CMM Error Simulator Users Guide

Table of Contents

Introduction

The CMM Error Simulator utility was written to provide simulated CMM measurement results in order to assist in the development of tools and procedures necessary for efficient calibration of coordinate measuring machines. Developing methods to extract specific machine errors from measurements require accurate test data so that methods can be evaluated properly. Using a real CMM can be problematic as measurement noise can bias the results and physically changing the shape of the machine in order to test different scenarios is not possible in many cases. Coordinate measuring machines must have physical errors to be evaluated properly.

In addition to providing test data for tool development the CMM Error Simulator was also designed to perform automatic comparison testing for different measurement strategies. This can be used to compare performance test standards or to evaluate a chosen measurement pattern. Manually testing all combinations of machine errors can be a very long process so automating this makes sense.

The CMM Error Simulator can simulate a variety of machine errors with various axis configurations of vertical and horizontal arm coordinate measuring machines in one of the four common kinematic chain orders. For horizontal arm CMM's it is possible to introduce errors due to tower deflection.

The individual measurement positions allow the use of variables for dynamic adjustment of size and location to suite the target machine measurement volume. If setup as intended no changes to any measurement should be required when switching between different measurement volumes.

This utility is cross platform and can be compiled to run on GNU/Linux, OSX, and Windows.

Overview

The CMM Error Simulator uses a single dialog window to the main interface. Measurement and machine data along with other settings are stored in a sub folder of the users home folder called *.errorsimulator* regardless of the operating system. The contents of this folder can be moved to different computers if it is desired to duplicate existing settings on another machine. The naming convention of a dot followed by the name of the application is typical for unix based applications.

A future version of the CMM Error Simulator will likely include an option to export and import all measurements and machines allowing easier transfer of data between different users.

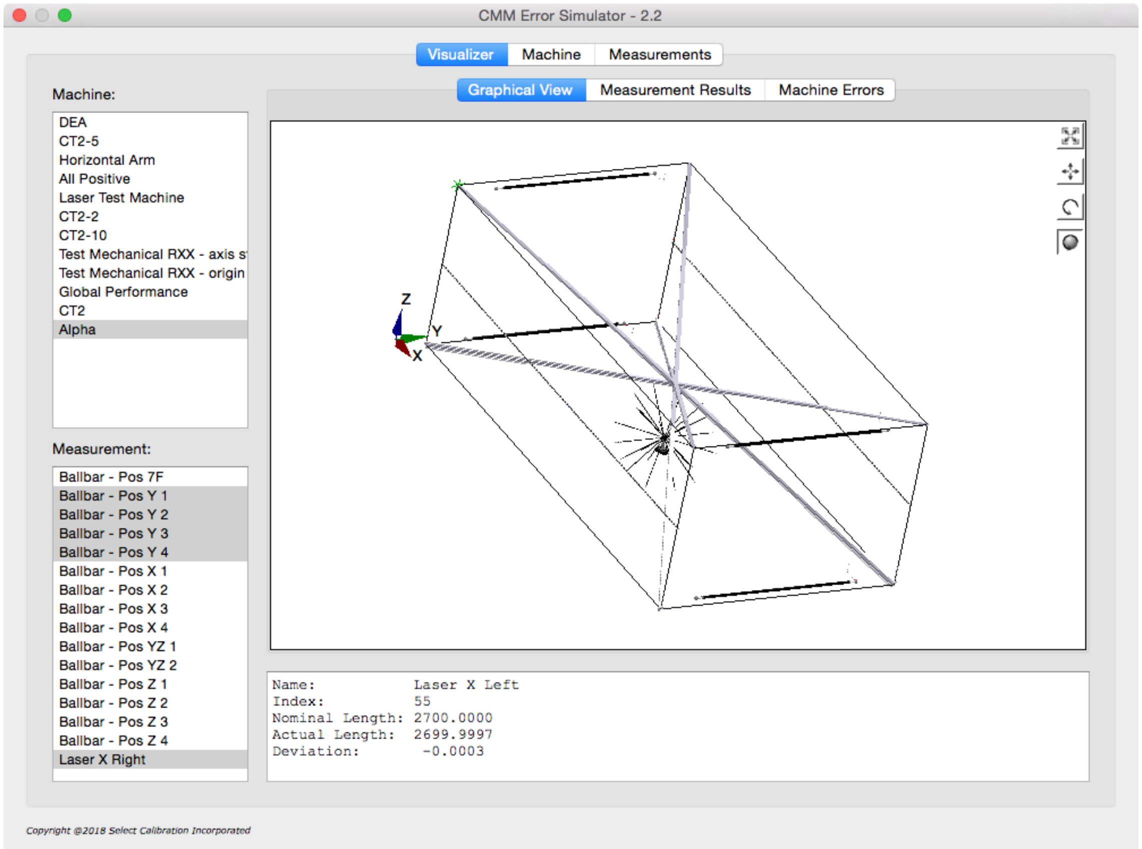


Illustration 1: Main view from the Visualizer Tab of the CMM Error Simulator program showing a graphical view of various measurements inside the volume of a selected machine.

Visualizer Tab

This view shows the results from combining a selected machine and one or more measurements. All simulated measurement data and a description of the machine error data is accessed from this view of the CMM error simulator program.

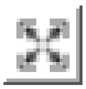
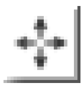
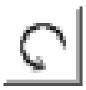
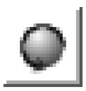
Graphical View

This view shows a graphical 3D representation of the measurement volume for the active machine and all selected measurements. Measurement items displayed inside the graphical view can show individual results when clicked with the left mouse button. The selected measurement item will be highlighted in blue and the text of the measurement will appear in the section below the graphical window.

A machine must be selected in order to display one or more measurements in the graphical view.

Graphical View 3D Controls

The 3D model display is not fixed and can be manipulated in a variety of ways. The volume of the selected machine is displayed as a wire cube. The model is displayed with the idea of a projection frustum to mimic the relative size of objects based on the relative distance of the viewer. This provides a slightly more realistic rendering of the volume of the data.

Image	*Description*
	Scale to fit. Adjusts the scale of the OpenGL Projection matrix to fit the visible data into the display viewport.
	Pan Mode. When enabled a right mouse button click and drag will move the position of the displayed model. For systems with a single mouse button use Ctrl + Mouse.
	Rotate 2D Mode. When enabled a right mouse button click and drag will rotate the model around the center of the viewport. For systems with a single mouse button use Ctrl + Mouse.
	Rotate 3D Mode. When enabled a right mouse button click and drag will rotate the model around the click position on the displayed model. For systems with a single mouse button use Ctrl + Mouse.

OpenGL

The graphical view of the measurement data is drawn using OpenGL. Starting with version 2.0 of the CMM Error Simulator utility a newer base class for rendering 3D data is used. The computer must have at least OpenGL version 2.x or higher in order to run this utility program with a functional 3D view of the measurement data.

Using the newer base class solves a number of problems such as the opaque (or nonexistent) zoom window. The newer OpenGL widget is also more suitable for using modern features such as vertex shaders. The CMM Error Simulator utility will be eventually updated with the newer OpenGL features and methodologies and moving to the new widget is the first step.

The advantage of the older OpenGL base class was compatibility with legacy systems. Version 1.x of the CMM Error Simulator utility would work on computers that only supported OpenGL 1.x.

Running the CMM Error Simulator program on computers that only support OpenGL 1.x the 3D view is replaced with an information window. An example of this information window is shown in illustration 2.

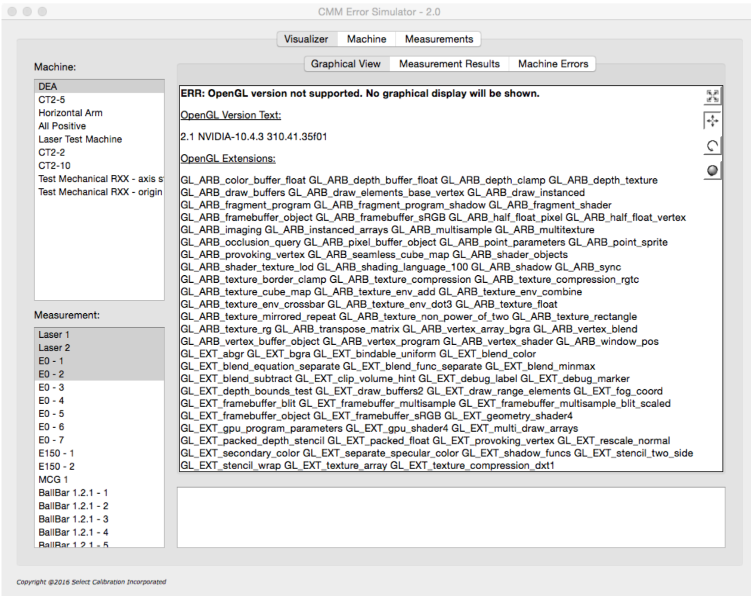


Illustration 2: Information screen that is displayed with unsupported OpenGL versions.

Measurement Results

This view of the Visualizer Tab shows the text result of all selected measurements. Depending on the type of data some measurements are combined into a single table such as the ball bar data. Measurements that consist of more than one measured value are reported as a group for each selected measurement.

The following shows examples of measurement data displayed in this view:

```
ISO 10360-2 Measurement
-----------------------------------------------------------------------------------------
Name:            Position 1
Probe Offset:    0.0000, 0.0000, -151.0000
Start Position: 5000.0000, 2500.0000, -1800.0000
Test Axis:       -0.851379928, -0.425689964, 0.306496774

   Nominal      Actual       Dev
-----------------------------------------------------------------------------------------
 1175.0000  1175.0029     0.0029
 2350.0000  2349.9930    -0.0070
 3525.0000  3524.9753    -0.0247
 4700.0000  4699.9550    -0.0450
 5875.0000  5874.9372    -0.0628

Max Error:  0.0029
Min Error: -0.0628

MCG Measurement
-----------------------------------------------------------------------------------------
```

```
Name:            MCG 1
Probe Offset:    0.0000, 0.0000, -75.0000
Center Position: 2500.0000, 1250.0000, -1500.0000

  Elevation   Azimuth     Length     Error
-----------------------------------------------------------------------------------------
  -45.0009   359.9993   499.9921    -0.0079
  -45.0011    45.0011   499.9900    -0.0100
  -45.0006    90.0026   499.9950    -0.0050
  -44.9998   135.0025   500.0021     0.0021
 …
   45.0010   179.9993   499.9914    -0.0086
   45.0012   225.0011   499.9898    -0.0102
   45.0006   270.0026   499.9950    -0.0050
   44.9997   315.0026   500.0024     0.0024

Max Length Error:  0.0077
Min Length Error: -0.0102

Laser Measurement
-----------------------------------------------------------------------------------------
Name:           Laser X Left
Probe Offset:   0.0000, 0.0000, -125.0000
Start Position: 0.0000, 10.0000, -900.0000
Test Axis:      1.000000000, 0.000000000, 0.000000000

  Scale Nom  Scale Act  Scale Dev      XX         YY         Ra         Rb         Rc
-----------------------------------------------------------------------------------------
    0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
   50.0000    50.0000    -0.0000    -0.0008     0.0000     0.0009     0.0000     0.0000
  100.0000   100.0000    -0.0000    -0.0015     0.0000     0.0017     0.0000     0.0000
  150.0000   150.0000    -0.0000    -0.0022     0.0000     0.0026     0.0000     0.0000
  200.0000   200.0000    -0.0000    -0.0029     0.0000     0.0034     0.0000     0.0000
  ...
 4800.0000  4799.9999    -0.0001     0.0098     0.0000     0.0149     0.0000     0.0000
 4850.0000  4849.9999    -0.0001     0.0096     0.0000     0.0143     0.0000     0.0000
 4900.0000  4899.9999    -0.0001     0.0094     0.0000     0.0137     0.0000     0.0000
 4950.0000  4949.9999    -0.0001     0.0092     0.0000     0.0131     0.0000     0.0000
 5000.0000  4999.9999    -0.0001     0.0090     0.0000     0.0125     0.0000     0.0000

Max Scale Error:  0.0000
Min Scale Error: -0.0003
```

Measurement Results – Save Text

The *Save Text* option will create an output text file of all the currently displayed results. The output file contains everything that is displayed from this view of the data.

Measurement Results – Export Measurements

The *Export Measurements* option will create one or more measurement files containing data suitable for external testing. The output format of all files is suitable for Select Calibration Incorporated and matches the current revision of all related measurement software.

Exported measurement data includes the probe offset. The addition of the probe offset mimics the effect from a measurement on an actual CMM.

Measurement Results – Evaluation Report

The *Evaluation Report* option will create a single file containing an extensive comparative set of results from all selected measurements.

The number of available errors from the active machine determines the total size of the output file. Each error from the active machine is combined in every possible configuration producing a series of measurement results for each unique combination. This function was used to perform a comparison of the ASME B89.4.1:1997 and ISO/IEC 10360-2:2009 or ASME B89.4.10360-2:2008 performance test standards.

Machines with all error parameters active will produce an output file containing 65535 measurement result lines. This process can take some time to complete. A progress dialog and the option to cancel the process will automatically appear when using this function.

Machine Errors

This view shows the calculated errors of the active machine. The errors are displayed in the form of a typical CMM error map. An example of this data is shown below:

```
Selected Machine: CT2-5

Squareness
------------------------------------------------------------------------------
YZ: 0.0050
XY: 0.0050
ZX: 0.0050

X Axis Data
------------------------------------------------------------------------------
     Pos          Lx          Ly          Lz          Rx          Ry          Rz
------------------------------------------------------------------------------
       0.0      0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
     100.0      0.0000     -0.0001      0.0001      0.0005      0.0005      0.0005
     200.0      0.0000     -0.0002      0.0002      0.0010      0.0010      0.0010
     300.0      0.0000     -0.0003      0.0003      0.0015      0.0015      0.0015
     400.0      0.0000     -0.0003      0.0003      0.0020      0.0020      0.0020
     500.0      0.0000     -0.0002      0.0002      0.0025      0.0025      0.0025
     600.0      0.0000     -0.0001      0.0001      0.0030      0.0030      0.0030
     700.0      0.0000      0.0000     -0.0000      0.0035      0.0035      0.0035
     800.0      0.0000      0.0003     -0.0003      0.0040      0.0040      0.0040
     900.0      0.0000      0.0005     -0.0005      0.0045      0.0045      0.0045
    1000.0      0.0000      0.0008     -0.0008      0.0050      0.0050      0.0050
```

Y Axis Data

Pos	Lx	Ly	Lz	Rx	Ry	Rz
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
100.0	0.0003	0.0000	-0.0003	0.0005	0.0005	0.0005
200.0	0.0006	0.0000	-0.0006	0.0010	0.0010	0.0010
300.0	0.0008	0.0000	-0.0008	0.0015	0.0015	0.0015
400.0	0.0009	0.0000	-0.0009	0.0020	0.0020	0.0020
500.0	0.0011	0.0000	-0.0011	0.0025	0.0025	0.0025
600.0	0.0011	0.0000	-0.0011	0.0030	0.0030	0.0030
700.0	0.0011	0.0000	-0.0011	0.0035	0.0035	0.0035
800.0	0.0011	0.0000	-0.0011	0.0040	0.0040	0.0040
900.0	0.0010	0.0000	-0.0010	0.0045	0.0045	0.0045
1000.0	0.0009	0.0000	-0.0009	0.0050	0.0050	0.0050
1100.0	0.0007	0.0000	-0.0007	0.0055	0.0055	0.0055
1200.0	0.0004	0.0000	-0.0004	0.0060	0.0060	0.0060
1300.0	0.0002	0.0000	-0.0002	0.0065	0.0065	0.0065
1400.0	-0.0002	0.0000	0.0002	0.0070	0.0070	0.0070
1500.0	-0.0006	0.0000	0.0006	0.0075	0.0075	0.0075
1600.0	-0.0010	0.0000	0.0010	0.0080	0.0080	0.0080
1700.0	-0.0015	0.0000	0.0015	0.0085	0.0085	0.0085
1800.0	-0.0020	0.0000	0.0020	0.0090	0.0090	0.0090
1900.0	-0.0026	0.0000	0.0026	0.0095	0.0095	0.0095
2000.0	-0.0033	0.0000	0.0033	0.0100	0.0100	0.0100

Z Axis Data

Pos	Lx	Ly	Lz	Rx	Ry	Rz
-1000.0	0.0008	-0.0008	0.0000	-0.0050	-0.0050	-0.0050
-900.0	0.0005	-0.0005	0.0000	-0.0045	-0.0045	-0.0045
-800.0	0.0003	-0.0003	0.0000	-0.0040	-0.0040	-0.0040
-700.0	0.0000	-0.0000	0.0000	-0.0035	-0.0035	-0.0035
-600.0	-0.0001	0.0001	0.0000	-0.0030	-0.0030	-0.0030
-500.0	-0.0002	0.0002	0.0000	-0.0025	-0.0025	-0.0025
-400.0	-0.0003	0.0003	0.0000	-0.0020	-0.0020	-0.0020
-300.0	-0.0003	0.0003	0.0000	-0.0015	-0.0015	-0.0015
-200.0	-0.0002	0.0002	0.0000	-0.0010	-0.0010	-0.0010
-100.0	-0.0001	0.0001	0.0000	-0.0005	-0.0005	-0.0005
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

This data is generated based on the increment values shown at the top of the Machine Error display of the data. The data can be viewed with any desired increment by editing the fields and pressing the *Update* button.

This data is provided to show the end result of all machine errors. This data is not used for calculation of the measurement errors therefore the input map increments have no affect on any *calculated measurement result.*

Machine Tab

This view is for managing all available simulated coordinate measuring machines.

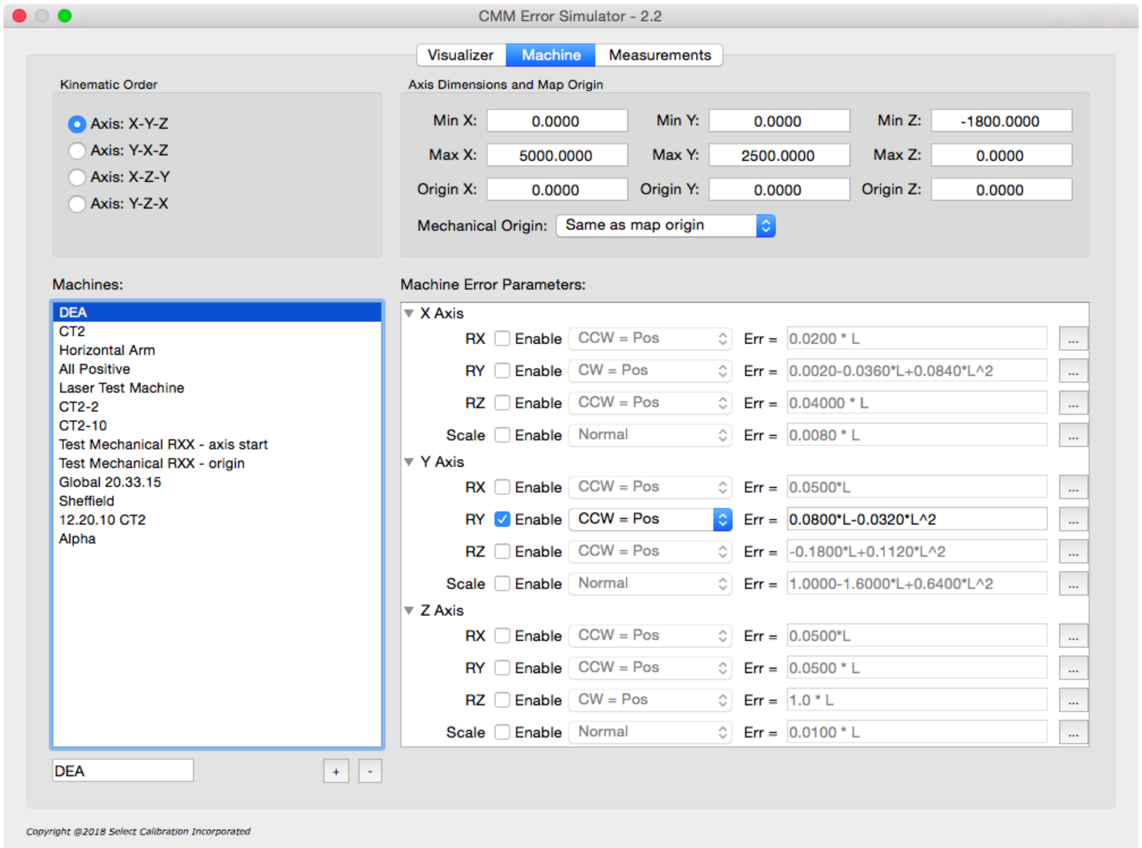


Illustration 3: View from the Machine tab of the CMM Error Simulator program.

Creating or Deleting Machines

New machines can be created by pressing the '+' button at the bottom of the list of machines. Existing machines can be removed by selecting one or more machines then pressing the '-' button.

All machines are added with a unique name of Untitled (or Untitled – n). To change the name of any machine manipulate the name field at the bottom of the machine list.

All machine names must be unique. Names that are entered which already exist will use the closest unique name possible (or will be ignored).

Kinematic Order

The kinematic order defines how the axis of a machine is connected to each other. The selection of the kinematic order will affect the measurement data when combined with the machine. The four kinematic orders supported by the CMM Error Simulator utility are listed below:

Kinematic Order	*Description*
X-Y-Z	The axis of the simulated CMM has the X as the first axis, the Y connected to the X, and the Z connected to the Y. This configuration is assumed to be a vertical arm CMM.
Y-X-Z	The axis of the simulated CMM has the Y as the first axis, the X connected to the Y, and the Z connected to the X. This configuration is assumed to be a vertical arm CMM.
X-Z-Y	The axis of the simulated CMM has the X as the first axis, the Z connected to the X, and the Y connected to the Z. This configuration is assumed to be a horizontal arm CMM.
Y-Z-X	The axis of the simulated CMM has the Y as the first axis, the Z connected to the Y, and the X connected to the Z. This configuration is assumed to be a horizontal arm CMM.

Axis Dimensions and Map Origin

This section defines the limits of the CMM machine axis. The origin entry defines the rotation zero position and is typically at XYZ zero.

The mechanical origin option allows for placing the rotation point at positions other than the machine origin. The default is to have the rotation origin the same as the map origin but other configurations are possible.

Illustration 4 shows an example for the mechanical rotation point on the bridge axis of a CMM. When specifically testing for the effect of compensation calculated from different points of an axis this feature is invaluable.

The list of possible axis combinations is suitable for generic testing. Not every possible axis combination is available or even technically required.

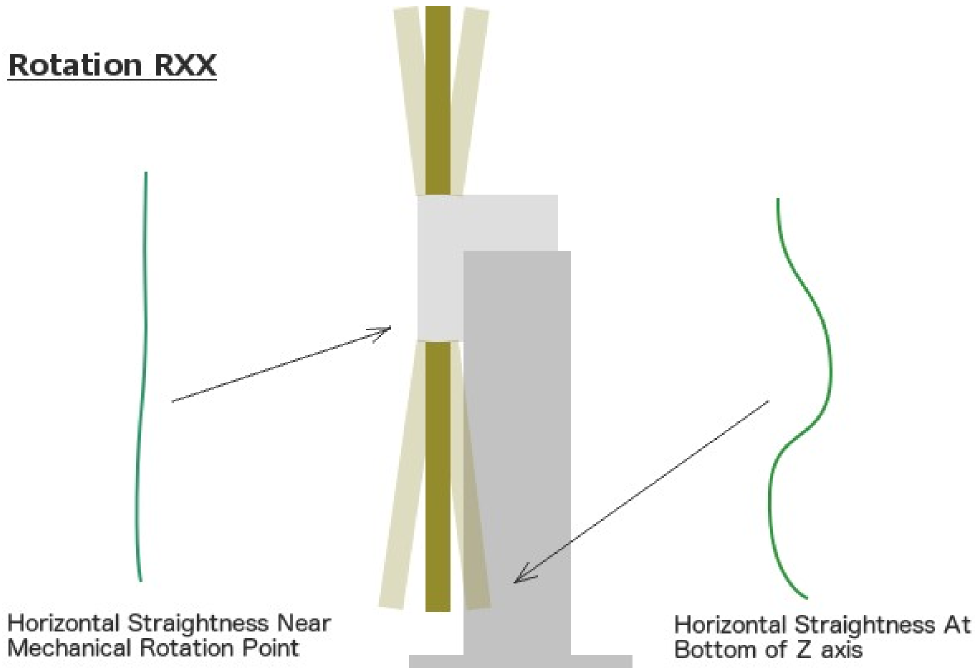


Illustration 4: Example of the effect of rotation error RXX at different points in the X axis affecting the Y axis straightness.

The options are listed based on the sign of the axis. The mechanical rotation is always assumed to be at either end of a machine axis. For example, the option '*Axis positions -X +Y +Z*' will place the mechanical origin at the negative end of the X axis and the positive ends of the Y and Z axis.

Machine Error Parameters

The X, Y, and Z machine axis can have up to four error parameters. For horizontal arm CMM's an additional D axis is added and allows a single entry for an expression suitable for tower deflection.

All parameters are entered as a constant or formula expression. The following are examples of different expressions that can be used to describe machine axis errors:

$$E_r = 0.005$$

$$E_r = 0.005 * L$$

$$E_r = 0.005 + 0.002 * L + 0.003 * L^2 - 0.004 * L^3$$

The first example is a constant. This value will be applied evenly to all data of the simulated CMM. The second example is a gradient with the variable *L* substituted for the actual position in the machine volume. The third example is in the form of a polynomial with coefficients. The resulting shape from this expression is complex.

Using a constant for angular data is equivalent to adding a squareness error (depends on the parameter). The affected axis and rotation direction can be precisely controlled using constants.

Expression Variables

The following are variables that can be used for the machine error expressions:

Variable	*Description*
L	Position in the map coordinates specific for each axis. The value is from the XYZ zero point regardless if this position is inside the machine volume or not.
PUp	Position from the XYZ zero point specifically for the vertical axis (Z). This variable is only used for the deflection axis parameter.
POut	Position from the XYZ zero point specifically for the horizontal axis (Y or X). This variable is only used for the deflection axis parameter.
LUp	Length from the minimum position of the vertical axis (Z). This variable is only used for the deflection axis parameter.
LOut	Length from the minimum position of the horizontal axis (Y or X). This variable is only used for the deflection axis parameter.

Expression Editor

The expression editor allows the user to input measurement errors along the length of an axis and turn this into an equivalent expression. It is very useful for errors that are not constant or can be described with a simple slope. The expression editor dialog can be opened by clicking on the ellipse button to the right of the expression field.

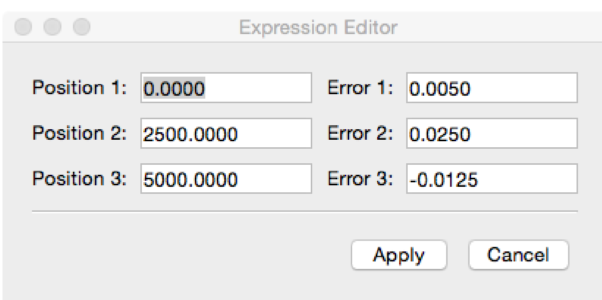


Figure 1: Expression editor showing three points along the axis of the machine and the amount of desired error at each point.

Using the inputs from the example shown in figure 1 the resulting expression is:

$$Err = 0.0050 + 0.0195 * L - 0.0046 * L^2$$

The expression editor is not available for deflection parameters due to the different variables available to express distance.

Deflection Expressions

The tower deflection of a horizontal arm are not a constant expression. The value that is used for all evaluations is based on the result of the expression and is usually unique depending on the vertical and horizontal position. Most horizontal arm CMM's can be described with something similar to the following expression:

$$R_t = E * LUp * LOut$$

When viewing the error map data for the machine the tower deflection will be shown as a table containing the result of the expression at different points along the two input axis.

Expression Signs

For angular data the interpretation of the machine error expression is determined by the selection of *CCW=Pos* or *CW=Pos*. This selection does not change the sign of the expression but how the data is to be interpreted when converting the angular value into a position offset.

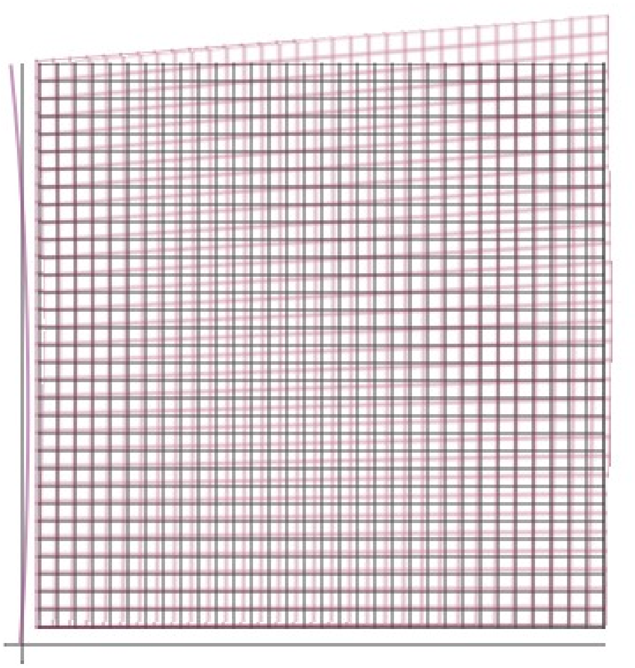


Illustration 5: Interpretation of machine error for rotation around Z axis (viewer).

The interpretation of the machine error is a description of the physical machine characteristics. A machine error with a *CCW=Pos* sign and an expression that produces a positive value will result in a simulated machine as shown in illustration 5. The input error expressions represent the physical machine errors and the measurement results are what would be expected on a machine with these physical errors prior to compensation.

The straightness parameters and signs are calculated automatically from the input angular data. These parameters cannot be directly accessed.

For scale data the sign represents the sign of the deviation when comparing the actual to nominal. A *normal* sign will create a positive deviation when the actual position of the machine moves more positive than the nominal position (equivalent to how it would appear when measuring with a laser). *Inverted* sign is the opposite where a more positive laser reading would be considered a negative correction (deviation sign is equivalent to the measured deviation of a physical gauge on a machine and opposite to a laser).

Squareness interpretation is based on angle measurements between the primary and secondary axis for each of the three parameters. The options for the sign are based on how measurements would be interpreted at angles +/- 45 degrees to the machine axis.

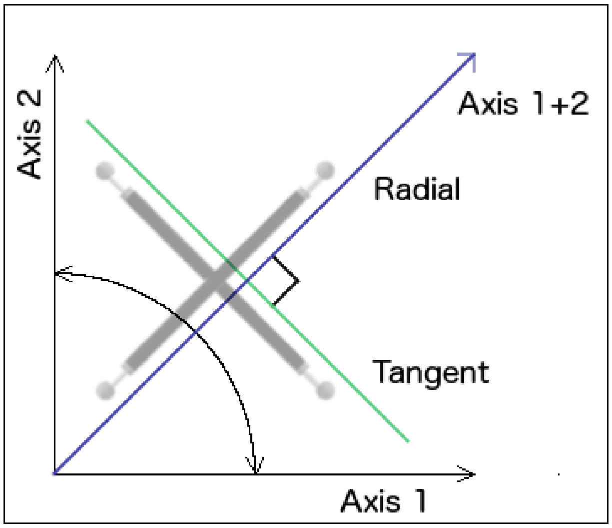


Figure 2: Definition of radial and tangent between two axis of a coordinate system.

When the simulated measured length parallel to the radial axis (sum of axis 1 and axis 2) is greater than the simulated measured length perpendicular to the radial axis (parallel to the tangent axis) then one of these two conditions are true:

- Setting is *Rad<Tan=Pos* and the expression result is positive.
- Setting is *Rad>Tan=Pos* and the expression result is negative.

The measured length and the displacement are always reversed.

Measurements Tab

This view allows the editing of one or more measurements that are to be evaluated on the different simulated machines. Four different kinds of measurements are currently supported by the CMM Error Simulator program:

- Laser (six parameter).
- ISO/IEC 10360-2
- Renishaw Machine Checking Gauge

- ASME B89.4.1 ball bar

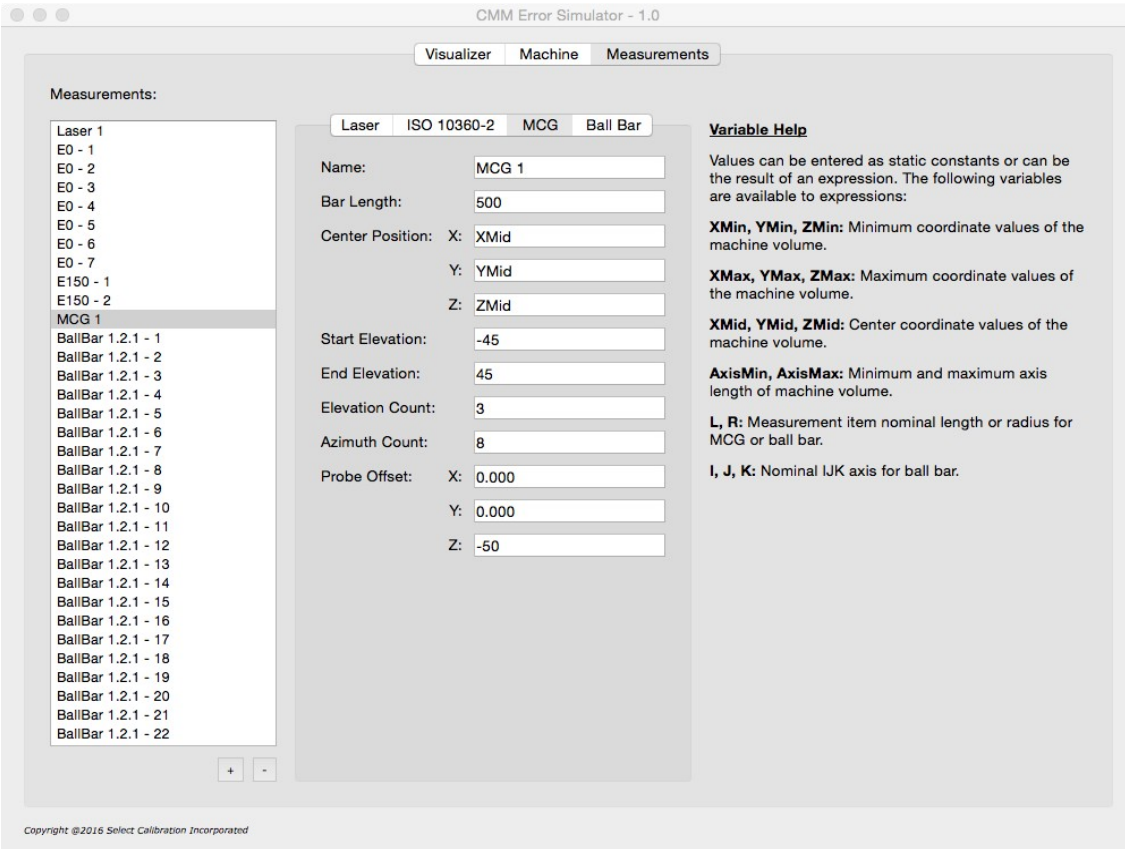


Illustration 6: View of the measurements tab with the MCG gauge active.

Measurement Management

New measurements can be created by pressing the '+' button at the bottom of the list of measurements. Existing measurements can be removed by selecting one or more measurements then pressing the '-' button.

The name of the new measurement will be automatically generated from a default name or will be based on the name of the currently selected measurement item if a selected item exists. The name can be altered by editing the *Name* field at the top of the measurement parameters.

When a measurement is selected the editor will automatically highlight the settings specific for the type of selected measurement with all other measurement types disabled. To have all measurement types active unselect any active measurement first.

The type of measurement that is added is based on what is currently active. For example, to add a new ball bar measurement ensure the ball bar editor is the active view.

Expression Variables.

The following are variables that can be used for measurement expressions:

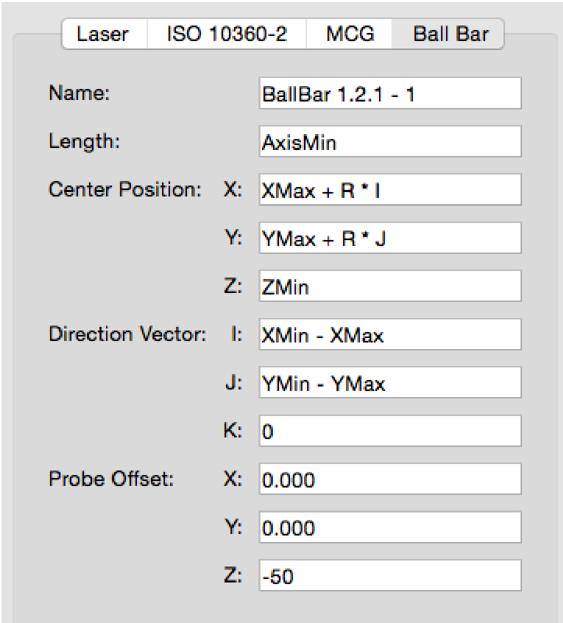
Variable	*Description*
XMin	The minimum X axis machine coordinate.
YMin	The minimum Y axis machine coordinate.
ZMin	The minimum Z axis machine coordinate.
XMax	The maximum X axis machine coordinate.
YMax	The maximum Y axis machine coordinate.
ZMax	The maximum Z axis machine coordinate.
XMid	The center position of the X axis.
YMid	The center position of the Y axis.
ZMid	The center position of the Z axis.
AxisMin	The shortest length of the X, Y, or Z axis.
AxisMax	The longest length of the X, Y, or Z axis.
L	The nominal measurement length.
R	The nominal measurement length divided by two (L/2).
I	The normalized I value of the IJK direction.
J	The normalized J value of the IJK direction.
K	The normalized K value of the IJK direction.

Some variables cannot be used in fields that result in the creation of the variable (recursive variable). For example, the variable 'L' cannot be used inside any length field as the value of this variable must be determined by solving the expression of this field first.

Measurement Variable Example

The following shows an example of a measurement expression for a ball bar. The table following the image describes the different variables used.

In this example the goal was to have a ball bar placed at the bottom of the machines Z axis in a direction between the back/left and front/right corners. Since the dimensions of the machine are not (or may not) be cubical the I and J values would not be 0.707 and 0.707. Also, the position of one of the two spheres must be located at the back/left corner of the machines measurement volume. The length of the ball bar must be set to be the same as the shortest machine axis.



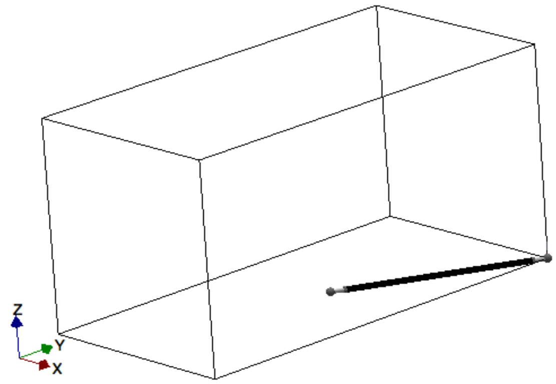


Illustration 7: Image showing position of the ball bar based on expression parameters shown to the left.

Expression	*Description*
Name	The name of the measurement as it will appear in the measurement list.
Length	The variable *AxisMin* is used for the expression. The length of the ball bar will be the shortest axis of the machine.
Center Position X	The expression *XMax + R * I* will place the center of the ball bar measurement one half the length of the ball bar starting at the maximum X axis position and traveling in the normalized I value of the IJK direction.
Center Position Y	The expression Y*Max + R * J* will place the center of the ball bar measurement one half the length of the ball bar starting at the maximum Y axis position and traveling in the normalized J value of the IJK direction.
Center Position Z	The expression *ZMin* will place the center of the ball bar measurement at the lowest position in the Z axis.
Direction Vector I	The expression *XMin - XMax* defines the I value of the IJK direction. The direction is normalized automatically when processed.
Direction Vector J	The expression Y*Min - YMax* defines the J value of the IJK direction. The direction is normalized automatically when processed.
Direction Vector K	The expression *0* sets K value of the IJK direction to zero.
Probe Offset X	The probe offset in the X axis direction used for the measurement. The value is entered as a constant.
Probe Offset Y	The probe offset in the Y axis direction used for the measurement. The value is entered as a constant.
Probe Offset Z	The probe offset in the Z axis direction used for the measurement. The value is entered as a constant.

Probe Offset Sign

The sign for the probe offset is always interpreted as the relative position of the stylus ruby from the probe connection point at the end of the last axis of the machine. The signs for all axis is using the standard convention and is reversed as compared to some inspection software (PC-DMIS for example).

All measurements will draw the relative position of the stylus provided the probe offset is not zero.

Laser Measurements

All simulated measurement results when using the laser report the scale, straightness, and all angular values typical for a six parameter laser. All simulated measurements are bidirectional.

Measurement lines that are not parallel to an axis will only show scale errors. The straightness and angular fields will still exist but all values will be reported as zero.

Revision History

Date	*Version*	*Changes*
July 27, 2016	1.0	New Program
July 28, 2016	1.0.1	Revision of documentation regarding expression constants.
Aug 6, 2016	1.1	Added option to specify a mechanical rotation point independent of the mathematical rotation point.
Nov 6, 2016	1.2	Bugfix: Wrong IJK surface normal values sent to OpenGL Added minimum offset before drawing knuckle probes.
Dec 14, 2016	2.0	Bugfix: Software crash for horizontal arm when measurements exceed axis length. Improvements to selection. Added selection highlight. Switched to newer OpenGL base class. Added option to detect minimum usable OpenGL version and disable sections of the program that are not compatible.
Apr 25, 2018	2.1	Bugfix: Ball bar measurement data was created without the probe offset included in the position of each sphere. Bugfix: Ballbar data had an incorrect title label.
Nov 28, 2018	2.2	Bugfix: Probe offset offsetting map axis positions. Added expression builder