ZX-1 Micro Operators Manual

Direct Optical Research Company

ZX-1 micro operators manual version 1.1

Introduction

Thank you for purchasing one of Direct Optical Research Company's ZX-1 micro Interferometers.

Fringes created by introducing an internal reference path can be used to quantify the surface topography of connector endfaces. When measuring PC or APC style connectors, concentric ring patterns will be produced, indicating both the center and radius of curvature. The user may easily switch between inspection and interferometric modes without re-focusing.

The systems fully enclosed design minimizes contamination of the optics, greatly reducing maintenance.

To ensure consistent repeatable results and high reliability, great care has been taken in the design and manufacture of the ZX-1 micro. To achieve the best possible results from your machine, please take the time to read this operators manual thoroughly.

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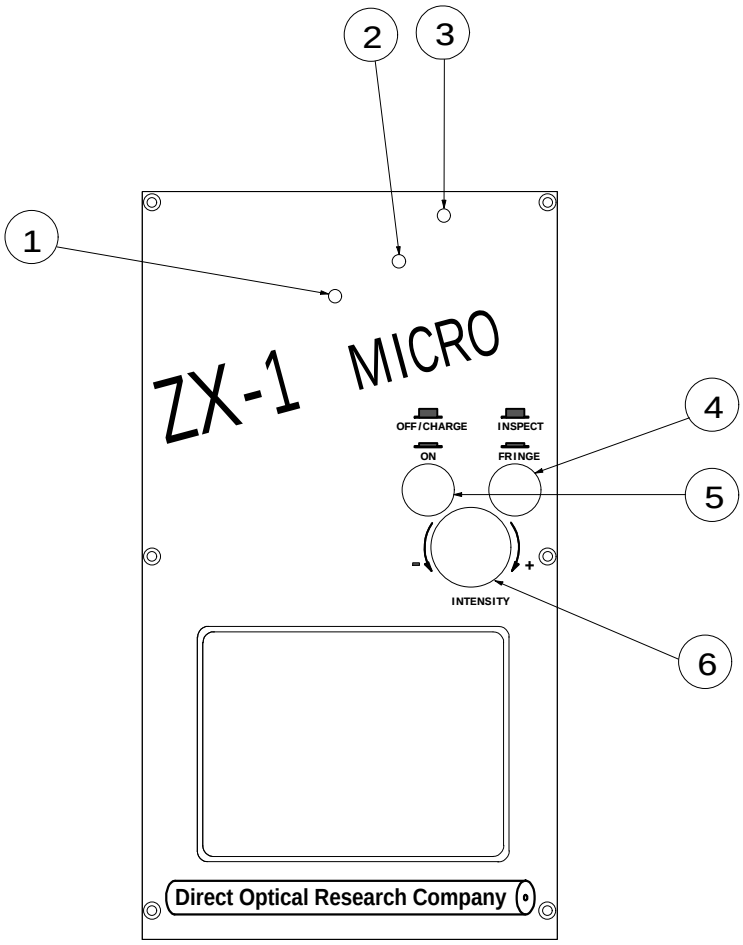
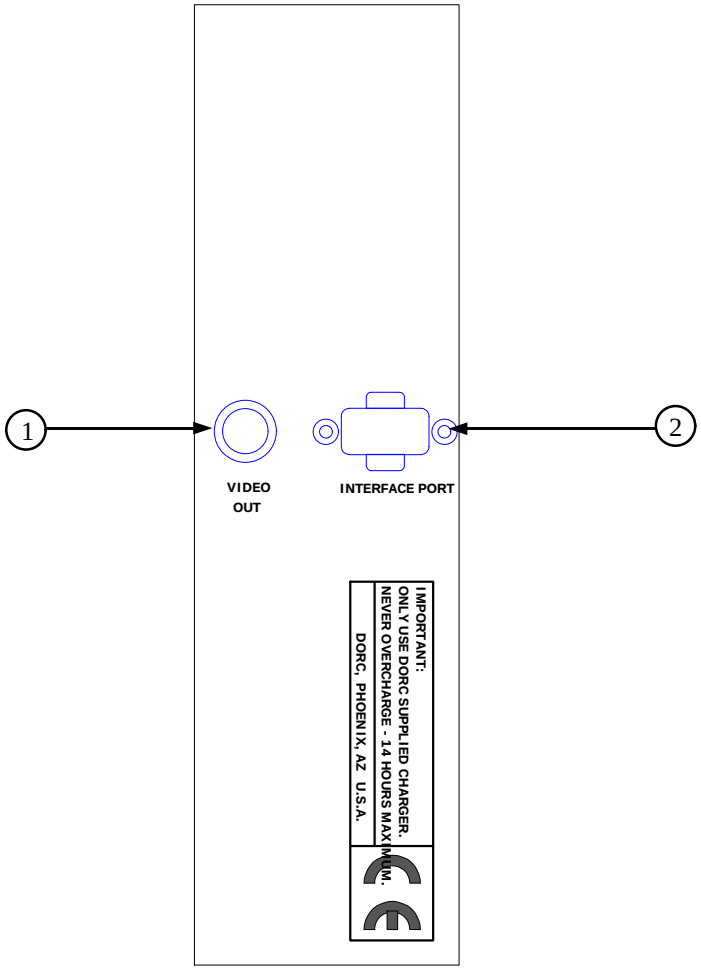
ZX-1 micro front panel controls and adjustments



1	**Reference Mirror Focus**	M2 ball driver adjustment access for setting the reference mirror focus.
2	**Reference Mirror X Axis**	M2 ball driver adjustment access for setting the reference mirror x axis.
3	**Reference Mirror Y Axis**	M2 ball driver adjustment access for setting the reference mirror y axis.
4	**Inspection/Fringe Select Button**	Switches the unit between inspection and interferometric modes. When this button is in the up position the unit is in inspection mode.
5	**ON,OFF/CHARGE Button**	When this button is in the down position the unit will be powered on. When in the up position the unit will be off, and the batteries will be charging if the external power supply is connected to the interface port and plugged into an AC outlet.
6	**Intensity Control Knob**	Use this control to vary the brightness of the image.

ZX-1 micro video and power connections



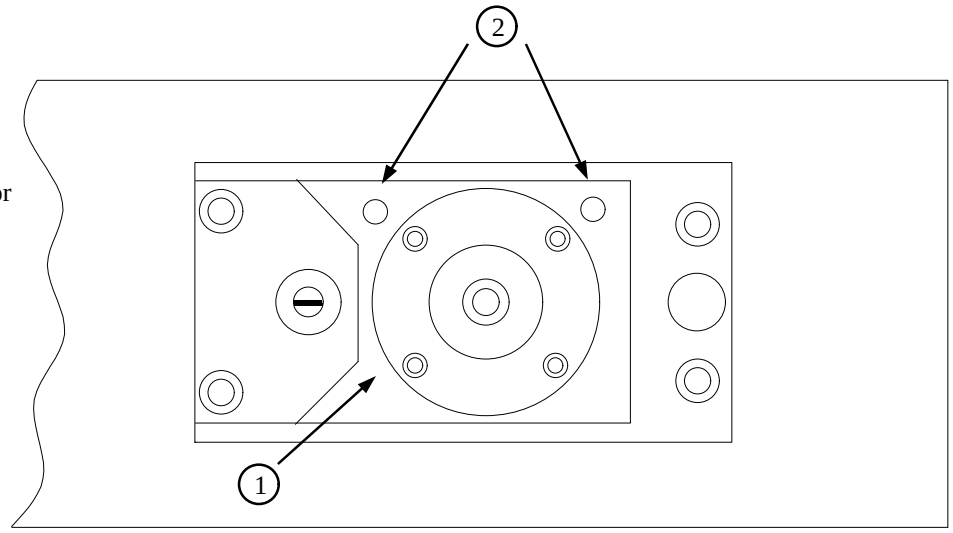
1 If you wish to view the image on an external monitor, connect a BNC cable from the VIDEO OUT port on the ZX-1 micro to a compatible NTSC composite video monitor.

2 The INTERFACE PORT is used to connect the external power supply. When this supply is connected to the interface port and plugged into a AC wall outlet, the ZX-1 micro will not use power from the internal rechargeable battery pack. If you wish to re-charge the internal battery pack, please ensure that the front panel button is in the up position as indicated by the OFF/ CHARGE legend.

NEVER CHARGE THE BATTERY PACK FOR LONGER THAN 14 HOURS. DOING SO MAY DAMAGE THE ZX-1 MICRO AND WILL REDUCE THE RE-CHARGEABLE BATTERY'S LIFE.

1 Universal Holder

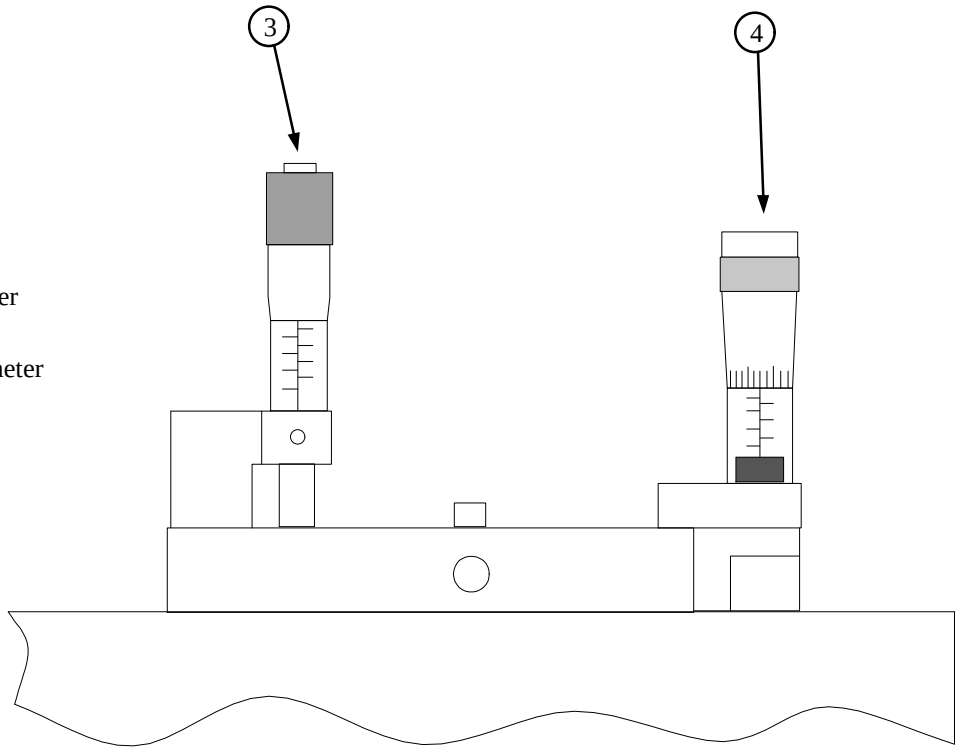
2 Mounting Holes For Adapter Plates



Plan View Of Chuck Assembly

3 Tilt Micrometer

4 Focus Micrometer



Micrometer Controls

Using the ZX-1 micro for the first time

The ZX-1 micro is left purposely discharged when shipping. Before the first use, please ensure that the ZX-1 micro is fully charged. This can be achieved by using the provided external AC adapter plugged into the Interface Port.

NEVER CHARGE THE BATTERY PACK FOR LONGER THAN 14 HOURS. DOING SO MAY DAMAGE THE ZX-1 MICRO AND WILL REDUCE THE RE-CHARGEABLE BATTERY'S LIFE.

Calibrating the ZX-1 MICRO

Checking the calibration involves ensuring that the ZX-1 micro gives exactly the same fringe pattern, relative to the center of the fiber, regardless of the orientation in which the connector is inserted.

Verifying that the calibration of your ZX-1 micro is correct is essential under the following conditions:

1. Immediately after receiving the machine.
2. Immediately after replacing a universal holder.
3. Routinely in a production environment. Use a schedule that best suits your needs. This might vary from once a week or day, to every shift change, depending on your policy.

Since the procedure is extremely quick and easy to perform, we recommend that you check the calibration frequently.

Direct Optical Research can supply an optional "mapped" PC reference ferrule for checking universal chuck calibration. Using these reference connectors is highly recommended. Alternatively, you can use a connector of your own, with an apex which is easily identified (>20μm) to check the calibration. We do however, recommend that you use the same connector each time, for the reference. This way, operators become familiar with what the image should look like when calibrated, rather than working with an unknown connector.

Calibration Procedure

1. Insert the reference ferrule or connector into the chuck. Optimize the image by using the intensity controls and focus micrometer as necessary.
2. Switch to fringe mode if currently in inspection mode and optimize the fringe contrast by adjusting the focus micrometer. Rotate the ferrule such that the apex of the ferrule is at the 12 o'clock position. See figure 1.
Note the magnitude of the apex. i.e. its distance from the center of the fiber.
3. Rotate the apex to the 3 o'clock position, and verify that the magnitude is still approximately the same. See figure 2.
4. Repeat for the 6 and 9 o'clock positions (see figures 3 and 4). Providing that the magnitude of the apex offset is the same size, relative to the center of the fiber, then calibration verification has been established.

A correctly calibrated ZX-1 micro is shown in figures 1-4.

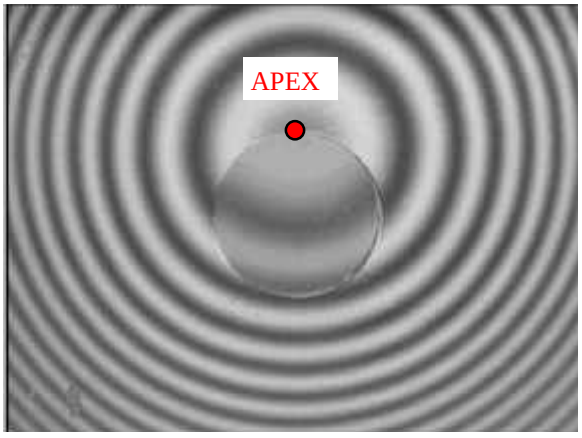


Figure 1 - Connector at 12 o'clock

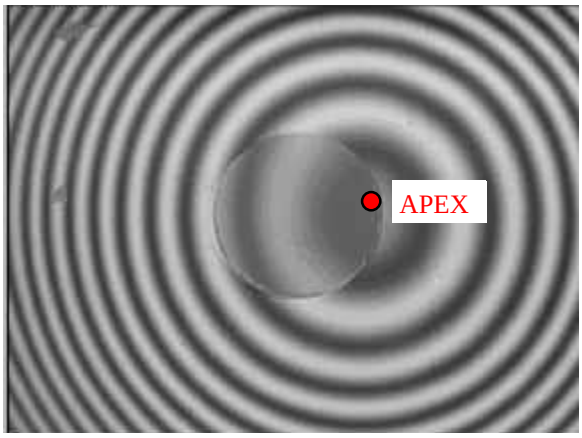


Figure 2 - Connector at 3 o'clock

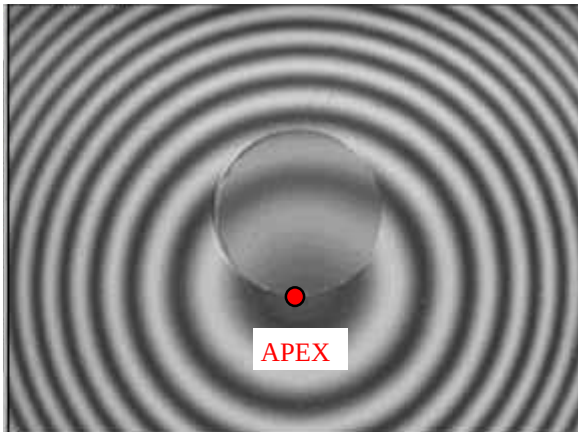


Figure 3 - Connector at 6 o'clock

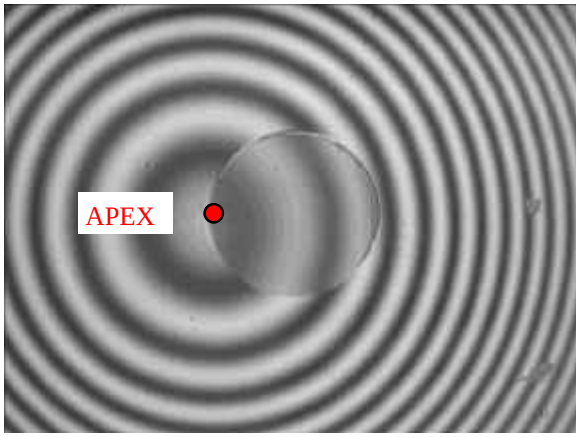
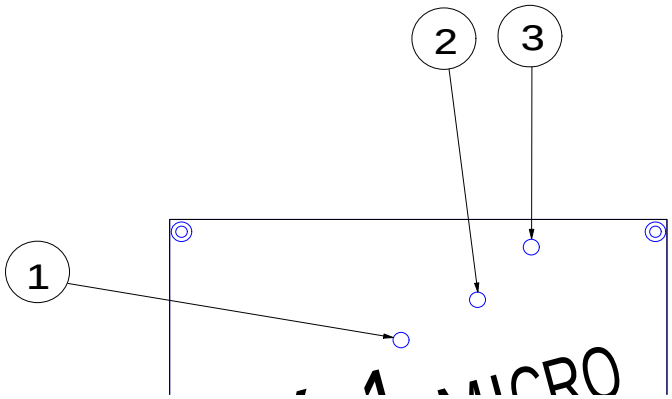


Figure 4 - Connector at 9 o'clock

5. If your system is out of calibration it is necessary to adjust the reference mirror.

There are 3 possible adjustments of the reference mirror, Rx, Ry and Rz. These are identified as (1), (2) and (3) as shown below and are accessible through the front case of the ZX-1 micro. All adjustments are made with the M2 ball driver supplied with the ZX-1 micro. As the reference mirror calibration effects the results on the apex offset parameter, it is advisable to check this routinely as described in the previous procedure. If it is necessary to adjust the reference mirror on a regular basis then this may be due to a worn connector holder. *If this is the case then contact Direct Optical Research Company or your local representative for further technical assistance.*

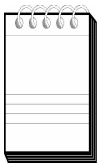
For optimum results, adjustments should be performed with a mapped reference connector, available as an option from Direct Optical Research, however, it is possible to use any spherically polished connector to perform this task. If a Direct Optical Research reference connector is not available then choose a PC connector with an apex offset between 20 and 50 microns. Please note that the following adjustments can be slightly iterative and it may be necessary to repeat the series of adjustments until the final goal is reached.



Ensure that the connector is clean and insert it into the universal holder. Rotate the connector so that the apex lies in the 12 o'clock position. Note the magnitude of the apex.
Rotate the connector to the 6 o'clock position and note the value of the apex. If the apex is larger at the 12 o'clock position than the 6 o'clock position, then it will be necessary to turn the Y axis adjuster (3) in the clockwise direction. If the apex is smaller at the 12 o'clock position than the 6 o'clock position, then it will be necessary to turn the Y axis adjuster (3) in the counter-clockwise direction. **All adjustments will be very small**. Rotate the connector between these two positions, adjusting the Y axis on the reference mirror until the two apex magnitudes appear to be the same value.

Rotate the connector to the 3 o'clock position and note the value of the apex. Rotate the connector to the 9 o'clock position and note the value of the apex. If the apex is larger at the 3 o'clock position than the 9 o'clock position, it will be necessary to turn the X axis adjuster (2) in the counter-clockwise direction. If the apex is smaller at the 3 o'clock position than the 9 o'clock position, it will be necessary to turn the X axis adjuster (2) in the clockwise direction. **All adjustments will be very small**. Rotate the connector between these two positions, adjusting the X axis on the reference mirror until the two apex magnitudes appear to be the same value.

As the X and Y adjusters have some "cross-talk", it is necessary to rotate the connector one final time to ensure that the apex magnitude is constant with rotation.
Finally, switch the ZX-1 micro to Inspect mode on the front panel. Adjust the focus to obtain a sharp clear image. Switch to Fringe mode. If no fringes are seen on the display, slightly adjust the focus on the reference mirror (1) to obtain high contrast fringes.



Move the focus adjuster slowly as it is very easy to miss the focal point at which fringes occur.

Making a Measurement

Once the calibration has been checked, ensure the unit is switched into the inspection mode (inspect/fringe button **out** on the front panel). Clean the connector as per the manufacturer's recommendations. Insert the connector into the universal holder, as shown on page 7, on the top of the ZX-1 micro. The optimum viewing angle of the internal LCD monitor is with the ZX-1 micro tilted back at approximately 60 degrees.

The universal holder is a precision 2.5mm hole. The ferrule should slide in easily. Never force a ferrule into this holder as it will damage the holder and may render the ZX-1 micro unusable.

Adjust the focus micrometer until the image is in focus. Adjust the intensity knob to achieve the sharpest looking image on the monitor. Switch between inspection and fringe modes as required. Providing the image is in focus when in inspection mode, fringes should appear as soon as the unit is switched to fringe mode (inspect/fringe button **in** on the front panel). Only slight adjustment of the focus should be required to achieve very high contrast fringes.
Interpreting the fringes will enable you to pass or fail the sample depending on your quality control criteria.

What Are the Images Telling You?

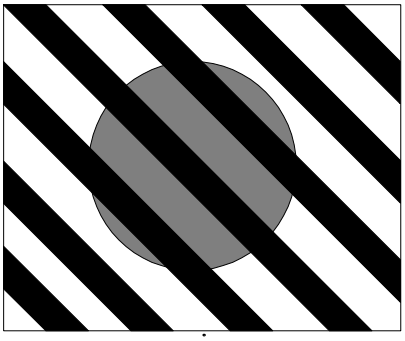
Correctly interpreting the images shown on the monitor is an essential part of the measurement sequence.

In the inspection mode, you are primarily looking for defects such as scratches, digs or contamination. Although the inspection mode is very useful for checking the sample for obvious defects, it cannot provide quantitative information on the surface topography. For this, we have to enable the interferometric or fringe mode. In essence we compare the surface under test to a known optical flat.

With the reference path enabled, constructive and destructive interference is generated between the sample and reference paths. This creates the white and black fringes that become superimposed on the sample's image. Each fringe is equal to a change in height of half the wavelength of the source LED. The ZX-1 micro uses an LED peaking at a wavelength of 660nm, thus the height change from one black (or white) fringe to the next equals a 330nm or 0.33µm change in height. Providing that the diameter over which the number of fringes counted is known, then the angle of the endface of the sample may be easily calculated.

When measuring spherical polishes on connectors, the main objectives are to find the center of the polish with respect to the fiber (apex offset), the fiber height with respect to the ferrule and also to calculate the radius of curvature.

Example



This drawing of an flat polished connector shows 7 fringes across a field of view of 250µm.

End angle can be calculated using the following formula:
Tan (End angle) = (7 x .33)/ 250 µm
Tan (End angle) = 2.31/250 radians
Tan (End angle) = 9.24 milliradians
End angle = 0.529 Degrees

Measuring the Radius Of Curvature

This example shows the interferometer being used to measure a PC style connector. The polish applied to these connectors is designed to be spherical, and the circular fringes produced show this to be true. There are 4 whole visible black rings or fringes across a diameter of approximately 375µm. The diameter was calculated using the fiber diameter of 125µm as a reference.

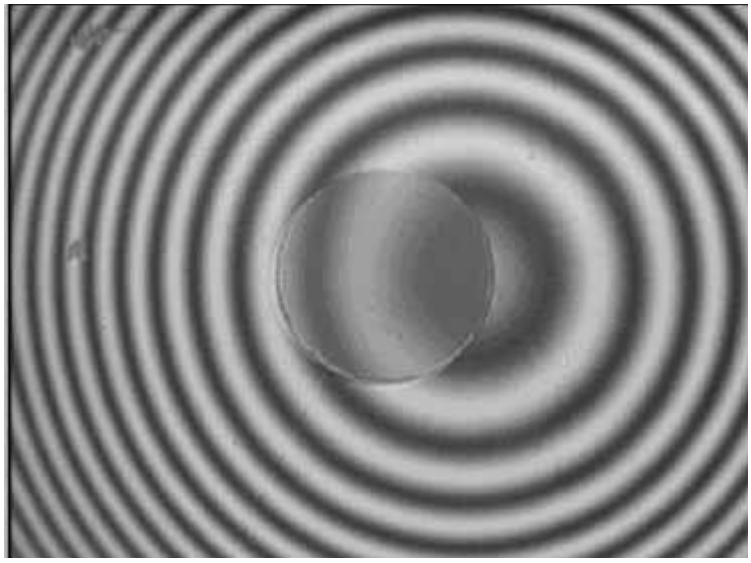


Figure 5. PC with 4 whole fringes.

Using the following formula referring to figure 6:

Radius of curvature (R) = $\frac{(4H \times H) + (D \times D)}{8H}$

Where: H = The number of circular rings (fringes) X 0.33μm
D = The diameter over which the fringes are being counted (μm)
And: Assuming a truly spherical polish.

Radius of curvature = $\frac{((4 \times 4x\ 0.33) \times (4x\ 0.33)) + (375 \times 375)}{8 \times 4x\ 0.33}$

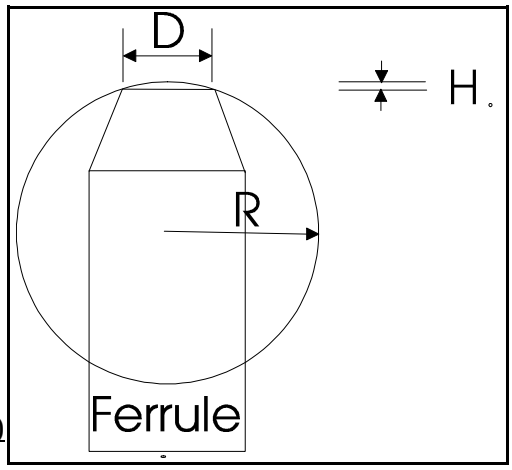


Figure 6

= $\frac{6.96+140,625}{10.56}$ = 13,317 μm = **Radius of curvature = 13.3mm**

Although this method may be used to calculate the actual radius of curvature, it is not normally required for production environments. Depending on the specifications of your products, a maximum and minimum number of rings (fringes), in the field of view, would constitute a pass/fail criteria.

Measuring the Fiber Height

It is possible to estimate the fiber undercut or protrusion using the ZX-1 micro. To achieve this it is necessary to observe how the fringes change their direction as they pass from the ferrule surface to the fiber surface. One whole black or one whole white fringe represents a change in height of 165nm. By estimating the change in fringe width at this transition, it is possible to approximately calculate the magnitude of the fiber height relative to the ferrule surface.
An example is shown below.

Fringe on ferrule surface

Fringe on fiber surface

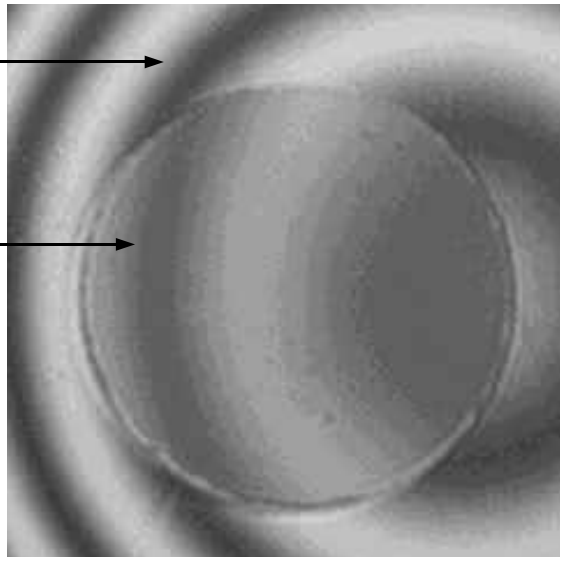


Figure 7

In the example shown in figure 7, the fringe moves to the right by almost one whole black fringe indicating a fiber height of approximately 165nm. As the fringe moves towards the apex, this also indicates that this is in fact undercut rather than protrusion. If the fringe moved away from the apex, then this would indicate fiber protrusion.

In a connector which has a small apex offset or large radius of curvature it is possible that no fringes pass through the fiber/ferrule interface. If this is the case then use the tilt micrometer to tilt the connector slightly until a fringe passes through this region.

Do not forget to remove the tilt once the fiber height has been measured!

Measuring the Apex Offset

When measuring the center of the radius of curvature of the polish with respect to the center of the fiber (commonly known as apex offset), a limit is normally set by specifying the distance from the center of the fiber to the center of the circular fringes. Knowing that the fiber diameter is 125µm, it would be safe to assume that any connector found with the center of the fringes outside of the fiber diameter has an apex larger than 62.5µm. The current standards specify an apex less than 50µm. The example below shows a connector with an apex offset of approximately 62.5µm.

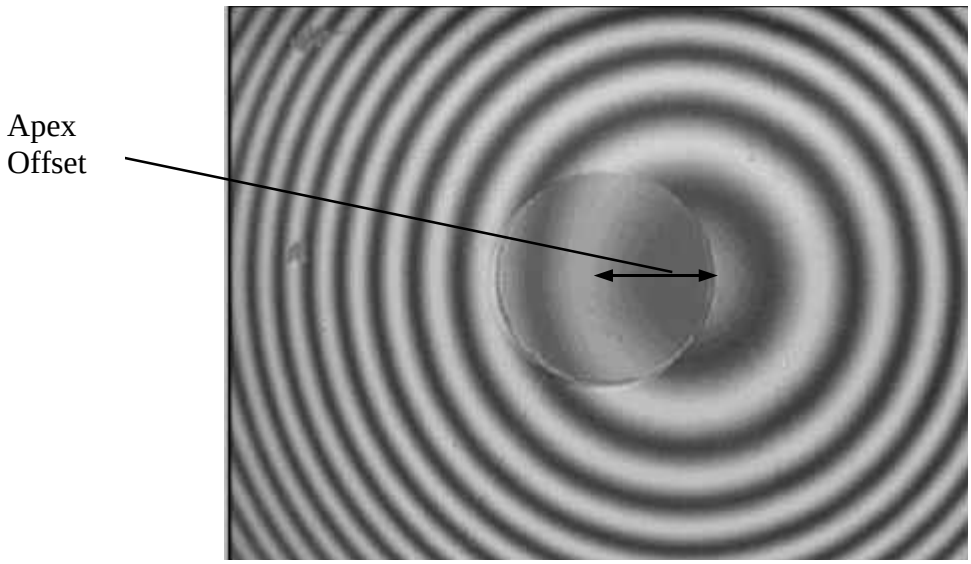


Figure 8

Measuring Angled Polished Connectors

The most popular angled polished connectors are the 8 degree FC/APC, ST/APC and SC/APC. The Option /01-m FC connector adapter, provides a key-way for the Angled FC/PC. The options /02-m and /03-m provide keying plates for ST and SC respectively. When measuring angled connectors they must be measured with reference to their keys. This is achieved by fitting the appropriate adapter plate over the universal chuck.

1. Fit the adapter plate over universal holder using the two M3 screws. ***Do not over tighten.*** See page 7 for location of the threaded holes. Insert the connector into the chuck aligning the key to fit into the plate correctly. Adjust the angular micrometer until it is felt just touching the mechanical stop. This is the 8 degree position.

The universal holder is a precision 2.5mm hole. The ferrule should slide in easily. Never force a ferrule into this holder as it will damage the holder and may render the ZX-1 micro unusable.

2. Switch to inspection mode and adjust the focus micrometer until the image is in focus. Adjust the intensity knob to achieve the sharpest looking image on the monitor. Switch to interferometric mode and optimize the image. On a perfectly angled and polished connector, the circular fringes will be centered around the fiber resembling a standard PC connector.
Should the apex offset be off to the left or right of the center of the fiber, this indicates that the angle of the polish is not exactly 8 degrees. If the apex offset is vertically offset from the center of the fiber, this indicates an error in the relationship of the ferrule's polish with respect to the key of the connector. This is shown in figure 9 below. For clarity we have drawn a circle to represent the center of the fiber and a square to represent the apex offset. As the apex lies to the right of the center of the fiber then the angle is more than 8 degrees.

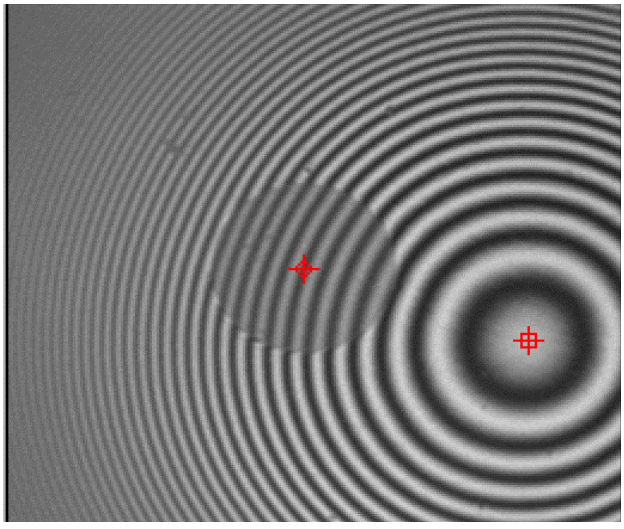


Figure 9

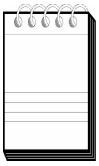
Troubleshooting guide

The following troubleshooting guide should help solve most problems that you might encounter while using the ZX-1 micro Interferometer. In the unlikely event that this guide cannot locate or solve your problem, please refer to page 20 - **What to do if all else fails!**

ZX-1 micro is totally inoperable.

Check that the unit is plugged in to an active power outlet using the interface port as the internal rechargeable battery pack may be fully discharged.

To check if the ZX-1 micro has power, remove the connector from the universal holder, turn the intensity knob fully clockwise and look down the universal holder. The red light from the led should be clearly visible.



The led is eye-safe. However, treat the led the same way as a bright light bulb and do not look at the led directly for longer than necessary .

If no visible light is seen and the front panel button is in the on position, please refer to page 20.

No image is seen on the internal monitor.

Ensure that the unit has power as above.

Ensure that a sample is correctly inserted into the universal holder and focused.

If possible connect an external monitor to the ZX-1 micro. If an image is displayed on the external monitor then the problem is with the internal monitor. If this is the case then refer to page 20 to obtain additional assistance.

An image is seen - but it is too dark, bright or grainy.

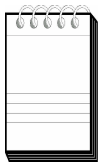
The most likely cause for any of these conditions is incorrect settings of the ZX-1 micro's intensity control.

ZX-1 micro does not switch between inspection and interference modes.

Providing the ZX-1 micro is powered up, a motor should be heard turning each time the inspect/ fringe button is toggled. If this motor is not heard then an internal fault should be suspected. Refer to page 20 to obtain additional assistance.

No fringes are seen when switching to interferometric mode.

In a correctly calibrated system, and assuming that the image in inspection mode is focused, fringes should be seen as soon as the reference path is switched in by selecting fringe mode. If fringes are not seen, re-focus in inspection mode. Switch back to fringe mode and see if fringes are now visible. Providing fringes are now visible, no further action is required. If fringes are still not seen then the reference mirror focus should be adjusted following the procedures on page 8, "Calibrating the ZX-1 micro."



The ZX-1 micro must be in interference mode to see the fringes. Ensure that the switch labeled Inspect/Fringe on the front panel is in the Fringe position in order to see the interference fringes.

Fringes are seen but they are very low contrast.

Adjust the focus of the sample very slightly to maximize the contrast. If this does not work then you may have insufficient light to produce high contrast fringes. Turn the intensity control on the front panel of the ZX-1 micro clockwise to compensate.

Interferometric image changes each time you load the same sample.

This effect is almost certainly caused by incorrect calibration. Follow the calibration procedure on page 8 of this manual to correct this problem.

Check to see if the ferrule being tested is significantly undersize. This would cause the sample to easily move off the interferometer's optical axis, introducing a random error. This effect can be easily identified by switching to inspection mode, and applying light pressure to the rear of the sample. Correctly sized samples will not move position on the monitor.

Check to ensure that there is no tilt on the tilt micrometer if measuring a PC connector. Another reason could be due to excessive wear on the universal holder. If this is the case please contact Direct Optical Research to purchase a replacement.

Fringes are seen - but only over part of the sample.

This effect is seen when the surface height of the sample exceeds the coherence length of the source. Either the angle of the polish is too large to measure, or the radius of curvature in the selected field of view is too small.

When measuring angled connectors, this effect may be seen while adjusting the tilt micrometer to locate the sample's true angle. As the chuck approaches the angle of the sample, this effect will disappear.

Connector ferrule will not fit in chuck.

Most connector manufacturers place extremely tight tolerances on the diameter and circularity of their ferrules. To maximize measurement accuracy, we manufacture holders that are only a few microns larger than the accepted largest tolerance. If your ferrule does not fit into the chuck then it is probably out of specification or may have been contaminated with dirt or polishing slurry. Try cleaning the connector ferrule with a suitable solvent.
Although we could manufacture holders that would accept marginal or out of specification ferrules, we would have to sacrifice system repeatability to do so. Please feel free to contact us if our holder diameter does not meet your requirements. If mechanically feasible we will be happy to make a suitable custom modification.

What to do if all else fails!

All of DORC's products are designed and manufactured to minimize maintenance or failure. In the unlikely event that your ZX-1 micro develops a fault, please do one of the following:

Outside the U.S.A.

Contact the representative through which the unit was initially purchased and explain in detail the problem you are experiencing. They will either be able to solve the problem, or arrange for the repair of your ZX-1 micro.

Within the U.S.A.

Contact the representative through which the unit was initially purchased and explain in detail the problem you are experiencing. They will either be able to solve the problem, or arrange for the repair of your ZX-1 micro.

or

Contact one of our service representatives at the following address:

Direct Optical Research Company
Attn: Service Manager
734 West Highland Avenue
Phoenix, AZ 85013

Tel: 602-279-2099
Fax: 602-279-2025
E-mail: support@dorc.com
www.dorc.com

We understand how frustrating it is to have a faulty piece of test equipment. We will do our best to resolve any problems or failures you might have, both quickly and efficiently. Please be prepared to provide us with any additional information, or test results we may require. This will help us to make a better evaluation of your problem, greatly increasing the accuracy of our diagnosis, and the speed of it's resolution.