TPI
Pocket Balancer

Field Balancing System

User Guide: 3.1

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1 OVERVIEW

Pocket Balancer is a high specification single and two plane rotor balancing tool based on an extremely rugged (IP67) handheld device.

The system comprises a rugged (IP67) handheld device that connects up to two accelerometers and a tachometer sensor.

Balancing proceeds when a user runs the rotor at the required speed and measures the out-of-balance vibration using the accelerometer(s) and tachometer sensor.

A trial weight is then placed and the rotor is then run again so that Pocket Balancer can calculate the effect of the trial weight placement on the vibration. This effect is then used to determine the required value and position of the balancing weight that must be added to the rotor.

The basic Pocket Balancer system comprises the following components:

- Rugged IP67 handheld device (TDS Nomad)
    - Including battery charger & accessories.
- 3 x BNC interface head.
- 1 x IEPE accelerometer.
- TPI 505L Tachometer and 5 metre connecting cable.
- Carrying Case.

1.1 Getting started

The first thing you should do is to make sure you have the latest version of **Microsoft ActiveSync™** (for Windows XP) or **Mobile Device Centre** (Windows 7 or Vista) installed on your PC or laptop computer. This program is used to allow the PC to talk to the Pocket Balancer unit using the supplied USB cable or docking cradle. If you do not already have ActiveSync™ (or MDC) on your PC it can be downloaded **free of charge** from Microsoft's website:

http://www.microsoft.com/en-gb/download/details.aspx?id=15

or for Windows Mobile Device Centre:

http://www.microsoft.com/en-gb/download/details.aspx?id=14

When the Pocket Balancer installation software is run, and if ActiveSync™ or MDC is running and the Pocket Balancer unit is **connected**, the Pocket Balancer software will automatically be installed onto the Rugged IP67 Handheld device via the USB cable.

If the Pocket Balancer unit is **not connected** during the installation, the Pocket Balancer software will be downloaded and installed onto the Pocket Balancer unit via the USB cable **the next time it is connected** to the PC. It is always best to have the Pocket Balancer unit connected during the installation particularly when performing an update as this ensures the unit will be updated with the latest version.

You will be prompted with various messages during this procedure and the installation is intuitive and straight forward (see Section *3.1 Software Installation*).

If you are re-installing the software (to upgrade to a newer version for example) the previous version will need to be removed **prior** to the new version being installed. This happens automatically and you will be prompted with a message asking if you wish to completely remove the application. You should answer 'yes' to this question and the installation will remove the old version and update it with the new version (see Section 3.2).

1.2 Power switch

Powering the Pocket Balancer unit on and off is done by briefly pressing the power (on/off) button **for less than one second**.

A **one second** press of the on/off button will turn the display backlight on or off.

A slightly longer than one second press of the on/off button will bring up the reset screen which also allows other modes to be selected such as screen cleaning or alignment, changing battery etc.

N.B. if it is ever necessary to reset the Pocket Balancer Handheld device (if it won't power on for example) this can be achieved simply by holding down the on/off button for approximately 5 seconds. After displaying a 5 second countdown the Handheld device will give an audible double "bleep" and reset. No data or programs will have been lost.

Resetting the Handheld device is not something that should need doing very often but may be required if, for example, the battery has been allowed to fully discharge whilst a program was still running.

2 Hardware

2.1 Setup

The Pocket Balancer unit comes fully configured with an IP67 end cap already fitted.

2.2 Power Supply

The accelerometer sensors take their power from the Pocket Balancer unit and this should have a suitably charged battery prior to use. The TPI 505L Tachometer Laser Sensor operates from its own internal “AA” batteries (x2).

N.B. It is recommend that the unit is charged for at least 12 hours prior to its first use.

2.3 Sensor connection

The TPI Tachometer Laser Sensor must be plugged into the rightmost of the three connectors, as viewed from the front of the Pocket Balancer Unit, and the accelerometer sensor for single-plane balancing connects into the middle connector. For two-plane balancing, the second accelerometer sensor must additionally be plugged into the leftmost connector.

2.4 Service

The Pocket Balancer system contains no user serviceable parts. In the unlikely case of malfunction, please return the complete unit to your supplier for repair.

3 Software - General

3.1 Installation

Simply run the Pocket Balancer install program from the CD supplied on a laptop or desktop PC. The Pocket Balancer program can then be installed to the Pocket Balancer unit if it is connected to the PC or on the next connection if not. The Pocket Balancer program can then be found on the ***Programs*** menu of the Pocket Balancer unit. Pocket Balancer is initially configured to auto-start whenever the Handheld device is turned on (although this option can subsequently be turned off if desired).

The Pocket Balancer Report Writer software can also be installed to the PC using the install program.

3.2 Software Updates

TPI operates a policy of continuous product improvement and releases software updates for its products from time to time. These can be found at:

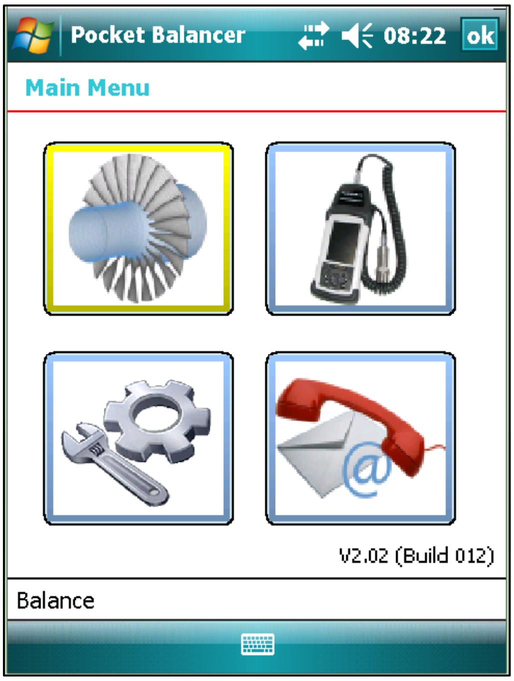
http://tpi.pocketvibradownload.com

3.3 General Operation

Pocket Balancer is a highly intuitive program, but the following sections of this manual will describe its functionality in detail.

4 Software – Pocket Balancer

4.0 Opening Menu



The opening Main Menu screen shows four icons that allow the user to select from the following functions:

- Run balancer (“rotor” icon)
- Vibration Meter Mode (“meter” icon)
- Configuration and set-up menu (“gear wheels and spanner” icon)
- Display contact information (“telephone” icon)

Navigation around the opening menu screen can be achieved by using the PDA’s cursor keys and pressing the **enter** key (◄┘) when the desired icon is highlighted in yellow. Alternatively an icon can also be selected by touching it (e.g. by using a stylus).

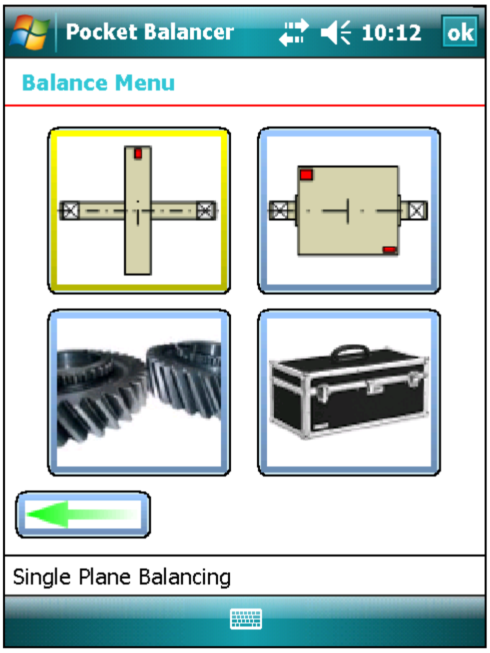
4.1 Contact details

Selecting the contact details icon (the “telephone” icon bottom right) displays the screen shot opposite.

Return to the Main Menu screen is achieved by touching the green “back” arrow icon (e.g. using a stylus) or simply by pressing the **enter** key (as the icon is highlighted in yellow). Alternatively return to the Main Menu screen can also be achieved by touching the “OK” symbol top right of screen or by pressing the “OK”” button on the PDA.

4.2 Balancing Mode

Balancing mode is selected from the Main Menu with the “rotor” icon (top left of the 4 main menu icons). This gives a further choice of 4 different modes as shown.

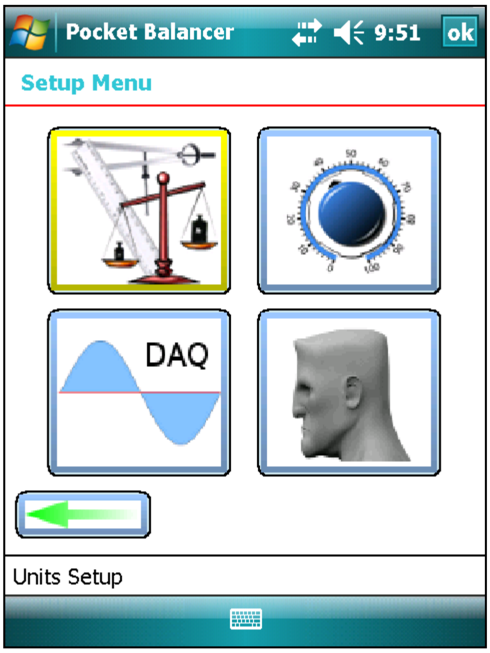


This allows the user to select from:

- Single plane balancing (“narrow rotor” icon top left)
- Two plane balancing (“wide rotor” icon top right)
- Configuration and set-up menu (“gear wheels” icon)
- Tool box (“toolbox” icon)

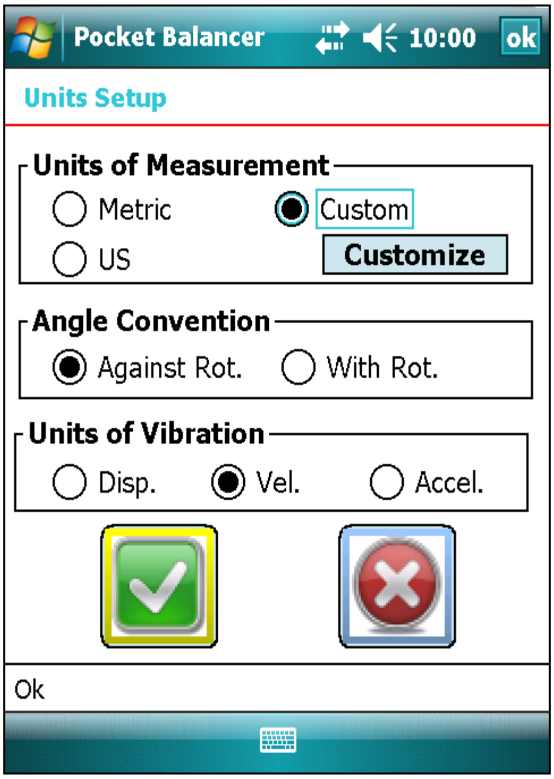
4.2.1 Balancing Mode Set up

The “gears” icon, bottom left of the Balance Menu screen, allows the user to select from a range of options on the balancing setup menu.



- **Set up the Units (“Scales” icon)**
- **Set up the Data Acquisition Averaging (“DAQ” icon)**
- **Save and load Profiles (“Head “ icon)**
- **Set up the Balancing Mode (“Control knob” icon)**

4.2.1.1 Units set up

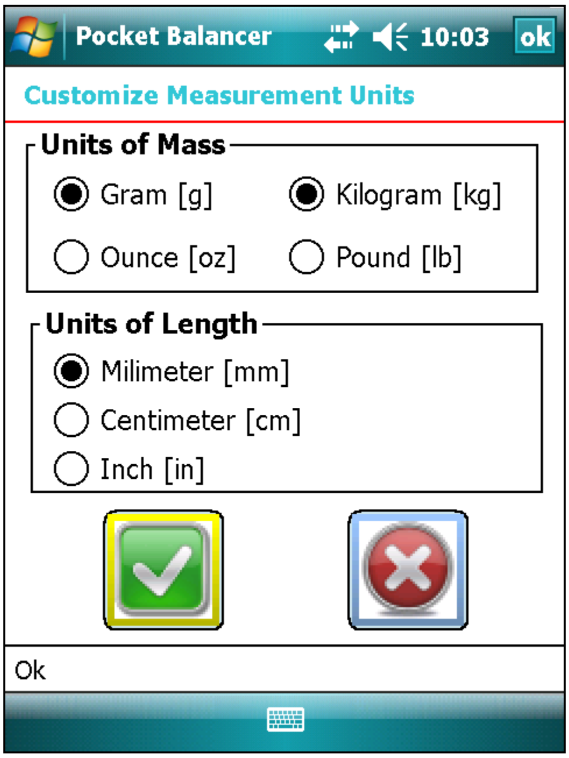


In the Units setup screen, the units of measurement can be selected to be either Metric (e.g. mm/s), US (e.g. ins/s), or custom.

If **Customize** is selected, the custom units can be defined using the choices shown below.

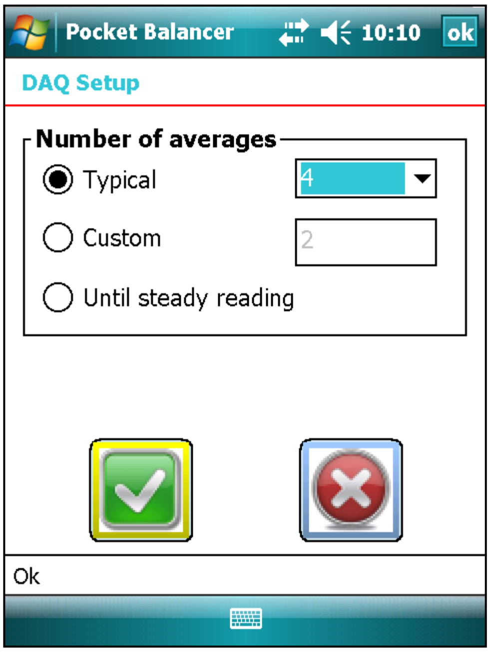
It is also possible for the user to change the convention for angular measurement from **AGAINST** rotation (the default) to **WITH** rotation.

Additionally the user can select whether the vibration level will be displayed in terms of **Displacement**, **Velocity** (the default) or **Acceleration**.



4.2.1.2 DAQ set up

The DAQ (Data Acquisition) setup screen allows the user to determine the number of averages used in determining the out-of-balance vibration and its angle.

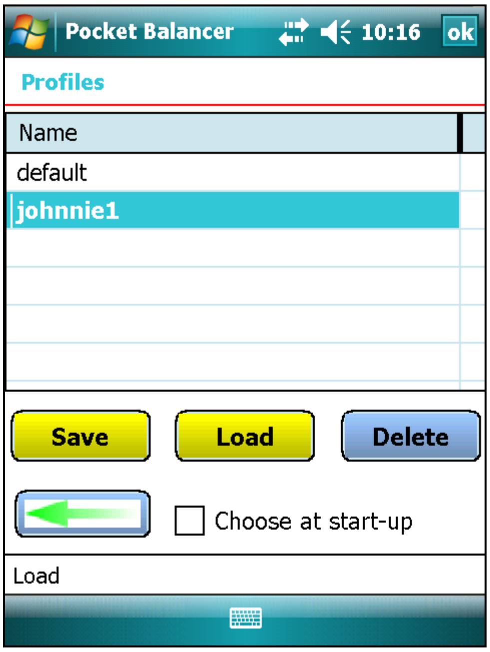


Typical (recommended) values of 4, 8, 16, 32 or 64 averages can be selected from a drop-down menu, but other values can also be specified using the **Custom** option.

A third option is to continue averaging until a steady reading is obtained.

The higher the number of averages chosen, the greater the level of accuracy which can be obtained, but each balancing run will then take longer to collect its vibration data. The default value is 4 averages.

4.2.1.3 Profiles



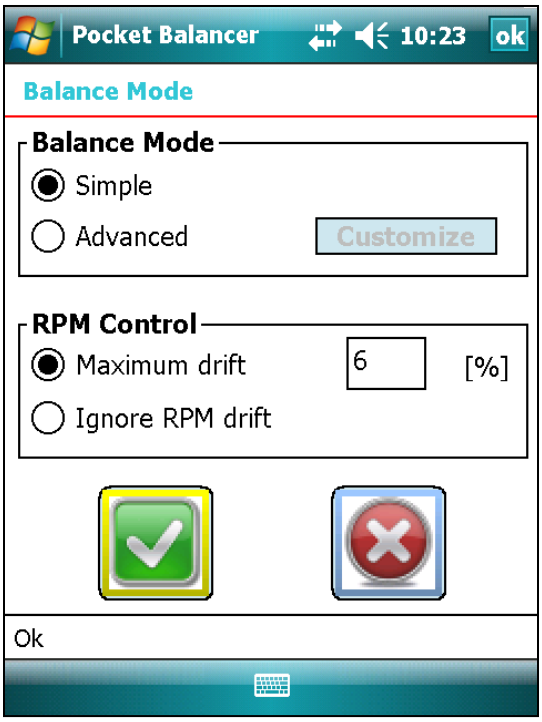
The user also has the option of Saving and Loading balancing run setups as profiles, using the Profile screen.

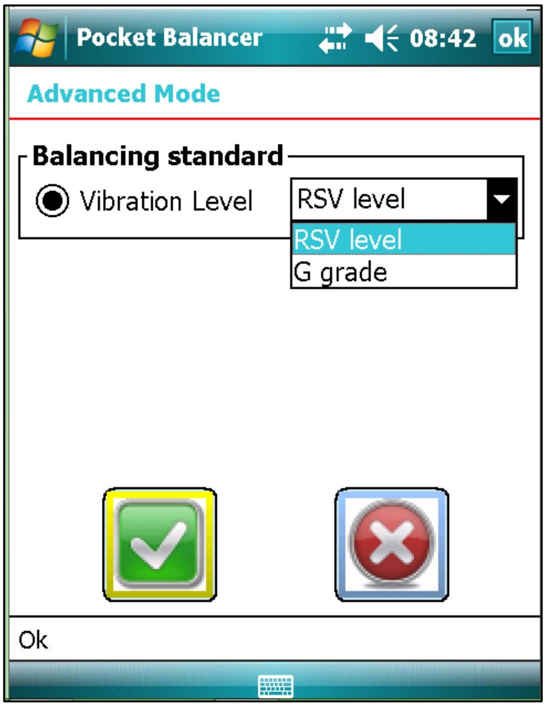
This allows a preferred configuration to be **Saved** to a file from which it can be **Loaded** again so that the instrument can be used in precisely the same mode in future.

4.2.1.4 Balance Mode

This screen allows the user to choose between the balance modes **Simple** and **Advanced**. If **Advanced** is selected, this can then be **Customized** by selecting the blue button.

This screen also allows the user to specify the amount of tolerable drift in the RPM measured by the tachometer sensor.





Customization of the Advanced balancing mode consists of a choice of “standards” for target vibration level.

The choice is between:

- RSV (Run Speed Vibration) level, which, as for the **Simple** mode, defaults to 2.8 mm/s.
- G grade, which gives a choice of standard options when setting up an individual balance run.

4.2.2 Single Plane Balancing Mode

Selecting Single Plane Balancing mode opens up the single plane balancing wizard.

The wizard will take the user through a series of steps in order to perform a single plane balancing run.

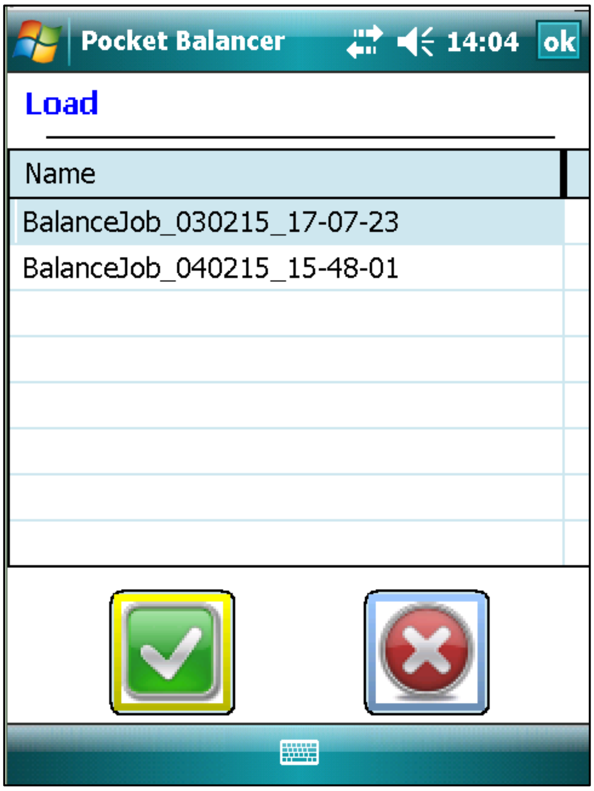
These steps are summarized below, prior to being individually explained in the following sections.

Single Plane Balancing Run Steps:

- Step 1 – load previous job (Optional)
- Step 2 – select balancing type: (Standard/Fixed Point/Fixed Weight)
- Step 3 – set balancing parameters
- Step 4 – measure initial out-of-balance vibration
- Step 5 – specify a trial weight
- Step 6 – collect trial weight run data
- Step 7 – specify the balance weight
- Step 8 – measure new out-of-balance vibration
- Step 9 – specify trim weight
- Step 10 – measure final out-of-balance vibration

N.B. Selecting **Exit** at the end of the run automatically provides the option to **Save** details of the balancing run before exiting.

Step 1 – Load Previous Job (Optional)

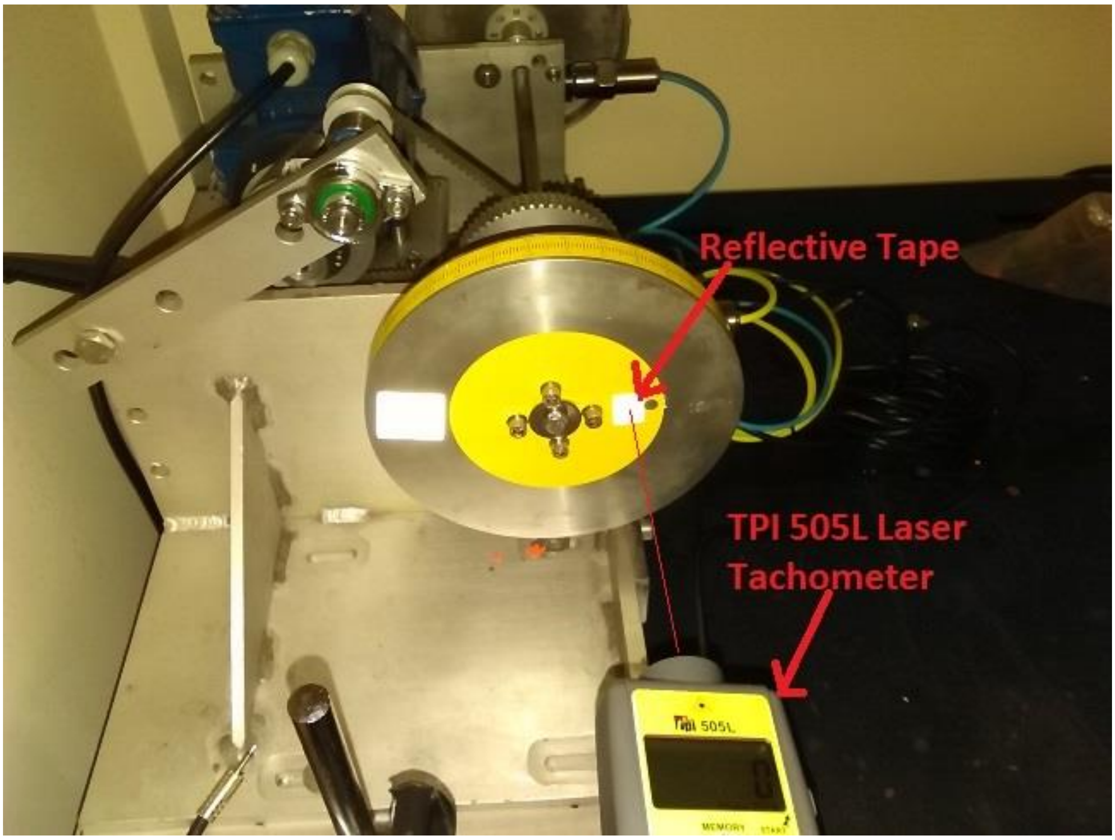


Selecting **Load** at Step 1 will allow the user the option of loading in a previously saved balancing run.

This can be selected from a drop-down list of all the previously saved jobs as shown.

Once the selected balancing run has been loaded, the user can step through that run, and can repeat data entry and retake meter readings, starting from any step in the process, exactly as described for a new balancing run.

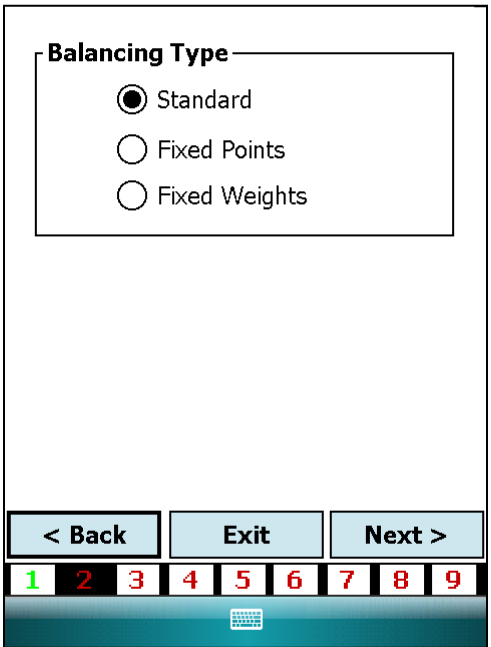
Before moving to Step 2, the user should ensure that a tachometer sensor and accelerometer are correctly connected as described in section 2.3 - Sensor Connection.



The tachometer sensor should be positioned to shine its laser onto a marker of reflective tape, placed on the rotor at a position where the reflected beam will not be interrupted and can be received by the sensor, as illustrated.

Tachometer positioning can be checked by spinning the rotor and confirming that the tachometer registers a speed on its integral LCD display.

Advancing through the steps of the balancing process is achieved by selecting Next> at the bottom right of each Balancing Wizard screen. The <Back option can be used to go back through a balancing run to the user's selected step, allowing the re-entry of data and/or the re-running of the balancing run from that point.



Step 2 – Select Balancing Type

The second step allows the user to select the type of balancing that is to be done. There are 3 basic types to choose from, as shown.

Standard – assumes any weight can be placed at any angle.

Fixed Points – assumes any weight can be placed at only a few specified locations (such as blades on a fan)

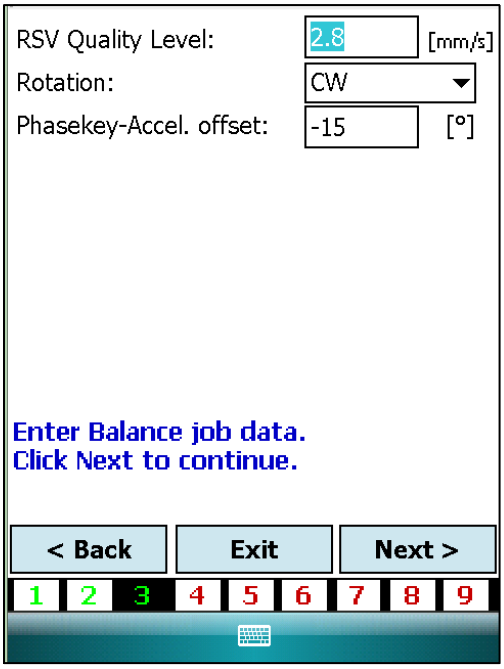
Fixed weights – assumes the balancing weights are integral to the rotor but can be set to any angle.

Step 3 – Set Balancing Parameters

N.B. It is especially important, at this point, to get the direction of rotation correct. ALL angles are, by default, measured AGAINST the direction of rotation, although this can be changed in the Units setup screen (4.2.1.1).

The range of parameters available at this point for the user to reset before continuing with the balancing run depends on which of Simple or Advanced Modes has been selected in Balancing Mode Setup (4.2.1.4)

(a) Simple Balancing Mode



Standard Balancing

Firstly, the user can set the RSV (Run Speed Vibration) Quality Level to be applied to the run. This specifies the maximum permissible residual vibration level [mm/s] used to determine the success of a balancing run. This value defaults to a pre-set standard of 2.8 mm/s.

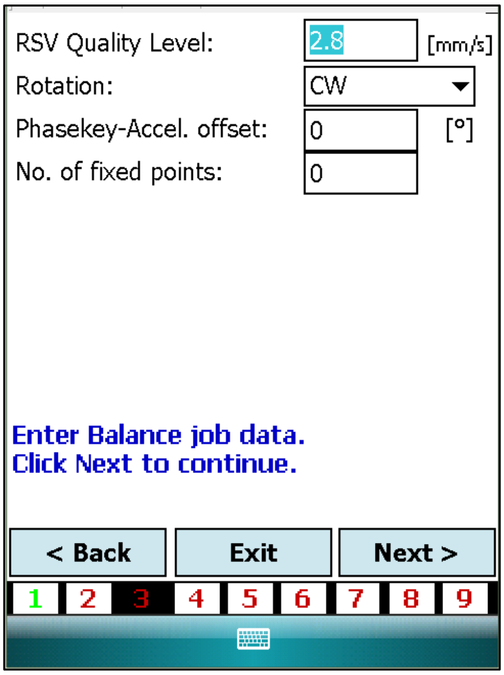
Secondly, the direction of rotation of the rotor (clockwise or counter-clockwise) can be set.

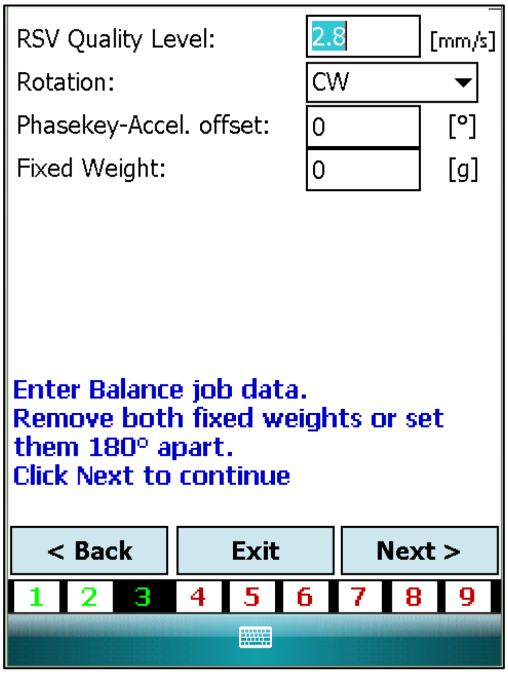
Lastly, in this case, the Phasekey-Accelerometer offset angle is specified. This is the angle between the tachometer sensor and the accelerometer, with the tachometer position being defined as zero degrees, and the accelerometer position given as +/- degrees. For accurate measurements to be recorded, the Pocket Balancer software needs to make allowance for any disparity between the positioning of the sensors. (By default the software works on the basis of the two being in alignment.)

Fixed Points Balancing

In this instance, an additional option is presented, allowing the user to enter the number of available fixed points on the rotor upon which balancing weights can be affixed (e.g. the blades of a fan).

The balancing software works on the basis of these points being evenly distributed around the rotor, with one being positioned at 0 degrees.





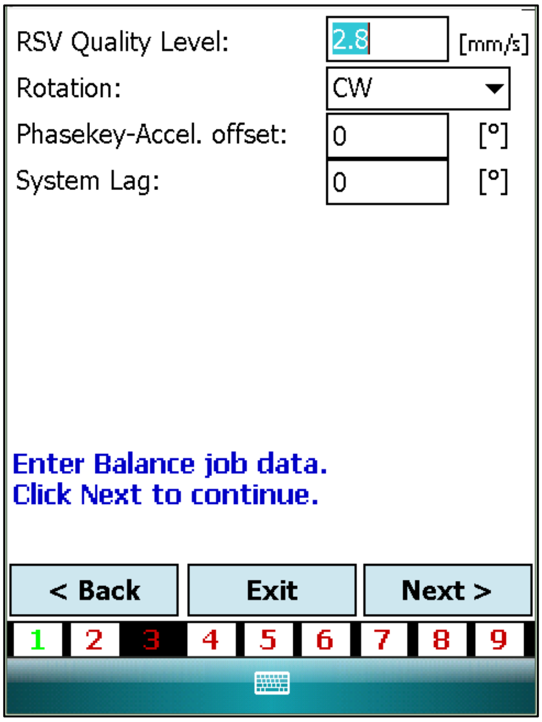
Fixed Weights Balancing

Here, the balancing process works using a matched pair of integral, but independently movable weights. At this point the user enters the weight of each one of the pair.

(b) Advanced Balancing Mode

If the user has specified the use of Advanced Balancing Mode in Pocket Balancer setup, the screen shown at step 2 will contain more information, as shown.

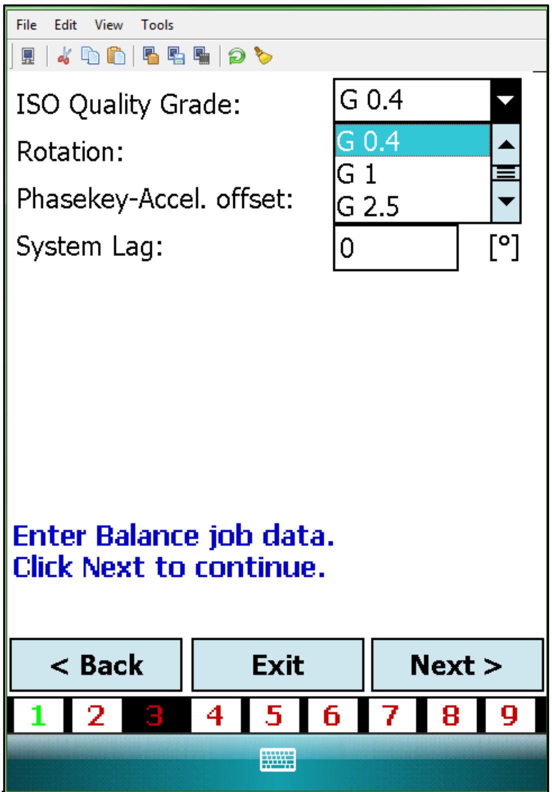
Standard Balancing



If the RSV Quality Level option has been selected in Advanced Mode setup, the only difference between this and the equivalent Standard Mode balancing run is the addition of the System Lag value.

This represents a complex summation of any physical, mechanical and electrical delays inherent in the transfer of vibration data from the rotor to the Pocket Balancer software.

Since its effect tends to be self-cancelling across the entirety of a balancing run, and its precise value is very difficult to calculate, this is generally best left unchanged.



If G Grade Quality Level option has been selected, the same options are presented to the user, with the exception that a dropdown menu of ISO Quality Grades is displayed for the user to select the required level of refinement.

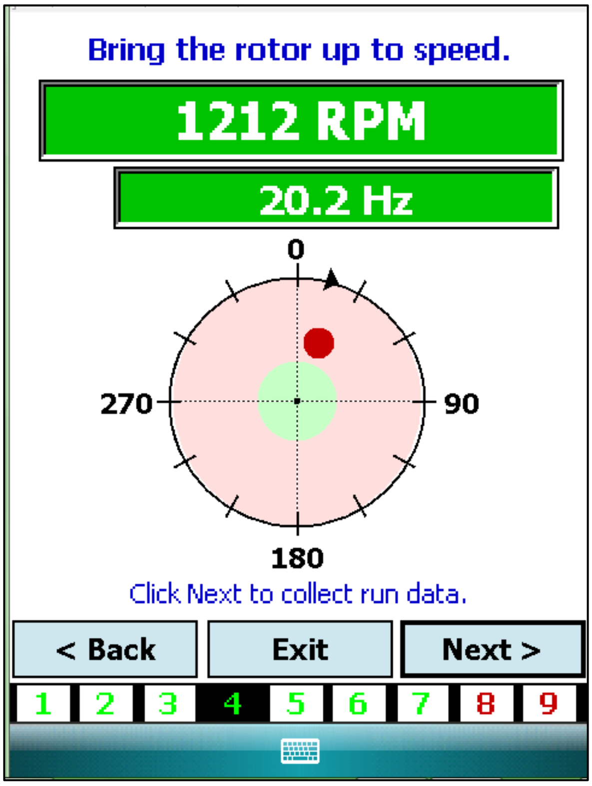
Fixed Points and Fixed Weights Balancing

These options display exactly the same additional features in Advanced Mode as does Standard Balancing.

Step 4 – Measure Initial Out-of-Balance Vibration

Selecting **Next>** again prompts the user to bring the rotor up to speed.

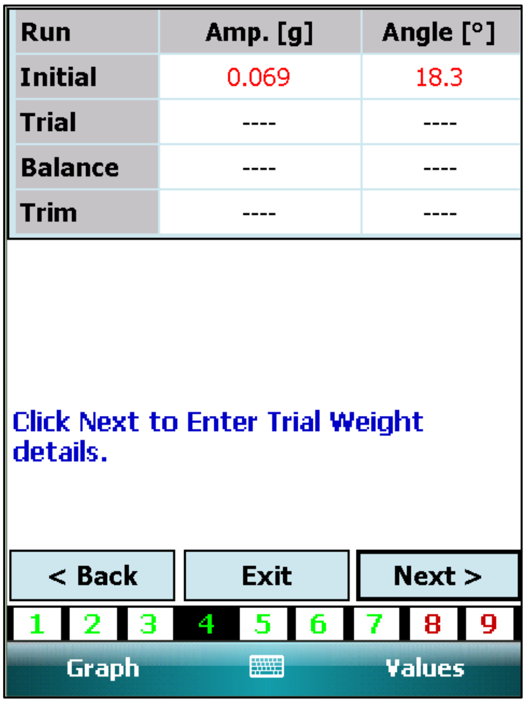
Once the speed reading has steadied, the background of the numeric readout will change from red to green.



The red spot on the graphic display will settle, indicating the angle of the rotor's 'heavy spot'. The magnitude of the vibration is represented by the distance of the spot from the centre of the graph.

The green circle in the centre of the graph represents the acceptable target vibration, as defined in the Quality Level parameter for this balancing run.

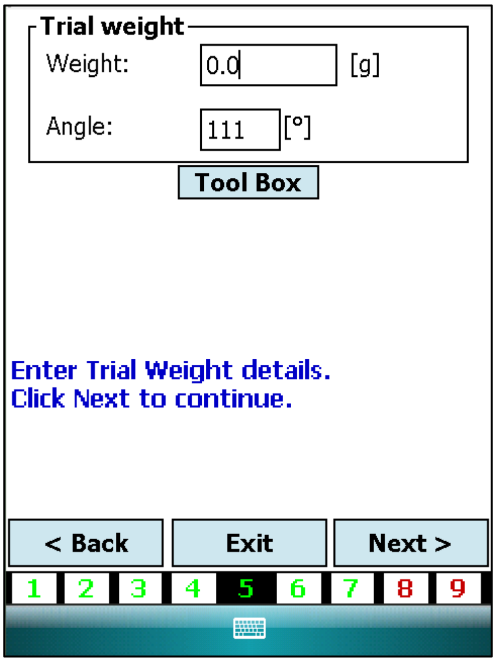
Next> will now display messages to say that the Pocket Balancer unit is collecting and then processing data to establish the extent to which the rotor is out of balance.



The results of these calculations are next displayed in tabular form.

Step 5 – Specify Trial Weight

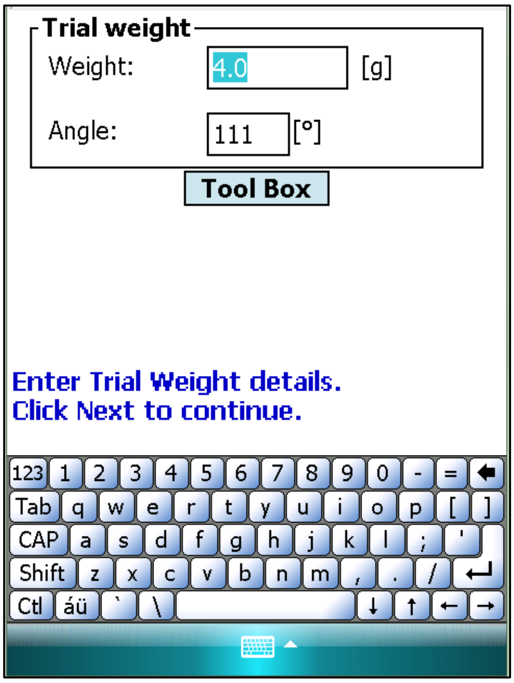
The next step is to specify the value of the trial weight to be added.



The ideal position of the trial weight is automatically determined by the balancing software and presented to the user already filled in on the screen. It is up to the user whether to use this position or specify another.

The value of the trial weight should be accurately entered at this point. In the example shown this is measured in grams.

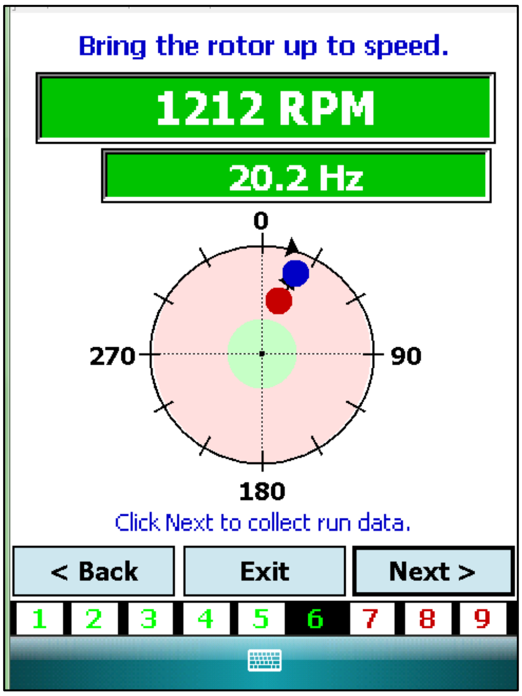
Touching on the keyboard symbol at the bottom of the screen brings up the soft keyboard to allow the user to input the value of the trial weight.



Once this is completed, touching on the keyboard symbol at the bottom of the screen hides the keyboard again to reveal the program steps and progress keys.

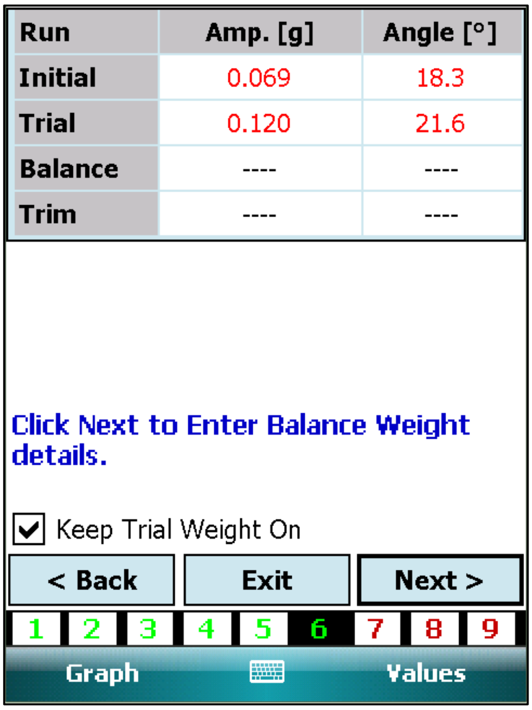
Entering **Next>** and bringing the rotor up to speed will then cause the software to progress to the next step - measuring the effect of the trial weight on the out-of-balance vibration.

Step 6 – Collect Trial Weight Run Data



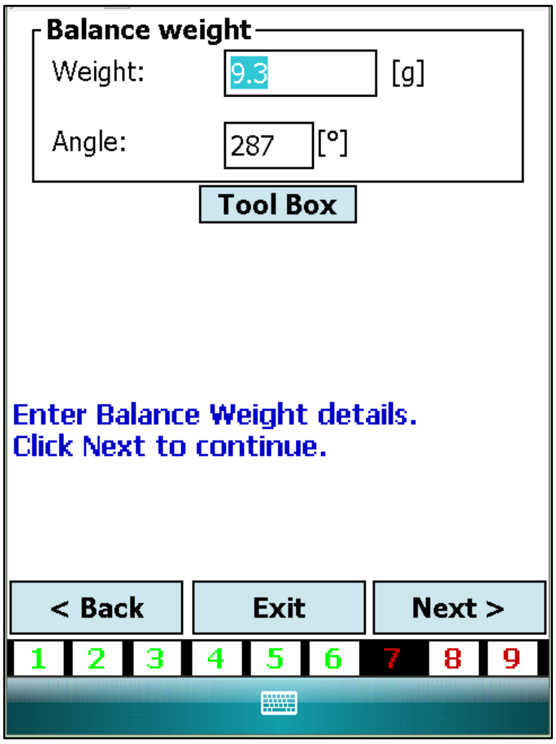
After collecting the data, the software will now graphically display the effect of adding the trial weight

Here it can be seen that the heavy spot has now moved to that indicated by the blue dot.



The user has the option to retain the trial weight on the rotor. **If this is done, the "Keep Trial Weight On" check box MUST be selected.** This will cause the balance weight and angle to be immediately re-calculated.

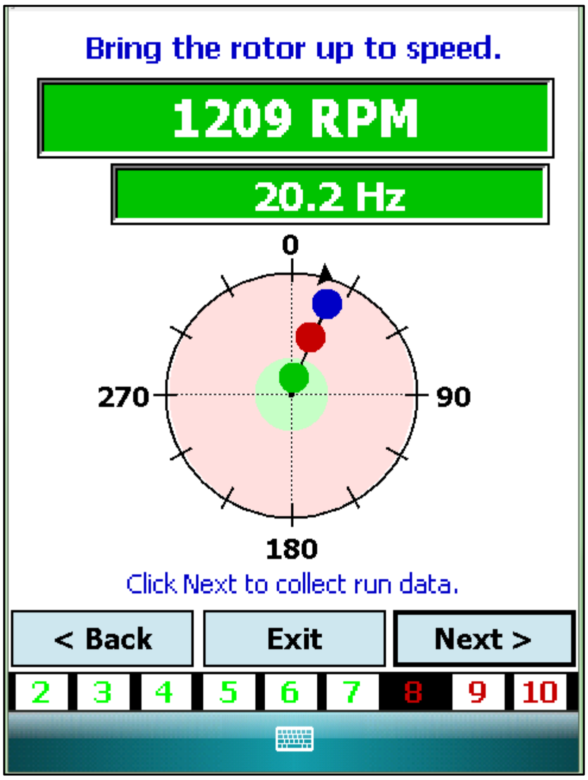
Whichever method is selected, the recommended balance weight details are now displayed.



Step 7 – Specify Balance Weight

Once the balancing weight has been added to the rotor, the user can now confirm the balance weight details by selecting **Next>**. This will cause the software to move to step 8 where the new vibration level will be measured.

Step 8 – Measure New Out-of-Balance Vibration



When the rotor has been brought up to speed, the new value of vibration and the position of the heavy spot will now be displayed.

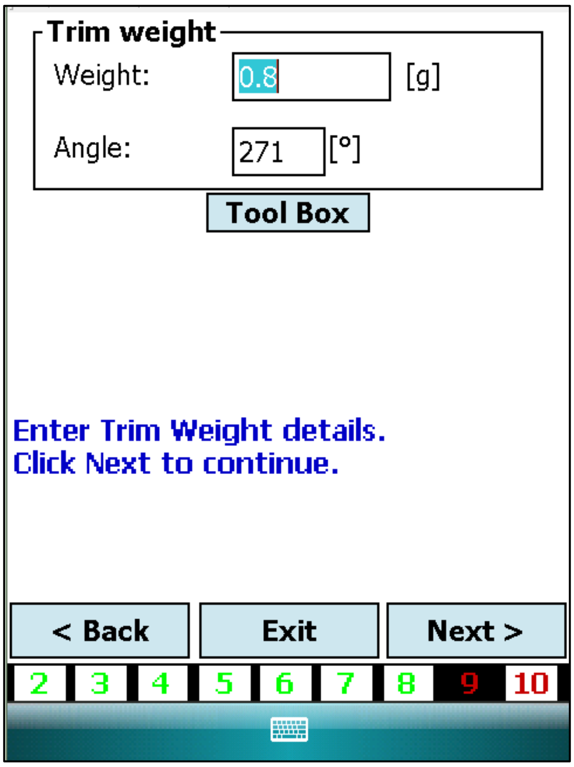
In this particular case the vibration has fallen below the specified threshold ISO value of 2.8 mm/s, so the balancing job has met its specification.

Step 9 – Specify Trim Weight

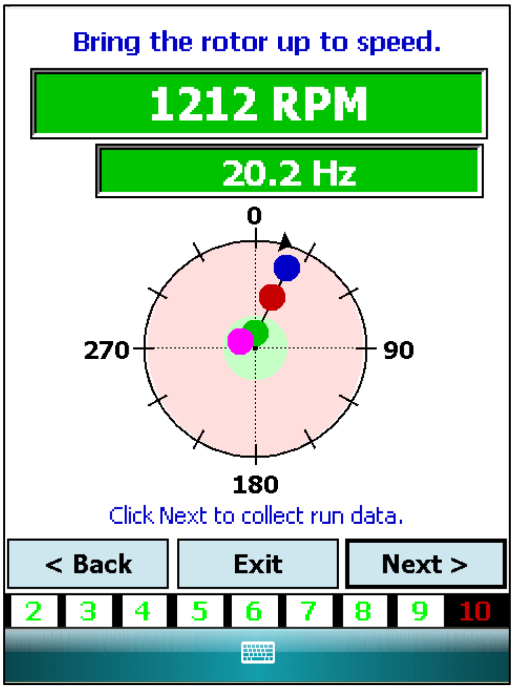
Selecting **Trim** at Step 8 allows the user to add a trim weight to further improve the rotor balancing.

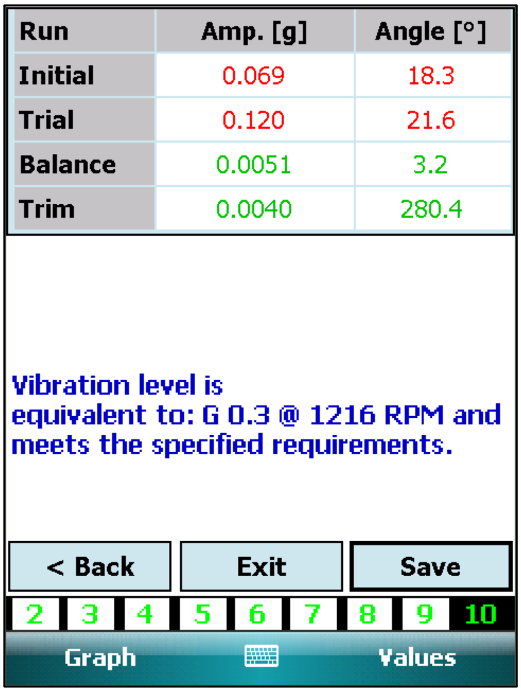
The suggested trim weight value and position are displayed and entered in the same manner as for the trial and balance weights.

"Next" then starts one last measurement run, producing a completed set of balancing data for the rotor.



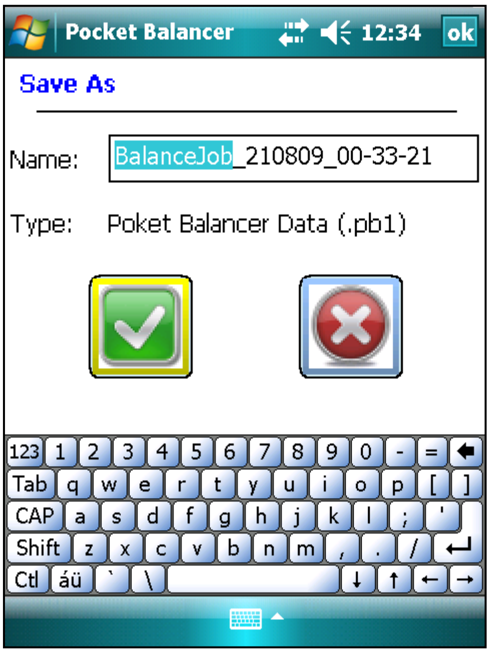
Step 10 – Measure Final Out of-Balance Vibration





This final step completes the balancing run and the user is given the option to **Save** and Exit the program.

Selecting **Exit** causes a message to be displayed further prompting the user to **Save** the balancing run if desired.



The “Save” dialogue box appears as shown. A default filename in the format “BalanceJob_[*date*]_[*time*]” is automatically displayed.

The user can overwrite this default name to any other desired value prior to saving.

4.2.3 Two Plane Balancing Mode

Selecting Two Plane balancing mode from the balance menu opens up the two plane balancing wizard.

The wizard will take the user through the necessary steps to perform a two plane balancing run.

As might be expected, the process is, in most respects, very similar to that for Single Plane Balancing. For the sake of brevity, and to avoid repetition, only those steps specific to the Two Plane Balancing process, and important points of note, are dealt with in depth.

Two Plane Balancing Run Steps:

- Step 1 – Load previous job (optional)
- Step 2 – Select rotor type
- Step 3 - Select balancing type:
  (Standard/Fixed Point/Fixed Weight)
- Step 4 – Set balancing parameters
- Step 5 – Measure initial out-of-balance vibration
- Step 6 – Specify a trial weight for Plane A
- Step 7 – Collect Plane A trial weight run data
- Step 8 – Specify a trial weight for Plane B
- Step 90 – Collect Plane B trial weight run data
- Step 10 - Specify the balance weights for both Planes.
- Step 11 – Measure new out-of-balance vibration
- Step 12 – Specify trim weights
- Step 13 – Measure final out-of-balance vibration

N.B. Selecting **Exit** at the end of the run automatically provides the option to **Save** details of the balancing run before exiting.
.

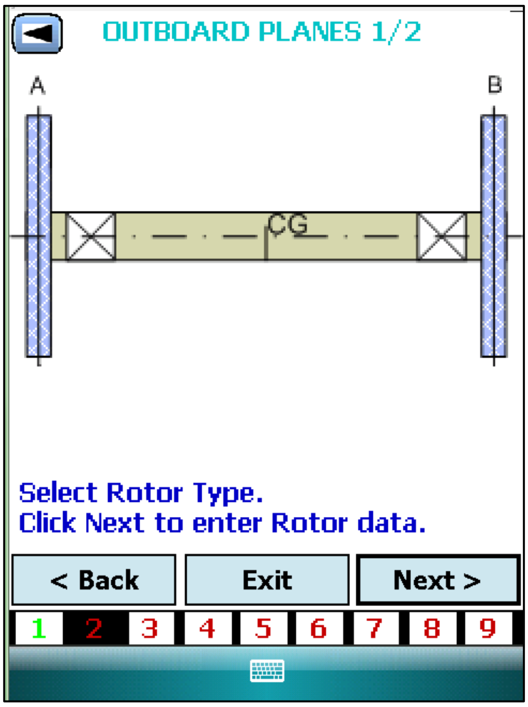
Step 1 – Load Previous Job (Optional)

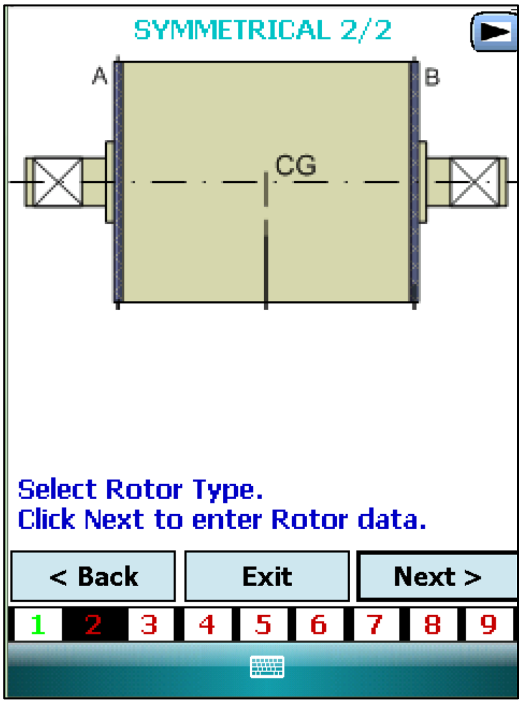
In exactly the same manner as with single plane balancing, the user is given the option to Load a previously saved balancing job as the first step in the balancing run. This can be done by selecting the **Load** button.

As with Single Plane Balancing, selecting **Next>** from any screen progresses to the next step in the balancing run.

Before moving to Step 2, the user should ensure that a tachometer sensor and <u>two</u> accelerometers are correctly positioned and connected as described in section 2.3 - Sensor Connection.

Step 2 – Select Rotor Type



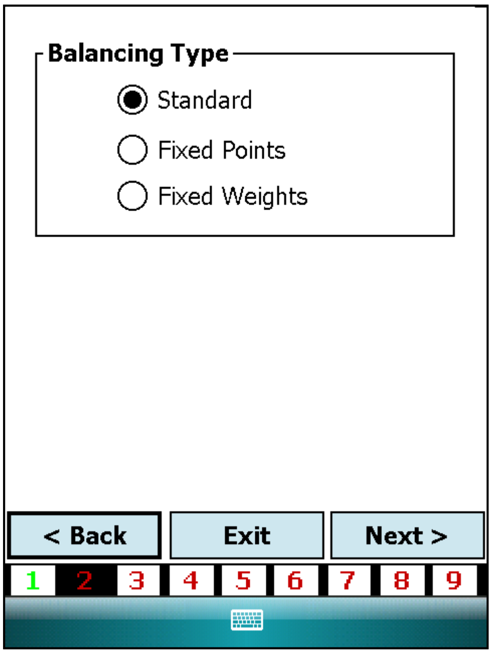


The user can now choose between 2 configurations of two plane rotor:

The rotor type is selected using the scroll arrows adjacent to the rotor type name at the top of the screen.

Step 3 – Balancing Type

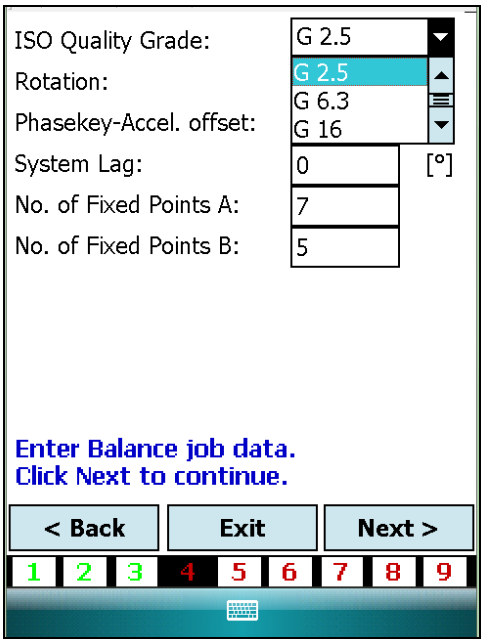
Exactly as with single plane balancing, the next step allows the user to select the type of balancing that is to be done. The same 3 basic types are available, as shown.



Step 4 – Set Balancing Parameters

N.B. It is especially important, at this point, to get the direction of rotation correct. ALL angles are, by default, measured AGAINST the direction of rotation, although his can be changed in the Units setup screen (4.2.1.1).

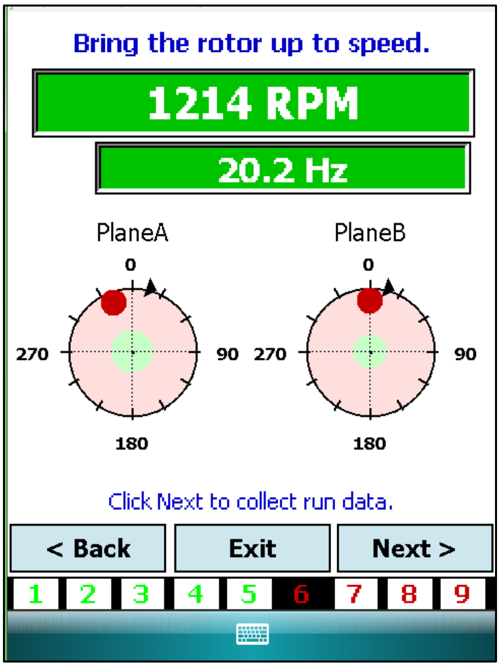
The range of parameters available for the user to reset before continuing with the balancing run again depends on which of Simple or Advanced Modes has been selected in Balancing Mode Setup (4.2.1.4).



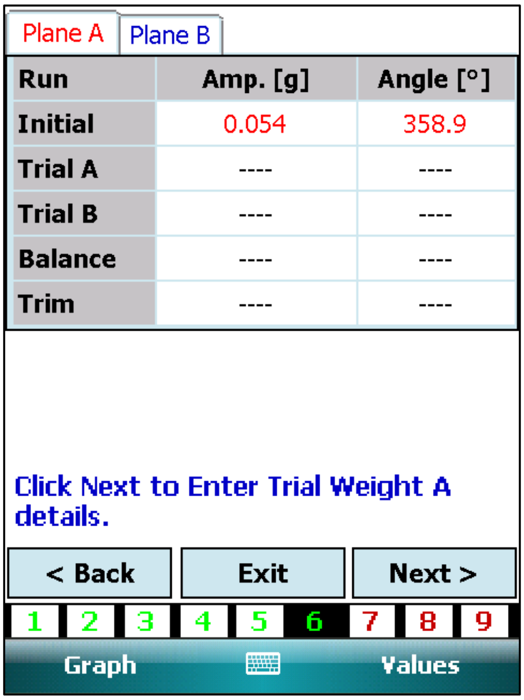
This is essentially the same as the equivalent step in single plane balancing (4.3.2 – Step 3), the only difference being that, when fixed-point balancing has been selected, different numbers of fixed points (e.g. fan blades) can be specified for each of the two rotors (designated as "A" & "B").

Step 5 – Measure Initial Out-of-Balance Vibration

Progressing to Step 6 causes the software to measure the initial out-of-balance vibration for each rotor. Graphic displays are shown for both rotors



These levels are then displayed as two separate screens for Plane A and Plane B. Switching between the two planes is achieved by selecting the appropriate tab at the top of the tabular display.



Step 6 – Specify Trial Weight for Plane A

The next step in the process is to specify and attach a trial weight to Plane A.

The trial weight value must be entered accurately and the angle at which it is placed should also be accurately specified on this screen prior to running the rotor up to speed to measure the effect of the trial weight.

Step 7 – Collect Plane A Trial Weight Run Data

The effect of the Plane A trial weight is then displayed exactly as for a Single Plane balancing run. After this, the user is prompted to specify and place a trial weight on Plane B.

Step 8 – Specify Trial Weight for Plane B

N.B. it is vitally important, at this point, to REMOVE THE TRIAL WEIGHT FROM PLANE A. The user is prompted to do this with an on-screen message.

The user can now specify the exact value and angular position of the trial weight for Plane B.

Step 9 – Collect Plane B Trial Weight Run Data

The rotor is then brought back up to speed for the measurement of the effect of the trial weight on Plane B.

The software now computes the required balancing weights for the two Planes. These can be viewed separately by selecting the planes via the appropriate tabs at the top of the tabulated results.

Step 10 - Specify Balance Weight for both Planes

The next steps involve specifying the values and positions of the balance weights.

N.B. TRIAL WEIGHTS MUST BE REMOVED before balance weights are applied. The user will be prompted to do this with an on-screen message.

If using fixed points, the balance weight may be shown as being divided between two fixed blade positions.

Step 11 – Measure New Out-of-Balance Vibration

Having fitted the balancing weights to Planes A and B, the next step in the balancing process is to measure the new level of out-of-balance vibration.

Step 12 – Specify Trim Weights

In the example shown here the balancing run has still not reduced the out-of-balance vibration to the target levels, so a trim run will be attempted. The next step is to specify and fit the trim weights.

N.B. THE PREVIOUSLY ADDED BALANCE WEIGHTS MUST NOT BE MOVED.

Step 13 – Measure Final Out-of-Balance Vibration

The final step in the process is to display the resulting levels of out-of-balance vibration following the trimming run.

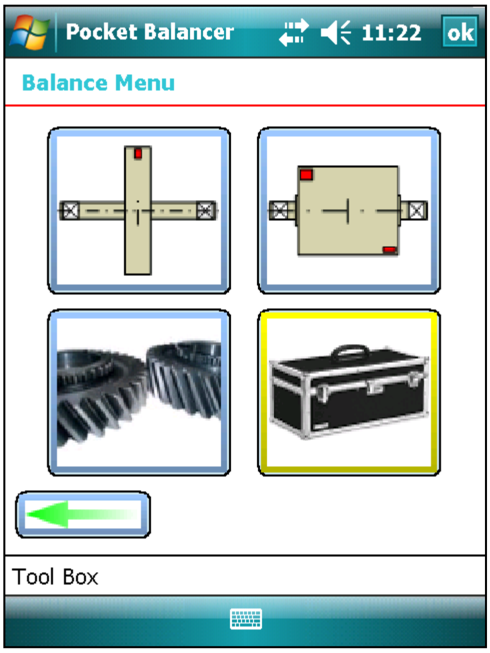
The user is now offered the opportunity of saving the balancing run details into a file.

N.B. Selecting **Exit** at any stage during the balancing run will give the user the option to **Save** the details of the balancing run prior to exiting.

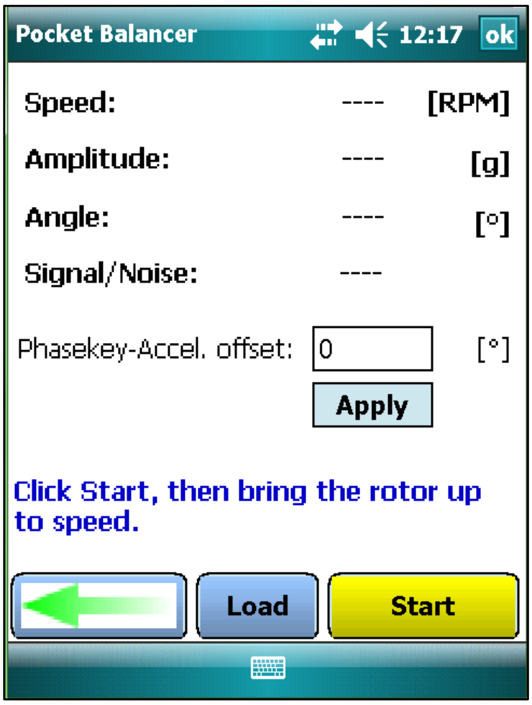
4.2.4 Balancing Tool Box

Selecting the Tool Box ion from the Balance Menu opens up the balancing tool box screen as shown below.

This then allows the user to select from a range of options that are described in detail below.



4.2.4.1 Coast Down

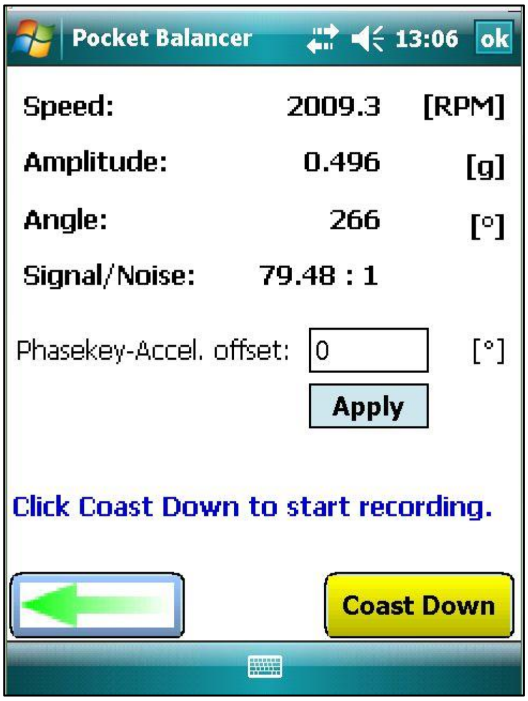


The Coast Down screen gives the user the option to perform a rotor coast down test, where the amplitude and phase of rotor vibration are each presented as a function of the rotor speed.

The user is initially given the option to Load the graphical output from a previously-saved coast down run, from the drop-down menu selection presented by the **Load** button**.**

To perform a new Coast Down run, the user first selects the **Start** button. The Coast Down software then prompts the user to bring the rotor up to the start speed for the run (which should be a little higher than the maximum run speed in normal use). Selection of the Coast Down button and switching off power to the rotor, starts the calculation process.

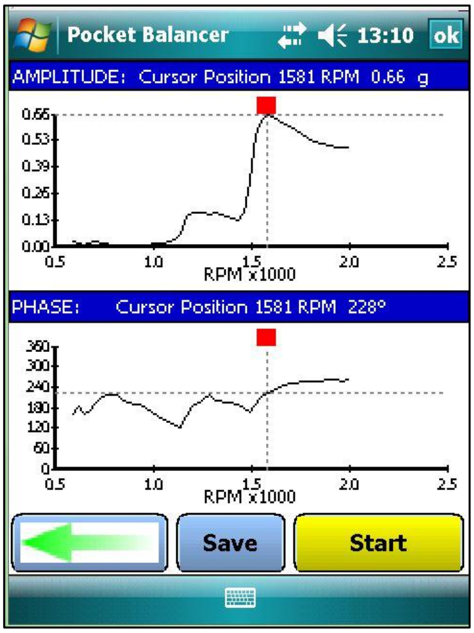
As with a Balancing Run, the Phasekey-Accel. Offset figure should be set to represent the angular displacement between the tachometer (0 degrees) and the accelerometer. Again, the default for this measurement is AGAINST the direction of revolution.



The displayed Signal/Noise ratio indicates of the 'cleanness' of the peak frequency signal produced throughout the coast down by the FFT (Fast Fourier Transform) analysis within the software, and is used to dynamically establish the validity for output of the data.

The units to be used, and whether the amplitude of the vibration is to be displayed in terms of displacement, velocity or acceleration, depend upon the values set up in **4.2.1.1 Units set up,** as with other functions within the Pocket Balancer.

Upon completion of the coast down run, the software produces a pair of graphs, showing the vibration amplitude and phase angle respectively, plotted against run-speed (as it decreases from right to left.)



The graphs are equipped with a moveable cursor, which can be dragged with the stylus, moved to a selected spot by tapping the screen, or moved using the left and right arrow keys.

The cursor is linked across the two plots, enabling the user to accurately identify points of interest. The current position of the cursor is displayed numerically in the blue heading above each graph.

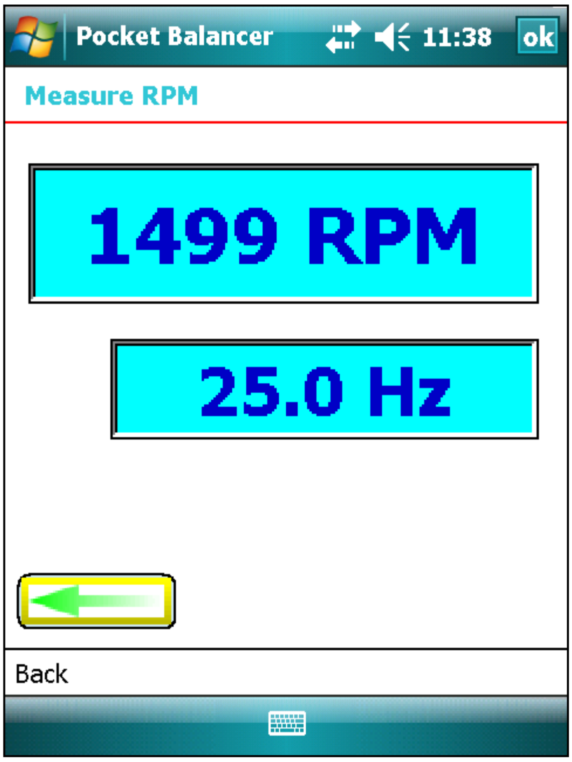
The two graphs can also be zoomed in, in tandem, to aid in pinpointing critical values. This is achieved by drawing a rectangle on the Amplitude plot with the stylus (starting at the top left-hand corner of the required screen area). A double tap on either graph returns both to their original size.

The coast down function is particularly useful in identifying any resonant (critical) speed in the rotor characteristic which could adversely affect a balancing run. This resonance is typically characterised by a peak vibration amplitude coinciding with a dramatic change of phase angle.

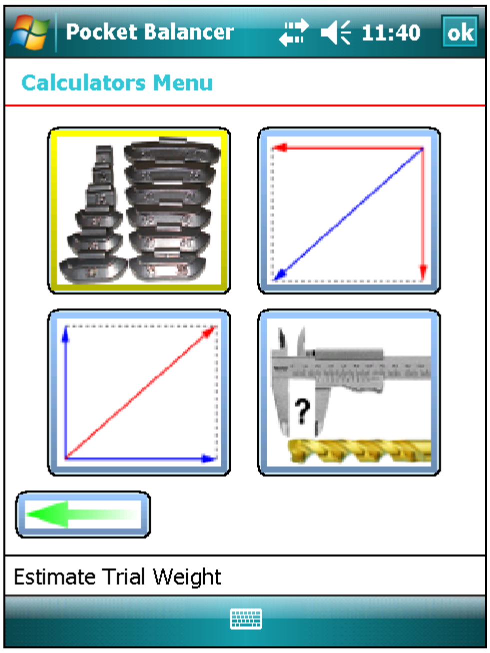
The user now has the option to Save this graph so that it can subsequently be recalled using the Load button. Saving the data from the coast down run also produces an Excel-compatible C.S.V. (Comma Separated Variable) file holding the run-speed and vibration amplitude and direction for each point plotted on the coast down graphs for this run.

4.2.4.2 Measure RPM

This feature displays the motor running speed, as measured by the tachometer sensor.



4.2.4.3 Calculators Menu



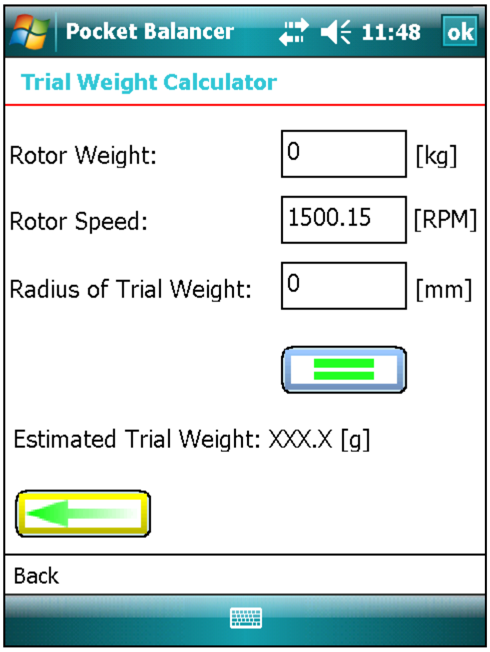
The TPI Pocket Balancer contains a number of helpful calculators that are particularly useful for balancing purposes.

These include:

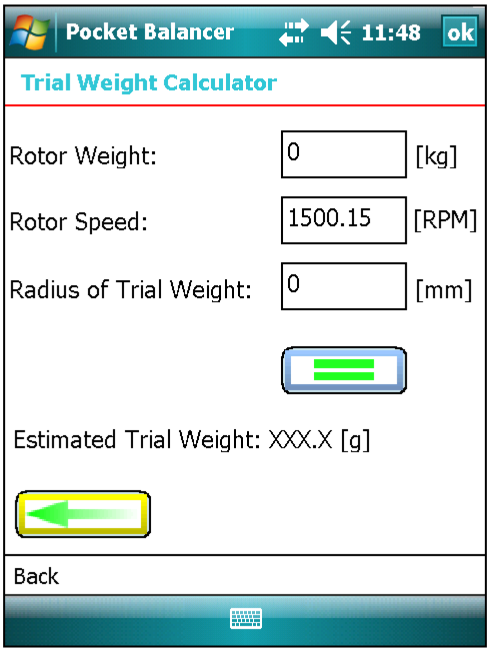
- **Estimate Trial Weights**
- **Split Weight**
- **Combine Weights**
- **Drill depth**

Estimate Trial Weights

By specifying the rotor weight and speed and the radius where the trial weight is to be placed, the calculator will give an estimation of the value of the trial that should be used.



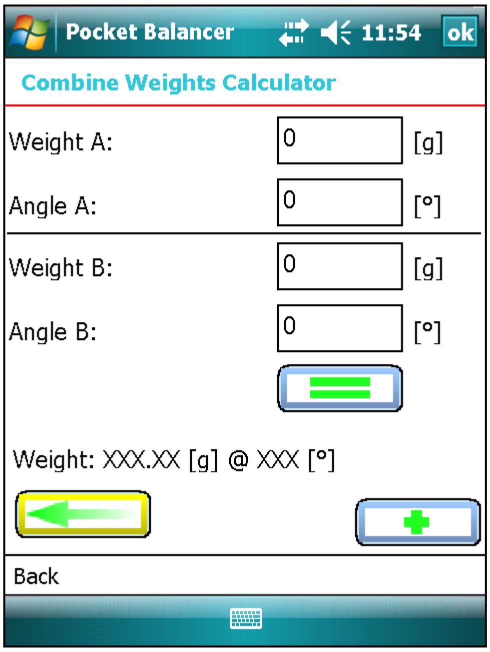
Split Weight Calculator



If a balancing weight is required to be split (between two fixed locations on the rotor for example) the split weight calculator can be used to determine the values that need to be placed at the specified angles to give an equivalent balancing weight to that required.

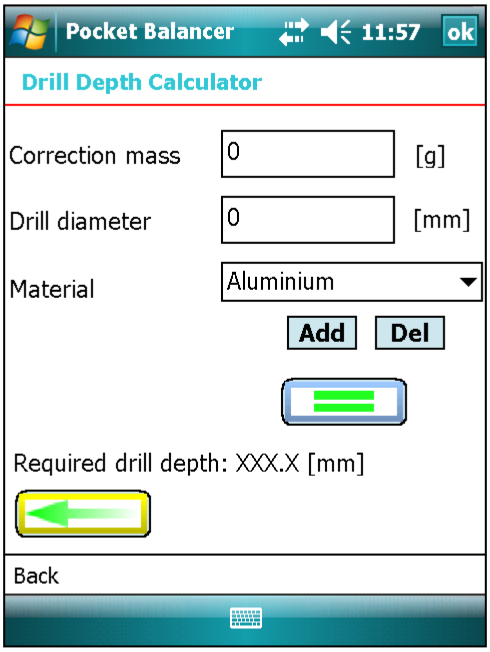
Combined Weights Calculator

In a similar way, if it is desired that two separate balancing weights at different locations are required to be combined together, the Combined Weights Calculator can be used to determine a the value and position of a single weight that will act in the same manner as the two separate weights.

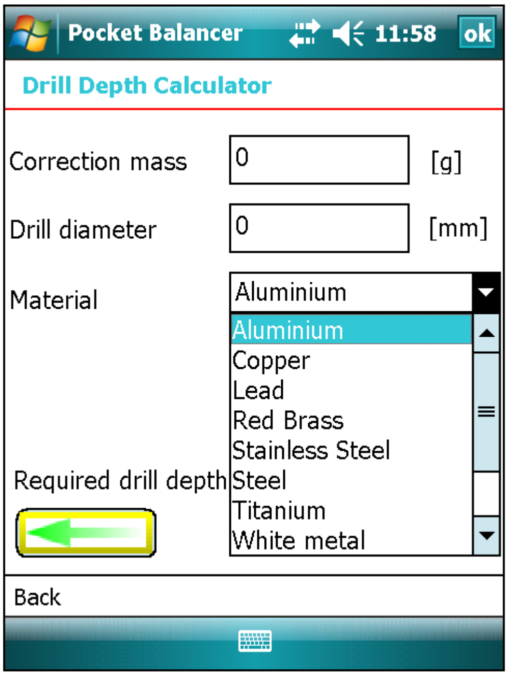


Drill Depth Calculator

It is sometimes desirable to balance a rotor by removing weight instead of adding it. The drill depth calculator is designed for this reason. It is capable of determining the required drill depth to give the removal of weight given the material to be drilled and the diameter of the drill bit to be used.



Fairly obviously the removed weight will be 180 degrees away from the position where a balance weight would normally be added.



The user is given the opportunity to specify the desired correction mass, the drill bit diameter and the type of material to be removed by drilling. This allows the calculator to display the required drill depth.

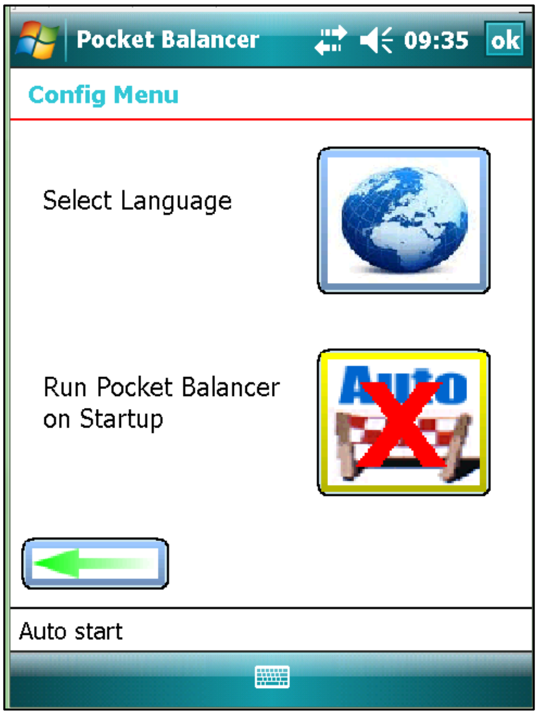
4.3 Configuration Menu

The third option is the Configuration Menu (spanner and gear wheel icon), which gives the user the opportunity of specifying other languages (as available) by selecting the globe icon.

It is also possible to select whether the Pocket Balancer program will “Auto-start” when the Handheld device is turned on. This feature is selected using the “Auto and Start Flag” icon. The large red X indicates when Auto-start is NOT selected.

4.4 Vibration Meter Mode (Pocket VibrA Lite)

The final option is ***Vibration Meter Mode*** (Pocket VibrA meter icon), which opens up **Pocket VibrA Lite**, the operation of which is explained in detail in Appendix 1 of this user guide.



5 Specifications

Size	220 mm x 95mm x 45mm
Weight	500g (not including accelerometer)
Environmental	
Water:	MIL-STD-810F, Method 512.4 IP67 sealed against accidental immersion (1m for 30 min)
Drop:	MIL-STD-810F, Method 516.5, Procedure IV 26 drops from 1.22 m 6 additional drops at –20º 6 additional drops at 60º
Operating:	-30º to 65º
Storage:	-40º to 70º
Humidity:	MIL-STD-810F, Method 507.4
Sand & Dust:	IP67, MIL-STD-810F, Method 510.4, Procedures I & II
Battery life	Typically 8-20 hours operating time depending on backlight usage.
RPM measurement	10 RPM to 50 000 RPM
Balancing RPM range	60 RPM to 6000 RPM
Input range	+/- 50g with IEPE 100mV/g accelerometer.
Dynamic range	+/- 50g to +/- 0.01g (74dB) IEPE 100mV/g accelerometer.
ISO Quality Grade	G0.4/G1/G2.5/G6.2/G16/G40/G100/G250/G630
Accelerometer Connection	Standard BNC connection for IEPE accelerometers.
Vibration Measurement Units	Displacement Velocity Acceleration

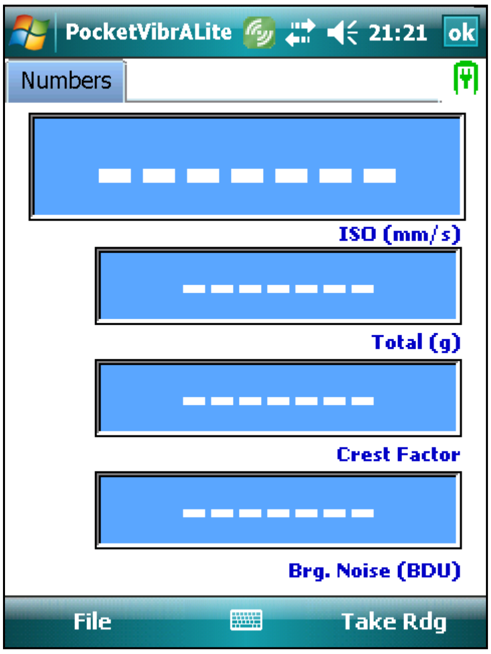
Balance View	Tabular and Graphical data representation
Colour coded readings	Red: above specified limit Green: below specified limit
Options	Carrying case with neck strap Stylus lanyard

Appendix 1 – Pocket VibrA Lite

A1.1 Startup

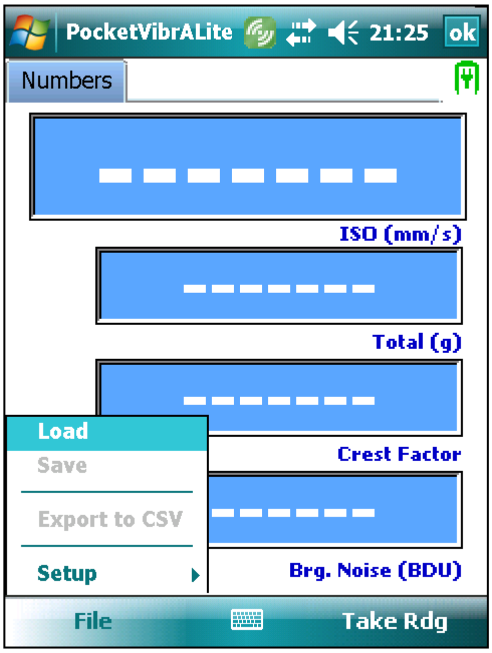
The opening display screen is shown briefly while Pocket VibrA Lite initialises. This screen also shows the version number of the software at the bottom of the screen.

This screen is followed closely by the readings screen.



The bottom line of the display shows a menu bar with two options that can be selected either by tapping the screen or by pressing the “soft” keys (-) that are located immediately below the screen.

The two menu options available are **Take Rdg** (take reading), and **File** which activates the menu shown.

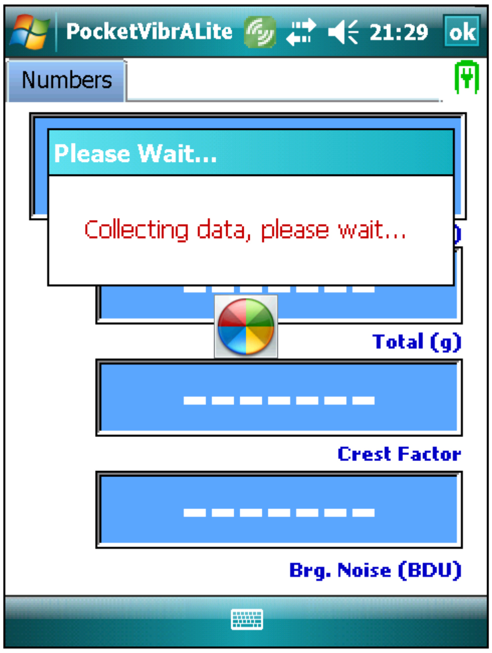


Until a reading is taken the only two menu options that are active are **Load** and **Setup**.

These functions are explained in **Section A1.4 File (Setup) Menu.**

A1.2 Taking a reading

Taking a reading can be achieved either by touching **Take Rdg** on the menu bar on the screen, pressing the right hand softkey (-) or by pressing the Enter key (◄┘).



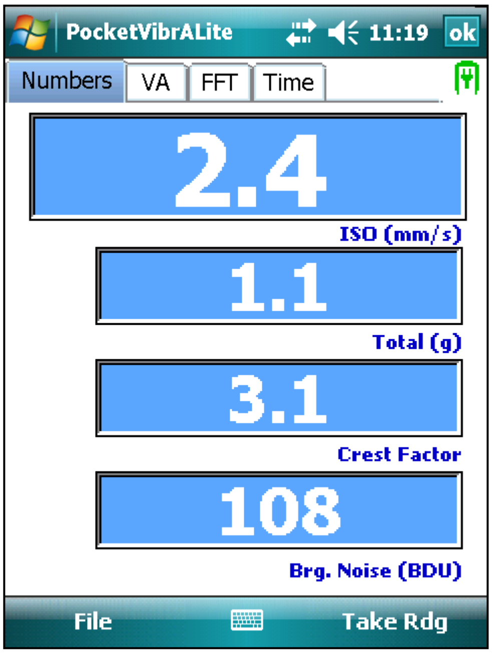
As long as an accelerometer is connected, a reading will then be taken, a process that lasts a few seconds. If an accelerometer is not connected, an error message will be displayed.

N.B. during this time it is important not to move the accelerometer, to ensure a valid reading is obtained.

It is important to ensure that the measurement is taken with the accelerometer mounted on a flat surface on the equipment being monitored. The magnet must not be loose and should be tightly screwed to the accelerometer (the use of some thread lock should help ensure the magnet does not come loose from the accelerometer while it is in use).

A1.3 Vibration readings

A1.3.1 Numbers screen



Once a vibration reading has been taken, the display will initially show four values, as shown in the screenshot on the right.

- ISO value
- Total g (acceleration)
- Crest factor
- Bearing Noise

The **ISO value** (in mm/s) is the large number at the top of the screen, which is the RMS (average) of the vibration velocity in the frequency band 10Hz (600 RPM) to 1kHz (60,000 RPM), as specified by the ISO standard[1].

Total acceleration – this is the RMS (average) value of the total vibration in the frequency range 10Hz to 15kHz (the upper limit of the Pocket VibrA Lite frequency response). This reading is shown in units of **g** (Earth's gravitational constant, where g = 9.81 m/s^2).

Crest Factor – this is a measure of the shape of the vibration waveform and is defined as the peak of the waveform divided by its RMS (average) value. Crest Factor is sometimes used as a measure of the quality of a machine's bearings. This is based on the fact that high Crest Factor is often associated with high frequency bearing noise as illustrated in the following diagrams.

The following diagram (Figure 1) shows a vibration waveform with a crest factor of 1.47, which is very close to that of a pure sine wave. Crest factor can never have a value lower than 1.414, which is the value for a pure sine wave.

---

[1] ISO 10816-1:1995. Mechanical vibration -- Evaluation of machine vibration by measurements on non-rotating parts

This particular vibration waveform was taken from a brand new bench grinder with good bearings and shows a waveform with a period of 0.02 seconds, which is due to run speed vibration at 50Hz (3,000 RPM). There is very little high frequency bearing noise visible on the waveform.

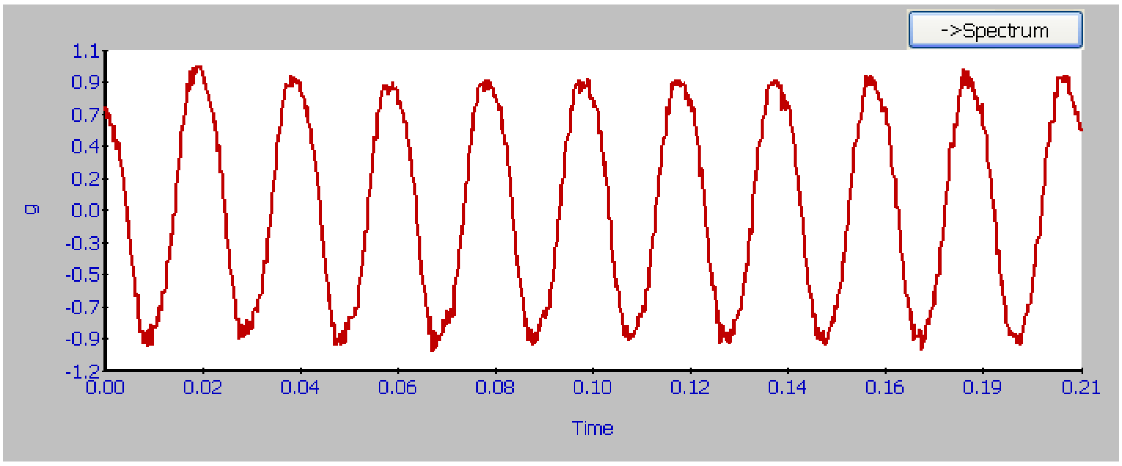


Figure 1 – Vibration waveform from a “good” bearing

By comparison the waveform shown below (Figure 2) has a crest factor of 8.83 and shows noisy “spikes” typical of worn bearings. This waveform was in fact taken from a deliberately damaged bearing on an identical bench grinder to the one producing the waveform in Figure 1.

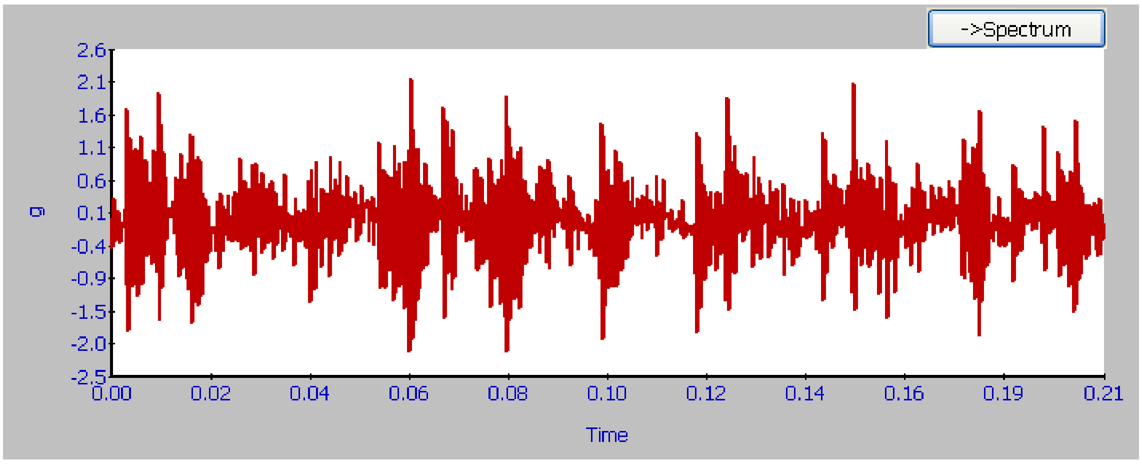


Figure 2 – Vibration waveform from a damaged bearing

You can just about see the run speed vibration waveform (still with a 0.02 second period) but it is “buried” underneath the high frequency bearing noise.

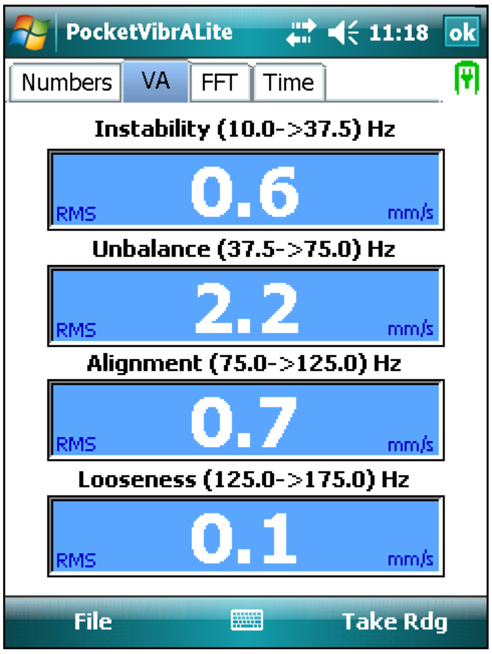
Bearing Noise - the final reading shown is the value of high frequency noise in Bearing Damage Units (BDU), where 100 BDU corresponds to 1g RMS vibration. This is a measure of the wear on the bearings in the equipment being monitored. The higher the number the more worn is the bearing.

1g of vibration (100 BDU) generally corresponds to a high level of bearing noise and so can be considered indicative of a damaged bearing. In other words it may be helpful to think of the Bearing Noise figure as being very roughly equivalent to **“percentage”** of bearing wear.

For example the bearing waveform shown in Figure 1 above for a good bearing gave a Bearing Noise figure of 1.66 BDU.

However the Bearing Noise figure for the damaged bearing waveform in Figure 2 above was 101.2 BDU.

A1.3.2 Vibration Analysis



Moving across the tabs at the top of the screen from **Numbers** to **VA** (vibration analysis) shows the readings of vibration velocity broken down into each of 4 bands.

Moving between the display tabs can be achieved by using the cursor arrows or simply by touching the desired tab.

The names and frequency ranges of the bands are all based on multiples of the specified **Running Speed** (50Hz in this case).

N.B. in order to perform a vibration analysis it is important that the running speed of the machine is entered correctly. This is done in "Setup" as described in Section 3.3 of this guide.

The frequency ranges of the bands are based on the following multiples of running speed[1]:

Instability: 10Hz (600 RPM) up to 0.75 times running speed

Unbalance: 0.75 to 1.5 times running speed

Alignment: 1.5 to 2.5 times running speed

Looseness: 2.5 to 3.5 times running speed

The following descriptions of these frequency bands show why they are based on these particular frequencies.

[1] Multiples of running speed are often referred to as "orders"

Instability:

Vibration in the frequency band 10Hz (600 RPM) up to 0.75 times running speed means the vibration is occurring at less than the running speed of the machine. This not usual for a normal machine and may be an indication of an electrical fault, looseness, rubbing or some such problem that is causing uneven running. Because of the difficult of classifying them separately, these types of fault are often grouped together into the category of Instability.

Unbalance:

The level of vibration in the frequency band 0.75 to 1.5 times running speed is usually indicative of how well balanced the machine is. A large vibration at the running speed indicates that the machine is out of balance. However even a very well balanced machine will usually show some vibration at the running speed but this figure should ideally be quite low (e.g. typically less than 2 mm/sec for a medium sized machine).

Alignment:

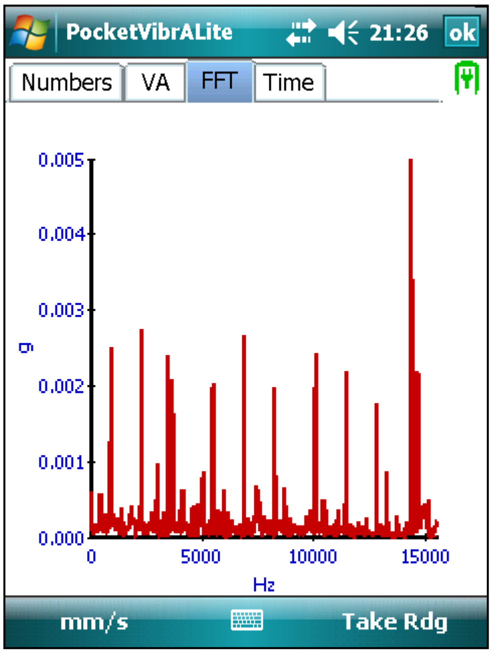
Vibration in the frequency band 1.5 to 2.5 times running speed is a possible indication of misalignment. This is based on the fact that shaft misalignment can result in a double peak in the waveform due to there being two different centres of gravity (one from each shaft). In other words the accelerometer picks up a peak as each centre of gravity passes by and hence there will be two positive and two negative peaks each revolution of the shaft. This will typically give rise to a vibration signal at double the running speed of the machine.

Looseness:

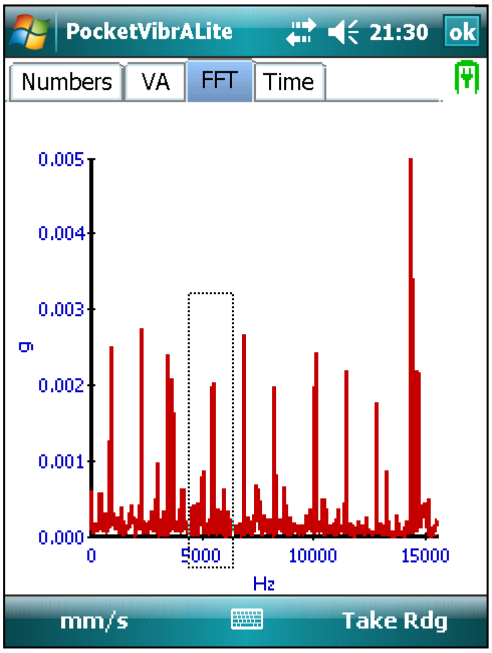
Vibration in the frequency band 2.5 to 3.5 times running speed is a possible indication that something may be loose (e.g. loose mounting bolts, weak foundations etc.) as it is not usual to see third order vibration in a machine unless there is some structural looseness that is being “excited” by the vibration of the machine.

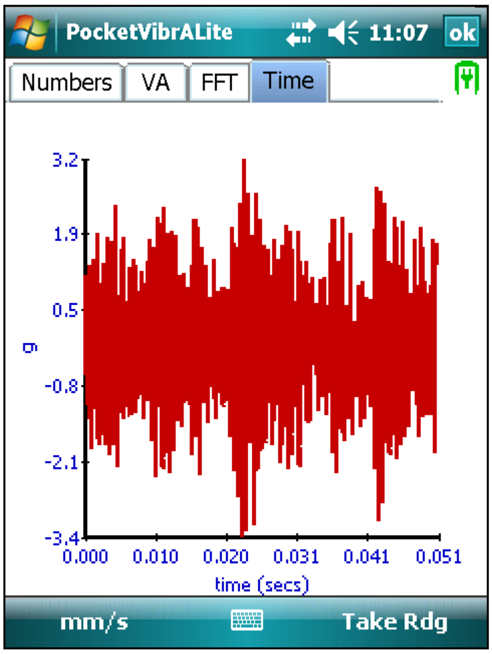
A1.3.3 FFT (frequency plot) screen

Moving across to the **FFT**[1] screen tab brings up a frequency plot of the vibration reading. Both vibration velocity (in mm/s) and acceleration (in g) can be displayed.



Switching between the two is achieved by touching the appropriate units displayed on the menu at the bottom left of the display, or by pressing the left hand soft key (-).



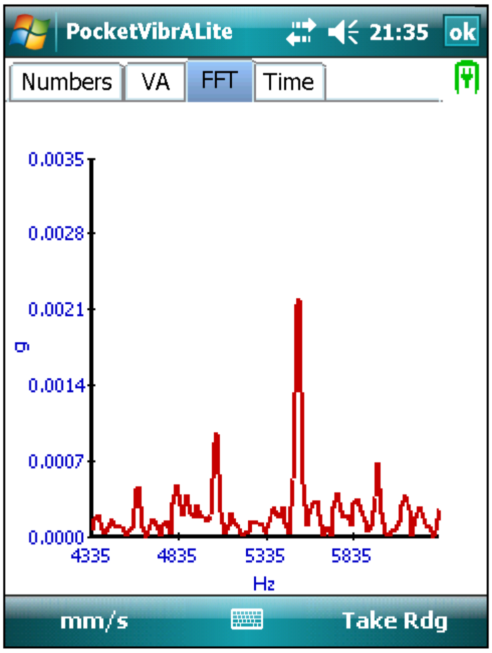


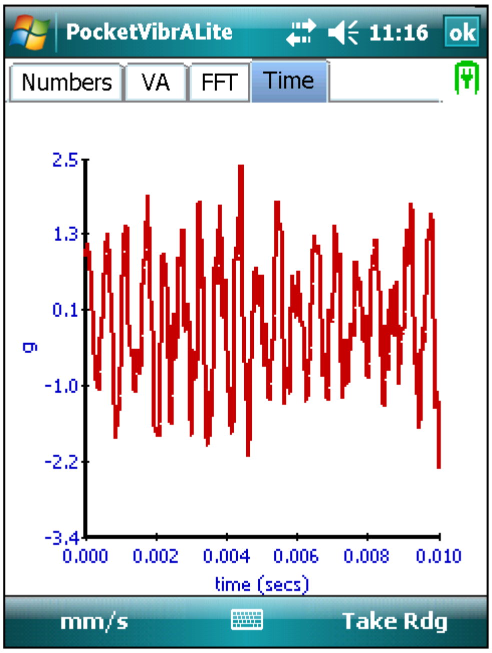
It is also possible to **zoom** into the FFT display. This is done by touching the screen and dragging a zoom box from the top left to the bottom right-hand corner of the desired area, as shown in the example display on the left. The display on the right shows the effect of zooming into this zoom box. Tapping the screen twice in quick succession (double tap) returns the screen to normal display.

[1] FFT stands for Fast Fourier Transform and is a mathematical technique for calculating the frequency spectrum of a vibration waveform. FFT is often used as an abbreviation for a frequency spectrum plot.

A1.3.4 Time (waveform) screen

Moving across to the **Time** screen tab brings up a display of the time waveform of the vibration reading. Again, both vibration velocity (in mm/s) and acceleration (in g) and the display can be switched between them in exactly the same way as with the FFT display.





It is also possible to **zoom** into the time waveform display in exactly the same way as for the FFT zoom feature just described. Un-zooming is also achieved with a double screen tap.

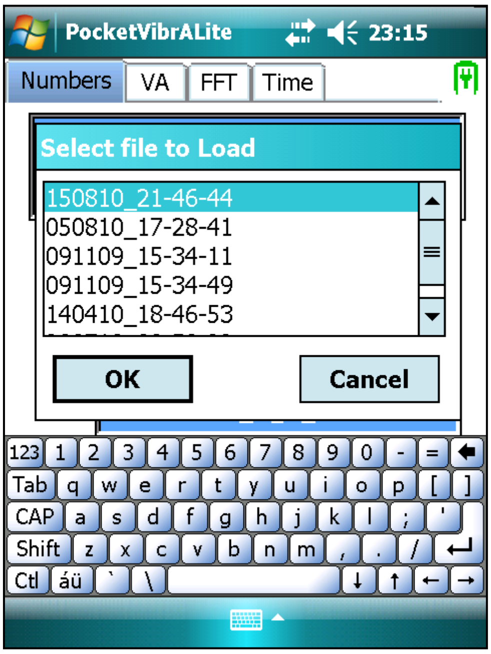
A1.4 File (Set up) Menu

The File (or Setup) menu is entered from the main menu screen either by touching **File** on the menu bar on the screen, pressing the right hand softkey (-) as previously explained in Section 3.0

The options available under this menu include:

- Load – loads in the values from a previously saved reading
- Save – save a reading into the Pocket VibrA Lite memory
- Export to CSV – save a reading as an Excel compatible (comma separated variable) data file
- Setup – customisation and configuration menus

A1.4.1 Load



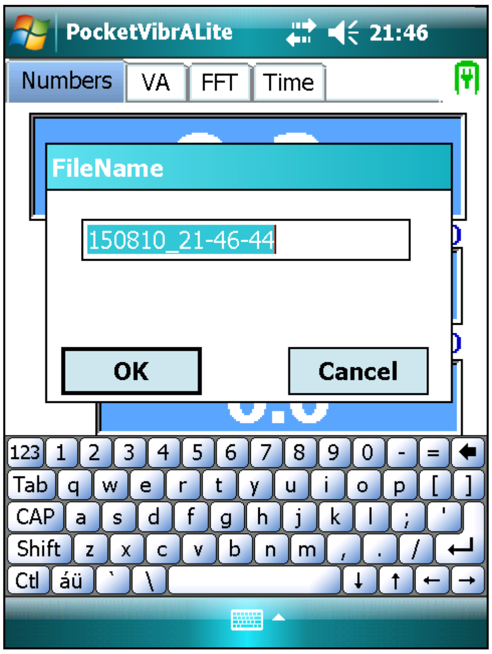
Loading a previously saved readings file is achieved by selecting **Load** from the File menu. This opens a dialogue box from which the user can select the previously saved readings file.

The reading can then be examined in the same way as when it was first taken via the Numbers, VA, FFT and Time display tabs.

A1.4.1 Save

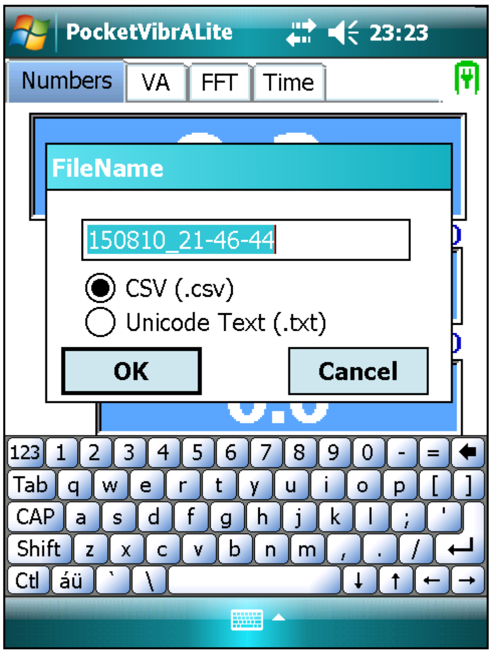
This menu option opens a dialogue box, allowing the user to save the current reading into a file with the displayed filename.

The default filename is the date and time the reading was saved. This can be edited to any preferred naming convention.



A1.4.3 Export to CSV

It is also possible to save readings in a format compatible with Excel spreadsheets, as a comma separated variable (CSV) file.



Selecting **Export to CSV** from the File menu opens a dialogue box where the user can input the filename for the saved CSV file. The default filename is the date and time the reading was taken but this can be edited by the user.

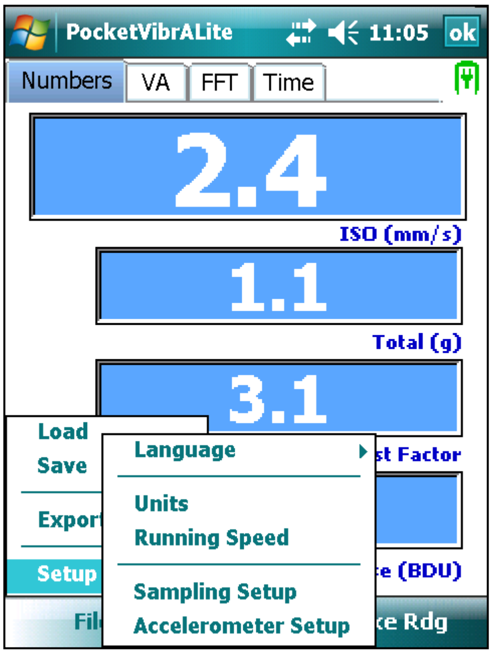
The filename extension will be either .csv or .txt depending on the option chosen. Unicode Text might, for instance, be used to save files containing non-standard language codes which will not load into CSV files.

A1.4.4 Setup

Selecting **Setup>** from the File menu displays a further menu..

This menu contains the following sub-menu options:

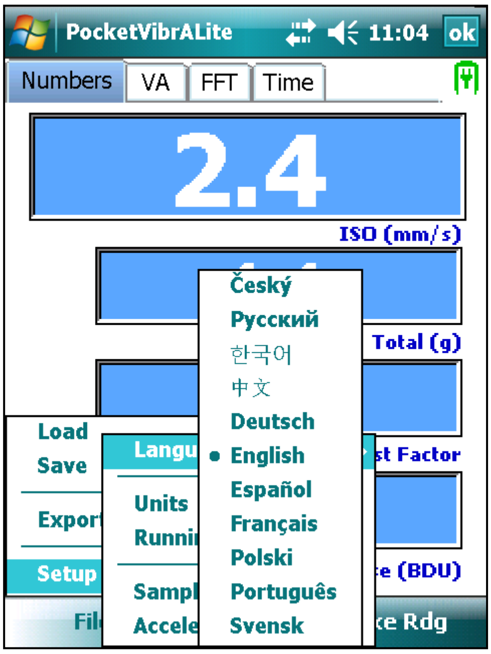
- Language
- Units
- Running Speed
- Sampling Setup
- Accelerometer Setup



A1.4.4.1 Language

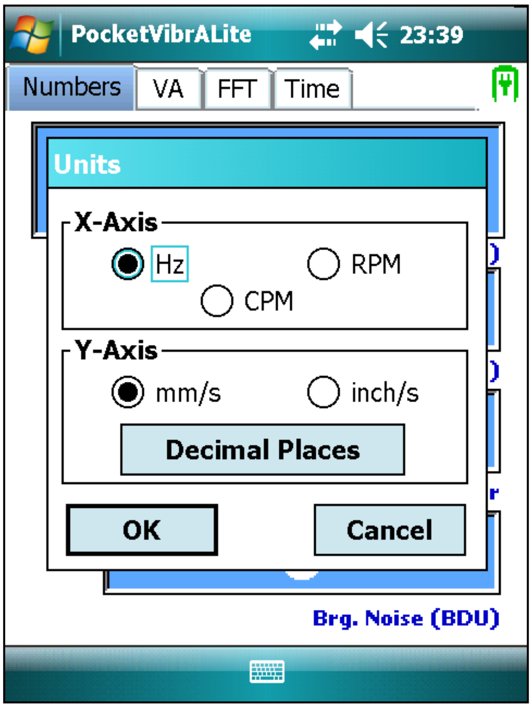
Pocket VibrA Lite can be run in a variety of different languages selectable from the pop-up language menu.

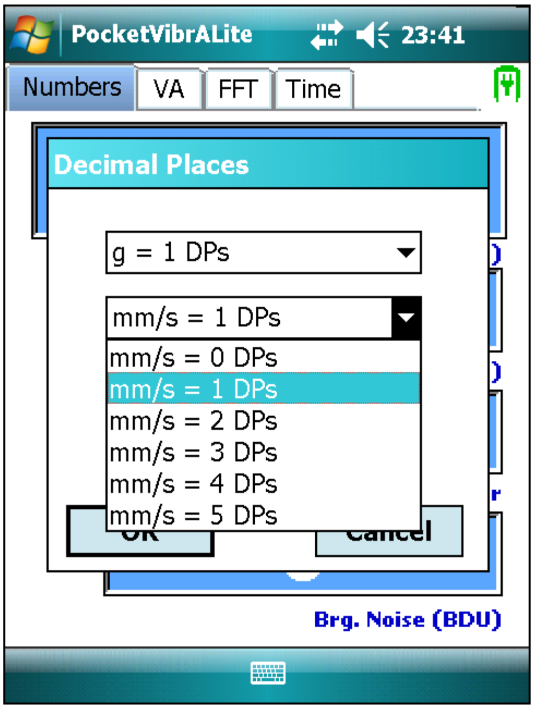
If you require a particular language that is not shown please get in touch with TPI, as it may be that we can arrange for you to receive an update containing that particular language.



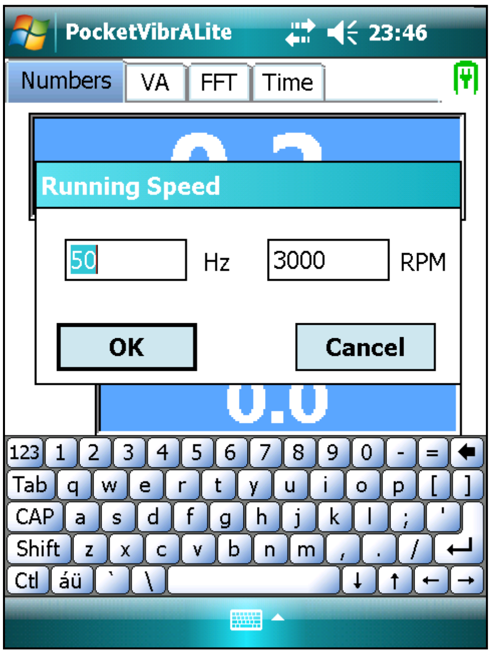
A1.4.4.2 Units

The **Units** menu can be used to change the displayed x and y axis values, and to set the number of decimal places that are displayed on the Numbers screen, up to a maximum of 5.





A1.4.4.3 Running Speed



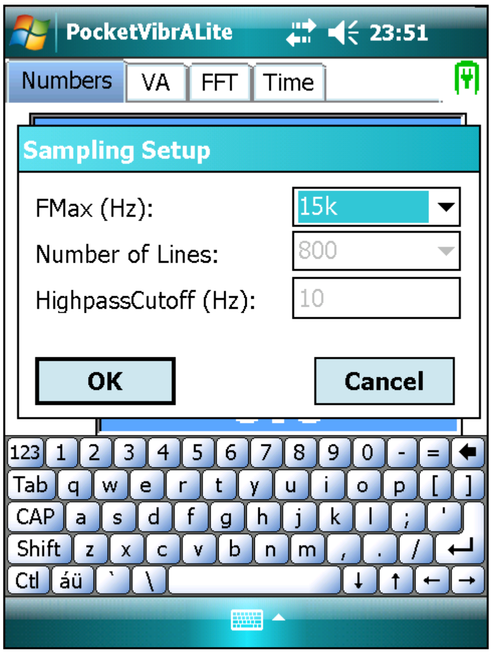
In order to perform a vibration analysis (VA) it is important that the running speed of the machine is entered correctly.

The running speed can be entered and displayed in units of Hertz[1] (Hz) or RPM[2]. Entering the value as Hz causes the RPM value to be filled in automatically and vice versa. The conversion factor is 1 Hz equals 60 RPM.

A1.4.4.4 Sampling Setup

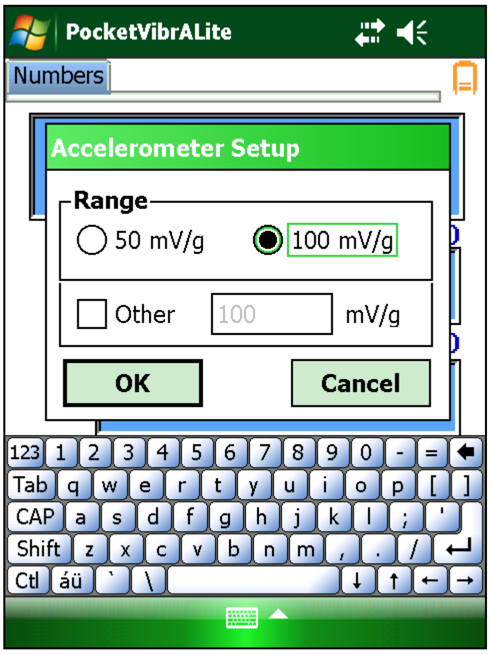
Choosing **Sampling Setup** from the File menu opens the dialogue box shown right. The user has the ability to set Fmax to either 15kHZ (default value) or 1kHz if higher frequency resolution is required.

The number of lines displayed in the frequency spectrum is fixed at 800 and the high pass cut off frequency (Fmin) is fixed at 10Hz (600 RPM).



[1] Hertz are also sometimes referred to as cycles per second.
[2] Revolutions per minute (RPM) are sometimes also referred to as cycles per minute (CPM)

A1.4.4.5 Accelerometer Setup



Selecting Accelerometer Setup from the setup menu allows the user to set the mV/g of the connected Accelerometer.

Revision History

ISSUE	PAGES	DATE	NOTES
3.1	59	05/03/15	