MULTITACTION

MT CELL
CALIBRATION MANUAL

MT553UTB

MT555UTB

Revision 6
February 2018

Regulatory information

European Union Directive on Restriction of Hazardous Substances (RoHS)

MultiTaction Cells comply with the following regulatory standards:

- RoHS
- EN 55022
- EN 55024
- IEC 61000-3-2
- IEC 61000-3-3
- IEC 62471
- IEC60950-1:2005+A1:2009

For more compliance information, please provide MultiTaction with the serial number of your MultiTaction Cell.

Contents

1 Introduction

This manual contains instructions for geometry calibration (camera alignment), touch calibration and color calibration on MultiTaction 55" ultra-thin bezel Cells. Current models are the MT553UTB and MT555UTB. The manual includes calibration instructions using:

- **On-screen display (OSD):** Use the OSD to configure individual Cells. See section 3.
- **Site Manager:** Use Site Manager to configure Cells from your desktop computer or laptop. You can configure individual Cells or multiple Cells at the same time. See section 6.
- **Argyll CMS:** Use Argyll CMS to color calibrate MultiTaction video wall. See section 10.

MultiTaction Cell

1.1 About MultiTaction Cells

MultiTaction Cells are multi-touch modular LCD displays intended for, but not limited to, retail businesses, advertising, exhibitions, museums, education, and design installations.

'Multi-touch' means the Cells can track and react to several people interacting with them simultaneously. 'Modular' means the Cells can be easily stacked and combined to form video walls and video tables that show interactive content and react to multiple users' touch.

2 OSD: Geometry Calibration

MultiTaction Cells utilize a camera matrix for tracking objects on the Cell display surface. During transport and installation, the physical position of the infrared cameras may move a few millimetres if, for example, there was rough handling during transit. This will require a recalibration of the geometrical alignments of the cameras ie, a 'geometry calibration'.

Note: *Finger tracking often usually works even without geometry calibration, but for marker tracking it is often necessary. However, if you subsequently move your video wall to a new location, you may need to run the geometry calibration again to restore finger tracking accuracy.*

2.1 FAQs

- How often do I run a geometry calibration?

  You must run a geometry calibration after setting up your Cells for the first time or if you subsequently move the Cells to a new location.

- Can I run a geometry calibration on multiple Cells together?

  No. You typically run a geometry calibration on one Cell at a time.

  Although geometry calibration is an automated process launched from the OSD or Site Manager, it requires you to physically attach the supplied calibration sheet to the screen for the duration of the process. This requirement generally precludes bulk geometry calibration operations.

- What special equipment do I need?

  You need a white calibration sheet that is big enough to cover the whole display. A cardboard calibration sheet is supplied with each MultiTaction Cell.

  Tip: *Retain at least one of your Cell calibration sheets! Do not throw them all away after setting up your video wall. There may be occasions in the future when you need to recalibrate individual Cells.*

- Can I test the geometry calibration myself?

  Yes. You can inspect the geometry calibration results yourself.

  (Conversely, we recommend that you use a small group of representative users to test the results of touch calibration; see section 4.1.)

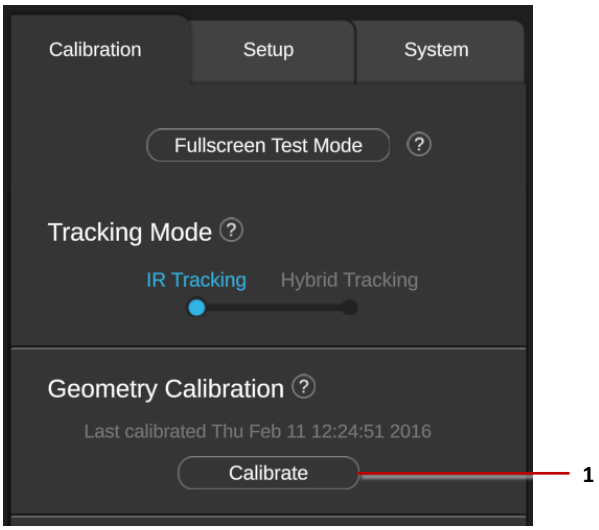
2.2 How to perform a geometry calibration

Note: *You can also launch a geometry calibration from Site Manager; see section 7.*

Calibration takes time, it could be between 5-10 mins but the good thing is that it makes a sound after it has finished. I would NOT recommend to remove the sheet after 5 min if sound is not heard.

Follow these steps:

1. Display the OSD; see section 3.
2. Go to the Calibration tab.
3. Go to the Geometry Calibration pane and tap the Calibrate button to start the calibration procedure.



OSD Calibration tab, Geometry Calibration section. **1** *Calibrate button.*

4. Place the white calibration sheet on top of the display. You have 15 seconds to do this before the actual calibration process begins.

   Tip: *Minimize light leakage onto the screen by taping the calibration sheet firmly in place on the Cell screen. Use a good quality paper tape that adheres well but leaves minimal adhesive residue when removed.*

5. Wait for the calibration to complete.

   This can take a maximum of 10 minutes, but usually completes within five minutes. A beep indicates when the calibration is complete.

   Note: *All MT555UTB models support 'calibration complete' beeps, but some older MT553UTB models do not. However, if your MT553UTB Cell has not beeped after 10 minutes, you can safely assume that the calibration is complete.*

6. Remove the calibration sheet.
7. You now need to test the geometry calibration; see section 2.3.
8. If you are satisfied with the geometry calibration results, tap the Save button. Otherwise, re-run the calibration.

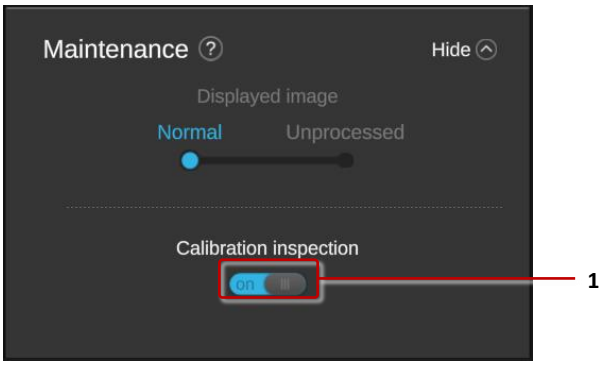
2.3 How to test the geometry calibration

To test the geometry calibration and confirm that the Cell's cameras are correctly aligned, you must perform a *calibration inspection*.

2.3.1 Display the OSD inspection pane

To perform a calibration inspection, you must first display the OSD *inspection pane*:

1. Display the OSD; see section 3.
2. Go to the System tab.
3. In the Maintenance section, set the Calibration inspection slider to On.



OSD System tab, Maintenance section. 1 *Calibration inspection slider.*

4. The OSD *inspection pane* now displays.

   The inspection pane shows a faint grid of rectangles, representing the Cell's camera matrix. Each rectangle represents the field of view for an individual camera.

   Touches anywhere on the screen are shown in the inspection pane as animated green or red circles. For more about the inspection pane, see section 3.3.

OSD inspection pane. 1 *Grid of rectangles represents the matrix of infrared cameras.*

Now use the inspection pane to test camera alignment; go to section 3.

3 OSD: Getting Started

MultiTaction Cells include an on-screen display (OSD) running on the internal computer. You primarily use the OSD to configure the tracking engine so that tracking data can be received by, or transmitted to, the application computer. You can also use the OSD to view Cell details such as its MAC address and current firmware version.

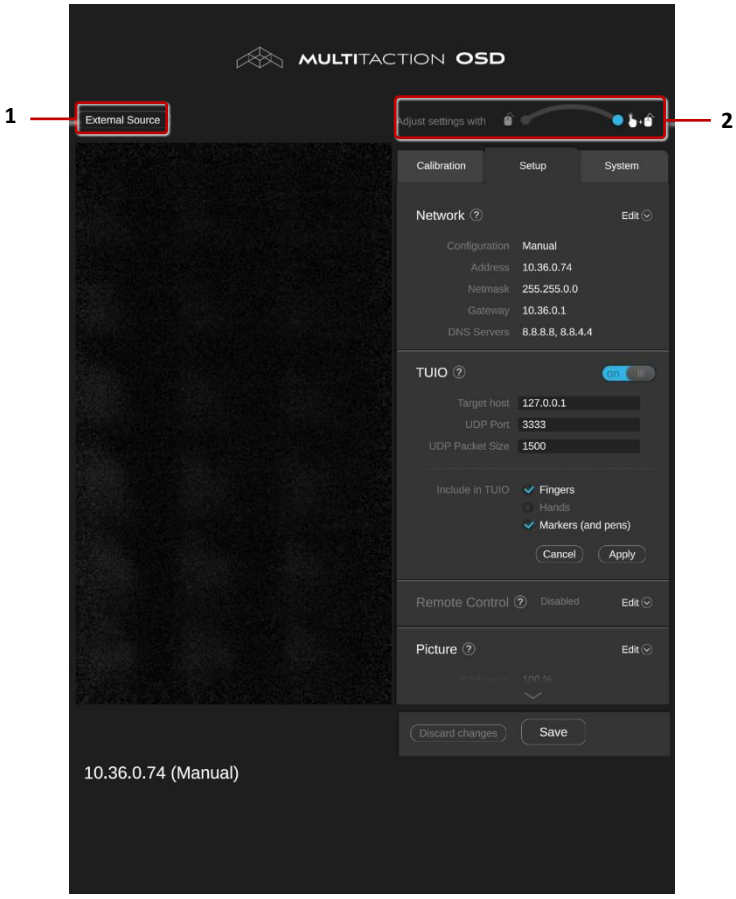
3.1 Display the OSD

Note: *A Cell has two sources for the image that is displayed on the screen: the OSD, running on the Cell's internal computer, or the 'external display' sent from the application computer.*

- **To show the OSD** and hide the external display, you need a mouse (or a keyboard with an integrated touchpad) attached to a rear USB port on the Cell. Simply click the mouse to show the OSD.

  By default, the OSD only accepts mouse input. To configure the OSD to also accept finger (touch) input, drag the Mouse-Finger slider from  Mouse Only to  Finger & Mouse.

- **To hide the OSD** and return to the external display, click the External Source button.



Example OSD. **1** *External Source button.* **2** *Mouse-Finger slider.*

For details about general OSD setup (for example, setting the display timeout and saving configuration changes), see the *Cell User Manual*.

3.2 Install the latest Cell firmware

You can use the OSD to update Cell firmware to improve tracking quality and other functions. Cells include a self-update feature in the OSD. To update the firmware:

1. Display the OSD; see section 3.
2. Go to the System tab and tap the Update button.
3. Tap the 'Check for updates' button.

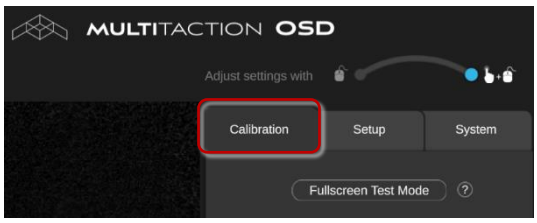
   This causes the software to connect to the MultiTaction update server
4. Start the update and install the latest firmware version.

   If a network connection to the server cannot be made, an error is shown on the screen.
5. The update procedure typically takes 20 minutes, but the time may vary depending on the speed of your network connection. During the update procedure, the Cell may temporarily flicker and reboot, depending on the contents of the update.

   Warning: *Do not turn off the Cell while updating the firmware.*
6. *(Applies only if upgrading to firmware version 2.0)* Set the tracking parameters to their default values.

   Note: *Default values for some tracking parameters have been optimized in firmware 2.0 for more accurate tracking results. However, existing values for tracking parameters remain unchanged when you update the Cell firmware. We therefore recommend that you manually reset all parameters to the new default values when updating to firmware 2.0. This ensures the new default values are used instead of any 'old' default values from firmware 1.9 or earlier.*

   a. Display the OSD and tap the Calibration tab.



OSD Calibration tab.

   b. Go to the section for the tracking feature you want: Fingers, Markers or Pens.

   c. Turn on the tracker by moving the On-Off slider to On.

   d. Tap the Defaults button to set the tracking parameters to their default values.

OSD Calibration tab, Fingers section. 1 *Defaults button.* 2 *On-Off slider.*

3.2.1 Test the camera alignment

When you test the camera alignment in the inspection pane, you must check:

- The shape of the rectangles representing the camera fields of view. Are they regular in shape and aligned with the Cell camera matrix?
- The appearance of the green ○ and red ○ touch indicators ('circles'). These represent the location where you touched the screen. Are they the right color and in the correct position?

In the inspection pane, follow these steps:

1. Consider the shape of all rectangles in the grid.

   Their shape should be regular. Any distorted rectangles are evidence that the cameras are misaligned and need to be re-calibrated. For details of what to look for, see section 3.2.2.

2. Verify that the cameras can correctly detect touches along the top and bottom edges of their fields of view.

   To do this, drag your finger horizontally across the entire screen between each row of cameras. On an MT555 Cell, you need to make three horizontal sweeps of the screen to cover all cameras. Use the rectangles in the inspection pane as a guide to the location of each camera.

   When you touch the screen, green circles ○ display in the inspection pane and track the movement of your finger along the top and bottom edges of the rectangles. Red circles ○ indicate a 'rejected' touch event. For details of what to look for, see section 3.2.3.

   Note: *You do not need to drag your finger along the top and bottom edges of the screen. If you do so, your finger will be partly outside the LCD panel and so beyond the camera's field of view. Also, it is highly unlikely that camera alignment errors will occur in these areas of the screen.*

   Tip: *Systematically drag your finger across the* ***entire screen****. Do not drag your finger only across the inspection pane.*

Horizontal drag pattern to test touch detection

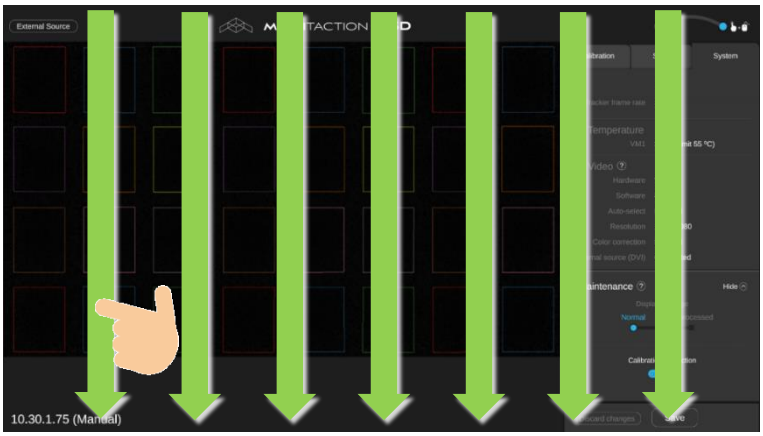
3. Verify that the cameras can correctly detect touches at the sides of their fields of view.

   To do this, drag your finger horizontally vertically down the entire screen between each column of cameras. On an MT555 Cell, you need to make seven vertical sweeps of the screen to cover all cameras. Use the rectangles in the inspection pane as a guide to the location of each camera.

   As before, green circles ○ display in the inspection pane and track the movement of your finger down the sides of the rectangles. Red circles ○ indicate 'rejected' touch events. For details of what to look for, see section 3.2.3.

   Note: *You do not need to drag your finger down the left and right sides of the screen. If you do so, your finger will be partly outside the LCD panel and so beyond the camera's field of view. Also, it is highly unlikely that camera alignment errors will occur in these areas of the screen.*

   Tip: *Systematically drag your finger down the* ***entire screen****. Do not drag your finger only down the inspection pane.*

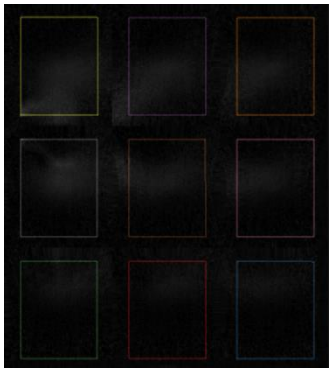


Vertical drag pattern to test touch detection

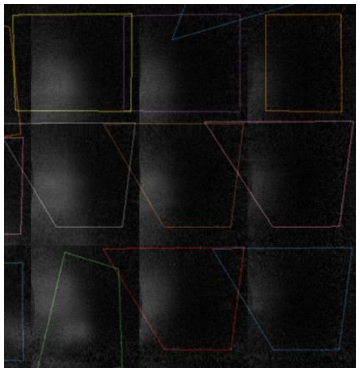
4. If you are satisfied with the geometry calibration results, tap the Save button. Otherwise, re-run the calibration.

3.2.2 What to look for: camera fields of view (rectangles)

Each rectangle in the inspection pane should have a regular shape and be aligned with the horizontal- and vertical-axis of the camera matrix. Any distorted rectangles are evidence that the cameras are misaligned and their fields of view need to be re-calibrated.



Regular rectangles



Distorted rectangles

In the second example above, the rectangles are badly distorted because the calibration was performed without a calibration sheet in place and with direct sunlight falling on the screen. This video wall is unusable for interactive purposes.

Note: *The inspection pane shows gaps between the rectangles. This is intentional and allows you to test touch tracking at the boundaries between adjacent cameras. In reality, camera fields of view are contiguous, with no gaps between them.*

3.2.3 What to look for: touch indicators (green and red circles)

Note: *Technically, touch indicators in the inspection pane are represented by green ellipses ○ or red ellipses ○. Informally, they are often simply called 'fingers' or 'circles'. This manual refers to them as circles.*

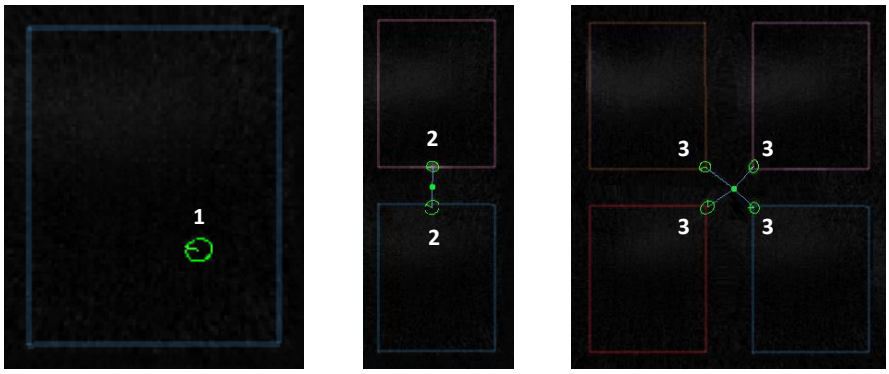
When you drag your finger across the Cell screen (green or red circles) display in the inspection pane and track the movement of your finger; see section 3.3 for further details.

Where your finger traces the boundary between two rows or columns of cameras, two green circles display, simultaneously tracking the movement of your finger along the bottom of the upper row and the top of the lower row, or down the right side of the first column and the left side of the second column.

Likewise, if you touch the screen exactly at a location where four cameras meet (that is, where four fields of view converge), the touch event is detected by all four cameras. Consequently, four green circles appear in the inspection pane at the corners of the four rectangles.

Examples of good calibration

In the examples below, the geometry alignment was successful and the Cell cameras are correctly aligned. The rectangles are regular in shape and the green circles are correctly positioned, indicating that touches are being correctly detected.



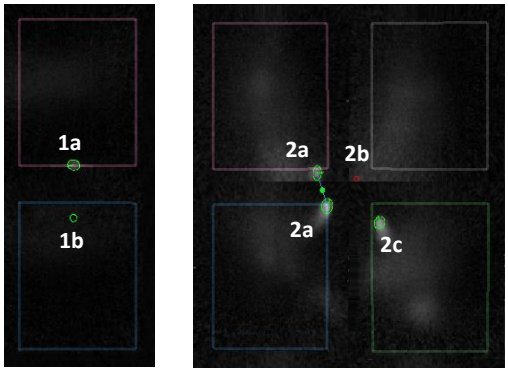
1 *The green circle indicates that a camera has correctly detected a touch event.*

2 *Two linked green circles on the edges of adjacent rectangles indicate that the corresponding cameras both correctly detected a touch on the screen at the boundary between them.*

3 *Four linked green circles at the corners of four rectangles indicate that the corresponding cameras all correctly detected a single touch event at the location where their fields of view converge.*

Examples of bad calibration

In the example below, the geometry alignment failed and the Cell cameras are not aligned correctly. The rectangles are distorted and misplaced green and red circles indicate that touch events are not correctly detected.



1 *The first green circle* (1a) *is correctly located on the edge of the upper rectangle. But this implies that a second circle* (1b) *must be located on the edge of the lower rectangle. Because the second circle is slightly offset from the edge, and not linked to the fist circle, this indicates the lower camera is not aligned correctly.*

2 *Two green circles are reasonably located and linked together* (2a)*, but a third circle is red and in the wrong location* (2b)*. A fourth circle is not precisely on the corner* (2c) *and is not linked to the first two circles. These errors indicate the corresponding cameras are not aligned correctly.*

3.3 About the inspection pane

You use the OSD *inspection pane* to test a geometry calibration.

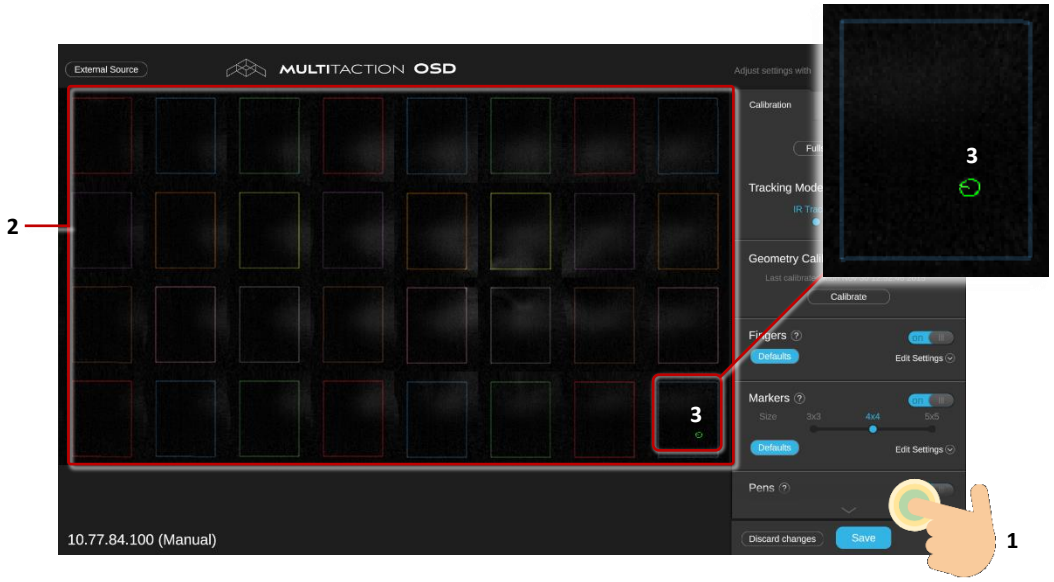
The inspection pane shows a faint grid of rectangles. This grid represents the Cell's camera matrix. On MT555 Cells, the matrix comprises 32 cameras, arranged in a four-by-eight grid. Each rectangle represents the field of view for an individual camera.

When you touch the Cell screen, a green circle ○ or red circle ○ appears in the inspection pane and tracks the movement of your finger, pen or codice card:

- A green circle ○ indicates a valid touch event. That is, the touch event is genuine (not a false touch—see below) and was detected inside a camera's field of view. The rectangle that the green circle appears in tells you which camera detected the touch event.
- A red circle ○ indicates a 'rejected' touch event. For example, the touch event is outside a camera's field of view or construed to be a false touch (for example, the tracking computer concluded that the screen was not touched a finger).

For example, if you touch the bottom right corner of the Cell screen, a green circle displays in the bottom right rectangle of the inspection pane. This tells you that the touch event was detected by the internal camera in row 4, column 8.

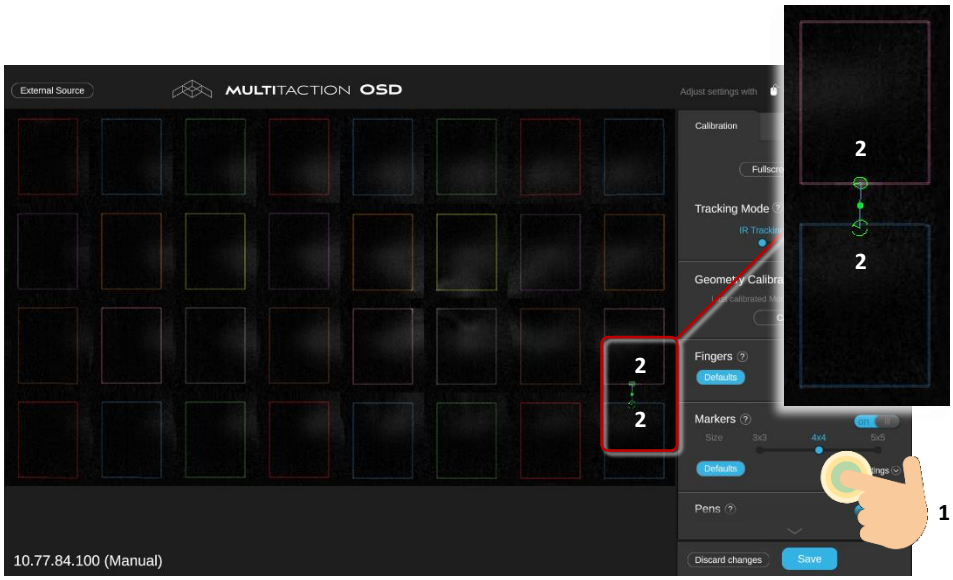
Note: *The inspection pane shows gaps between the rectangles. This is intentional and allows you to test touch tracking at the boundaries between adjacent cameras. In reality, camera fields of view are contiguous, with no gaps between them.*



OSD inspection pane: Single camera detects touch event

*In the example above, a touch event is detected in the bottom right corner of the screen (**1**). This touch event is shown in the inspection pane (**2**) as a green circle in the bottom right rectangle (**3**). This rectangle corresponds to the camera that detected the touch event.*

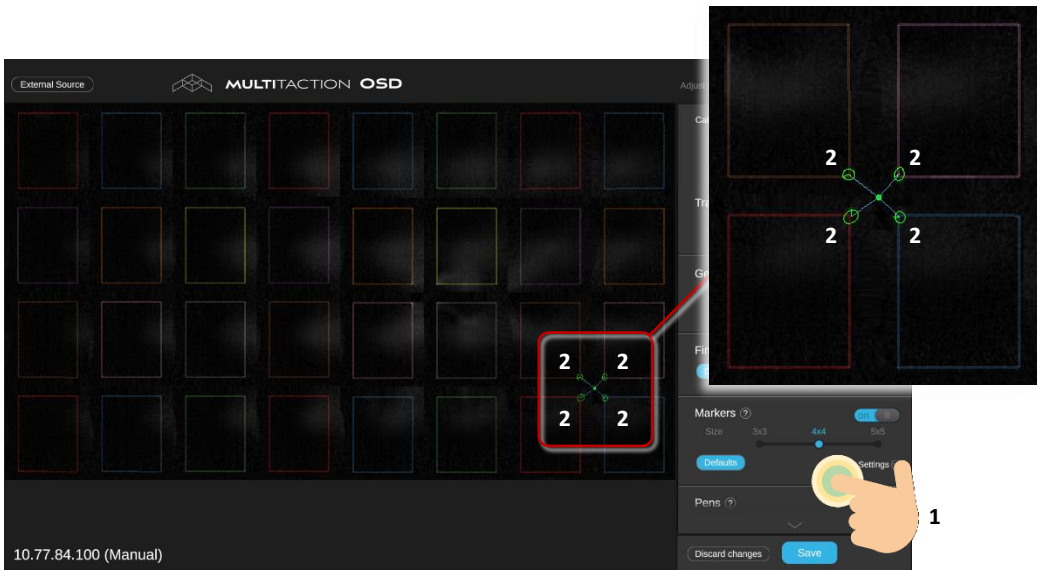
If you happen to touch the screen exactly at the boundary between two cameras (that is, where the cameras' fields of view meet), the touch event is detected by both cameras. Therefore, two green circles appear in the inspection pane: one circle appears on the top or right edge of a rectangle; the second circle appears on the bottom or left edge of the adjacent rectangle. If you then drag your finger horizontally or vertically along the boundary between the cameras, the two green circles move in parallel; see the screenshots on page 16.



OSD inspection pane: Two cameras detect touch event

*In the example above, a user touches the screen at the boundary between two cameras (**1**). The touch event is detected by both cameras, so appears as two green circles in the inspection pane (**2**). Because the touch event occurred at the boundary between cameras, the green circles appear on the adjacent edges of the two rectangles that correspond to these cameras.*

Likewise, if you touch the screen exactly at a location where four cameras meet (that is, where four fields of view converge), the touch event is detected by all four cameras. Consequently, four green circles appear in the inspection pane at the corners of the four rectangles:



OSD inspection pane: Four cameras detect touch event

*In the example above, a user touches the screen at a location where four cameras converge (**1**). The touch event is detected by all four cameras and so generates four green circles in the inspection pane. The circles appear at each corner of the four rectangles that correspond to these cameras (**2**).*

4 OSD: Touch Calibration

After the camera geometry calibration is complete (section 2), you can test the touch tracking and, if necessary, adjust the touch tracking parameters. Your goal is to make touch tracking as accurate as possible ('touch calibration').

4.1 FAQs

- **How often do I perform touch calibration?**
  You must perform touch calibration after setting up your Cells for the first time.
- **Can I calibrate multiple Cells at the same time?**
  Yes. You can use the Site Manager application to calibrate trackers on multiple Cells at the same time; see section 7.

  You can also use the OSD to calibrate trackers on individual Cells.
- **What special equipment do I need?**
  You need an infrared pen and codice marker to test pen and marker tracking.
- **Can I test the touch calibration myself?**
  Yes, you can test pen and marker tracking yourself. However, we recommend that you use a small group of representative users to test finger tracking. This is because users' touch characteristics vary in terms of hand size, finger size, and how firmly they touch the screen.

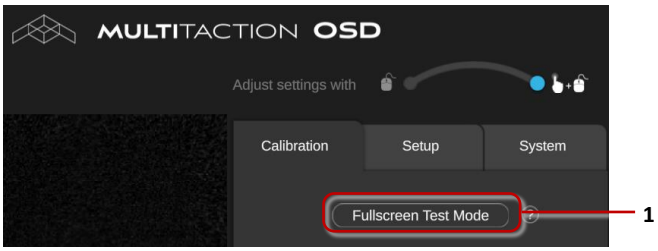
  For example, if your end-users will include a large number of children or students, try to include children or students in your group of testers.
- **Which firmware version do these instructions refer to?**
  Instructions in the following sections refer to Cell firmware version:
  2.0.8-taction20-1 or later

4.2 How to test touch tracking

After confirming that the cameras are correctly aligned, you need to confirm that touch tracking is correctly calibrated. You do this by displaying the Cell in 'fullscreen test mode' and touching random points across the screen with your finger, a marker, and an infrared pen.

To test whether touch tracking is performing correctly:

1. Display the OSD and tap the Calibration tab.
2. Tap the Fullscreen Test Mode button.

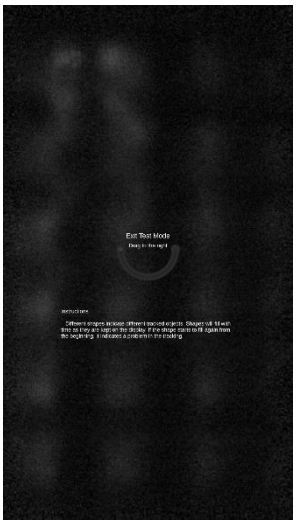


OSD Calibration tab. **1** *Fullscreen Test Mode button.*

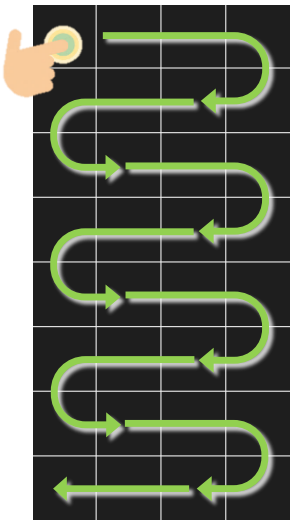
3. Drag your finger, marker or pen across the camera matrix to confirm that touch and drag events are correctly detected across the entire Cell screen:
   - **Finger tracking:** Touch the glass *firmly*. Also, hover your finger 10 millimeters above the screen at random points and test for *false touches*. **Important!** *Long fingernails can cause finger detection errors.*
   - **Marker tracking:** First, place the marker *flat* on the glass and confirm that the same marker value is returned consistently. If the marker is not flat on the screen, the tracking engine will detect your fingers and may misinterpret the touch event.

     Second, rotate the marker 45° and confirm that the marker value is returned correctly. **Important!** *This test needs a 45° rotation. Do not rotate the marker 90° or 180°!*
   - **Pen tracking:** You don't need to test for false touches by hovering the pen; its infrared beam is only activated when you hold the pen tip against the glass.

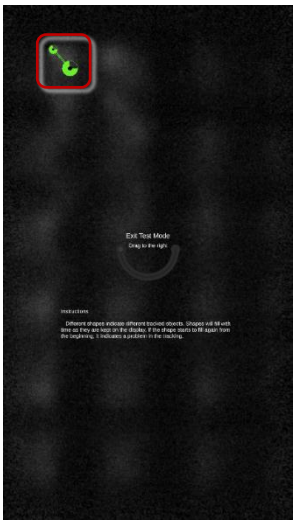
   For details about what to look for, see section 4.2.1 and section 4.2.2.



1 *Cell screen in Fullscreen Test Mode.*



2 *Touch and drag pattern.*



3 *Touch event detected and displayed as green circle.*

Note: *In MT553 and MT555 Cells, there are 32 internal cameras arranged in a 4x8 grid.*

4.2.1 What to look for: Finger and pen tracking

This section describes how to assess whether touch tracking is working correctly *while the Cell is in fullscreen test mode*.

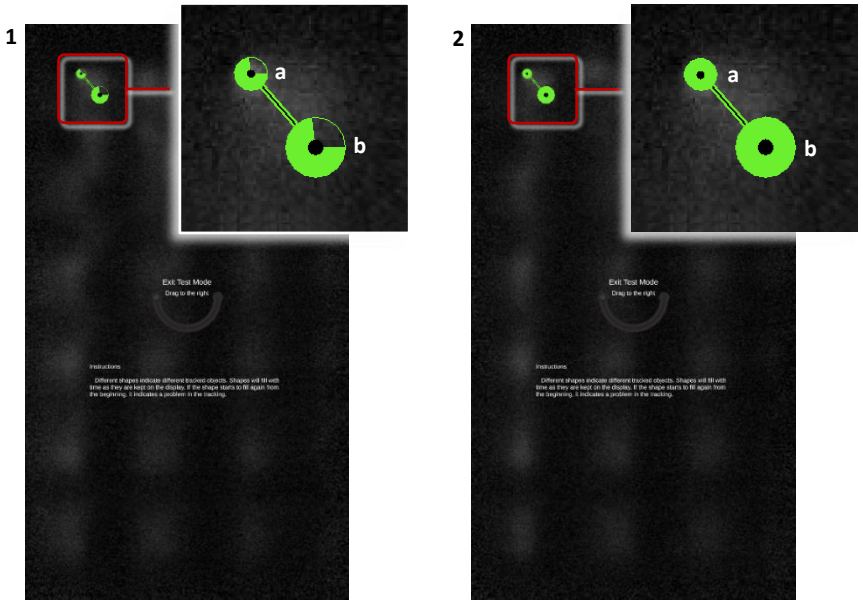
If touch tracking *is* working correctly:

1. When you touch the screen with your finger or infrared pen, a hollow green circle (the 'donut') displays on the screen. The donut indicates a new touch event.

   Note that two green circles display when you touch the screen with a finger. The smaller circle is your fingertip; the larger circle is the rest of your hand. You can ignore the larger circle.

   Tip: *When you test finger tracking, always touch the glass firmly and confidently. Tracking errors can occur if you use soft or tentative finger gestures.*

2. The hollow circle quickly fills to solid green when the tracking engine confirms the touch event.



*Cell screens in fullscreen test mode. These examples show a finger touch event. The smaller green circles represent your fingertip (**a**); the larger green circles represent your hand (**b**).*

1 *New touch event detected. Green circles fill up while confirmation in progress.*

2 *Touch event confirmed. Green circles are full.*

3. When you move your finger or pen across the screen, the solid green circle tracks your movement.
4. If you lift your finger or pen from the screen and then re-touch it, a new touch event is generated and steps 1-3 are repeated.
5. *(For finger tracking only)* If you hover your finger 10 millimeters above the glass, no touch event is detected.

If touch tracking is *not* working correctly:

- A green circle is *not* displayed when you touch the screen, or the green circle intermittently disappears as you drag your finger or pen over the screen.
- *(For finger tracking only)* You may see a hollow green circle display before your finger touches the glass eg, while it is still 10 millimeters or more above the glass. Such errors are sometimes called 'false fingers' and can cause unintended zooming of the screen content.

4.2.2 What to look for: Marker tracking

This section describes how to assess whether touch tracking is working correctly *while the Cell is in fullscreen test mode*.

If touch tracking *is* working correctly:

When you repeatedly place a marker flat on the screen, the correct marker value is returned consistently. Likewise, the correct value is returned when you rotate the marker 45°.

If touch tracking is *not* working correctly:

The correct marker value is *not* returned consistently. You may need to adjust the marker tracking parameters or the problem may be caused by the material used for the marker.

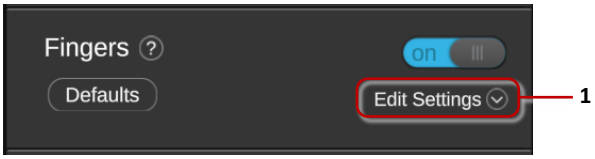
If the marker uses a black ink that reflects infrared light, the marker displays as a completely white square in fullscreen test mode because the black elements of the barcode are not detected. In this situation, you must change the material used for the printed markers.

4.3 How to fix the tracking parameters

Use the OSD to calibrate individual Cells, one at a time.

There are separate tracking parameters for different tracking features: fingers, markers and pens. The configuration procedure is the same in each case:

1. Confirm the Cell is running the latest firmware. You can use the OSD to update Cell firmware; see the *Cell User Manual* for details.
2. Display the OSD and tap the Calibration tab.
3. Go to the Fingers section.
4. By default, the tracking parameters are hidden. Tap the Edit Settings button to display the available parameters.



OSD Calibration tab, Fingers section. **1** *Edit Settings button.*

5. Adjust the parameters as required. For details, see:

   Finger tracking: section 11.1.

   Marker tracking: section 11.2.

   Pen tracking: section 11.3.

6. Tap the Save button to save the new tracking parameters.

   If you do not save, any changes to the tracking parameters will be lost when the tracking computer next restarts.

   Tip: *Scroll to the bottom of the Calibration tab to see the Save button.*

5 OSD: Color Calibration

After the touch calibration is complete (section 4), you can calibrate the video output to ensure that screen colors are accurate and consistent across all Cells. Your aim is to achieve the most even results across your video wall in terms of color, brightness and contrast.

5.1 FAQs

- **Is color calibration necessary?**

  Yes, if you require color accuracy and/or color consistency across your video wall.

  Under certain conditions, users can notice subtle color differences between Cells. In general, such differences are only noticeable if the screen content includes a large expanse of flat color that extends across adjacent screens. Such color differences are rarely noticeable in movies, images with color gradients, and images that do not extend beyond a single Cell.

  - If you value color consistency across your video wall, color calibration is a necessary part of your video wall setup.
  - If color accuracy is of critical importance for you (for example, if it is essential that product colors are rendered accurately on your video wall), then color calibration is an essential part of your video wall setup.
  - If color accuracy is desirable but not essential, or if you regard subtle color differences between Cells as unimportant, then you can omit color calibration from your video wall setup.

- **How often do I perform color calibration?**

  If color calibration is deemed necessary, you must color-calibrate your Cells after setting them up for the first time and at regular intervals thereafter (say, monthly).

- **Can I compare specific colors on my Cell screens?**

  Yes. We recommend you use Site Manager for this; see section 4.

  Using the OSD, you can display white, black, three shades of gray, and pure red, green or blue on individual Cell screens. However, a better solution is to use Site Manager, which allow you to display any color on multiple Cell screens at the same time.

- **Can I color-calibrate multiple Cells at the same time?**

  No. You can only color-calibrate Cells one at a time. This is true whether you use the OSD, Site Manager, or a colorimeter.

- **What special equipment do I need?**

  If you only need consistent colors across your video wall, you do not need special equipment. You can perform manual, comparison-based calibration.
  If you want accurate colors ie, you want to calibrate screen colors to match industry standards such as sRGB, NTSC, and AdobeRGB, you will need to use a colorimeter.

- **What are the requirements for color calibration?**

  - Allow your Cells to warm up. Make sure that your Cells have been powered up for at least 30 minutes prior to performing a color calibration.
  - Lighting conditions must be suitable. Ensure there is no direct light falling on your Cells.

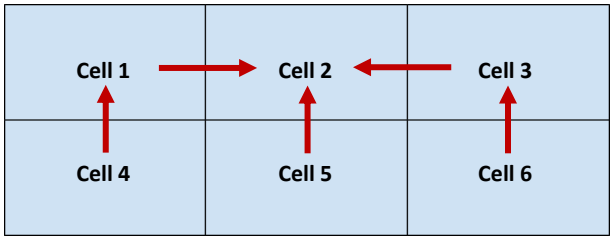
5.2 Color calibration methods

There are two broad approaches to color calibration.

5.2.1 Manual, comparison-based calibration

This is generally the fastest method for achieving satisfactory results. First, you choose a central Cell in your video wall as the reference Cell. You then calibrate the colors and, if required, the brightness and contrast of the adjacent Cells to match the reference Cell.

You systematically repeat this process, calibrating each Cell to match its immediate neighbor, until all Cells have video output that matches the original reference Cell.



Example video wall. Here, Cell 2 is the reference screen. First, you calibrate Cells 1 and 3 to match Cell 2. Then calibrate Cells 4, 5 and 6 to match Cells 1, 2 and 3 respectively.

5.2.2 Colorimeter-based calibration

As an alternative to manual calibration, you can use a colorimeter to calibrate screen colors for all Cells in your video wall to an industry standard.

In digital imaging, a colorimeter (or calibrator) is a portable device used for calibrating video output across multiple devices to achieve consistent colors and brightness. Colorimeters include a sensor and accompanying software to display color swatches on the screen of a video output device. The sensor rests flat on the device screen and measures the color swatches as they appear.

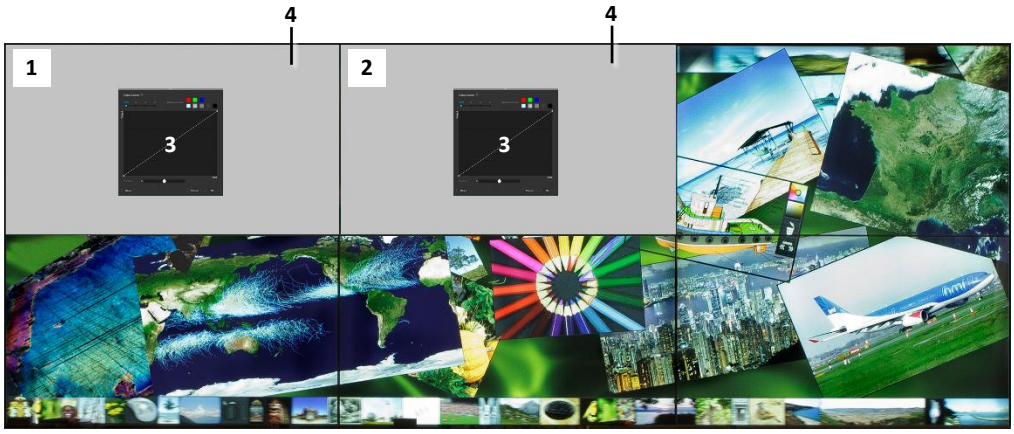
MultiTaction currently recommend X-Rite colorimeters, including the ColorMunki product range and particularly the i1Display Pro:
http://www.xrite.com/i1display-pro

Summary instructions for using the i1Display Pro colorimeter to calibrate Cell screens (with particular emphasis on Ubuntu application computers) are given in section 10.

5.3 How to calibrate colors

Use the OSD to color-calibrate individual Cells, one at a time.

Using the comparison-based calibration method in section 5.2.1, you display the Color Curve screen on two adjacent Cells, allowing a side-by-side comparison of the Cells' color output. If required, you can now make color corrections to the second Cell, adjusting its color output to visually match the first Cell. You then repeat the process for each Cell in the video wall. See the following sections for full instructions.



Example video wall with two adjacent Cells set up for color comparison and correction.

1 *Color Curve screen displayed on Cell 1.* **2** *Color Curve screen displayed on Cell 2. This is the reference Cell.* **3** *Color-correction dialog.* **4** *Background reference color.*

5.3.1 Compare Cell brightness

(This section is optional. You can omit this task if you are satisfied that all Cells in your video wall are displaying at the same level of brightness.)

Follow these steps:

1. On all Cells in your video wall, display the OSD and go to the Setup tab.
2. On all Cells, go to the Brightness slider in the Picture section; see the screenshot in section 5.3.2.
3. With all Cells in your video wall now displaying the same OSD screen, review your video wall:
   a. Identify the darkest Cell. This is your 'brightness reference Cell'.
   b. Confirm that the brightness of the reference Cell is 100%.

   Why set the darkest Cell to 100%? Because this approach ensures that all Cells in your video wall can be matched to the brightness of the darkest Cell. If you selected a brighter Cell as the reference Cell, you would be unable to raise the brightness enough on the darkest Cell to match the reference Cell.

   Tip: *Compare the white text in the OSD to identify differences in brightness across Cells in your video wall.*
4. If necessary, reduce the brightness of the other Cells to match the darkest Cell.

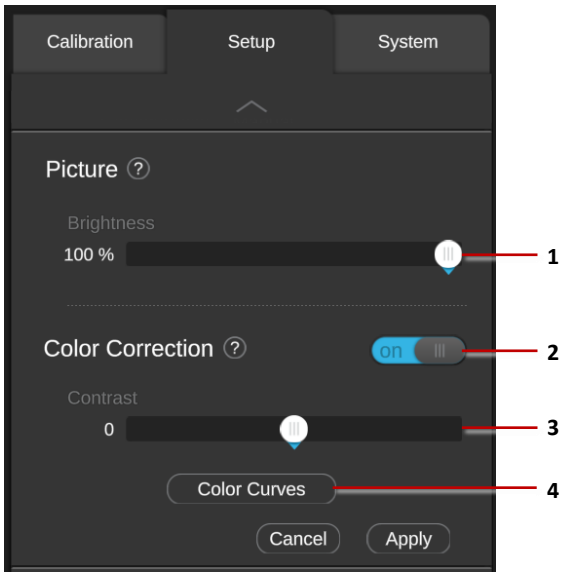
5.3.2 Prepare the Cells for side-by-side color comparison

Follow these steps on the reference Cell and the Cell you want to calibrate:

1. On both Cells, display the OSD and go to the Setup tab.
2. On both Cells, display the Color Curve screen:
   a. In the Setup tab, go to the Color Correction section.
   b. Set the Color Correction slider to On.
   c. Tap the Color Curves button to display the Color Curve screen.

   The Color Curve screen comprises a color curve dialog on a reference color background that fills the Cell screen; see the screenshot on page 25.

   Now compare and adjust the current Cell's color output to match the reference Cell.



OSD Setup tab, Picture and Color Correction sections. 1 *Brightness slider.* 2 *Color Correction slider.* 3 *Contrast slider.* 4 *Color Curves button.*

5.3.3 Compare and adjust a Cell's color output to match the reference Cell

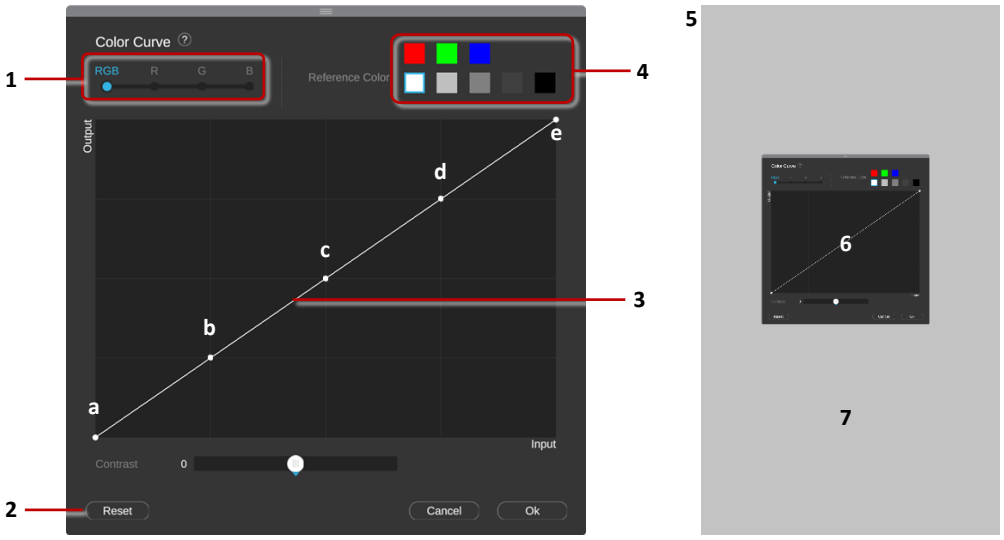
Use the Color Curve screen to systematically compare the reference colors on both Cells. If differences between Cells are visibly apparent, adjust the relevant color curve on the current Cell until the reference color matches the reference Cell.

Based on our experience in the field, we advise that you need only compare three or four reference colors, ranging from black down to light gray, to reveal any visible differences in color output between the Cells.

1. On both Cells, display the color curve screen; see section 5.3.2.
2. On both Cells, tap the *black* reference color swatch in the color curve dialog.

   The Cell's background color reference changes to black.
3. Compare the reference colors on the two Cells. If there is a visible difference:
   a. On the Cell you want to calibrate, select 'RGB' on the curve selector.
   b. Use your finger to adjust the slope of the curve by dragging upwards the point at the curve origin (point **a** in the screenshot below) until the black background matches the reference Cell.

      Why move the point at the curve's origin? Because only this point on the curve represents the pure black input color (ie, hex color #000000 or RGB (0,0,0).
   c. If you need to undo any curve changes, tap the Reset button.



Color curve dialog *Color curve screen*

1 *Curve selector: RGB, R, G, B.* **2** *Reset button.* **3** *Color-correction curve.* **4** *Reference color swatches.* **5** *Color curve screen showing color curve dialog (**6**) on reference color background (**7**).*

Adjustment points on color curve:

a *Adjust this point to compare black output.*

b *Add and adjust this point to compare dark gray output.*

c *Add and adjust this point to compare mid gray output.*

d *Add and adjust this point to compare light gray output.*

e *Adjustments to this point affect white output. Differences in white output are more easily corrected by adjusting the Cell brightness; see section 5.3.1.*

For help with this dialog, see section 5.4.

4. Repeat steps 2 and 3 for the *dark gray* reference color. But this time if there is a visible difference between the two reference colors:
    a. Use your finger to add a new point on the curve at the first vertical axis (point **b** in the screenshot on page 25).
    b. Drag this new point up or down to change the shape of the curve until the dark gray background matches the reference Cell.
5. Repeat steps 2 and 3 for the *mid gray* reference color. If there is a visible difference between the two reference colors:
    a. Use your finger to add a new point on the curve at the middle vertical axis (point **c** in the screenshot on page 25).
    b. Drag this new point up or down to change the shape of the curve until the mid gray background matches the reference Cell.
6. Repeat steps 2 and 3 for the *light gray* reference color. But this time if there is a visible difference between the two reference colors:
    c. Use your finger to add a new point on the curve at the third vertical axis (point **d** in the screenshot on page 25).
    d. Drag this new point up or down to change the shape of the curve until the light gray background matches the reference Cell.
7. Systematically repeat steps 1 through 6 for each Cell in your video wall, calibrating the Cell to match its immediate neighbour.

Tip: *You do not need to compare the red, green and blue reference colors. These 'pure' colors are unlikely to reveal any differences in screen color output. If you want to compare a specific color, use Site Manager. Its Solid Color feature allows you to display and compare specific RGB values on multiple Cell screens at the same time; see section 4 for details.*

5.4 About the Color Curves dialog

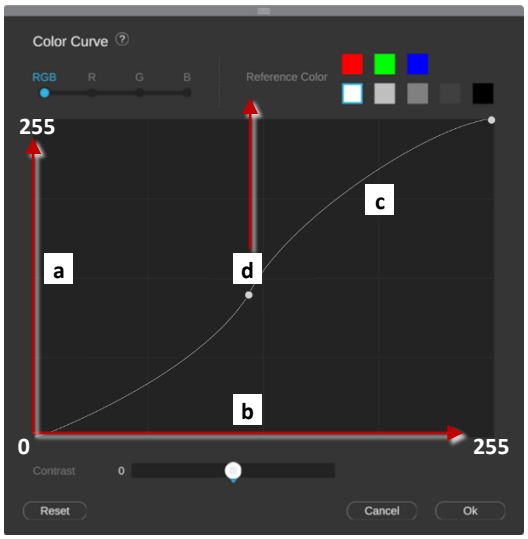
The Color Curves dialog shows a graph of color-correction curves:

- **The horizontal axis** represents the tonal range of input colors ie, colors transmitted to the Cell from the application computer's GPU. The axis ranges from the least intense tones (ie, black) on the left to the most intense tones (ie, white, or pure red, green or blue) on the right.
- **The vertical axis** represents the tonal range of output colors ie, the Cell's (adjusted) output colors that display on the screen. The axis ranges from the least intense tones (ie, black) at the bottom to the most intense tones (ie, white, or pure red, green or blue) at the top.
- **A curve** represents the output adjustments, if any, applied to the tonal range of a color input.

  There are curves for each color channel (red, green, and blue) plus an RGB composite channel. You use the RGB curve to adjust the red, green and blue channels simultaneously.

  When you adjust the shape of a curve, you effectively change how the Cell adjusts output colors for a given input color. For example, if you steepen part of the RGB composite curve, you instruct the Cell to adjust tones in the steeper range to appear lighter on the Cell screen.

  A straight diagonal line through the graph origin (ie, the zero point of the curve) indicates that no adjustments will be applied to an input color ie, color tones are reproduced on the Cell screen exactly as they are received from the GPU.



Color curve dialog

a *Output axis.* **b** *Input axis. Values on both axes range from 0 to 255.* ***c*** *Color-correction curve.*

d *Tap the curve to add points. Drag points upwards and off the graph to remove them.*

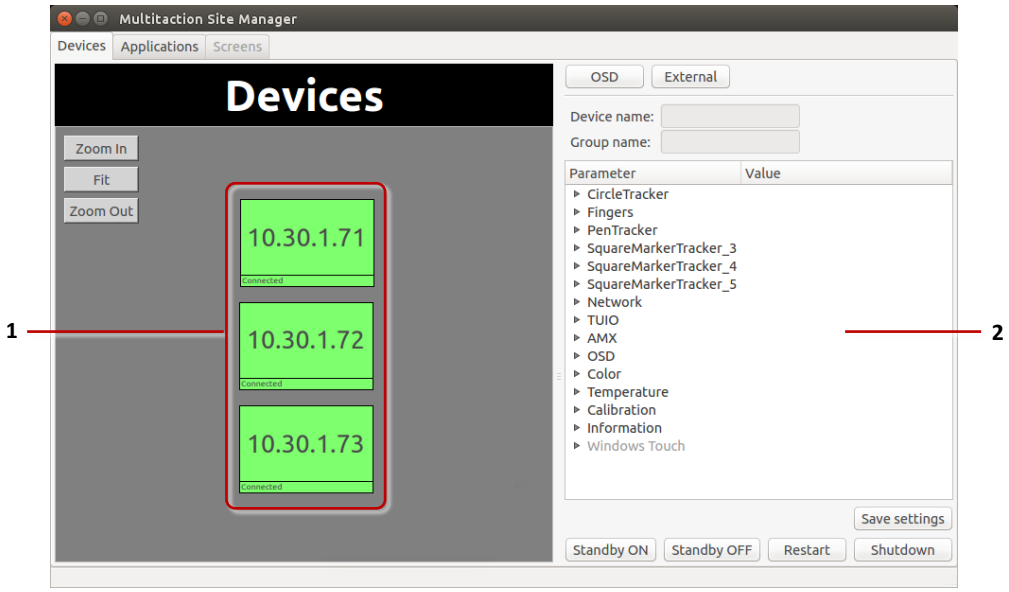
6 Site Manager: Getting Started

Site Manager is a Cornerstone application for remote management of MultiTaction Cells. You can use Site Manager to quickly edit tracking parameters and perform color calibration.

Using Site Manager on your laptop, you can configure an individual Cell or you can roll out configuration changes to multiple Cells at the same time. For example, if you need to change the marker size from 4x4 to 5x5, Site Manager enables you to update all the Cells in your video wall simultaneously.

This section provides summary instructions for using Site Manager to calibrate your Cells. Full documentation for Site Manager is available at https://cornerstone.multitouch.fi/application.

Terminology: *For simplicity, the instructions below refer to 'your laptop' when describing the computer that runs Site Manager. Although this computer is generally a laptop, you can run Site Manager on any device that supports Cornerstone (Ubuntu, Windows or OS X) and which is on the same network as the Cells. Such devices include tablets and desktop computers.*



*MultiTaction Site Manager (Ubuntu version). In this example, three Cells (**1**) are available for remote management. Cell parameters (**2**) can be configured from a laptop.*

6.1 Set up Site Manager

Cell calibration in Site Manager involves the following steps:

1. Set up Site Manager on your laptop.

   Confirm that the Cornerstone runtime or Cornerstone SDK is already installed on your laptop and that your laptop is connected to the same network as your Cells.

   Site Manager is included in the Cornerstone runtime and SDK. For Cornerstone installation instructions, see the *Cell User Manual*.

2. *(Optional)* If you want to use Site Manager to manage Cornerstone applications running on your Cells, you must explicitly enable Site Manager support. If you only want to use Site Manager to configure your MultiTaction Cells, you can skip this step.

   a. Site Manager can only be used to manage Cornerstone applications if a Cornerstone application is running on the application computer. Any Cornerstone application can be used. However, Cornerstone applications do not automatically accept Site Manager connections. Instead, you must explicitly enable support for Site Manager.

   b. To enable support for Site Manager, pass the following parameter to the Cornerstone application when it starts:
   `--enable-site-manager`
   For details about running Cornerstone applications, see the *Cell User Manual* or the online Cornerstone documentation at:
   https://cornerstone.multitouch.fi/application.

3. Launch Site Manager. To do this, double-click the Site Manager icon in the file manager or run the following commands:

   Windows

   ```
   cd C:\Cornerstone-x.y.z\bin
   SiteManager.exe
   ```

   Linux `/opt/cornerstone-x.y.z/bin/SiteManager`

   OS X `/opt/cornerstone-x.y.z/bin/SiteManager.app/Contents/MacOS/SiteManager`

   Where `x.y.z` refers to your Cornerstone version such as 2.0.0.

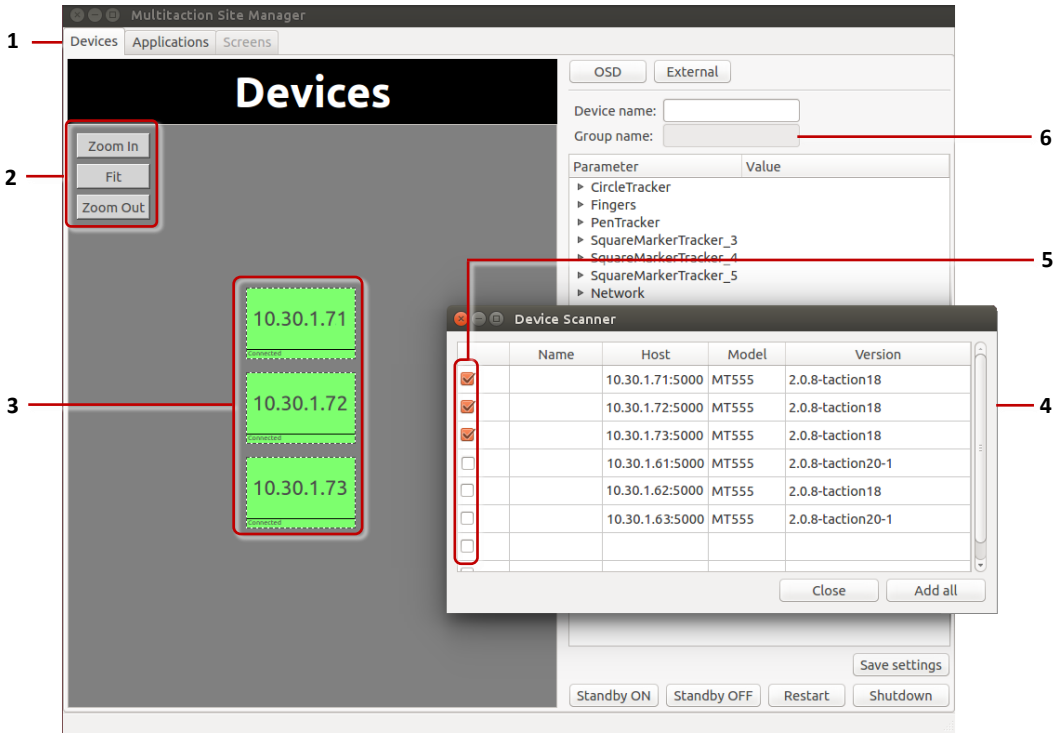
6.2 Add the Cells you want to manage

To manage Cells remotely, you must first add them into Site Manager by scanning your network for MultiTaction devices. Then you must ensure that these Cells are running the latest firmware.

1. Launch Site Manager and go to the Devices tab.
2. Right-click anywhere in the left-hand pane and select Scan.
3. Wait while Site Manager scans the network and detects available devices.

   Detected devices are listed in Device Scanner dialog. Devices are identified by their assigned name (if they have one) and IP address.
4. In the Device Scanner dialog, select the check boxes for the Cells you want to configure.
5. Close the Device Scanner dialog.

   The Cells you selected are shown in the left-hand pane and are available for remote management.



Site Manager, Device Scanner dialog. **1** *Devices tab.* **2** *Zoom buttons.* **3** *Cells available for remote management.* **4** *Device Scanner dialog.* **5** *Device check boxes.* **6** *Group name box.*

6. *(Optional)* Click the zoom buttons as required to change the display in the left-hand pane.

   For example, click the Fit button to automatically zoom the display so that all Cells are visible in the left-hand pane.

7. *(Optional)* For easier device management, you can organize Cells into groups:

   a. Select the Cells in the left-hand pane.

      Tip: *To select multiple Cells, hold down the Shift key and click each Cell you want.*

   b. Right-click one of the Cells and choose Group Devices.

   c. Enter a group name, for example, Lobby Video Wall.

   Now when you apply a configuration change to any Cell in the group, the change is applied automatically applied to all Cells in the group.

   To remove a group, right-click one of the Cells in the group and choose Ungroup Devices.

8. Confirm the Cells are running the latest firmware. To do this, right-click the left-hand pane and select Firmware Updates

   MultiTouch releases firmware updates for MultiTaction devices to improve tracking quality and other functions. You can use Site Manager to check for firmware updates and apply the updates to selected Cells.

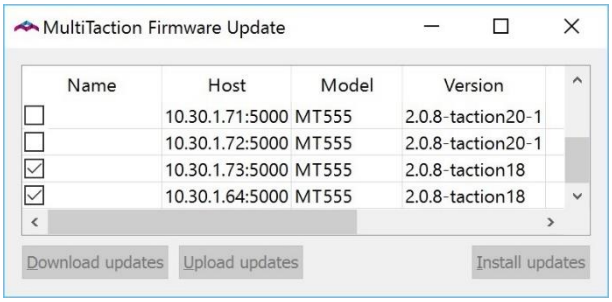
9. In the Firmware Update dialog, the Version and Status columns indicate whether a Cell requires an update.

   a. Select the check boxes for the Cells you want to update.

   b. Click the Download Updates button to download the latest firmware to Site Manager.

   c. Click the Upload Updates button to upload the latest firmware to each selected Cell.

   d. Click the Install Updates button to install the latest firmware on each selected Cell.



Firmware Update dialog (Windows version)

You can now configure your Cells remotely from your laptop.

7 Site Manager: Geometry Calibration

You can use Site Manager to start a geometry calibration on individual Cells. You may want to do this because, unlike the OSD, the Site Manager screen indicates when a calibration is running and, by implication, when it has finished.

7.1 FAQs

For touch calibration FAQs, see section 2.1.

7.2 How to test the geometry calibration

Although you can *perform* a geometry calibration in Site Manager, you cannot *test* the geometry calibration using Site Manager. For testing, you must use the OSD; see section 2.3.

7.3 How to perform a geometry calibration

Site Manager enables to perform geometry calibrations on specific Cells. Although

it is possible to launch geometry calibrations on multiple Cells at the same time from Site Manager, it is not usually practical to do so. This is because the calibration process requires you to physically attach the supplied calibration sheet to each Cell screen for the duration of the process. This requirement generally precludes bulk geometry calibration operations.

Follow these steps:

1. Ensure that you know the name or IP address of the Cell you want to calibrate.

   You will need these details when you start the geometry calibration in Site Manager.

2. Place the white calibration sheet on top of the screen of the Cell you want to calibrate.

   You must get the calibration sheet into position now because you will not have a chance to do so after you start the geometry calibration in Site Manager.

   Tip: *Minimize light leakage onto the screen by taping the calibration sheet firmly in place on the Cell screen. Use a good quality paper tape that adheres well but leaves minimal adhesive residue when removed.*

3. Launch Site Manager and go to the Devices tab.

4. In the left-hand pane, select the Cell you want to calibrate.

   Note: *If you select a Cell that is a member of a group, all Cells in the group are selected automatically. Because geometry calibrations are generally only performed on one Cell at a time, you may need to ungroup Cells before you proceed with the geometry calibration; see step 7 in section 6.2.*

5. Expand the Calibration parameter group in the right-hand pane.

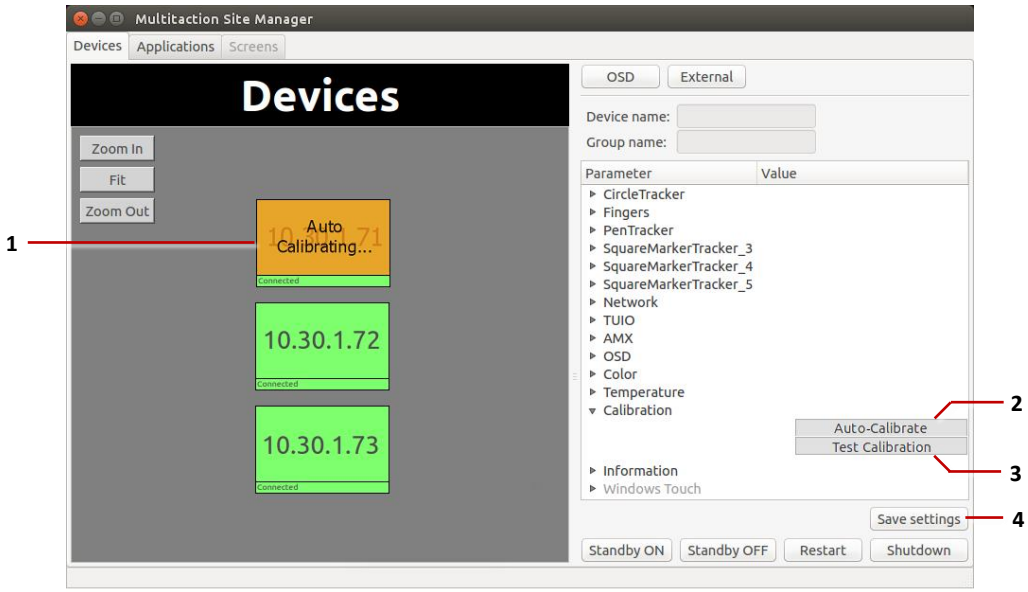
6. Click the Auto-Calibrate button to start the calibration.

   In the left-hand pane, the Cell being calibrated changes color to orange and displays an ‘Auto Calibrating…’ status message while the calibration is running.

7. Wait up to five minutes for the calibration to complete.

   You will know when the calibration has completed because, in the left-hand pane, the Cell color reverts to green and the 'Auto Calibrating…' message disappears. A beep also indicates when the calibration has completed.

   Note: *Some MT553UTB models do not support 'calibration complete' beeps.*



Site Manager, Devices tab. 1 *The Cell being calibrated is orange while the geometry calibration is running.* 2 *Auto-Calibrate button.* 3 *Test Calibration button.* 4 *Save settings button.*

8. You now need to test the geometry calibration.

   Although you can *perform* a geometry calibration in Site Manager, you cannot *test* the geometry calibration using Site Manager. For testing, you must use the OSD; see section 2.3.

9. If you are satisfied with the geometry calibration results, tap the Save settings button. Otherwise, re-run the calibration.

8 Site Manager: Touch Calibration

8.1 FAQs

For touch calibration FAQs, see section 4.1.

8.2 How to fix the tracking parameters

In Site Manager, the Devices tab includes features for editing tracking parameters on selected Cells. Follow these steps:

1. Launch Site Manager and go to the Devices tab; see the screenshot below.
2. In the left-hand pane, select the Cells you want to configure.

   Tip: *If you select a Cell that is a member of a group (see step 7 in section 6.2), all Cells in the group are selected automatically.*
3. Available Cell parameters are listed in the right-hand pane. Expand the parameter group you want and specify the parameter values.

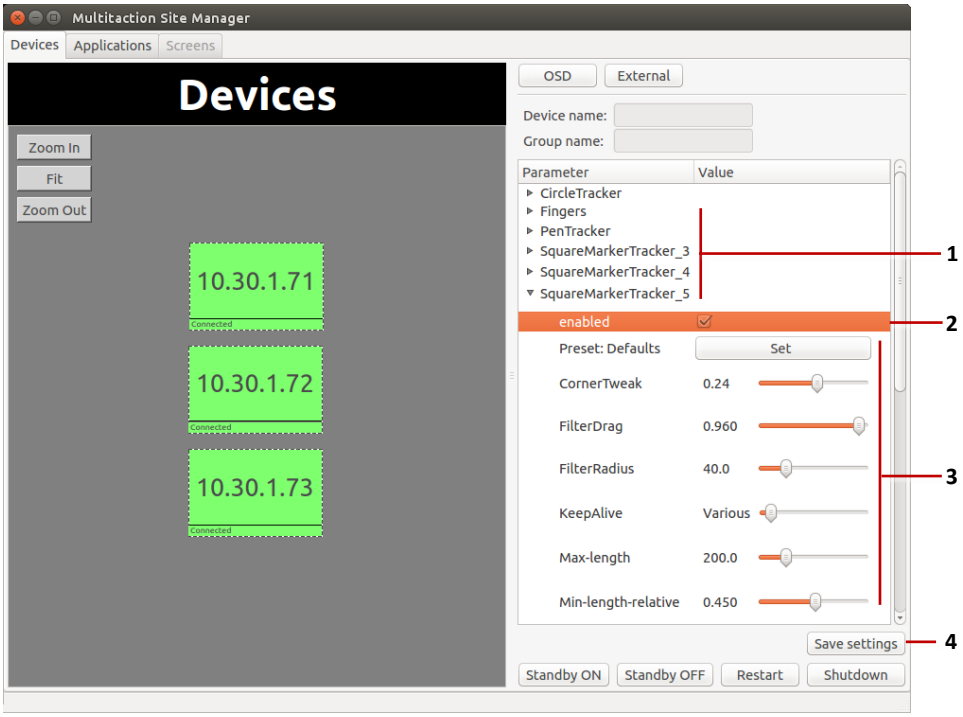
   For example, to adjust the marker size to 5x5 across all Cells in your video wall, expand the **SquareMarkerTracker_5** group and select the 'enabled' check box. (When this check box is selected, it automatically disables the corresponding check boxes for 3x3 or 4x4 markers.)

   For specific parameter fixes, see:

   Finger tracking: section 11.1.

   Marker tracking: section 11.2.

   Pen tracking: section 11.3.



Site Manager, Devices tab. **1** *Tracking parameters for fingers, pens and markers.* **2** *'enabled' check box for 5x5 markers.* **3** *Parameters for 5x5 markers.* **4** *Save settings button.*

4. Click the Save Settings button.

   If you do not save, any changes to the tracking parameters will be lost when the Cell's internal computer next restarts.

Now test the touch tracking; see the next section.

8.3 How to test touch tracking

You can use Site Manager to confirm that touch tracking is correctly calibrated on a Cell. You do this by displaying the Cell in 'fullscreen test mode' and touching random points across the screen with your finger, a marker, and an infrared pen.

To test whether touch tracking is performing correctly:

1. Launch Site Manager and go to the Devices tab.
2. In the left-hand pane, select the Cell you want to test.

   Note: *If you select a Cell that is a member of a group, all Cells in the group are selected automatically.*

3. Expand the Calibration parameter group in the right-hand pane.
4. Tap the Test Calibration button; see the screenshot on page 33.
5. Drag your finger, marker or pen across the camera matrix to confirm that touch and drag events are correctly detected across the entire Cell screen. For details of how to test, see step 3 in section 4.2.

   For details of what to look for when testing, see section 4.2.1 and section 4.2.2.

9 Site Manager: Color Calibration

9.1 FAQs

For color calibration FAQs, see section 5.1.

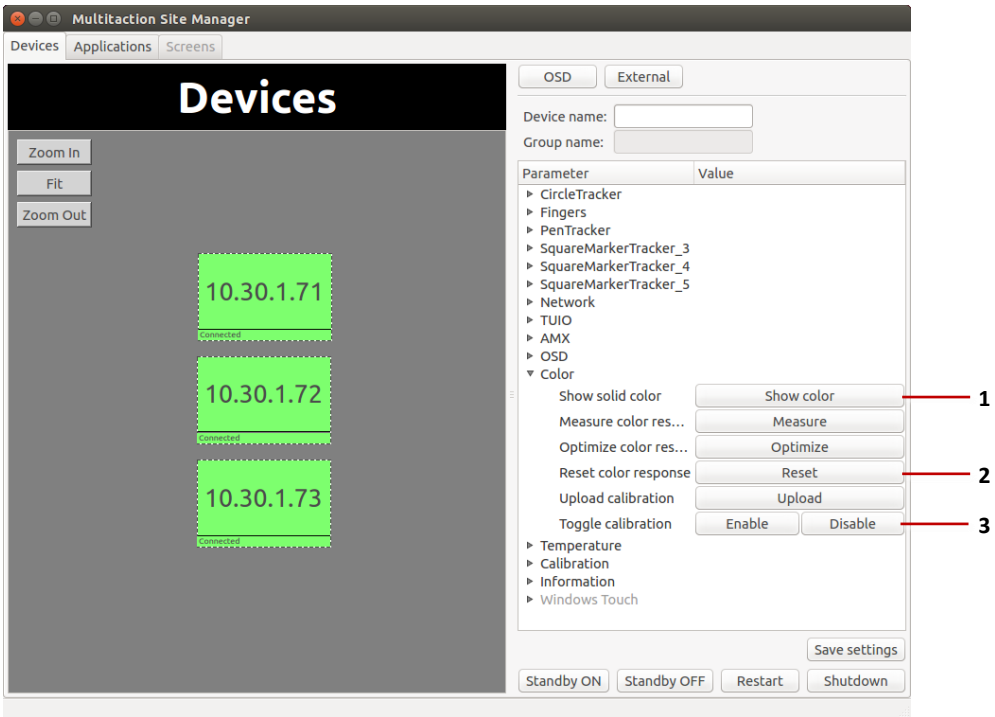
9.2 How to compare specific colors across multiple Cell screens

Site Manager can help you perform manual, comparison-based color calibration (see section 5.2.1) of your video wall. Specifically, the Show Solid Color feature enables you to display solid blocks of specific RGB colors on multiple Cell screens simultaneously. This allows you to identify at a glance which Cells require color calibration.

Follow these steps:

1. Launch Site Manager and go to the Devices tab.
2. In the left-hand pane, select the Cells you want to compare.

   Tip: *If you select a Cell that is a member of a group (see step 7 in section 6.2), all Cells in the group are selected automatically.*
3. Expand the Color parameter group in the right-hand pane.



Site Manager, Devices tab. 1 *Show Solid Color button.* 2 *Reset Color Response button.* 3 *Toggle Calibration buttons, Enable and Disable.*

4. Click the Show Solid Color button. This displays the Select Color dialog.

5. In the Select Color dialog, choose the color you want to display:

   Basic colors: You can choose from 48 predefined basic colors. Click a basic color swatch then click OK.

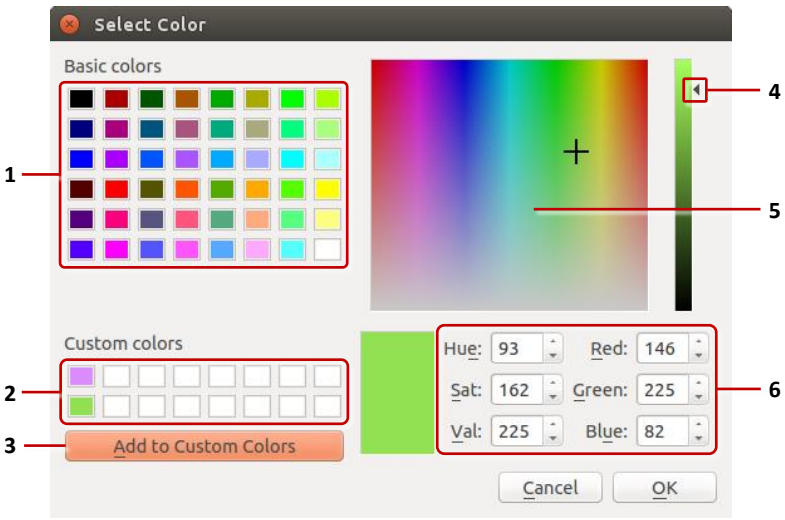
   Custom colors: If you want to compare a specific color across your Cells:

   a. Click the color you want in the Colors rectangle. Then, if required, drag the luminosity marker up or down to adjust the lightness.

      Or you can specify the HSV or RGB values directly.

   b. Click the Add to Custom Colors button.

   c. Click the new custom color swatch then click OK.



Select Color dialog. 1 *Basic color swatches.* 2 *Custom color swatches.* 3 *Add to Custom Colors button.* 4 *Luminosity marker.* 5 *Colors rectangle.* 6 *HSV and RGB values for custom colors.*

6. You can now visually compare how the color displays on the Cell screens.

   If any Cells require a color adjustment, make a note of whether the displayed color needs to be lighter or darker. Then open the OSD Color Curves screen on the affected Cell and adjust the color correction curves accordingly; see section 5.3.

Example video wall. 1 *Displaying external source video content.* 2 *Displaying the solid color specified in Site Manager. In this example, the color output of the lower left Cell* (3) *is lighter than the other Cells and requires calibration.*

10 Argyll CMS: Color Calibration

This section provides summary instructions for using Argyll CMS to color calibrate a MultiTaction video wall with an Ubuntu application computer.

10.1 About Argyll CMS

Argyll CMS is an open source color management system developed by Graeme Gill. It comprises a suite of display calibration and profiling tools for Windows, OS X and Linux systems. For more details, see www.argyllcms.com.

The color calibration process for MultiTaction Cells uses two Argyll CMS tools:

- dispcal generates ICC profiles for given calibration target information.
- dispwin sets video LUTs and installs or clears ICC profiles.

Note: *Argyll CMS does not have a graphical user interface. Its functionality can be accessed through GUI wrappers such as DisplayCAL, but the following sections do not use a GUI wrapper and instead describe command line operations.*

10.2 Install Argyll CMS

MultiTaction provides its own version of Argyll CMS. The MultiTaction version has an installation package named multitouch-argyll.

Run the following command to install the latest MultiTaction version of Argyll CMS:

```
sudo apt-get install multitouch-argyll
```

Note the following issues:

- **Do not confuse the multitouch-argyll and argyll installation packages!**
  The multitouch-argyll package installs the MultiTaction version of Argyll CMS. This version is *not* included in the Ubuntu PATH variable.

  The argyll package installs a standard version of Argyll CMS. When installed from Ubuntu, it *is* included in the PATH variable. This older version of Argyll CMS may already be present on your application computer.

  When you run the `install` command above, it updates any existing version of multitouch-argyll already installed. However, it will *not* update the argyll package.

- **You must use multitouch-argyll version 1.9.2 or newer.**
  The current multitouch-argyll package installs Argyll CMS 1.9.2, which is newer than the default version of Argyll CMS installed by the argyll package from Ubuntu.

  Version 1.9.2 supports the X-Rite i1Display Pro colorimeter. Earlier versions do not support this colorimeter.

- **You must specify the full path to multitouch-argyll tools**
  The multitouch-argyll package installs dispcal and dispwin to /opt/multitouch-argyll/bin.

  Because multitouch-argyll is not included in PATH, you must *specify* the full path to dispcal and dispwin when running calibration commands. This ensures you use the multitouch-argyll version of these tools.

  Conversely, the argyll package *is* included in PATH, so if you omit the full path in dispcal and dispwin commands, you will run the argyll version of these tools.

10.3 List the available Cells

dispcal and dispwin commands require you to specify which Cell is being operated on. Run the following command to list the discovered Cells:

```
/opt/multitouch-argyll/bin/dispwin -help
```

For example:

```
1 = 'Screen 1, Output DVI-I-1 at 2180, 0, width 1080, height 1920'
2 = 'Screen 2, Output DP-1 at 0, 0, width 1080, height 1920'
3 = 'Screen 3, Output DP-2 at 1090, 0, width 1080, height 1920
```

10.4 Color calibrate a Cell

This section describes how to use Argyll CMS tools in conjunction with an X-Rite i1Display Pro colorimeter to color calibrate a MultiTaction video wall.

Briefly, the color calibration process involves the following steps:

1. Clear any existing color profiles. See section 10.4.1.
2. Create a folder to store the ICC profiles that you will generate during the calibration process. See section 10.4.2.
3. Attach the colorimeter to the application computer. See section 10.4.3.
4. Generate the ICC profiles for each Cell in your video wall. To do this, you run a series of dispcal commands. See section 10.4.4 and section 10.4.5.

   Note: *At low quality calibration (recommended), this step takes around 8 minutes per Cell.*
5. Manually load the new ICC profiles. To do this, you run a series of dispwin commands. See section 10.4.6
6. Automatically load the new ICC profiles when the application computer restarts. See section 10.4.7.

10.4.1 Clear any existing color profiles

First, you must always clear any existing color calibration profiles before trying to calibrate a Cell.

Follow these steps:

1. Right-click the desktop on the application computer and launch a terminal emulator.
2. Run the following dispwin command for each Cell in your video wall. This command overwrites any existing profile and loads a linear set of Video LUT curves ie, resets the GPU color correction curves to diagonal straight lines:

   ```
   /opt/multitouch-argyll/bin/dispwin -d<n> -c
   ```

   Where

   `-d<n>` identifies the Cell. It is the Cell number returned in section 10.3.

   `-c` loads a linear set of Video LUT curves.

For example, run these three commands to clear any existing color profiles for the three-Cell MultiTaction Meeting Room solution:

```
/opt/multitouch-argyll/bin/dispwin -d1 -c
/opt/multitouch-argyll/bin/dispwin -d2 -c
/opt/multitouch-argyll/bin/dispwin -d3 -c
```

Note: *If you see a "VideoLUT is not accessible" message, make sure that Xinerama is not enabled in X11. (Xinerama is an X11 extension that enables X applications and window managers to use multiple physical displays as a single large virtual display.)*

Now create a folder for the generated ICC profiles; see the next section.

10.4.2 Create a folder for the generated ICC profiles

By default, Argyll CMS outputs the ICC profiles into /opt/multitouch/bin. However, this is a shared system folder so the current user does not have Write permission to this folder. You must therefore customize the calibration process to output the ICC profiles into a folder that the current user can write to.

If the current user is multi, we recommend that you create the following folder:
/home/multi/.config/color

For example:

1. Right-click the desktop on the application computer and launch a terminal emulator.
2. If the current directory is /home/multi, run these commands:
   ```
   cd .config
   mkdir color
   ```

Now attach the colorimeter to the application computer; see the next section.

10.4.3 Attach the i1Display Pro colorimeter

This section refers to the X-Rite i1Display Pro colorimeter. For full i1Display Pro instructions, please refer to the X-Rite documentation: http://www.xrite.com/i1display-pro/support

Follow these steps:

1. Connect the i1Display Pro colorimeter to a USB port on the application computer.
2. Mount the i1Display Pro colorimeter on the screen of the first Cell in your video wall. Use the counter-weight to ensure the colorimeter is flush on the Cell screen.

1 i1Display Pro colorimeter

2 Colorimeter in position on Cell screen

Now generate the ICC profiles; see the next section.

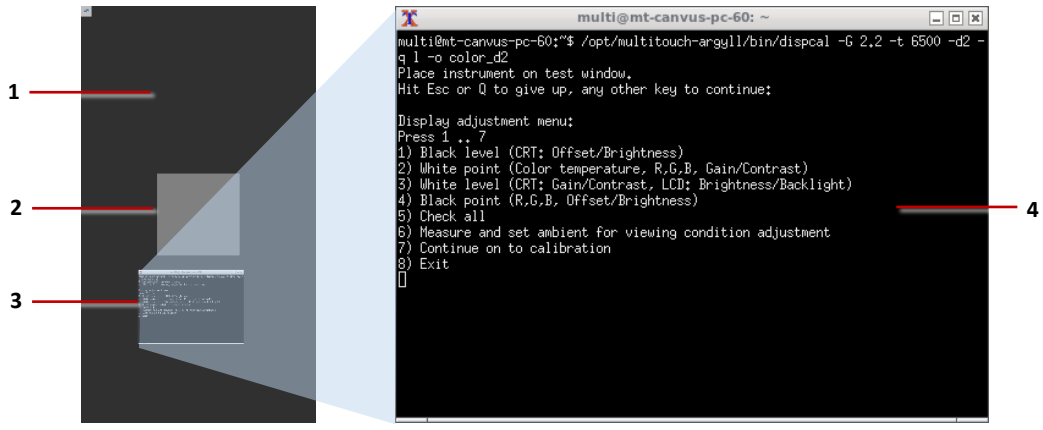
10.4.4 Generate the ICC profiles

dispcal generates ICC profiles for specified calibration target information. You must run dispcal to generate ICC profiles for the Cells in your video wall.

Note: *At low quality calibration (recommended), this step takes around 8 minutes per Cell.*

Follow these steps:

1. Right-click the desktop on the application computer and launch a terminal emulator.
2. To simplify the dispcal command in step, change to the /color folder you created in section 10.4.2.
   For example, if the current directory is /home/multi/.config, run this command:
   `cd color`
3. Run the following dispcal command to color calibrate a Cell to an external color target and generate an ICC profile:
   `/opt/multitouch-argyll/bin/dispcal <parameters>`
   Make sure you specify the Cell that has the i1Display Pro attached. For details about the required parameters, see section 10.4.5.
4. dispcal is a command line tool. When it starts, it displays the color measuring square on the Cell screen and then prompts for inputs.
   a. When prompted, position on the i1Display Pro colorimeter on the measuring square. Then press any key to continue (except Q or Esc).
   b. In the Display adjustment menu, press 7 to choose 'Continue on to calibration'.



Calibration in progress. **1** *Cell desktop.* **2** *Color measuring square.* **3** *dispcal prompts, including display adjustment menu (***4***).*

5. Generate ICC profiles for the remaining Cells in your video wall. For each Cell:
   a. Attach the i1Display Pro colorimeter to the Cell screen.
   b. Re-run steps 3 and 4.

Now install the ICC profiles to the Cells in your video wall; see section 10.4.6.

10.4.5 `dispcal` parameters

Use the following parameters with dispcal to generate an ICC profile:

```
dispcal [-P 0.25,0.5,1.0] -G 2.2 -t 6500 -d<n> -q l -o color_d<n>
```

Where:

`[-P 0.25,0.5,1.0]` optionally adjusts the position of the color measuring spot on the Cell screen. (The three values represent x, y, scale; the default values are 0.5, 0.5, 1.0.)

If it is used, the `-P` parameter ***must be first*** in the parameter list.

`-G 2.2` specifies the calibration uses gamma 2.2.

`-t 6500` specifies the calibration uses a white daylight locus target at 6500K (otherwise known as Standard Illuminant D65 or D_{65}).

For details about Illuminant D65, we recommend the Wikipedia article https://en.wikipedia.org/wiki/Illuminant_D65.

`-d<n>` identifies the Cell that the i1Display Pro colorimeter is currently attached to. For example, if the i1Display Pro is attached to Cell 2, use `-d2`.

Cell numbers are described in section 10.3.

`-q l` specifies low quality calibration.

Our testing revealed no perceptible difference between low and medium quality calibration. However, medium quality calibration took significantly longer to complete.

Note that very low quality calibration (`-q v`) produced very poor results, with significant color offset in blacks.

`-o color_d<n>` generates an *ICC profile* file (.icc) and an *output calibration* file (.cal). Both files use `color_d<n>` for the filename stem. For example, color_d1.icc and color_d1.cal. Note that you will only use the ICC profile.

Important! *Verify that the user running the dispcal command has Write permissions for the generated ICC profile and output calibration file.*

For example, run these three commands to calibrate the three Cells in a MultiTaction Meeting Room solution:

```
/opt/multitouch-argyll/bin/dispcal -G 2.2 -t 6500 -d1 -q l -o color_d1
/opt/multitouch-argyll/bin/dispcal -G 2.2 -t 6500 -d2 -q l -o color_d2
/opt/multitouch-argyll/bin/dispcal -G 2.2 -t 6500 -d3 -q l -o color_d3
```

Note: *For optimal results, we could measure the minimum and maximum brightness obtainable on each Cell and specify then these as requirements for the target (using `-b` and `-B` arguments). However, we generally don't do this because it is unlikely to affect the calibration results unless there is significant variance in Cell brightness.*

10.4.6 Manually load the ICC profiles

You must now run dispwin to install the ICC profiles generated in the previous section.

Follow these steps:

1. Right-click the desktop on the application computer and launch a terminal emulator.
2. Ensure that you are in the folder created in section 10.4.2.

   For example, /home/multi/.config/color.

3. For each Cell in your video wall, run this dispwin command to load the new ICC profile:
   `/opt/multitouch-argyll/bin/dispwin -d<n> color_d<n>.icc`
   Where:
   `-d<n>` identifies the Cell. It is the Cell number returned in section 10.3.
   `-color_d<n>.icc` is the ICC profile generated in section 10.4.4.

For example, run these three commands to calibrate the three Cells in a MultiTaction Meeting Room solution:

```
/opt/multitouch-argyll/bin/dispwin -d1 color_d1.icc
/opt/multitouch-argyll/bin/dispwin -d2 color_d2.icc
/opt/multitouch-argyll/bin/dispwin -d3 color_d3.icc
```

Now edit the autostart script to ensure that the ICC profiles are loaded automatically when the application computer restarts; see the next section.

10.4.7 Automatically load the ICC profiles

ICC profiles do not persist when the application computer shuts down. The ICC profiles must be reloaded every time the application computer restarts. You can automatically reload the ICC profiles by using use the Openbox autostart script.

Note: *Openbox is the default window manager on Linux video walls.*

Follow these steps:

1. Right-click the desktop on the application computer and launch a terminal emulator.
2. Create an Openbox autostart script in this location:
   `/home/multi/.config/openbox/autostart`
3. Add commands to load the ICC profiles into this script:
   `/opt/multitouch-argyll/bin/dispwin -d<n> <path>/color_d<n>.icc`
   Where:
   `-d<n>` identifies the Cell. It is the Cell number returned in section 10.3.
   `<path>` is the path to the folder containing the ICC profiles.
   `-color_d<n>.icc` is the ICC profile.

   For example, if the ICC profiles are in /home/multi/.config/color, add these three lines to automatically load profiles for the three Cells in a MultiTaction Meeting Room solution:.

```
/opt/multitouch-argyll/bin/dispwin -d1 /home/multi/.config/color/color_d1.icc
/opt/multitouch-argyll/bin/dispwin -d2 /home/multi/.config/color/color_d2.icc
/opt/multitouch-argyll/bin/dispwin -d3 /home/multi/.config/color/color_d3.icc
```

4. Run this command to make the autostart script executable:
   `chmod +x /home/multi/.config/openbox/autostart`
5. Restart the application computer.
6. When the application computer restarts, confirm that the ICC profiles have been loaded automatically. To do this, visually compare the screen colors with and without the ICC profiles:
   a. Check the screen colors now. The ICC profiles were loaded automatically when the application computer restarted.
   b. Clear the ICC profiles (see section 10.4.1) and check the screen colors again.
   c. If you are satisfied that autostart is loading the ICC profiles correctly, you can now reload the ICC profiles. Either restart the application computer or manually run autostart:
      `/home/multi/.config/openbox/autostart`

11 Fixes for Touch Calibration

You can use the OSD or Site Manager to fine-tune tracking parameters on your Cells.

Note: *The following sections refer to parameters by their names in the OSD. The equivalent parameter names in Site Manager are indicated where necessary. For a summary of parameter name differences in the OSD and Site Manager, see section 11.4.*

11.1 Fixes for finger tracking

Most finger tracking problems can be fixed by adjusting the following tracking parameters.

11.1.1 Finger tracking parameters

Because environmental conditions can vary so much (for example, temperature and ambient infrared light), you often need to experiment with parameter settings by trial and error, raising or lowering parameter values until you find a fix for tracking problems.

1. **Minimum brightness** (or **lumi-limit** in Site Manager) is the most important parameter for finger detection sensitivity. Try adjusting this parameter first.

   Minimum brightness defines how bright finger tips are expected to be. Lower this value to make tracking more sensitive; raise this value to make tracking less sensitive.

   If false touches occur when a finger hovers several millimeters above the glass, try raising this value to 0.130. This usually enables touch detection when a fingertip is 2mm above the glass.

2. **Minimum contrast** (or **edge-limit** in Site Manager) is the second most important parameter for finger tracking. If adjustments to minimum brightness do not fix your tracking problems, try adjusting the minimum contrast.

   Minimum contrast defines the 'brightness gradient' ie, how bright a fingertip should be compared to its immediate surroundings. Lower this value to make tracking more sensitive; raise this value to make tracking less sensitive.

   If false touches occur, try raising the minimum contrast until there are no false touches but true touches are still reliably detected.

3. **Detection radius** (or simply **radius** in Site Manager) is the third most important parameter for finger tracking. If adjustments to minimum brightness and minimum contrast do not fix your tracking problems, try adjusting the detection radius.

   The detection radius defines the expected radius of a fingertip, measured in camera pixels. Smaller values imply a user has smaller fingers; larger values imply larger fingers. Lower this value to make tracking more sensitive; raise this value to make tracking less sensitive.

   If false touches occur, try raising the detection radius until there are no false touches but true touches are still reliably detected. Remember to test with users who have small hands, especially if children are expected to use the system.

11.2 Fixes for marker tracking

Most marker tracking problems can be fixed by adjusting key tracking parameters or changing the material that the markers are printed on.

11.2.1 Marker tracking parameters

The key tracking parameters for markers are listed below in order of importance.

1. **Size** is the most important parameter for marker detection sensitivity. It specifies the size of marker that can be recognized by the tracking engine (3x3, 4x4, or 5x5).

   Although this may sound obvious, always confirm the Size parameter is set correctly for the markers you are using! For example, if you use 3x3 markers but the Size parameter is set to 4x4, markers will not be detected reliably.

   Important! *All users must use the same size markers. For example, you cannot support 3x3 and 4x4 markers at the same time on a single video wall!*

   Note: *'Size' refers to the number of rows and columns in the 2D barcode. It does not refer to the length and width of the physical marker.*

2. **Minimum brightness** (or **Threshold** in Site Manager) is the second most important parameter for marker tracking. If the Size parameter is correct but tracking problems still occur, try adjusting the minimum brightness.

   Minimum brightness defines the expected brightness of white areas on a marker ie, the threshold for detecting the white areas. The material that a marker is printed on can affect this threshold. For example, some markers use a black ink that reflects infrared light (see section 11.2.2). If your markers are not being detected correctly, try raising or lowering the minimum brightness until correct marker values are returned consistently.

3. **Maximum contour length** (or **Max-length** in Site Manager) is the third most important parameter for marker tracking. If the Size parameter is correct and adjustments to minimum brightness do not fix your tracking problems, try adjusting the maximum contour length.

   Maximum contour length sets the maximum length (in pixels) around the outer white border of the barcode. Crucially, when a marker is rotated 45°, its contour length can increase by up to 40% because of the pixel-by-pixel rendering procedure for on-screen diagonal lines.

   If correct marker values are not being detected consistently, try increasing the maximum contour length to ensure it is long enough to detect rotated markers.

11.2.2 Material used for printed markers

The type of material used for printed markers can affect the required value for minimum brightness. In particular, the black areas of a marker must be 'true' black. However, some printed markers use a black ink that reflects infrared light. When you place these markers on the Cell screen in *fullscreen test mode*, the entire marker is shown as a white square. In this situation, if adjustments to the key tracking parameters do not fix the problem, you must change the material used for the printed markers.

11.3 Fixes for pen tracking

Most pen tracking problems can be fixed by adjusting a key tracking parameter or changing the pen batteries.

11.3.1 Pen batteries

Before adjusting any tracking parameters, confirm that the batteries in your infrared pens are charged. If a pen has a flat battery, it will not emit an infrared beam. The infrared pens supplied by MultiTaction need two AAA batteries.

11.3.2 Pen tracking parameter

The key tracking parameter for infrared pens is **minimum brightness** (or **Threshold** in Site Manager). This parameter sets the threshold for detecting the tip of the pen. If your pens are not being detected correctly, try raising or lowering the minimum brightness by trial and error until you find a fix for tracking problems.

11.4 Comparison of parameters names in OSD and Site Manager

Parameter names in Site Manager do not always match the names of equivalent parameters in the OSD. However, despite the name differences, parameter functionality and effects are the same, whether adjusted in Site Manager or the OSD.

The table below lists the key parameters in the OSD and their equivalent names in Site Manager.

	OSD Calibration tab	Site Manager Devices tab
Finger tracking	**Fingers**	**Fingers**
	Minimum brightness	lumi-limit
	Minimum contrast	edge-limit
	Detection radius	radius
Marker tracking	**Markers**	**SquareMarkerTracker_3** **SquareMarkerTracker_4** **SquareMarkerTracker_5**
	Size	Each marker size (3x4, 4x4, 5x5) has its own ‘enabled’ checkbox
	Minimum brightness	Threshold
	Maximum contour length	Max-length
Infrared pen tracking	**Pens**	**PenTracker**
	Minimum brightness	Threshold