Calibration of OPTEK X-Ray systems

Covers 462X, 712X, and 942X Systems

Calibration of the OPTEK System in QC5000

Note: A complete calibration Includes

1. Mechanical Adjustments
2. Software Compensation by NLEC calibration
3. Verification of the calibration.

Newer X-ray machines incorporate a grid, which is visible to an X-ray camera thus video calibrations are replaced with those using X-ray standards and corresponding x-ray components. This eliminates the need for swapping out video components. Please note those changes necessary for your configuration.

Adjustments to the Camera System (5) See details below.

Parallax: A mechanical adjustment.

Camera Rotation: A mechanical adjustment.

Pixel calibration: Software compensation.

Camera Rotation Calibration: Software compensation.

Camera Offset: For multiple Magnification Systems

Adjustments to the Transport system (5) See details below.

Preparations: Remove any tooling, which might interfere.

Grid Alignment: Mechanical adjustment.

Grid Measurement: Determine the errors, Software compensation by NLEC calibration.

Implementation of NLEC Calibration: Software compensation for errors.

Verification: The calibration check program: Software verification of the compensation by NLEC.

Calibration Procedure

Do squareness or camera rotation first. Pixel cal can be approximate at this point.

Adjusting the Camera squarenes**s** (A Mechanical Rotation)

The next step in the alignment process is to ensure the camera is square to the X-axis travel. With a large crosshair on the video monitor, place a sharp image all the way to the left side of the screen just touching the horizontal line of the crosshair. Move the image to the right side of the screen with the joystick. The object should follow the line. If the does not follow the crosshair line, loosen the two camera mount set screws (Also used in adjusting Parfocality) and rotate the camera until the image stays on the line from left to right. Tighten the setscrews when the image touches the line from left to right.

Camera Rotation Correction (Software Alignment)

Position the 0.5 mm dot on the horizontal centerline of the monitor at the left side of the field of view.
From the CNC toolbar choose Axis Lock.
Read the section on the “Probe Library” if you do not know how the library operates

- Choose: Tools \ General Options \ Supervisor Setup Enter the security code to make changes.
- Choose: Probe \ Probe library \ Camera\ Camera Orientation to reset the camera rotation.
- Click on set zero. Click the Learn button. A calibration circle tool will appear on the left monitor. An instruction box will appear on the right. Follow these instructions to complete the Camera Rotation Correction.

This completes the Camera Rotation Correction. Exit this window by pressing OK.

Checking the Camera parallax **(A Mechanical Adjustment), Camera is over source.**

The dot method described here is the preferred method for checking the parallax adjustment. It requires no block and provides a more accurate parallax adjustment. If the source beam and camera are in alignment the same errors are seen on either side of the beam.

Assuring the X- ray camera is directly over the center of the source.

Check C:\OPTEK\ Maintenance for a Parallax.5pa program. This program is written at the factory. If it is not present create it this way:
Switch to MM units. Measure a dot or hole. Dots are preferred.
Do a CNC Goto selected feature to center this feature.
Zero on this feature. Do a goto zero.
Do four successive CNC moves, 1.5 mm in each direction and measure the feature again each time.
See the chart below for an example of the measurements before and after this adjustment.

Center	Centered	Location Before	After adjustment	Limits
1	X+1.5 mm	0.120 mm	0.065 mm	+/- 5 um
2	X-1.5 mm	-0.20 mm	-0.066 mm	+/- 5 um
3	Y+1.5 mm	0.145 mm	0.071 mm	+/- 5 um
4	Y-1.5 mm	-0.010 mm	-0.073 mm	+/- 5 um

Y- axis parallax adjustment

The actual Y-axis parallax correction is a mechanical adjustment to the source and power supply.

It should only be performed if it fails the above test .Typically this only occurs after a replacement of the source or a move of the entire machine.

Loosen the capsrews on the source (4) and power supply (4) to slide the units in the Y direction to complete the adjustment. Several tries may be needed.

X - axis parallax adjustment

The actual Y-axis parallax correction is a mechanical adjustment to the source and power supply.

It should only be performed if it fails the above test .Typically this only occurs after a replacement of the source or a move of the entire machine.
Loosen the capsrews on the source (4) and power supply (4) to slide the units in the Y direction to complete the adjustment. Several tries may be needed.

Pixel Calibration: Assuring that the feature measures at the correct size.

All on screen measurements are made by calculating pixels. These pixels have a set value that is determined through a simple calibration process.
If the pixels are not calibrated, any measurements made will be incorrect.

The pixel calibration is based upon the Calibration Slide. The standard Calibration Slide shipped with the system is for reference only. This is not a traceable item. If a traceable Calibration Slide is needed, please contact your OPTEK representative or contact Operations Technology, Incorporated for more information.

Calibration slides come in both Optical and X-ray varieties.
Set the OPTEK to Metric Mode.
The actual size of the dot is found on the back of the calibration slide case. To perform a calibration, the light levels must be set correctly.
Position the slide under the camera so the dot can be seen on the video monitor.
Adjust the light settings until the image is clear on the left monitor.
Do not bloom the image. Use a uniform gray color, no white.
Position the dot as close as possible to the center of the Field of View

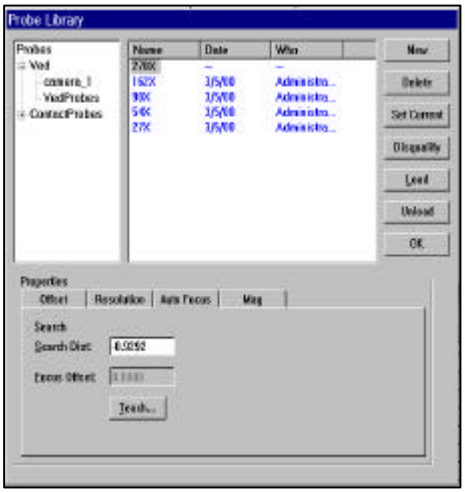
A Quick Overview of pixel calibration: Use Supervisor Password in Probe Library

Goto: Probe \ Probe library\ click the magnification of interest\ and chose resolution tab.
Select "Teach" to edit the calibration.
Enter the size of the calibration hole.
Arrange the calibration probe to cover the hole and double click to cause the probe to **shoot** from dark to light.
Check the feature view to determine if the hole diameter matches the slides given diameter.
The Turret Position is set at the factory for the programmable zoom lens. For all other systems, Turret Position 1 is used.

Detail:

When you do a pixel calibration this dialog box will come up to prompt you to enter the size of the artifact you are using to calibrate with. The size usually comes from the VED glass slide supplied with the system. If you select continue the system will prompt you to measure the specified artifact. If you say cancel it will return you to
Fill in the Standard Size for the dot this size should be taken from the information found on the rear of the slide case. After the appropriate information has been placed in the Standard Size area, click on **Cal. X and Y (Circle).** The circle tool will appear on the video monitor in the center of the screen. Using the digital positioner (track ball). Move the transport system until the dot is as close to the center of the circle tool as possible.
Size the circle tool to fit over the dot properly. **Click the right mouse button**. The system will measure the dot three times. From this the X and Y pixel dimensions will be determined. The present pixel value can be seen in the Pixel Size window**. Click OK** to exit the Learn VED Pixel Size window. **Click OK** to exit the Edit Calibration window.

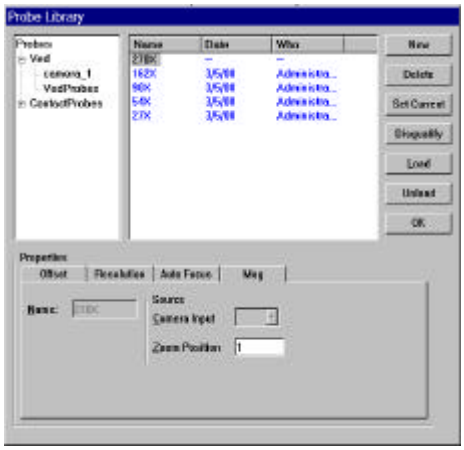
QC5000 Calibration procedure in the “Probe Library”



This is the place to set up your Camera / Magnifications / VED tools and do all your video calibrations.
This operation is for factory representatives who are installing new QC5000 operating system computers to existing machines.

1. Setup your Magnifications.
2. Assign Zoom Positions.
3. Teach Video Edge Detection.
4. Pixel Calibration.
5. Camera Skew.
6. Parcentricity Calibration. If a dual magnification system
7. •Go back and check all the calibrations by measuring the appropriate artifacts.

This is an **extremely important** part of the QC5000.
Probe Library works a lot like Windows/NT explorer. Click something on the left, it opens up and expands to the right.
If you turn on AutoFinish it will make calibrating easier. (Right click in video area)
Remember anything you want to calibrate must be on the right side!



Probe Library: Mag Tab

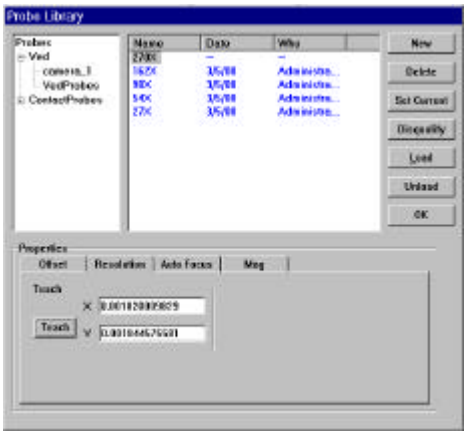
Selecting “new” creates a new magnification.
Selecting delete, removes a magnification.
Disqualify erases the data in the current calibration.
Selecting “load” loads a TP20 into the Probe Rack.
Warning, do not select load unless the rack has been properly setup
Selecting OK exits Probe Library

Probe Library: VED Probes

This is the section of Probe Library where you set up how many points will be taken when you fire a video probe.
Max scans tell you how many points per firing.
Edge type indicates dark to light, light to dark-or first edge algorithm. Type describes which algorithm will be used, Auto, Strongest or First.
Teach performs an edge teach.

Probe Library: Resolution Tab

Select teach to do your Video Pixel Calibration.
You MUST calibrate each magnification.
Notice the size of a pixel at each magnification.
Remember we do sub-pixel edge detection.
The QC5000's edge detection is far superior to the QC4000.
The edge detection is extremely sensitive in low light settings.



Camera Calibration- SKEW

This is the section of Probe Library where you do your Camera Calibration.
If you click on "Teach" Probe Library walks you through doing a camera Skew calibration.
If your camera image is backwards or opposite you can change the **Orientation** here.

Camera Skew works very similar to the QC4000.
Remember to make this one of your first calibrations

Probe Library-Offset Tab

This slide shows the offset from magnification MedHigh to the master mag High. These offset are also known as Parcentricity and Parfocality.
If you click on teach the system will walk you through the calibration. You should start this procedure at MedHigh.
Notice reference is not checked. Only the master probe (HIGH) in the group is checked.
The same calibration needs to be done for each of the other magnifications except High which is the Master Probe in this group.

Pixel Calibration for dual mode image intensified systems.

Calibrate in the Probe Library.

In newer Inner Vision X-ray systems factory equipped or those retrofitted for a dual mode image intensifier the pixel calibration is more involved.
Since some machines can be run in a **high magnification** and a **low magnification** and each has a **wide** angle and a **telephoto** setting the calibration must be done for each of the four situations.
Pixel calibration must be performed at the extents of travel for each situation (wide and telephoto) of the lens in each session. (In later systems with QC5000 this is sometimes handled as a second camera)
Please note: this is a workaround. The highest magnifications should always be the reference magnification if possible.
If the image of the calibrated dot is too large for the field of view find a smaller dot or hole. **Dots are better.** Then measure it at a lower calibrated magnification. Note the diameter at this calibrated magnification and use it as the artifact diameter in the pixel calibration of the higher magnifications diameter.

X-ray Calibration Dot Sizes

Note on the dual mode image intensifier system.
When measuring objects at magnifications between the extents of lens travel. Please lock the intensifier in position with the key lock. **Once locked, perform a pixel calibration on a dot approximately 80% of the field of view then proceed with the measurement program.**
Once the intensifier settings are changed the pixel calibration is no longer valid and must be redone.

A safe way to use this feature is to always have a calibration slide located on the transport, and incorporate a pixel calibration in to your program using user messages where required.

Item	Name	Intensifier	Approximate Magnification	Dot size in MM	Approximate Image size / 17" monitor QC4K	Approximate Image size / 17" monitor QC5K
1	X-ray	Single	20X	10 mm	8"	6"
2	Low Wide	Dual Mode	20X	5 mm	4"	3"
			30X - 50X	2.5 mm	3" - 5"	
3	High Wide	Dual Mode	50X	4mm	7.87	5.9"
4	Low Telephoto	Dual Mode	110X	2mm	8.67'	6.5"
			110X	1 mm	4.33"	3.24"
5	High Telephoto	Dual Mode	210X	.75mm	6.2"	4.65
			210X – 300X	.50 mm	4" – 6"	3"- 4.5"
			500X	.25 mm	5"	3.75"

Transport Movement Calibration in QC5000

QC5000 Grid Calibration Procedure

Over View - Part One

1. Start QC5000 (Ensure that all other optical and mechanical adjustments and calibrations have been done first.) Home the machine.
2. Turn OFF NLEC (Ensure that all other optical and mechanical adjustments and calibrations have been done first.) Menus Bar \Tools\ Options\ Password \ NLEC uncheck "enable"
3. Open the grid measurement program calibration".5pa. See "Part three" to create one if it is not available.
4. Place a breakpoint after skew and zero steps. (Record Mode) Tools \Programming \Editing steps Toggle breakpoint.
5. Open the QC5000 NLEC controller (Tools / Options / NLEC, Click "Calibrate"). **If you do not know how the controller works read the back round information following this procedure.**
6. Right click in background between grid stations.
   - a. ACF option for Certified Grids Only. Choose File \ Import from the ACF file matching the Grid serial number.
   - b. Standard Precision grids only. Choose \ File \ New for other grids with standard precision.
7. Verify columns / rows correct for grid stations to be used.
8. Right click in background between grid stations.
9. Choose Calibrate \ Start
10. Measure the "Zero" point and measure skew point (breakpoint on first measured dot) adjust measurement locations if machine is not in Power Assist mode. **Machine must stop after the skew and Zero steps.**
11. Click on lower left grid station in NLEC controller to see both bottom corners green.
12. Run the calibration program from first measured dot. (Run from Current Step) the tolerances should be red because NLEC is not enabled.
13. When the program is done: **right click in gray area.** Choose File\ Save. Save in c:\QC5000 directory as ("date of cal ".txt) this save is just for a calibration record. It ensures that the export will go to the correct location.
14. **Right click in gray area.** Choose File export as nlec.txt, The Nlec.txt file is created.
15. Turn ON NLEC, (Tools / Options / NLEC, Check box "**enable**")
16. Shut down QC5000 and restart with the homing routine.

Verify the Calibration- Part Two

Choose the calibration program. (File / Open / "calibration check .5pa")
Add fields to the features Template : Check the calibration data by adding "X difference from nominal" and "Y difference from nominal" fields to the "Feature" template window.
Measure the grid with the same program as in calibration with no changes in edge teach or lighting.
The tolerances should now be green with NLEC enabled. Export the data and deviations.
Save as "CAL Data and date of calibration" csv file.
Recalibrate if necessary.

Part Three "OPTEK FACTORY METHOD" and back round on the NLEC controller.

Use if a high accuracy grid and ACF AND DXF data files are available.
Optionally, a part program can be used to measure the calibration grid. (Recommended)
Create a part program from the import of a DXF file, which represents the ACF data.
Turn NLEC off. Goto program properties and uncheck use machine zero.
Record a skew and zero ,You can use Power Assist Mode.
Import the DXF. Choose record.
Select the imported features from the features list.
Choose tools / programming / auto program from features.
In the program window, group **edit the measurement steps** for scan direction. edge transition and tolerance.
Place a toggle breakpoint after the skew and zero steps and save the program. Follow the directions as given in the overview at the beginning of this section. The cal program has now been written.
Note: Both the current QC-4000 NLEC file formats, and the new formats detailed below are supported.

The NLEC Controller

Menu Options

(Right Click)Between dots

File/New
Create a new grid data file from scratch.

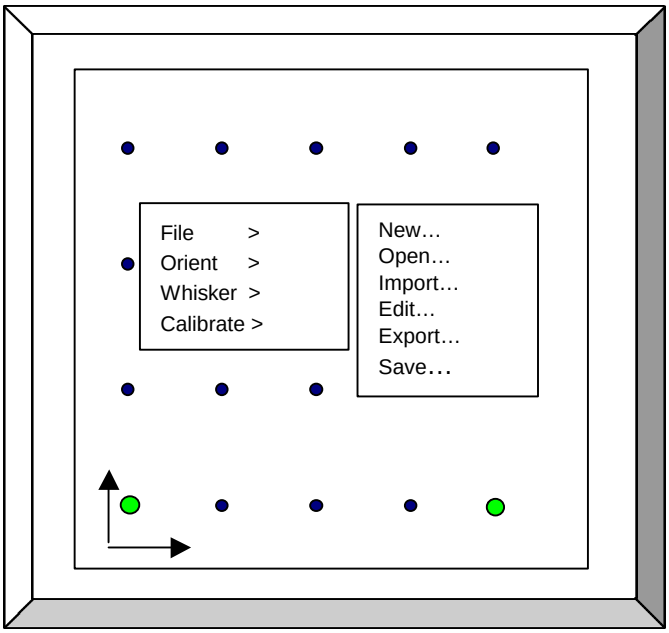
File/Open
Open an existing grid data file (QC5000 v2 format)

File/Import
Import an artifact file ACF (QC4000 format)

File/Edit
Edit the existing grid header information

File/Export
Export the error information to a calibration file (QC4000 format)

File/Save
Save existing grid data along with its calibration information (QC5000 v2 format)



Perform a datum/skew measuring two grid features along an edge. For best results the features should be as far apart as

Orient/Rotate Plus Rotate the grid data 90 degrees counter-clockwise
Orient/Rotate Minus Rotate the grid data 90 degrees clockwise
Orient/Flip Horizontal Flip the grid data about the horizontal axis (top to bottom)
Orient/Flip Vertica Flip the grid data about the vertical axis (left to right)
Whisker/ xxx Select the error whisker magnification, or turn it off
Calibrate/Start Start the grid calibration process
Calibrate/Restart Re-start the calibration process from the beginning
Calibrate/Cancel Terminate the calibration process without saving the data
Calibrate/Import Import the calibration data from the features already in the feature list