

# VirtualCMM Users Guide

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## Purpose

*VirtualCMM* is software that emulates the functions of a physical CMM. It was written primarily for testing the measurement routines of *MeasureDirect* when an actual CMM is not available. The virtual machine is animated and can display the recent probe path to help identify problems such as missing moves or inverted touch points.

The *VirtualCMM* includes a functional jogbox and indexable probe head. The communication protocol used by *VirtualCMM* is a subset of Leitz. It was decided to use an existing protocol for communication as this may be beneficial for troubleshooting future problems.

## User Interface

The user interface of *VirtualCMM* is shown in illustration 1 showing the Touch Points and Machine dock widgets on the left side and the jogbox on the right.

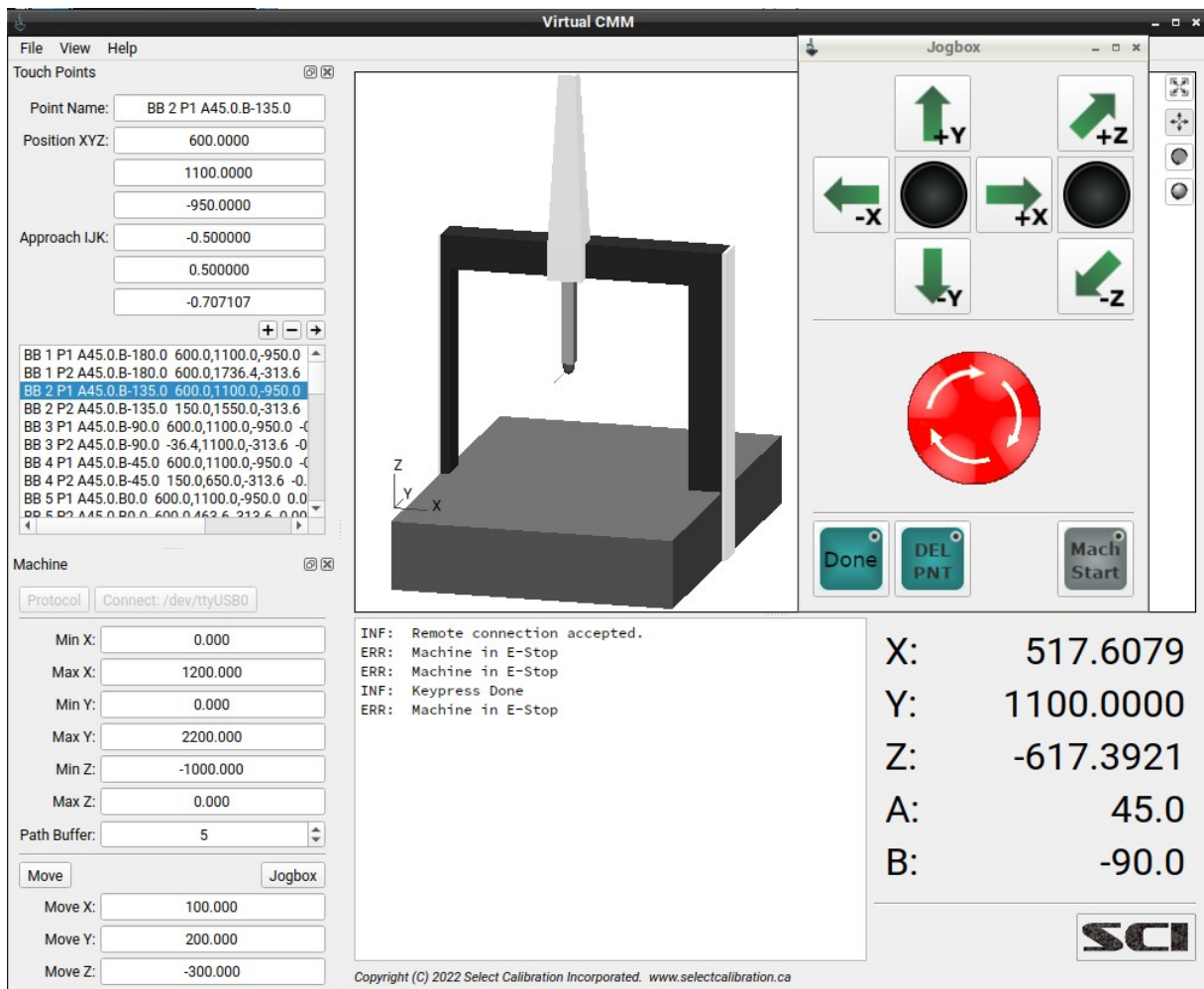


Illustration 1: View of the VirtualCMM utility

## Touch Points Dock Widget

The Touch Points dock widget is used to create simulated measurement points from the virtual CMM. Illustration 2 shows an example of the Touch Points widget.

To simulate a touch point with the virtual CMM double click on any of the points shown in the point list or press the send '->' key to create a touch point from data shown in the visible fields. New points are created by entering suitable information for the Point Name, Position, and IJK vector followed by clicking '+'. Points can be deleted by pressing on the '-' button.

On startup a set of test data is generated automatically. The test data can be used to measure any of the supported artifacts in one or more orientations of the machine volume.

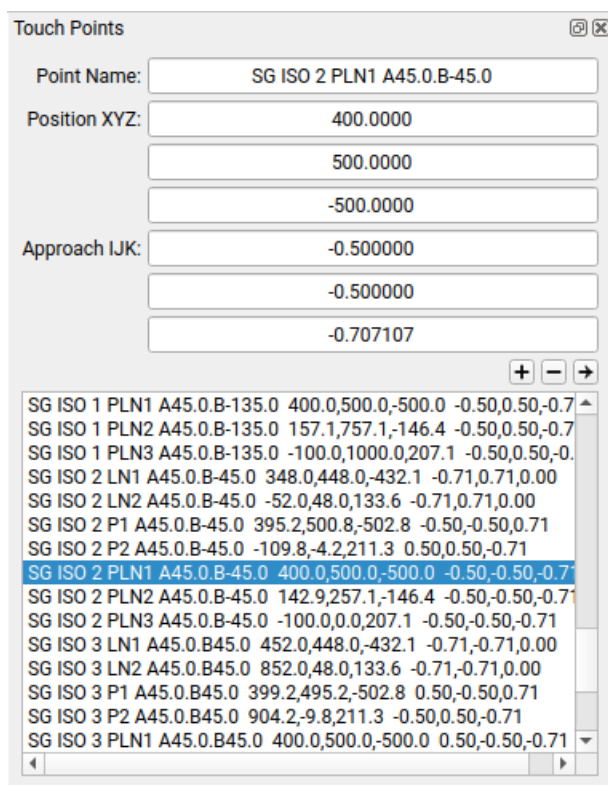


Illustration 2: Touch Points dock widget.

The naming convention of the test data points begins with two letters for the artifact type:

- BB = ball bar
- GB = gauge block
- PG = pin gauge
- RG = ring gauge
- SG B89 = step gauge suitable for B89.4.1 measurement
- SG ISO = step gauge suitable for ISO 10360-2 measurement

The name of automatically generated points specifies the measurement feature along with the

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nominal probe head AB angle for the measurement. For example, the point name is 'BB 2 P1 A45.0.B-135.0' means it is the first point (P1) of the second ball bar measurement (BB 2) and is ideally measured with a tool indexed to A45.0, B-135.0. For more complex measurements like the step gauge the feature types (plane, line, point) are included in the name description.

An efficient method to add a new point is to click on something that exists then update only the fields that are different before pressing the add button. The original point selection remains active so pressing the '-' button right away removes the source.

*Points with identical label names and values are allowed.*

*The IJK vector of all points is approach normal. The approach vector is inverted when presented to the inspection software.*

*The XYZ position of all touch points is automatically offset by the active tip radius. The default tip radius is 2 mm and changed by the inspection software driving the Virtual CMM.*

### Machine Dock Widget

The machine dock allows configuration of the communication link, definition of the dimensions of the CMM, access to the jogbox, and the ability to drive the machine to any position inside the measurement volume of the CMM. The display of the jogbox can be toggled on or off from this widget. Illustration 4 shows the machine dock widget setup for a 12.22.10 CMM.

The screenshot shows a window titled "Machine" with a close button. It contains several input fields and buttons:

- Protocol:** A dropdown menu.
- Connect:** A text field containing "/dev/ttyUSB0".
- Min X:** 0.000
- Max X:** 1200.000
- Min Y:** 0.000
- Max Y:** 2200.000
- Min Z:** -1000.000
- Max Z:** 0.000
- Path Buffer:** 5 (with a spin button)
- Move:** A button.
- Jogbox:** A button.
- Move X:** 100.000
- Move Y:** 200.000
- Move Z:** -300.000

Illustration 3: Machine dock widget.

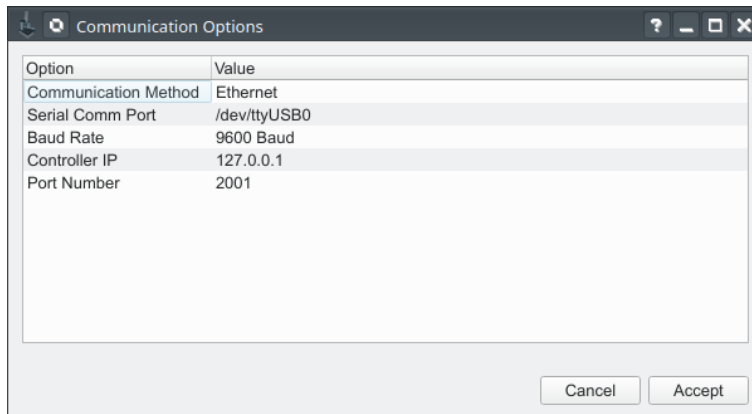
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## Communication

Starting with *VirtualCMM* version 2.0 it is possible to connect to the Virtual CMM using serial or Ethernet. The connection options are shown at the top of the Machine dock widget.

The Protocol button opens the communication dialog as shown in illustration 4.



*Illustration 4: Communication protocol setup.*

<i>Option</i>	<i>Description</i>
Communication Method	Selection of serial or Ethernet.
Serial Comm Port	For serial communication defines the name of the comm port.
Baud Rate	For serial communication defines the baud rate.
Controller IP	Define the IP address to monitor for connections when using Ethernet.
Port Number	Define the port number to monitor for connections when using Ethernet.

When the communication method is set to Ethernet the serial connection button is disabled. For serial communications the connection is opened or closed by toggling the connection button. The name of the serial port is shown in the text of the button.



*Illustration 5: Comm port opened when clicking on 'Connect: /dev/ttyUSB0'*

*The default comm port name is based on the operating system.*

## Move

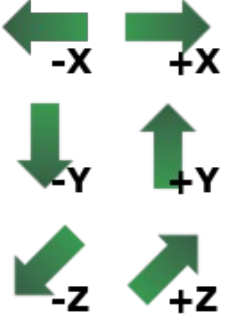




Drives the machine to the specified position. If the position is outside of the measurement volume the machine will stop at the edge of the measurement volume.

## Jogbox

The simulated jogbox allows the operator to manually drive the machine within the machine volume. The jogbox is modeless and does not attach to the main window. The appearance of the jogbox is switched on or off by pressing the *Jogbox* button in the Machine dock widget.

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The jogbox is loosely based on the Hexagon jogbox's with a subset of functions considered useful.

Button	Description
 <p>Directional Arrows for X, Y, and Z axis</p>	<p>Allows manually moving the CMM in the indicated axis by clicking on the button. The move distance and speed is fixed.</p>
	<p>Emergency Stop button.</p> <p>When an emergency is active the button will be shown in red otherwise grey.</p>
	<p>Machine start button. When an emergency is active the button is grey. When Machine Start is pressed the button will glow green.</p>
	<p>Done button used by the inspection software.</p>
	<p>Erase the last measured hit.</p>

When the *VirtualCMM* software is started it is expected that the user will press the *Machine Start* button to take the CMM out of emergency. Pressing the *Stop Button* will halt the virtual CMM and send an E-Stop message to the inspection software.

*The machine will always stay within the volume defined in the Machine dock widget. The probe may extend beyond the volume of the machine. When using the jogbox the machine will stop at the edge of volume.*

When controlling the VirtualCMM remotely an error is returned to the remote software if *VirtualCMM* is asked to move outside of the measurement volume of the CMM. An example of this kind of error is shown in illustration 6.

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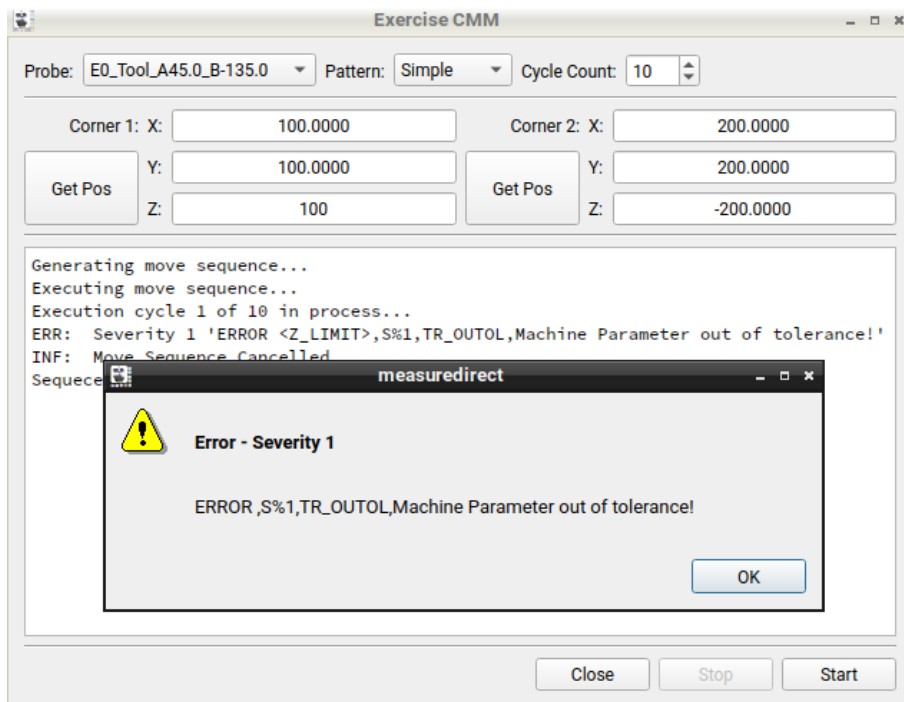


Illustration 6: Error reported from CMM when moved outside of measurement volume.

## Path Buffer

The path buffer option allows the user to show the motion of the probe and all touch points.

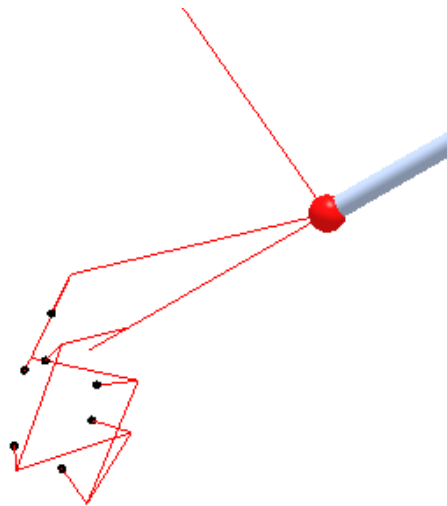


Illustration 7: Measurement of a ball bar sphere with the path buffer set to a higher value.



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The purpose of the buffer is to allow inspection of the individual points and path direction to ensure the measurement is as intended. Without the path displayed the user must carefully watch the simulation. The path only shows the motion of the machine over a specified number of samples so that the graphic view does not become cluttered. The path buffer can be disabled by setting the *Path Buffer Value* to zero.

### Log Window

The log windows contains information from the execution of the virtual CMM. Illustration 8 shows examples of different events recorded by the log such as touch points, jogbox key presses, errors, and other information.

```
INF: Remote connection accepted.
INF: Machine Online
INF: Keypress Done
Touch 675.000, 1025.000, -1006.066, -0.50000, 0.50000, -0.70711
Touch 525.000, 1175.000, -793.934, -0.50000, 0.50000, -0.70711
INF: Keypress Done
INF: Keypress Done
Touch 675.000, 1025.000, -1006.066, -0.50000, 0.50000, -0.70711
Touch 525.000, 1175.000, -793.934, -0.50000, 0.50000, -0.70711
INF: Keypress Done
INF: Keypress Done
```

*Illustration 8: Log window showing activity.*

### Stepgauge 10360-2 Measurement Example

This example shows the measurement of a step gauge using *MeasureDirect* while connected to the *VirtualCMM*.

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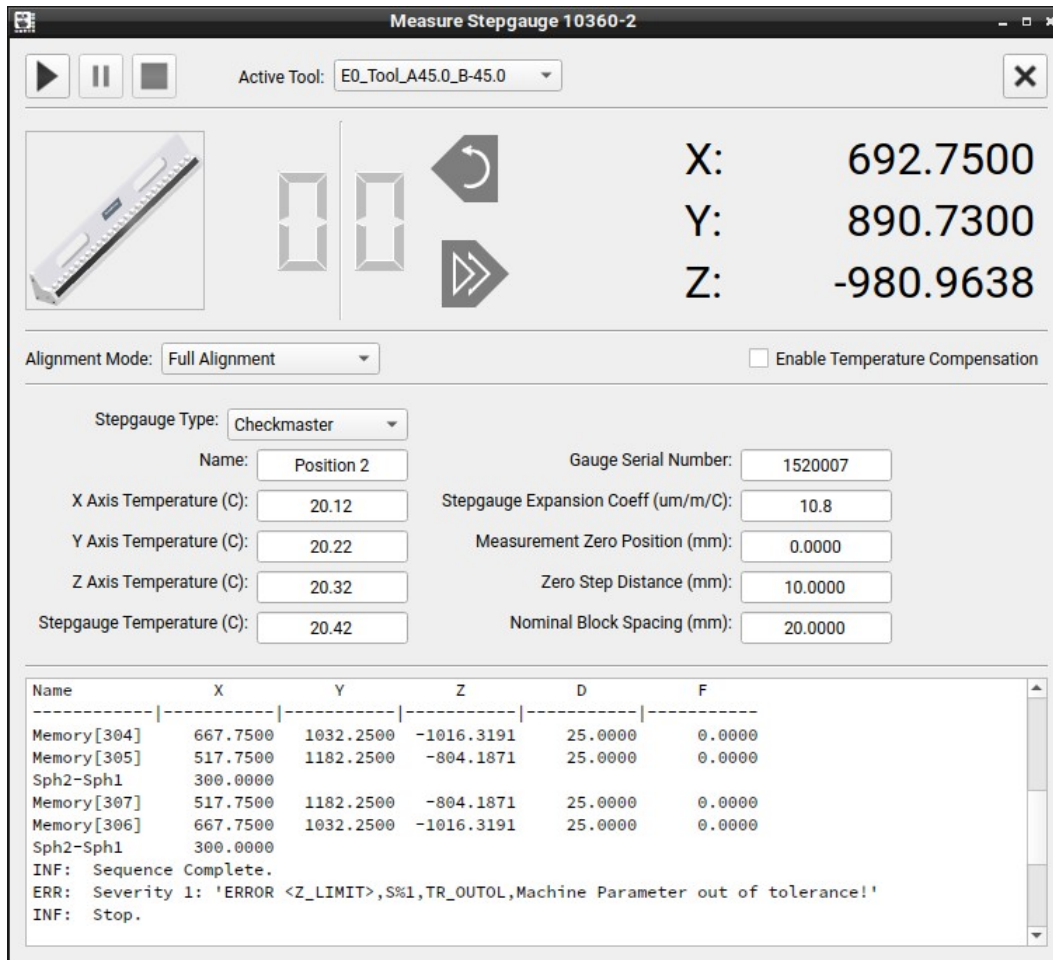


Illustration 9: Setup for measurement of a stepgauge diagonal position using tool oriented to A45, B-45.

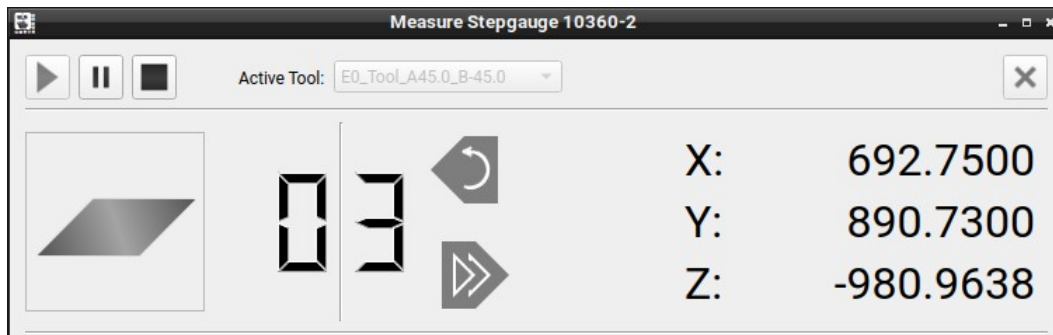


Illustration 10: Waiting for the three plane points on the stepgauge.

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Point Name:	BB 2 P2 A45.0.B-135.0
Position XYZ:	525.0000
	1175.0000
	-793.9340
Approach IJK:	-0.500000
	0.500000
	-0.707107
	+ - >
	SG ISO 3 P2 A45.0.B-90.0 -118.4,1104.0,-187.2
	SG ISO 3 PLN1 A45.0.B-90.0 600.0,1100.0,-904.2
	SG ISO 3 PLN2 A45.0.B-90.0 246.4,1110.0,-546.4
	SG ISO 3 PLN3 A45.0.B-90.0 -107.1,1100.0,-904.2
	SG ISO 4 LN1 A45.0.B-45.0 548.0,1048.0,-832.2
	SG ISO 4 LN2 A45.0.B-45.0 148.0,648.0,-266.4
	SG ISO 4 P1 A45.0.B-45.0 596.2,1101.8,-904.2
	SG ISO 4 P2 A45.0.B-45.0 89.2,594.8,-187.2
	SG ISO 4 PLN1 A45.0.B-45.0 600.0,1100.0,-904.2
	SG ISO 4 PLN2 A45.0.B-45.0 342.9,857.1,-546.4
	SG ISO 4 PLN3 A45.0.B-45.0 100.0,600.0,-190.4
	SG ISO 5 LN1 A45.0.B0.0 600.0,1026.5,-832.2
	SG ISO 5 LN2 A45.0.B0.0 600.0,460.8,-266.4
	SG ISO 5 P1 A45.0.B0.0 596.0,1098.6,-904.2
	SG ISO 5 P2 A45.0.B0.0 596.0,381.6,-187.2

Illustration 11: Selection of points used for the step gauge measurement starting with the plane PLN1, PLN2, and PLN3.

```
Touch 600.000, 1100.000, -900.000, -0.50000, -0.50000, -0.70711
Touch 342.929, 857.071, -546.447, -0.50000, -0.50000, -0.70711
Touch 100.000, 600.000, -192.893, -0.50000, -0.50000, -0.70711
Touch 548.000, 1048.000, -832.118, -0.70711, 0.70711, 0.00000
Touch 148.000, 648.000, -266.432, -0.70711, 0.70711, 0.00000
Touch 596.172, 1101.828, -904.243, -0.50000, -0.50000, 0.70711
Touch 89.172, 594.828, -187.236, 0.50000, 0.50000, -0.70711
```

Illustration 12: Record of touch points shown in log.

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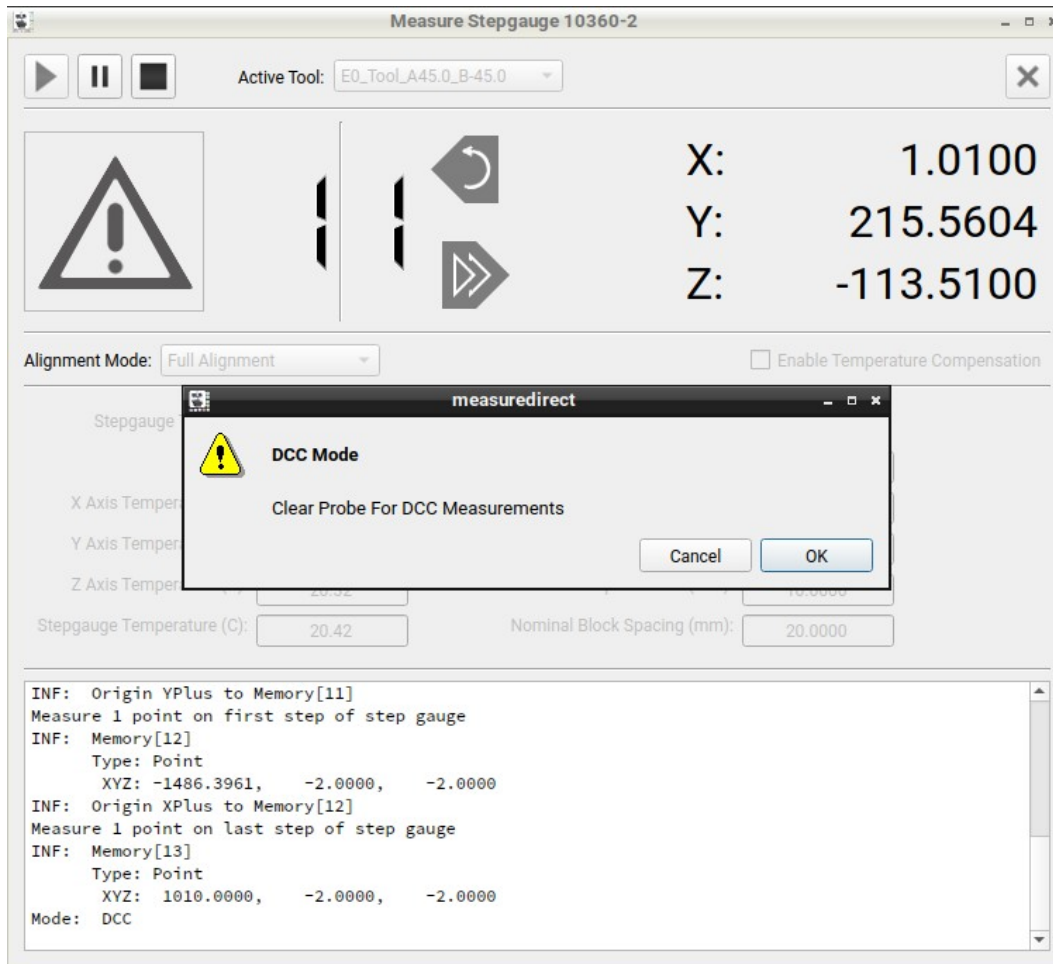
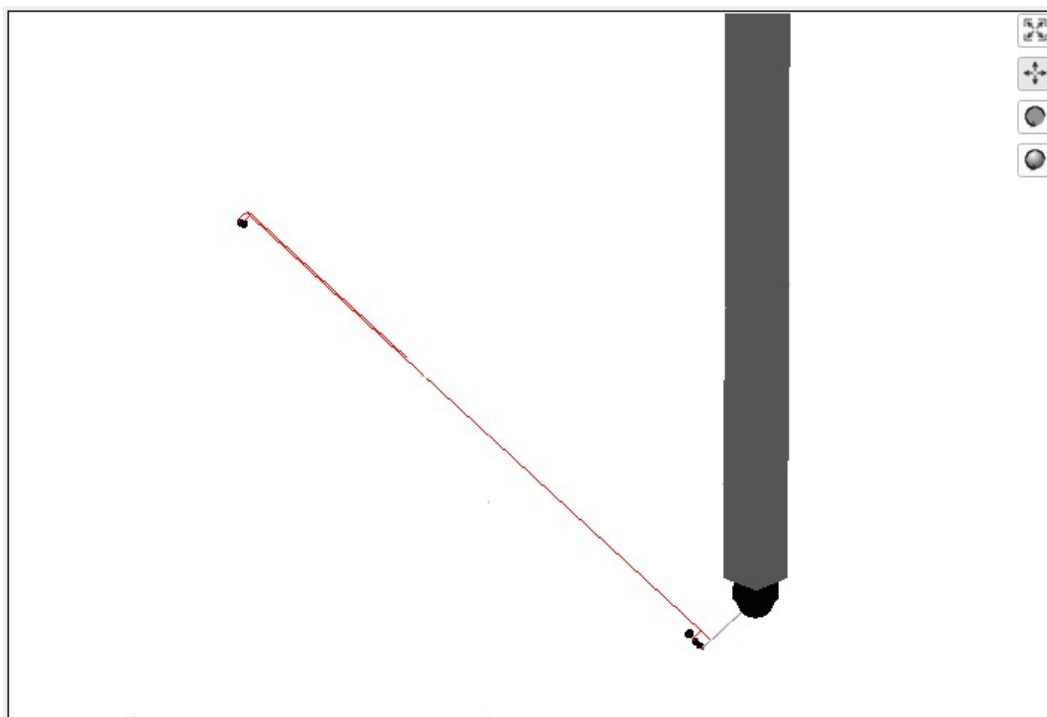


Illustration 13: Following the last measurement point MeasureDirect will begin the automatic sequence.

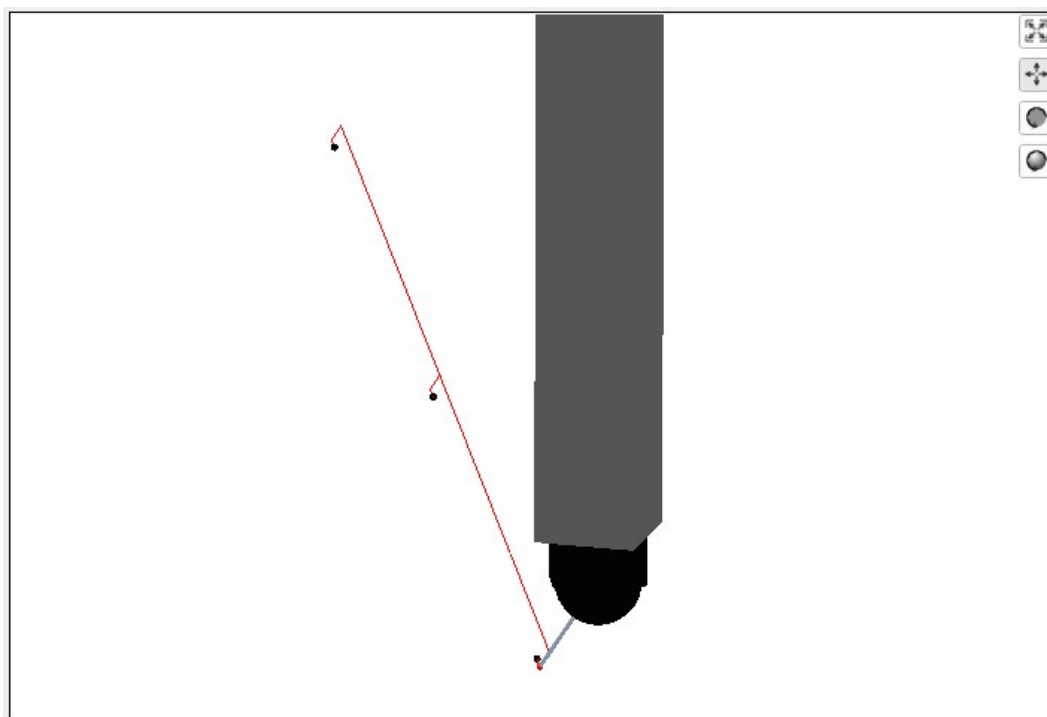


Illustration 14: Jogbox function buttons.

*The jogbox DONE button can be used to acknowledge features and prompts in MeasureDirect. DEL PNT can erase accidental touch points.*



*Illustration 15: View of the step gauge measurement sequence.*



*Illustration 16: Another view of the step gauge measurement sequence.*

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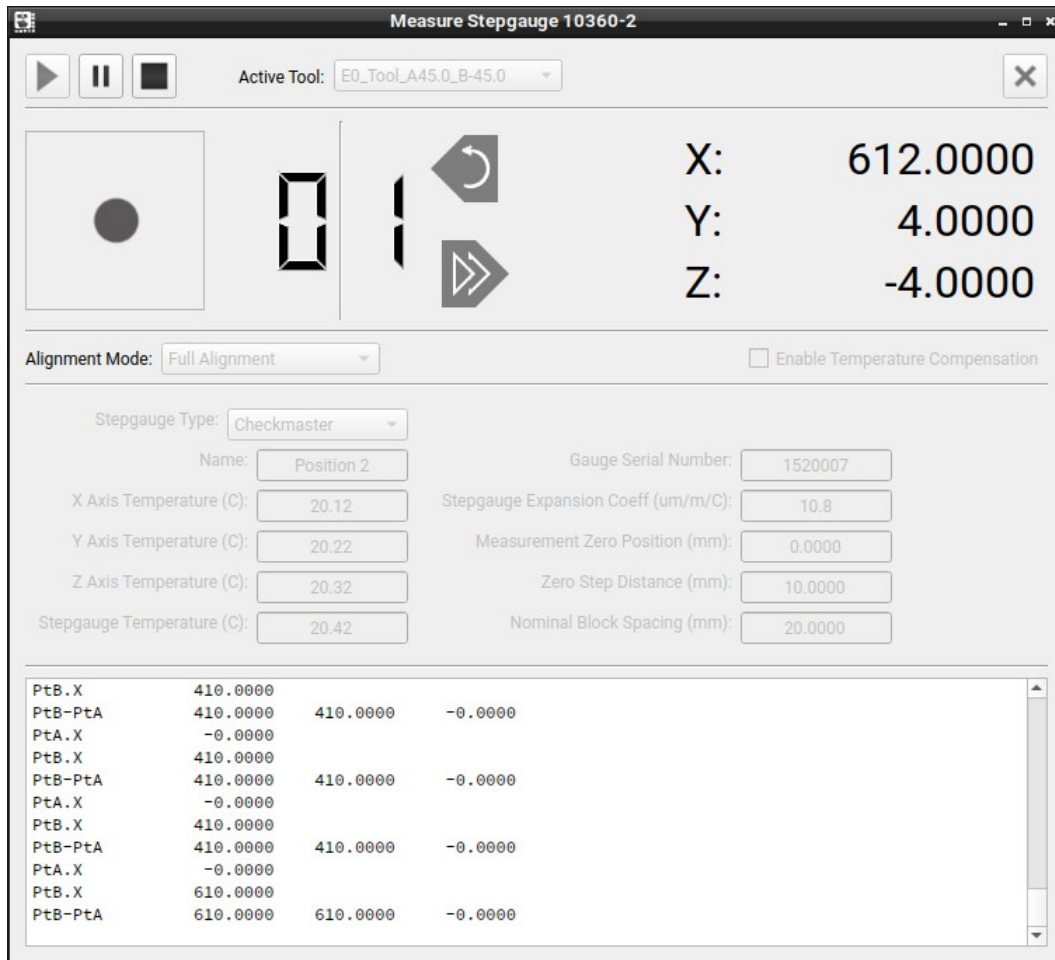


Illustration 17: Intermediate results shown in MeasureDirect.

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Revision History		
<i>Date</i>	<i>Version</i>	<i>Changes</i>
Dec 4, 2021	1.0	New program.
Dec 18, 2021	1.1	[bug fix] DRO not updated when probe offsets changed. [bug fix] Path lines not displayed on program startup. Added direct XYZ move option Update of OpenGL drawing routines. Changed sensitivity of wheel mouse zoom.
Jan 16, 2022	2.0	[bug fix] Make path line buffer end at last shown touch. [bug fix] Min and Max axis limits not validated. [bug fix] Home position not always at front / left / top. [bug fix] SG B+/-90 points does not fit inside the default volume. [bug fix] Not checking E-Stop at start of moves. Increase maximum size of path buffer. Added debug option to turn off logging of position requests. Added option for serial communication. Added option to configure serial or Ethernet IP and port connection. Added option for circular moves. Drive machine to manual touch point locations. Draw entire machine and not just the Z axis. Remove bounding cube.