

## Shock Analyzer V1.4

### Reference Manual

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## 1. Kit and Installation

The Shock Analyzer Kit consists on a data acquisition unit + speed sensor + load cell sensor to acquire data from a Shock Dynamometer machine.



### 1.1 Data acquisition unit

- **Display:** 16x2 char LCD display:

```
RPM: 0 STOP
CELL: 0 T:---
```

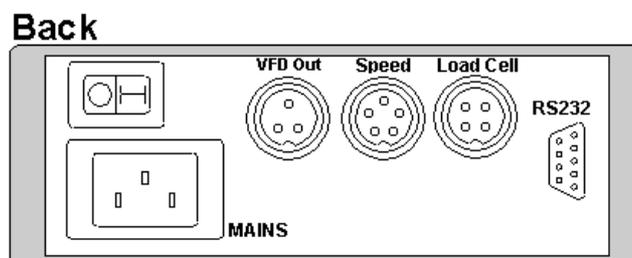
**RMP:** current speed of the machine.

**CELL:** Load Cell channel converted to Newtons, it depends on the calibration of the unit.

**STOP/RUN,** Current data transmission mode. It will be on “run” when acquiring data.

**T:** Temperature for the thermocouple type K input (usually tied to the shock absorber). Temperature can be in range from 0 to 999 degrees. If there is no sensor connected the reading will be: ---.

### 1.2 Unit connections



1. **Mains.** Computer type mains connector. Default voltage is 230 volt, 50/60 Hz. It can be requested for 115 volt too.
2. **VFD Output.** PWM output for the Variable Frequency Drive. From 0 to 5 Volt.

1	GND
2	PWM Output (0 to 5 volt)
3	8 volt, unregulated

3. **Speed Sensor.** Digital Inductive Sensor

1	5 volt (digital 5 volt)
2	GND
3	Not used
4	GND
5	Signal (active high)

4. **Load cell,** direct connection to load cell, (amplifier inside the unit).

1	Cell IN -
2	Cell IN +
3	5 volt (reg. analog vcc)
4	GND

5. **RS232.** Serial RS232 connector. 115200 baud, no parity. An USB to serial adaptor can be used with computers without serial ports.

6. **Thermocouple type K.** (At front) Input for temperature up to 1000 °C.

### 1.3 Installation

**Very important:** when using a *Variable Frequency Drive* (strongly recommended to power the motor) high electric noise pulses are generated and they will strongly affect the old inductive speed sensor, this problem is **completely solved** by using the provided ground cable (yellow) connecting the machine frame to the yellow plug in the back of the data acquisition unit. With the new Hall effect sensor the problem is lower.

**The speed sensor** has to be placed near the provided gear tooth (120-1 teeth) at a distance of less than 1 mm aprox. This sensor is connected directly to the data acquisition unit.





The sensor is thought to be placed horizontally in the machine (0 degrees) but if its position is different, it can be configured in the software: "sensor offset". The rotation should be **clockwise**. You can get it by swapping the cables from three-phase motor.

**The load cell** has to be placed at the upper side of the machine.



When adjusting the upper bar, the user should ensure that the shock absorber can move along all its displacement and it doesn't reach its boundaries because in such case, the force applied to load cell will be very high and it could be damaged.

#### 1.4 How it works?

The device senses all pulses from the speed sensor, and does an analog conversion from the Load Cell channel and the Thermocouple channel for every tooth pulse, and transmits all these data to the computer. Thus the data acquisition frequency is variable with the drum speed. The elapsed time between pulses is also transmitted to the computer to know the speed and the position for the machine at every moment.

When the missing tooth is detected (the elapsed time between teeth is greater than 50% from the last one) N-1 pulses have to be received, if other number of pulses have been read this is consider as an error, and the computer software discards all the cycle and starts it again, this ensures the data integrity for every cycle.

#### 1.5 Load Cell Calibration.

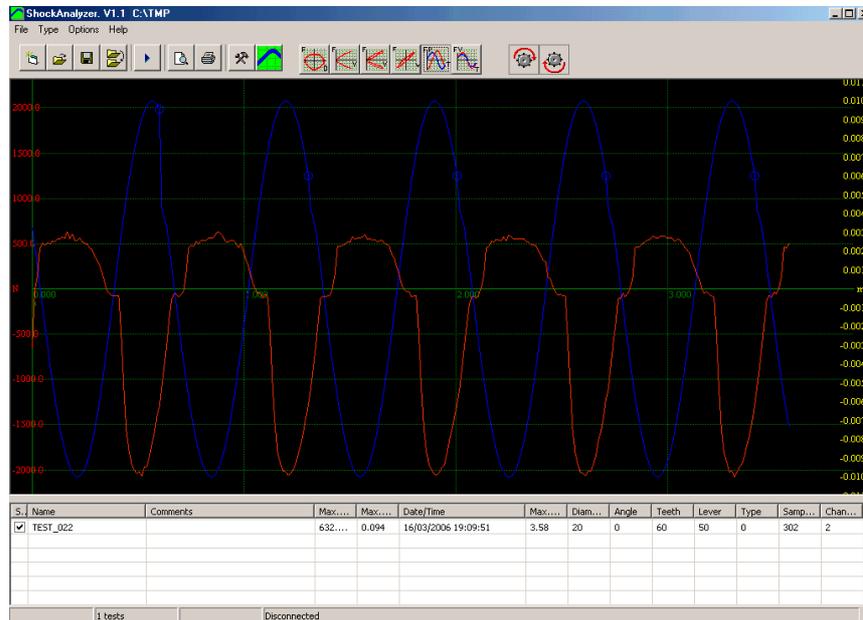
The value shown in the screen is the converted reading from Load Cell in Newtons.

Calibration should be checked for zero load (display=0) and calibration weight (known weight), without the dumper.

It will be interesting to use a mass as heavy as possible for each load cell, although it may be difficult to handle. When using lower weights (for example 50 kg for the 450

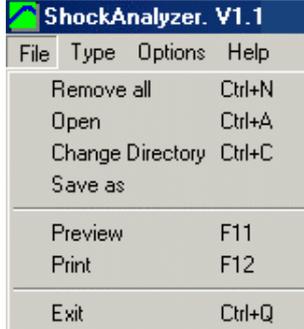
kg load cell) this may introduce a “scale” error, and the error at 450 kg will be unknown.

## 2 ShockAnalyzer Software.



### 2.1 The Menu

#### 2.1.1 File Menu



The screenshot shows the File menu of ShockAnalyzer V1.1. The menu items and their corresponding keyboard shortcuts are as follows:

File	Type	Options	Help
Remove all			Ctrl+N
Open			Ctrl+A
Change Directory			Ctrl+C
Save as			
Preview			F11
Print			F12
Exit			Ctrl+Q

**Remove All.** It removes all tests from the memory, but not from the disk.

**Open.** It shows a window to choose the tests to be loaded in memory. It is possible to load them one by one or several at once.

**Change directory.** It allows changing the directory where tests are automatically saved. Current directory is shown in the title of the window (upper text).

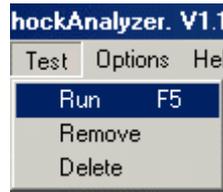
**Save as.** It allows saving the test with a different name or in a different place.

**Preview.** It shows a preview in the screen of the tests in the same way as they will appear in the printer.

**Print.** It prints the selected tests. It shows a window so you can first choose and configure the printer.

**Exit.** It exits from the program.

## 2.1.2 Test Menu

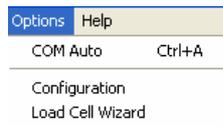


**Run (F5).** It shows the 'input data' window. In this window will enter the data for the test. Then, you can start the test by clicking over the 'Ok' button.

**Remove.** It removes the selected test from the memory (not from the disk).

**Delete.** It deletes the test run from the memory **and from the DISK**. Be careful.

## 2.1.3 Options



**COM Auto.** It will open the 'Automatic COM Port Selection' window. The process will search an answer from ShockAnalyzer unit at every port. When it is received it will be shown in green. If none answers you can repeat the process.

It is very useful to be used with USB adaptors, where the COM id is a pseudo-random number.

**Configuration.** Shows a window with the program configuration, it is explained below.

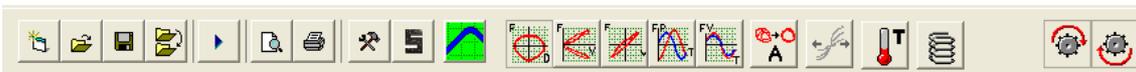
**Load Cell Wizard.** It opens the Load Cell Wizard window. See section 3.

## 2.1.4 Help Menu



**About.** It shows information about SportDevices, developer of the software and manufacturer of the unit.

## 2.2 The Button Bar



By clicking over these buttons you can do more quickly the same actions that using the menu. Options are:

**New.** File/new menu.

**Open.** File/open menu.

**Save as.** It saves the dyno run with another name or in another directory.

**Change directory.** File/change directory menu.

**Run.** Test/run menu. (F5 key)

**Preview.** File/preview menu (F11 key)

**Print.** File/print menu (F12 key)

**Tools.** It opens program configuration window.

**Load Cell Wizard,** see section 3.

**About.** Help/about menu.

**Draw Modes.** See below.

## 2.3 Draw Modes

### **2.3.1 Force vs Position**

It draws the force versus the direct position reading. It shows a “smile” type graph.

### **2.3.2 Force (average) vs Velocity**

It calculates the average for all cycles and draws it versus the velocity.

### **2.3.3 Force (all) vs Velocity (absolute)**

It draws all force curves versus the absolute function of speed. It shows a “C” type graph.

### **2.3.4 Force (all) vs Velocity**

It draws all force curves versus direct speed. It shows a “bended 8” type graph.

### **2.3.5 Force and Position vs Time**

It draws force and position channels (and temperature) versus time. It shows “oscilloscope” type graphs.

### **2.3.6 Force and Velocity vs Time**

It draws force and velocity channels (and temperature) vs time. Force is in phase with the speed when the machine pulls from dumper, and uses to be constant when the machine pushes the dumper.

### **2.3.7 Average**

This option enables or disables the average calculation. When enabled all turns of the same test are averaged to create a single graphs. It increases accuracy.

### **2.3.8 Extend**

When multiple speeds are recorded for a single test, this option expands the speed axis to fit all the curves in the same range, in order to ease the comparison.

### **2.3.9 Temperature**

It draws/hides the temperature curves from the tests (if recorded).

### **2.3.10 Spring analysis**

When multiple speeds are recorded for a single test, the first speed (low speed) is used to perform an analysis of the spring behavior of the shock absorber, the resulting line will be displayed and subtracted from the other curves to compensate the spring effect.

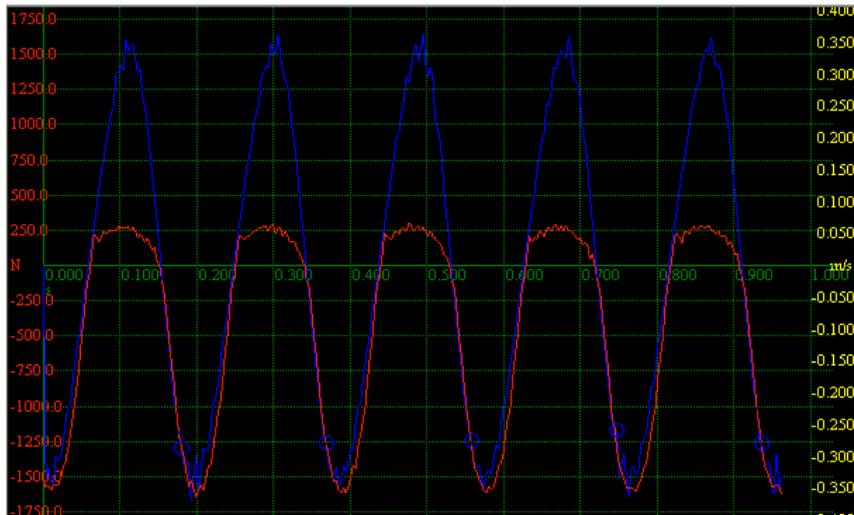
### **2.3.11 Push cycle**

The user can show/hide the push cycle of the graph,

### **2.3.12 Pull cycle**

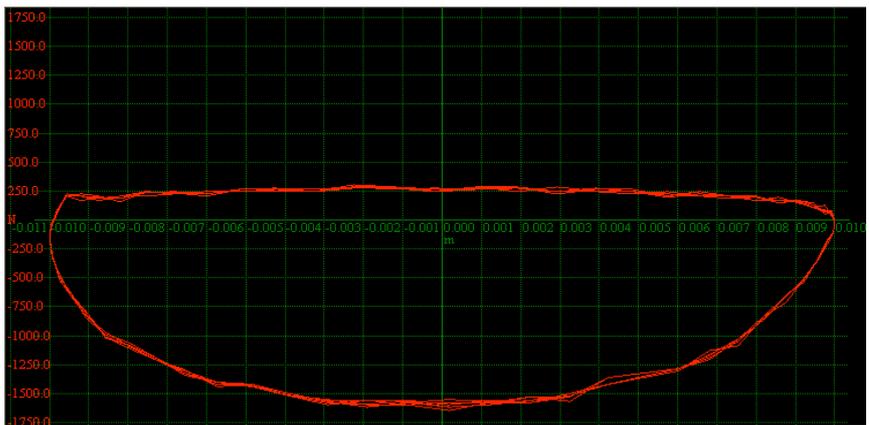
The user can show/hide the pull cycle of the graph,

### **2.3.13 Some Screenshots**



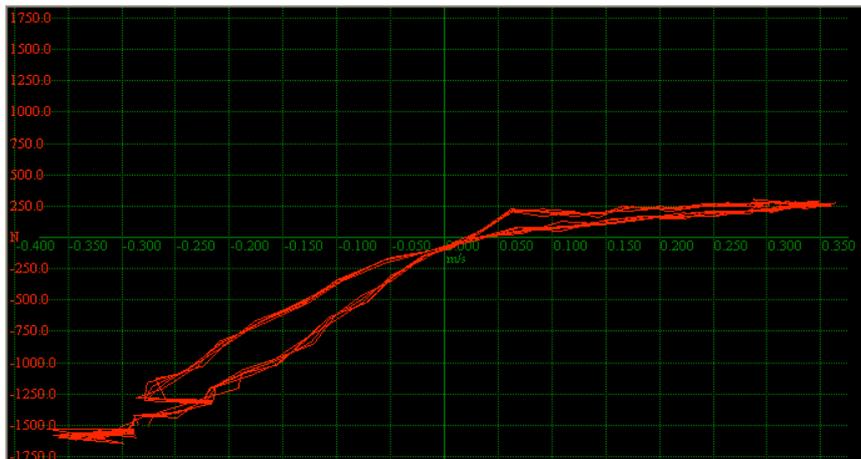
**Force and Velocity vs Time**

Force is in phase with speed, when the machine pushes the dumper the Force is approx. Constant (the dumper doesn't absorb too much power)  
 When the machine pulls from the dumper the force is proportional to speed, the dumper is converting energy to heat.



**Force vs Position**

Position is related with speed, at central position speed is maximum, at upper and bottom position speed is zero.



**Force vs Velocity**

For positive speed (push) force is close-constant (flat), for negative speed force is proportional to speed.

## 2.4 Test Columns

S. #	Name	Comments	Max....	Max....	Date/Time	Max....	Diam....	Angle	Teeth	Lever	Type	Samp....	Chan....
✓	TEST_022		632....	0.094	16/03/2006 19:09:51	3.58	20	0	60	50	0	302	2

The following data is shown for every loaded test, by double-clicking over the row the data window will be displayed, and the user can change some of these data

**Show**, the user can check/uncheck this column to show/hide the test,

**Name**, name of the test,

**Comments**, commentaries for the test,

**Max speed**, maximum speed detected during the test (km/h or mph)

**Max Force**, maximum force detected during the test, two values will be displayed for “push” force and “pull” force, (Newton, Kg or Pound)

**Date/Time**, date and time when the test was done,

**Max Time**, duration of the test,

**Diameter**, diameter corresponding to the drum position used for the test, the suggested drum has 10 positions (see below), each one with one angle and diameter.

**Angle**, angle for the drum position used for the test,

**Teeth**, number of teeth of the gear tooth, default is 60-1,

**Lever**, lever length, default is 50 mm,

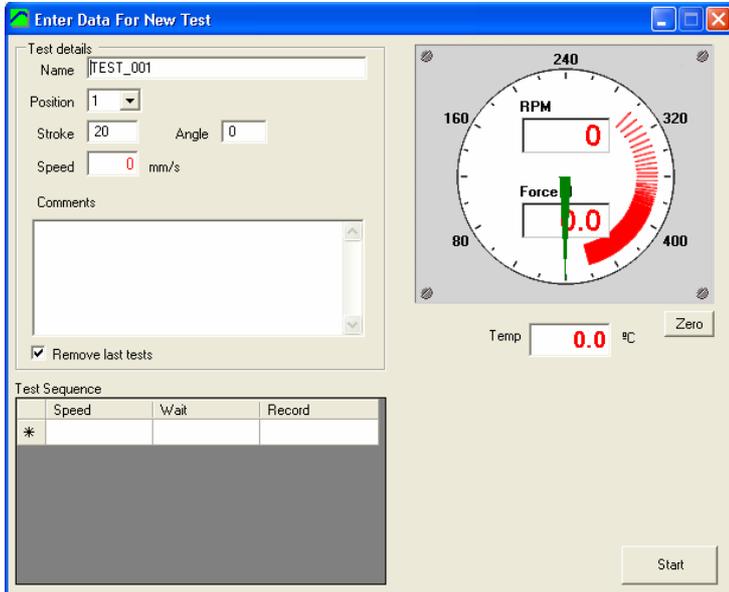
**Type**, type of machine, 0 for “Piston Crank” (default), 1 for Scotch Yoke Slider,

**Samples**, number of samples read by the unit, ( cycles \* teeth-1 )

**Channels**, number of channels stored (default = 3),

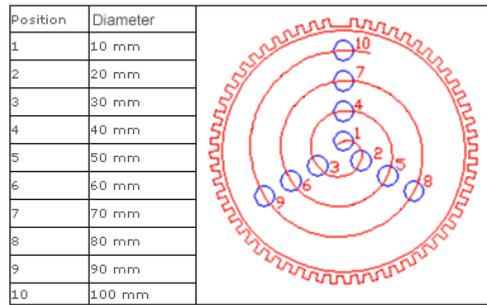
## 2.5 Test Data Window

This window is used when editing the data from an existing test, or when entering data for a new one.



The program increases the test name’s number each time a test is done.

The user should ensure the selected **position** matches the actual one on the machine.



Each position number has associated a **stroke** and an **angle** that the program will use to calculate the dumper movement.

**Speed box** is provided for test purposes, but **Test Sequence** table MUST be used.

### 2.5.1 Test Sequence Table (new)

When multiple speeds are recorded for a single test, this table is used to enter the different speed steps the motor will perform.

The values entered are:

- **Speed**, millimetres per second. It is a calculation from the Max rpm on the configuration, it doesn't consider the motor's load.
- **Wait**, number of turns to wait before starting to record data, this field is provided to let the motor accelerate up to the desired speed. For low speeds you can enter 1 turn, and for high speeds 3 turns.
- **Record**, number of turns to record, the minimum is 1.

## 2.6 Configuration

Configuration is distributed in three tabs:

### 2.6.1 Mechanism Type Tab



**Dyno Name**, name for the reports (print),  
**Lever**, length of the lever used to move the dumper (not the drum diameter),

**Length of Test**, number of turns to record for the test,  
**Pickup offset**, pickup should be mounted at 0 degrees (horizontally), but this parameter lets you compensate its real position.  
**Invert load cell**, you can invert the load cell reading with this checkbox. Usually people expects to see the “pull” part on the positive area of the graph and the “push” area on the negative part, but you can change it with this checkbox.

**Variable Speed Drive, Max Output RPM**, this value is used on the calculation of the linear speed for multi-speed tests. It is the maximum speed of reduction gear box (with VFD set to 100%)

**Piston Crank**, (by default) in this machine the mechanism is like into an engine, the created motion is not completely sinusoidal but the program has the mathematical model to calculate it.

**Scotch Yoke Slider**, this machine creates a perfect sinusoidal motion, but it is more complex to build,

**Scales, Thermocouple**, this value should be kept to 1. It will let the user to setup a different type of temperature sensor.

**Number of Teeth**, number of teeth for the gear tooth, including the missing tooth (by default 120),

**Write (button)**, used to transmit the number of teeth to the data unit, only for displaying purposes, it doesn't affect the accuracy of the system (if the unit has an improper value),

## 2.6.2 Options Tab



**Colour Printer**, when printing in a non colour printer all curves will use the same colour to ease the visual reading,

**Landscape**, portrait / landscape, the curves will be printed vertically or horizontally,

**Numeric Table**, a numeric table can be printed with the curves; the data shown is taken from the data of the test: position, speed, force.

**Language**, at the moment only English and Spanish are available. New translations can easily be done by editing the English.lan file with notepad, and saving it as “Francaise.lan” for example.

**COM Port**, here are displayed all available COM ports on the computer. You can change it manually, or you can use the **COM Auto** function in the Options Menu.

**Units:**

**International (scientific)**, Force is shown in Newtons and speed in meter/s

**Cegesimal (common)**, Force is shown in kg and speed is cm/s

**Imperial**: Force in Pounds and Speed in inches/s

**2.6.3 Colours Tab**

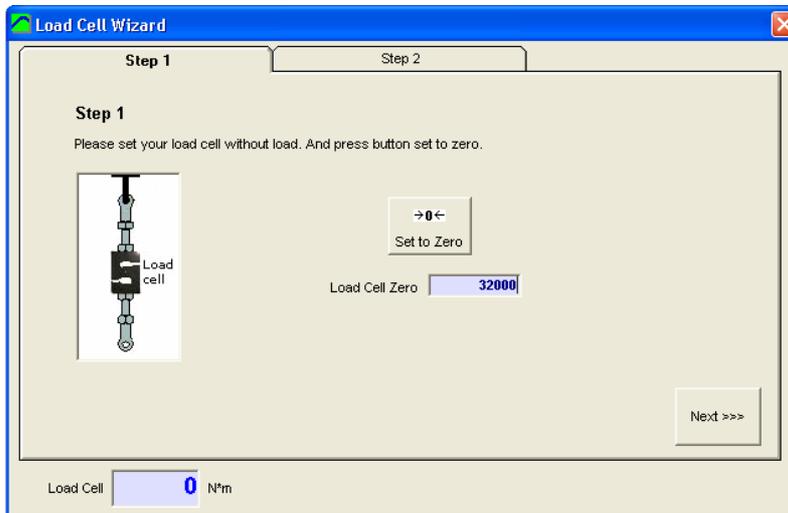


Each channel for each test can have a different colour. The user can edit them from this window. After editing, the write button has to be pressed to save the changes.

### 3 LOAD CELL WIZARD

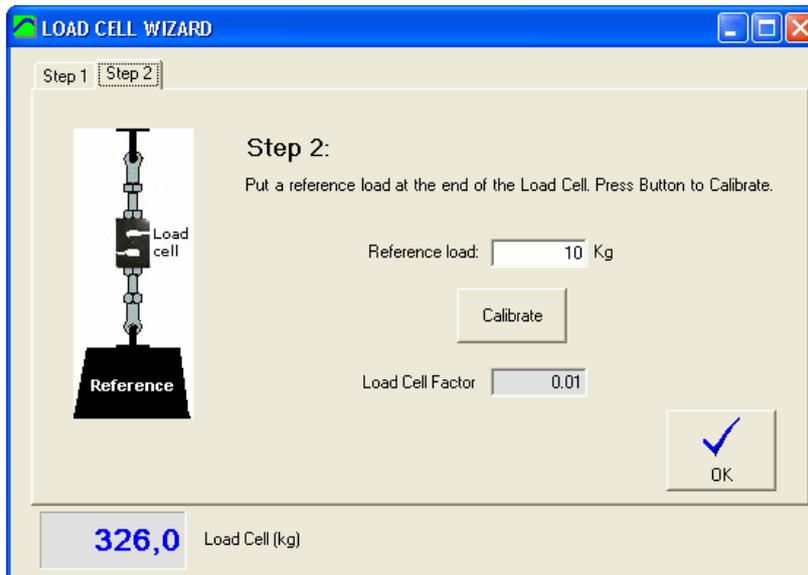
This window eases the Load Cell calibration process. It is divided into two steps:

#### 3.1 Load Cell Zeroing



With the load cell free, press the "set to zero" button and check the "load cell zero" value is between 30000 and 35000, otherwise there may be some problem on the wiring.

#### 3.2 Load Cell Scale



With the calibration weight pulling the load cell, enter the calibration weight value on the white box and press the "calibrate" button.

Check that the load cell reading (blue number, Kg) matches the "reference load" number.

Finally, press **OK** button to finish the calibration process.