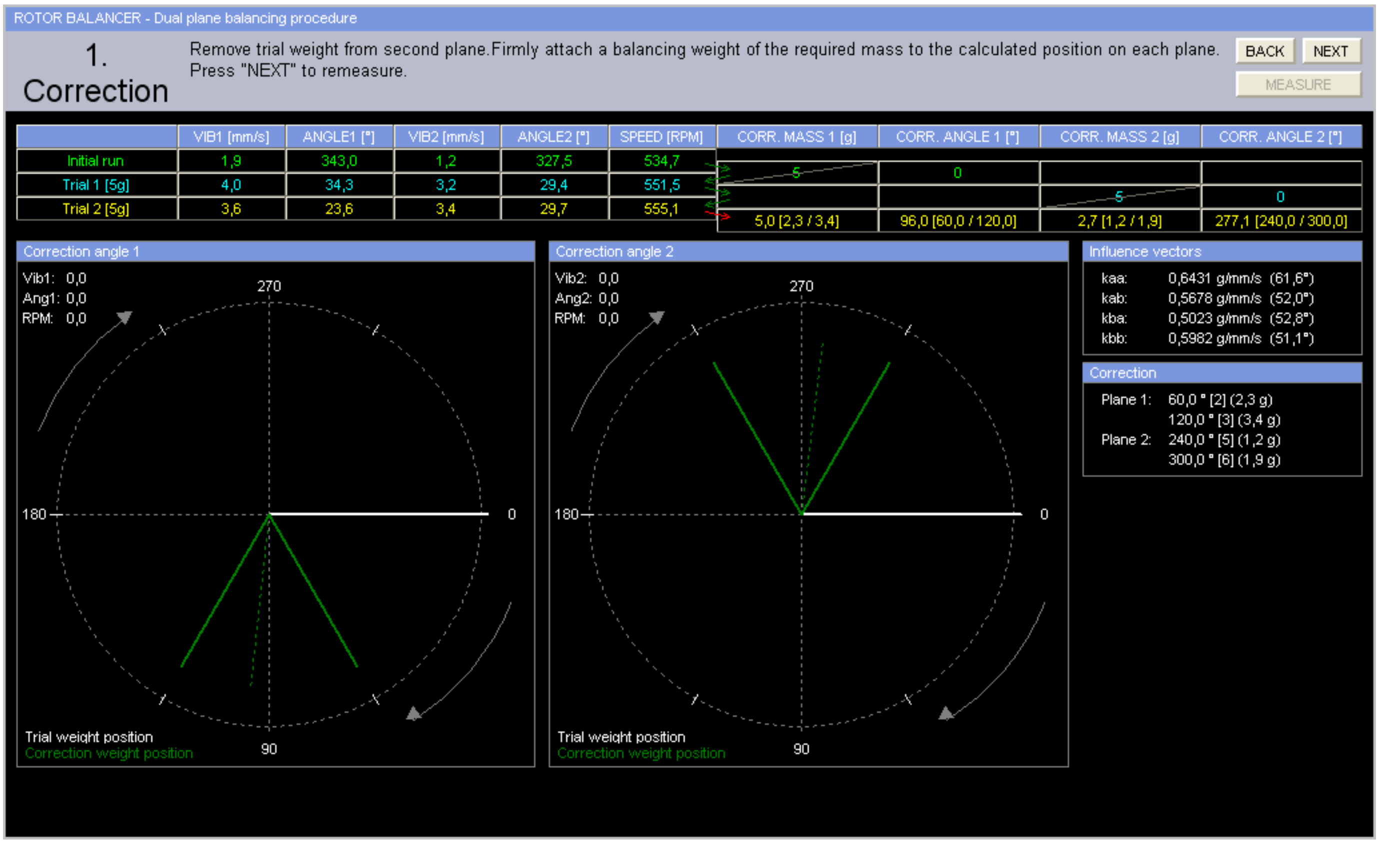


6.4 Correction

After both trial weights have been measured, program will calculate the masses and positions of correction weights. If you cannot place the correction weight on the calculated position, you can divide each plane to more divisions, as shown in the lower image.

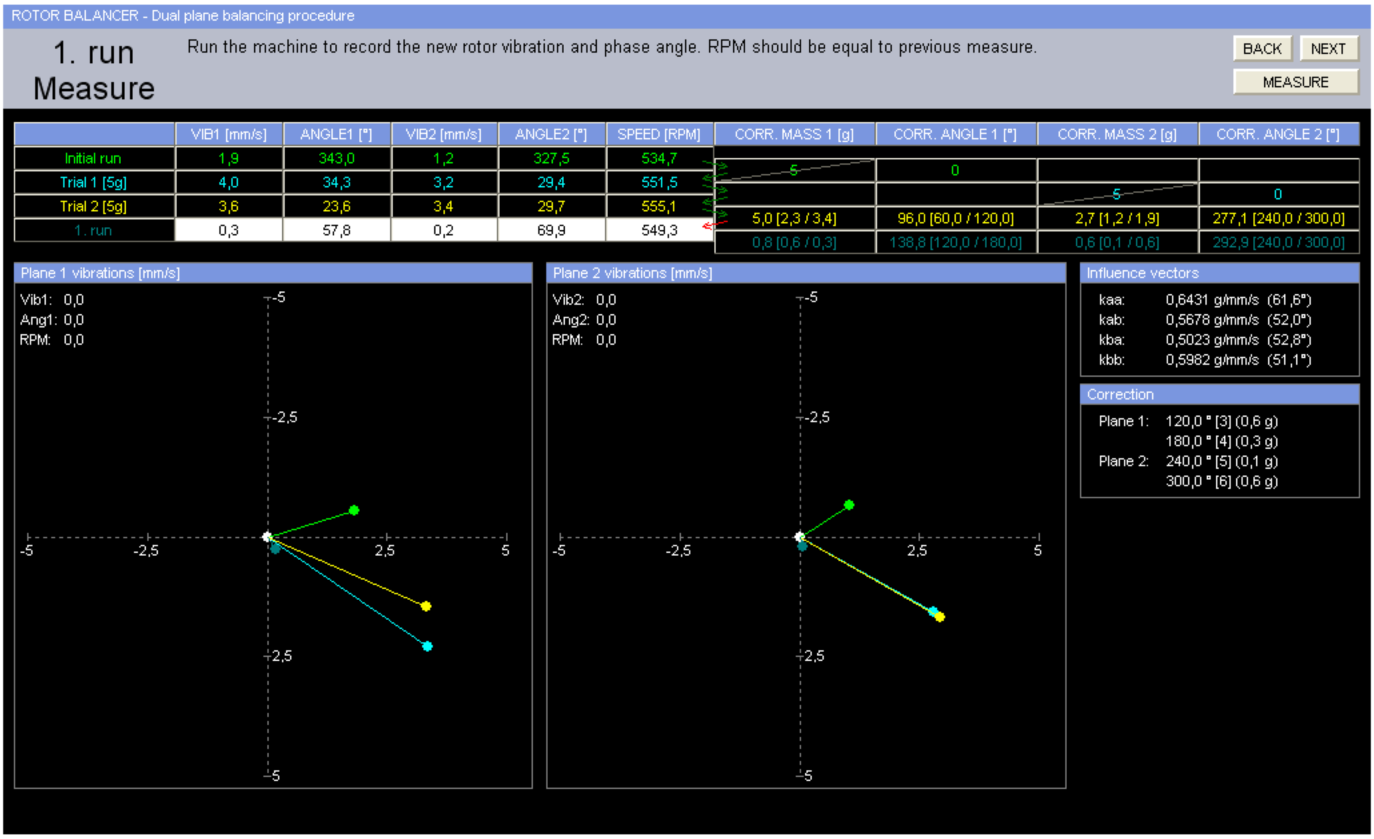
In this example, both planes are divided into 6 divisions.
If we look at the plane 1, instead of putting the correction weight on 96deg (5.0g), we can attach two correction weights: first on 60deg (2.3g) and second on 120deg (3.4g).

Gray arrow around angle graphs shows the rotation direction of the rotor. The correction weight position is measured forward (in the rotor rotation direction) from trial weight position in degrees.



6.5 Remeasuring

Next step is to remeasure the rotor to see what progress we have done.
If we are happy with results, we can stop measuring at this point, otherwise we can repeat steps described in chapters 6.4 and 6.5.



6.6 Rebalancing the rotor with system characteristics

If we want to rebalance the rotor with previously calculated system characteristics, the procedure is identical to procedure described in the chapter 5.7.