Reflecting Objective User Guide

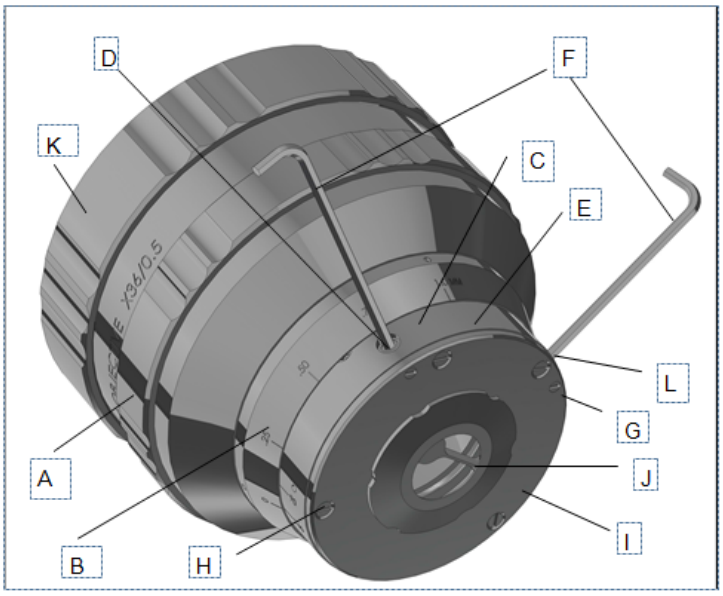
X25 NA 0.40 (5003), X36 NA 0.50 (5004), X52 NA 0.65 (5006), X74 NA0.65 (5007)

Beck Optronic Solutions

Introduction

The reflecting objectives designed and manufactured by Beck Optronic Solutions are based on the work of CR Burch. In his 1947 paper he showed that, by careful selection of the radii and their separation, a 2-mirror reflecting microscope objective can be free of spherical aberration, coma and astigmatism.

Theory also shows that, by having an adjustment for the separation between the two mirrors, the image quality can be corrected for a range of tube lengths and cover glass thicknesses. This compensation is available to the user in the x36, x52 and x74 objectives and is preset to the customer requirements in the other models.



Beck Optronic Solutions Reflecting Objective

On Receiving your Objective...

When you first receive the objective, unscrew it from the box and inspect it objective carefully to ensure that there has been no transit damage. Check also that the adjustment keys and the silverpoint slide have been included.

Mounting the Objective

The Beck Optronic Solutions reflecting objectives are mounted using a standard Royal Microscopical Society thread.

You will notice that the clamp ring (K) appears to be loose when the objective is not mounted. This is part of the feature that allows you to mount the objective in any preferred orientation. Screw the objective into the microscope or mounting plate but do not tighten it. Holding the clamp ring in one hand, turn the microscope body to a suitable orientation with the other. Then, hold the body in that position and fully tighten the clamp ring. You may use this adjustment to ensure that the tube length scale is easily visible or the centering screws are accessible or that the spider legs are in a specific orientation.

Summary of the Mounting and Alignment Procedures

These are described in more detail elsewhere in this document.

a) Mount the lens in your system using the RMS mounting thread. Orientate the body to suit your application before tightening the clamp ring.

b) Set the scales so that the tube length and cover slip thickness are correct for your application (except 5003 which is preset)

c) While viewing the silverpoint slide, adjust the centration screws to give a perfect image.

It is recommended that the centration is checked on a regular basis and particularly when the objective is demounted or transported or whenever the tube length or cover slip thickness correction is altered.

The Tube Length / Cover Slip Setting (except x25 NA 0.40)

It is a particularly nice feature of the Burch objective that changes in the tube length and the cover slip can be fully compensated by a small adjustment in the separation of the two mirrors. On the lower part of the objective are two adjacent scales; one showing the tube length (C) the other showing the cover slip thickness (B). Simply set the cover slip thickness against the appropriate tube length. [Note that the cover slip thickness is for normal cover slips made from a borosilicate crown glass (refractive index about 1.51). Please contact BOS for a correction factor if your cover slip is from a material with a significantly different refractive index. This setting ***must*** be performed before centring the secondary mirror.

Mirror Centring Adjustment

It is typical of this type of mirror system that the image quality is particularly sensitive to very small centring misalignment of the secondary mirror. In order to remove this centring error a 'silverpoint' slide is provided. It is a metallised microscope slide which has many tiny pinholes in the region of 0.5 to 5 micron diameter. When correctly adjusted and focused, their images should be a perfect 'Airy disc' encircled by two or three diffraction rings. Mount the slide, illuminate it by transmitted light, focus it and find a region showing only small pinholes. Adjust the secondary mirror by using the two Allen keys (F) in grub screws (set screws) (D).

The aim is to eliminate any coma (which is asymmetric - comet-like) so that the images become perfectly circular. You will be confident that the objective is correctly adjusted when each point image is perfectly circular, the diffraction rings are continuous and the image looks the same either side of best focus. [The procedure is described in more detail, with example images, in document BUG_ALIGB_ROG which is available at www.reflectingobjectives.com]

This adjustment ***must*** be repeated after any change in the tube length/cover slip setting.

Further Notes:

a) Centring Screws

When the objective leaves the factory, the adjusting screws (L) are deliberately tight to help eliminate misalignment during transit. In order to adjust the centration of the secondary mirror, it may be necessary to adjust the friction screws (G) in the front plate (I). These friction screws bear against the adjusting screws and by very slightly releasing them the force necessary to adjust the centring screws will be reduced.

Take care not to confuse the friction screws with the front plate retaining screws (H) which lie adjacent to them. The friction screws are the smaller and are black whereas the retaining screws are larger and are chrome plated.

b) Working Distance – Front

The front plate (I) carries a removable front stop (J) which ensures that no stray light can pass through the system. However, it does cause a slight reduction in the working distance. This stop is needed as, without it, it is possible for light to pass directly through the objective without being reflected from either mirror. If this were to happen it would cause serious flare in the image plane and would prevent much of the finer detail in the specimen from being seen. The use of the front stop (J) is, therefore, strongly recommended. However, if a slightly longer working distance is required and the illumination of the object can be restricted to the field of view only, the stop may be removed.

c) Centring the Optics

When centring the system, you must use the objective at the tube length and cover slip thickness that you have set on the scales. The tube length/cover slip setting **must never** be performed after the centring process as this adjustment affects the centration of the secondary mirror

A major feature of the reflecting objective is that it has no chromatic aberration. This means that, even if you have no means for observing an image at a wavelength outside of the visible region, you can properly align it in the visible region before mounting in your system.

Specifications

	5003 x25 NA 0.40	5004 x36 NA 0.50	5006 x52 NA 0.65	5007 x74 NA 0.65
Focal Length	8.00mm	5.4mm	3.5mm	2.6mm
Magnification	x25	x36	x52	x74
Field of view at the object	0.72mm diameter	0.50mm diameter	0.34mm diameter	0.24mm
Numerical aperture	0.40	0.50	0.65	0.65
% of central area obstructed	22.5%	13.0%	17.5%	13.3%
Working distance (approximate)	14.5mm	8.6mm	1.9mm	1.0mm
Mounting thread	RMS, 0.8" 36 T.P.I, BSW			

References

The first paper to show that a high NA, high magnification microscope objective could be made from 2 spherical mirrors is that of CR Burch - Proc Phys Soc of London 59, 41, 1947

There is an excellent paper by Seymour Rosin entitled 'Inverse Cassegrain Systems' - August 1968, Vol 7, No 8. This paper develops the aberration theory and shows many variants of the two-mirror system.

About Beck Optronic Solutions

BOS has a reputation for excellence in design and manufacture of precision optics that can be traced back over 175 years. Based near London, UK, BOS delivers complex, integrated electro-optic systems for defence and commercial use across the electromagnetic spectrum from UV to LWIR.

For pricing or further information please contact us at:

t: +44 (0) 1442 255755 | **f:** +44 (0) 1442 210770 | **e:** info@beckoptronic.com | www.beckoptronic.com

Registered in England No 09072729 | VAT No GB 196 4396 58

Registered office: Focus 31 – West Wing, Mark Road, Hemel Hempstead, Hertfordshire HP2 7BW, UK

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