



# **BenchCel Microplate Handling Workstation R-Series User Guide Addendum**

**November 2007**

**BenchCel Diagnostics version 17.0.3**

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## About this addendum

This addendum explains how to set the sensor thresholds for optimum operation and provides additional troubleshooting information. The addendum contains the following sections:

- “Setting sensor thresholds” on page 1
- “Hardware problems and software errors” on page 9

This addendum documents the following:

- BenchCel Diagnostics version 17.0.3 or later
- BenchCel firmware version 3.2.8 or later
- BenchWorks Automation Control version 43.0.1 or later

This addendum complements the labware setup instructions in the *BenchWorks Automation Control Software User Guide* and replaces the sensor adjustment topic in the *BenchCel Microplate Handling Workstation R-Series User Guide*.

## Setting sensor thresholds

### About this topic

To ensure optimum operation, you should set the Plate-presence and Orientation thresholds correctly for the type of microplate you are using. You must do so before you start a run with the type of microplate.

This topic explains how to set the Plate-presence and Orientation thresholds.

### Workflow

The workflow for setting the Plate-presence and Orientation sensor thresholds is:

Step	For this task...	See...
1	Calculate the Plate-presence threshold using the following: <ul style="list-style-type: none"> <li><input type="checkbox"/> Highest Plate-presence reading among all the stacks when no microplate is loaded</li> <li><input type="checkbox"/> Lowest Plate-presence reading among all the stacks when the first microplate is loaded in each stack</li> </ul>	“Calculating the Plate-presence threshold” on page 2
2	Determine the optimum sensor offset at each stack.	“Determining the optimum Orientation sensor offset” on page 5
3	Calculate the Orientation threshold based on the observed Notch Sensor readings.	“Calculating the Orientation threshold” on page 8

**Before you start**

Make sure you have three spare microplates for each BenchCel Workstation stacker head. For example, if the BenchCel Workstation has six stacker heads, you will need 18 microplates.

Make a copy of the provided “Worksheet for setting sensor thresholds” on page 11. You can use it to record sensor readings and facilitate threshold calculations.

**Calculating the Plate-presence threshold****To calculate the Plate-presence threshold:**

1. Install a stacker rack at each stacker head, and then physically load three microplates in each rack. (For instructions, see the *BenchCel Microplate Handling Workstation R-Series User Guide*.) The microplates should rest on top of the stacker grippers.

Do not click Load plates in BenchCel Diagnostics.

2. In the **BenchCel Diagnostics Controls** tab, click the **Labware** tab. In the **Sensors** area:
  - ◆ Set the **Plate presence** threshold at 225 units.
  - ◆ Set the **Intensity** at 100%.

Apply and save labware parameters	
Plate Dimensions (mm)	
Thickness:	14.30
Stacking thickness:	12.80
Plate Offsets (mm)	
Robot gripper offset:	8.00
Stacker gripper offset:	3.01
Sensors	
Orientation threshold:	175
Plate presence threshold:	225
Intensity (all sensors):	100
Orientation sensor offset:	
	3.00

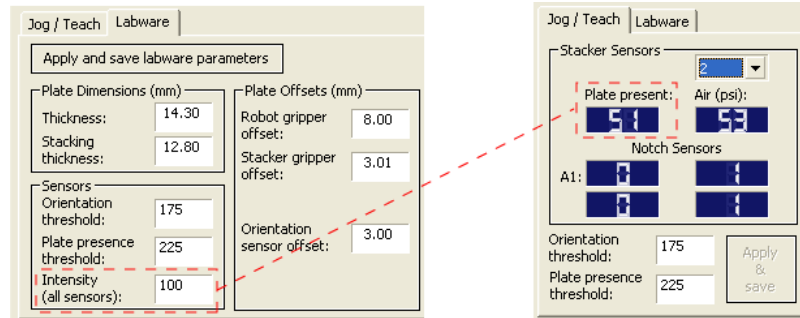
3. Click the **Jog/Teach** tab. In the **Stacker Sensors** area:
  - a. Select the first stack.
  - b. Record the **Plate present** reading.
  - c. Repeat steps a and b for each of the remaining BenchCel Workstation stacks.
  - d. Select the stack that has the highest Plate present reading.

Stacker Sensors	
Plate present:	Air (psi):
51	53
Notch Sensors	
A1:	
Orientation threshold:	175
Plate presence threshold:	225
Apply & save	

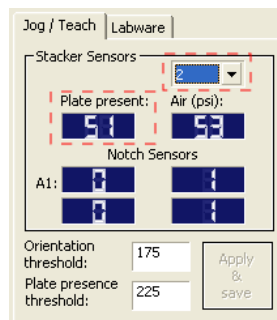
4. Click the **Labware** tab. In the **Sensors** area, reduce the **Intensity** so that the highest **Plate present** reading (Jog/Teach tab) is less than or equal to 175.

If the Plate present reading is very low, increase the Intensity to 100%. If the Plate present reading is greater than 175, decrease the Intensity slightly so that the reading is reduced to 175.

For example, a dark-colored microplate has a Plate present reading of 10. Increasing the Intensity to 100% increases the reading to 51 (shown in the example below). A light-colored microplate has a Plate present reading of 200. Decreasing the Intensity to 20 reduces the reading to 175.



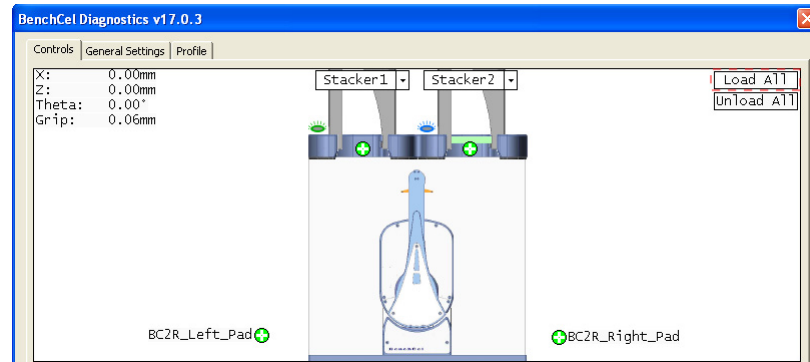
5. In the **Jog/Teach** tab, find the highest **plate present** reading ( $P_{\text{unloaded}}$ ) among all the stacks. To do this:
  - a. Select the first stack.
  - b. Record the **Plate present** reading.
  - c. Repeat steps a and b for each of the remaining BenchCel Workstation stacks.
  - d. Assign the highest Plate present reading to  $P_{\text{unloaded}}$ , the highest Plate presence threshold when no microplate is loaded. The value will be used to calculate the Plate presence threshold.



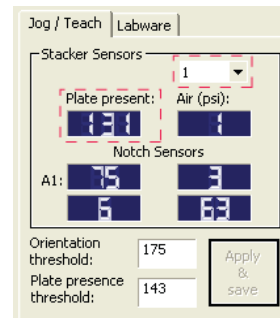
In the following example, the highest reading is 51 (stack 2).

Stack 1	Stack 2	Stack 3	Stack 4
48	51	50	45

6. In BenchCel Diagnostics, click **Load All**.



7. In the **Jog/Teach** tab:
- Select the first stack.
  - Record the **Plate present** reading.
  - Repeat steps a and b for each of the remaining BenchCel Workstation stacks.
  - Assign the lowest Plate present reading to  $P_{loaded}$ , the lowest Plate presence threshold when microplates are loaded. The value will be used to calculate the Plate presence threshold.



In the following example, the lowest reading is 131 (stack 1).

Stack 1	Stack 2	Stack 3	Stack 4
131	139	140	135

8. Calculate the Plate presence threshold as follows:

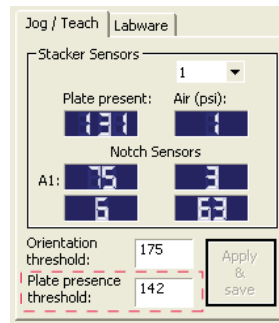
$$\text{Plate presence threshold} = P_{\text{unloaded}} + ((P_{\text{loaded}} - P_{\text{unloaded}})/2)$$

In the following example, the calculated threshold is 142.

$P_{\text{unloaded}}$	51
$P_{\text{loaded}}$	131
Plate presence threshold	142

If the calculated Plate presence threshold is less than 50, make sure you are using the stacker grippers to hold the stack (Stack Holding Method in the Labware Editor), and then repeat the procedure in this section.

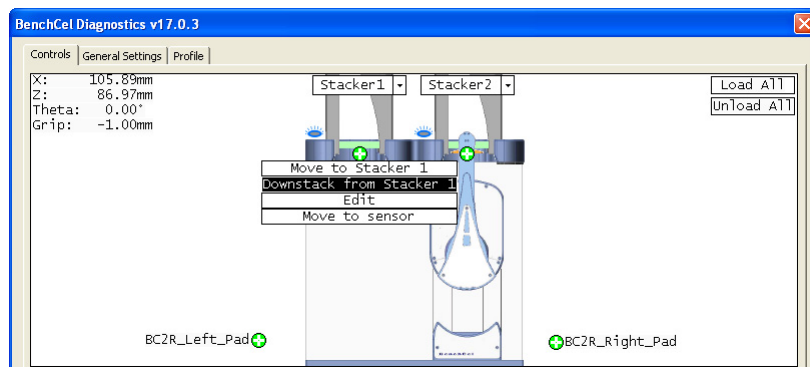
9. In the **Jog/Teach** tab, type the calculated **Plate presence threshold**.



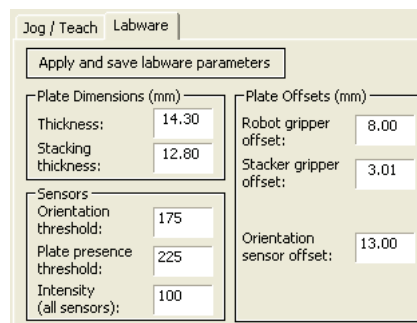
### Determining the optimum Orientation sensor offset

*To determine the optimum Orientation sensor offset:*

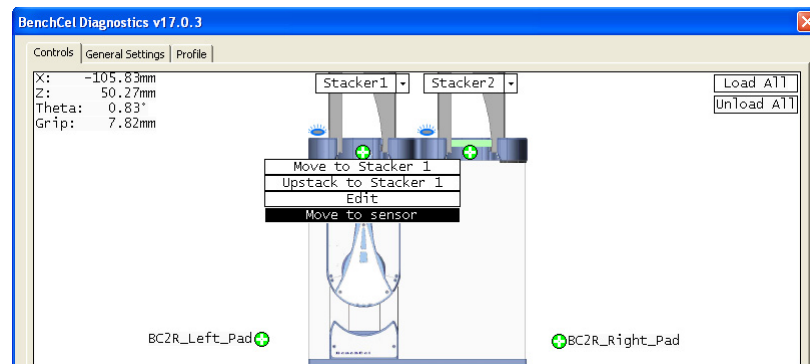
1. In BenchCel Diagnostics, click **Downstack** at the first stack.



2. In the **Controls** tab, click the **Labware** tab.
3. In the **Orientation sensor offset** box, type the initial offset value you want to use. To determine the initial value:
  - a. Determine the halfway distance (in millimeters) between the top of the microplate and the top of the skirt.
  - b. Determine the height of the microplate skirt (in millimeters).
  - c. Add the values from step a and step b.

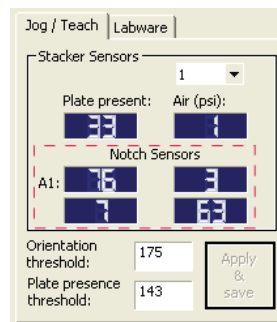


4. Click **Move to Sensor**. The robot moves the first microplate into the line of notch sensors.



5. Click the **Jog/Teach** tab and check the **Notch Sensor** readings. The notches should have much lower readings than the corners. In addition, the difference between the notch readings and corner readings should be at a maximum.

In the following example, the Notch Sensor values indicate that the microplate has two notches (3 and 7) and two corners (76 and 63).

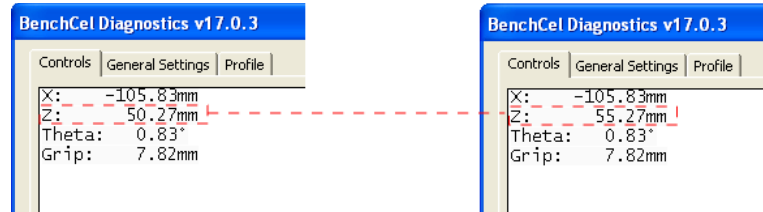


6. To find the maximum difference between the notch readings and corner readings:
  - a. Record the initial z-axis position ( $Z_{\text{initial}}$ ) in the upper left corner of the BenchCel Diagnostics screen.
  - b. Jog the robot up or down, and then check the **Notch Sensor** readings. You can repeat this step until you find the maximum difference between the notch readings and the corner readings.
  - c. Record the adjusted z-axis position ( $Z_{\text{adjusted}}$ ).

7. Calculate the jog distance:

$$\text{Jog distance} = Z_{\text{initial}} - Z_{\text{adjusted}}$$

In the following example, the jog distance is -5.00 mm.



$Z_{\text{initial}}$	50.27 mm
$Z_{\text{adjusted}}$	55.27 mm
Jog distance	-5.00 mm

8. Calculate the adjusted Orientation sensor offset:

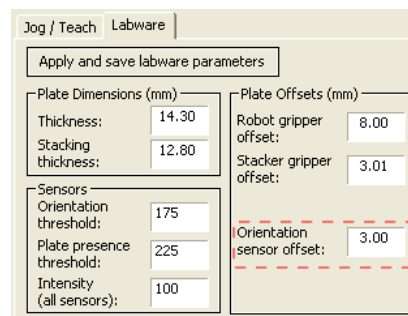
$$\text{Adjusted Orientation sensor offset} =$$

$$\text{Initial Orientation sensor offset} + \text{Jog distance}$$

In the following example, the adjusted orientation sensor offset is 3.00 mm.

Initial Orientation sensor offset	8.00 mm
Jog distance	-5.00 mm
Adjusted Orientation sensor offset	3.00 mm

9. Type the adjusted orientation sensor offset in the **Labware** tab.



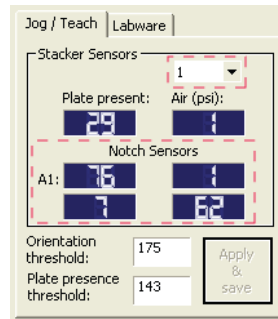
10. Select the next stack, and then click **Move to Sensor**. Check the Notch Sensor readings. The notches should have much lower readings than the corners. In addition, the difference between the notch readings and corner readings should be at a maximum.

11. Repeat step 10 for the remaining stacks.

## Calculating the Orientation threshold

### To calculate the Orientation threshold:

1. Click the **Jog/Teach** tab. In the **Stacker Sensors** area:
  - a. Select the first stack.
  - b. Record the highest reading for the notch and lowest reading for the corner. (In the example below, the highest notch reading is 7, and the lowest corner reading is 62.)
  - c. Repeat steps a and b for the remaining stacks.



2. Find the highest notch reading (Notch) among all the stacks. In the following example, the highest reading is 35 (stack 3).

Stack 1	Stack 2	Stack 3	Stack 4
0	25	35	15

3. Find the lowest corner reading (Corner) among all the stacks. In the following example, the lowest reading is 235 (stack 4).

Stack 1	Stack 2	Stack 3	Stack 4
244	238	245	235

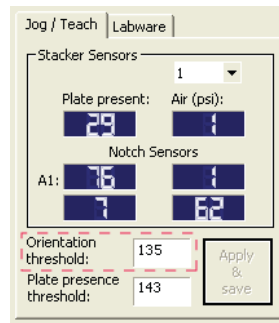
4. Calculate the Orientation threshold as follows:

$$\text{Orientation threshold} = \text{Notch} + ((\text{Corner} - \text{Notch})/2)$$

In the following example, the calculated threshold is 100.

Highest notch reading among all stacks	35
Lowest corner reading among all stacks	235
Orientation threshold (midpoint)	135

5. In the **Jog/Teach** tab, type the calculated **Orientation threshold**.



## Hardware problems and software errors

### About this topic

This topic supplements the troubleshooting chapter in the *BenchCel Microplate Handling Workstation User Guide*. If you are still experiencing problems with the BenchCel Workstation after trying the solutions, contact Velocity11 Technical Support.

### Hardware problems

Problem	Cause	Solution
More than one microplate was downstacked.	The Plate present reading is below the Plate presence threshold.	Use the procedure in “Setting sensor thresholds” on page 1 to adjust the threshold values.
The stack of microplates is dropped onto the shelf during the downstacking procedure.	In the shelf stack-holding method, the stacker gripper offset is too low. So the distance between the grippers and shelves is large.	Increase the stacker gripper offset.

## Software problems

Error message	Cause	Solution
Deadlock	The microplate is assigned to the wrong labware class.	Check that the labware belongs to the correct labware class in the Labware Editor. Most microplates should belong to the Uses Standard Plate Pad class. If you created a special class for a particular microplate, make sure it belongs to the special class.  For more information about setting up labware classes, see the <i>BenchWorks Automation Control User Guide</i> .
No plate in grippers	The Orientation threshold was used to detect microplate presence, and the sensor readings from all four corners are below the threshold. <i>Note:</i> The software always uses the Orientation threshold as a secondary check, even if the Check Orientation option is not selected.	Reduce the Orientation threshold value.
	The Robot gripper offset parameter value is incorrect.	Correct the Robot gripper offset value in the Labware Editor or in BenchCel Diagnostics. Velocity11 recommends an 8 mm offset for most labware.
	No microplate is available at the pickup location.	Make sure you load or place labware at the target location.
	The Orientation sensor offset parameter value is incorrect.	Adjust the Orientation sensor offset value in BenchCel Diagnostics. See “Setting sensor thresholds” on page 1 for detailed instructions.
	The sensor intensity and threshold need adjusting.	See “Setting sensor thresholds” on page 1 for detailed instructions.

## Worksheet for setting sensor thresholds

### Plate-presence threshold

#### Initial Plate present readings

Set the thresholds as follows:

- Plate presence threshold = 225 units
- Intensity = 100%,

Record the **Plate present** reading for each stack.

Stack 1	Stack 2	Stack 3	Stack 4	Stack 5	Stack 6

#### Plate present readings when microplates are unloaded

After adjusting the Intensity so that the highest Plate present reading is less than or equal to 175, record the **Plate present** readings for each stack.

Stack 1	Stack 2	Stack 3	Stack 4	Stack 5	Stack 6

Highest reading among all the stacks ( $P_{\text{unloaded}}$ ): \_\_\_\_\_

#### Plate present readings when the microplates are loaded

After loading the microplates at each stack (**Load All** in BenchCel Diagnostics), record the **Plate present** readings for each stack.

Stack 1	Stack 2	Stack 3	Stack 4	Stack 5	Stack 6

Lowest reading among all the stacks ( $P_{\text{loaded}}$ ): \_\_\_\_\_

#### Plate presence threshold

Plate presence threshold =  $P_{\text{unloaded}} + ((P_{\text{loaded}} - P_{\text{unloaded}})/2) =$  \_\_\_\_\_

**Optimum Orientation sensor threshold****Initial Orientation sensor offset**

Measure A and B of your microplate.



Initial Orientation sensor offset =  $(A/2) + B =$  \_\_\_\_\_ mm

**Jog distance**

Jog distance =  $Z_{\text{initial}} - Z_{\text{adjusted}} =$  \_\_\_\_\_ mm

**Adjusted Orientation sensor offset**

Adjusted Orientation sensor offset =

Initial Orientation sensor offset + Jog distance = \_\_\_\_\_ mm

**Orientation threshold**

After you calculate the adjusted Orientation sensor offset, in BenchCel Diagnostics, click **Move to Sensor** at each stack. In the **Notch Sensor** area, the notches have lower readings than corners.

**Highest Notch Sensor readings**

Record the highest notch reading for each stack.

Stack 1	Stack 2	Stack 3	Stack 4	Stack 5	Stack 6

Highest reading among all stacks (Notch): \_\_\_\_\_

**Lowest Corner readings**

Record the lowest corner reading for each stack.

Stack 1	Stack 2	Stack 3	Stack 4	Stack 5	Stack 6

Lowest reading among all stacks (Corner): \_\_\_\_\_

**Orientation threshold**

Orientation threshold =  $\text{Notch} + ((\text{Corner} - \text{Notch})/2) =$  \_\_\_\_\_



