

Optem[®] FMOS

Fixed-Magnification Optical System

Micro-Inspection Lens System

Optem FMOS in offers exceptional value and versatility while offering precision micro-inspection imaging over a broad range of parameters. FMOS consists of a wide range of upper and lower lens modules which, when combined in various configurations, yield a broad variety of static working distances and magnifications at the image plane of your CCD.

FMOS Lower Function Modules offer a variety of manual and motorized focus, illumination, custom configuration and objective integration options. The recent expansion of the FMOS line uses a special adapter for coupling Optem Zoom 125C Lower Modules to the FMOS upper tubes. This provides integration options with larger illuminated FOV's, polarized light and motorized focus.

Min. Mag. Configuration	(FT60 Upper Fixed Tube + B190 Lower Module)
Magnification Range	0.3X
Numerical Aperture	0.010
Resolution	30 lp/mm
Depth-of-Field	5.8 mm
Working Distance	195 mm
FOV (1/3" Camera)	11.9 x 15.9 mm
FOV (1/2" Camera)	15.9 x 21.2 mm
FOV (2/3" Camera)	21.9 x 29.2 mm
FOV (1" Camera)	31.8 x 42.4 mm
Max. Mag. Configuration	(FTM500 Upper Fixed Tube + Basic Obj Module + 50X MPlan APO Obj.)
Magnification Range	125X
Numerical Aperture	0.55
Resolution	1650 lp/mm
Depth-of-Field	0.0019 mm
Working Distance	13 mm
FOV (1/3" Camera)	0.029 x 0.038 mm
FOV (1/2" Camera)	0.053 x 0.070 mm
FOV (2/3" Camera)	0.59 x 0.78 mm
FOV (1" Camera)	0.077 x 0.10 mm



Specifying Your Optem FMOS Lens System

To specify your Optem FMOS Fixed-Magnification Lens System identify the parameters of your application and select the modular components which deliver the optimum imaging solution.

STEP 1. Determine the Field-of-View (FOV) you require by choosing your intended camera format (1/3", 1/2", 2/3" etc...), and using the dimensions of that camera format to calculate the optical magnification required (see camera dimensions below):

$$\text{Optical Mag.} = \frac{\text{Camera dimension (mm)}}{\text{FOV desired (mm)}}$$

STEP 2. The FMOS System requires a Fixed Tube and a Lower Function Module. First determine what Lower Function Module you require. Options include; **Basic (B)**, **Coaxial Illumination (C)**, **Internal Focus (F)** and **Internal Focus with Coaxial illumination (FC)**. Note: There are separate [Optical Performance Charts](#) for varying illumination methods and objective integration:

- Oblique (Ring light) or Substage Illumination (p. 06)
- Coaxial Illumination (p. 07)
- Infinity Corrected M PLAN APO Objectives (p. 08)

STEP 3. Choose the appropriate working distance you require for your application. By referring to the Optical Performance Charts TOP AXIS, choose the best working distance (WD). Keeping in mind, the higher resolution (NA) will be achieved with the shorter working distances. (see [Optical Performance Charts p. 06-08](#)).

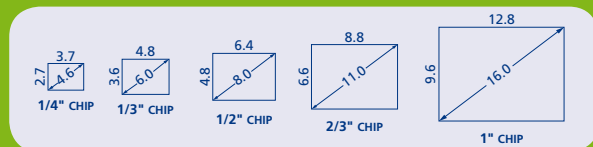
STEP 4. Select the Fixed Tube: The Fixed Tubes are shown on the LEFT AXIS of all [Optical Performance Charts](#), and each Fixed Tube has an optical focal length associated to it. When combined with the focal length of the lens in the Lower Function Module, the two create a magnification factor. This magnification factor, in relation to your camera format, will yield a specific Field-of-View (FOV), which is displayed in the box where the LEFT AXIS and TOP AXIS intersect.

STEP 5. When completed, you will have identified the following two components required for your functional FMOS Lens System.

- **Fixed Tube**
- **Lower Function Module**

Useful Formulas & Definitions

CAMERA CHIP DIMENSIONS (mm):



DEPTH-OF-FIELD (DOF):

The axial depth of the space on both sides of the object plane within which the object can be moved without objectionable loss of sharpness.

$$\text{DOF} = \lambda \div \text{NA}^2$$

λ = Wavelength of Light (Green Light = 0.000550mm or 550nm)

MAGNIFICATION:

The ratio of image size to actual object size.

$$\text{Optical Mag.} = \text{Camera Chip dim.} \div \text{Field-of-View (FOV)}$$

$$\text{Electronic Mag.} = \text{Monitor Diag.} \div \text{Camera Diag.}$$

NUMERICAL APERTURE (NA):

A measurement of the light collecting ability of the lens. A higher NA translates to a brighter image, better resolution, and shallower depth-of-field.

Components and New Features

Upper Fixed Tubes



FIXED TUBES (FT) – As the upper most component of your Optem FMOS Lens System, Fixed Tubes function to provide the desired magnification factor and correct back focal distance to the sensor of your C-mount camera.

FIXED TUBES, MINI (FTM) – For installations where space is at a premium, Mini Fixed Tubes deliver the same optical performance as FT Fixed Tubes in a fraction of the length.

Lower Function Modules

Lower Function Modules dictate working distance. When configuring your FMOS Lens System, select from a wide array of Function Modules to integrate the specific functionality desired in your Lens System:



BASIC (B) MODULE - This component delivers the most economical and space efficient system when ambient or independent illumination is planned and system focus can be affected through staging.



INTERNAL FOCUS (F) MODULE - Self-contained 10mm manual focus for precision image adjustment without manipulating staging or disturbing image stability.



COAXIAL ILLUMINATION (C) MODULE - Introduces coaxial (vertical) illumination using fiber optic, halogen or LED coaxial illuminators. (See p. 04 and p. 07)

INTERNAL FOCUS, COAXIAL ILLUMINATION (FC) MODULE

- Introduces 10mm manual internal focus with coaxial (vertical) illumination.



OBJECTIVE MODULES - Afford integration of Infinity-Corrected Objectives utilizing one of the following Modules: **Basic Objectives Module; Coaxial Illumination Objectives Module; Internal Focus Objectives Module; Internal Focus, Coaxial Objectives Module.** Objectives Modules feature M26 x 36T threads to accept Optem and Mitutoyo Objectives (See p. 08). An RMS thread adapter is available for Olympus and Nikon Objectives.



VARIABLE WORKING DISTANCE AUXILIARY LENS

- Intended for applications requiring working distances from 127 (5") – 432mm (17"), (See p. 09).

OPTEM ZOOM 125C LOWER MODULE ADAPTER

- Expand the modular flexibility of your FMOS Lens System with the imaging and functional versatility offered by Optem Zoom 125C Lens System Lower Function Modules, including:

- 15mm Manual or motorized fine focus
- 5mm Manual or motorized fine focus with coaxial illumination
- Polarized fiber optic coaxial illumination
- Infinity Macro Lens Accessory (See p. 09)



RESOLUTION:

The ability to distinguish or separate fine detail. Expressed in line pairs per millimeter (lp/mm). Numerical Aperture (NA) is the controlling factor over resolution... the higher the NA, the brighter the image, and the better the resolution.

Visual Resolution (lp/mm) = 3000 X NA
 $1 \div \text{lp/mm} = \text{Approx. microns } (\mu) \text{ resolved}$

VIGNETTING:

The blockage of rays from off-axis object points by constraining apertures. Vignetting results in the darkening of the corners on your monitor.



Illumination Options

Illumination Options

The Optem FMOS Lens System offers a variety of illumination options to meet a variety of imaging requirements.

04

You have two basic illumination options which can be integrated with your FMOS System... coaxial illumination or oblique ringlight illumination.

Coaxial Illumination Options

Coaxial (or vertical) illumination is most useful on highly reflective objects. Optem's Coaxial Illuminators project cool, white light perpendicularly onto the specimen for exceptional contrast and field uniformity (Refer p. 07 for performance).

Select from one of several coaxial-equipped lower function modules when specifying your FMOS lens system and integrate one of the three following options of coaxial illumination (See FMOS System Diagram p 10-11).

LED COAXIAL ILLUMINATORS – Programmable 1-Watt LED Coaxial Illuminators offer reduced power requirements and heat generation with substantial service life gains. LED Coaxial illuminators are available in straight and right-angle configurations to meet your specific space requirements, and feature compact designs and simplified cable management. These can be driven by stand-alone, single-channel programmable controllers. Coaxial LEDs emit brilliant cool light in the visible spectrum and deliver virtually identical optical performance to our fiber optic and halogen Coaxial Illuminators.



FIBER OPTIC COAXIAL ILLUMINATORS – Integrate coaxial illumination from your choice of either 110V or 220V Optem VSI Fiber Optic Illuminators using flexible 40- or 60-inch flexible fiber bundles.

10W HALOGEN COAXIAL ILLUMINATORS – When economy is high priority, Halogen light sources are available with a 6V Variable Transformer (110V / 220V). Ventilated lamphouses are required for use with halogen illuminators (see System Diagram p. 10-11).

POLARIZED LIGHT – When imaging highly reflective subjects, Polarizer Modules with built-in Analyzers are available to introduce polarization to both LED and Fiber Optic Coaxial Illumination paths.

Oblique Ringlight Options

Dark Field Illumination is generally used on 3-D objects to cast light rays at an angle onto an object, thus better defining its surface profile. Optem offers the following dark field illuminators for the FMOS System (Refer p. 06 for performance).

FIBER OPTIC RING LIGHTS – Oblique Ringlight Illumination is ideal to better define features of dimension rich subjects. Driven with the same VSI Fiber Optic Illuminator as conventional coaxial systems. Qioptiq offers Ringlights specifically designed for a variety of configurations, including integration of objectives (see System Diagram p. 10-11).

Motorization and Configuration Accessories



Motorizing Lens System

Optem FMOS Lens Systems can be specified with motorized focus functions utilizing Zoom 125C Lower Function Modules. Select from Stepper or DC Motor options.

STEPPER MOTOR – The stepper motors provide accurate repeatability of zoom magnification and/or focus using a Hall-effect sensor to set repeatable home position. A desktop rocker switch controller offers manual control and features an RS-232 port for automated computer control. Includes controller instructions with a list of RS-232 control commands, a Windows® control program, and startup LabVIEW control program. An OEM controller board version is available for streamlined integration.



DC MOTOR – DC motors provide continuous, fine adjustment and control of focus function. A desktop joystick controller offers simultaneous control of both zoom and focus functions.



Configuration Accessories

Extend the versatility of your FMOS Lens System with two new innovations in form and function.

MID-SYSTEM RIGHT-ANGLE MODULE – This accessory allows the introduction of a 90° of your optical axis at the mid-body point of your FMOS Lens System. Users can now integrate any FMOS, Zoom 70XL or Zoom 125C Lower Function Modules below the right-angle turn, maintaining full working distance and affording greater configuration flexibility. *NOTE: the Mid-System Right-Angle Module produces a mirror (reversed) image.*



DUAL-MAGNIFICATION MODULE – Simultaneously integrate two Optem FMOS Fixed Tubes and/or Zoom 70XL Zoom Modules with TV Tube, over a single subject. This permits real-time dual fixed and/or zoom imaging of your object of interest with your choice of magnifications, FOVs, camera formats and camera types. Integrate any of the full range of FMOS, Zoom 70XL and Zoom 125C Lower Function Modules below the Dual-Mag Module, or integrate compact vertical illumination through the compact Dual-Mag coaxial block.



Optical Performance

Infinity Macro Lens Accessory

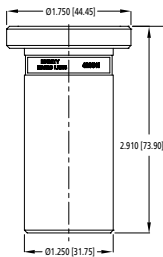
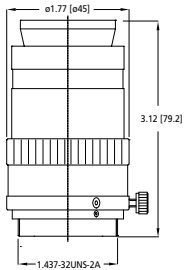
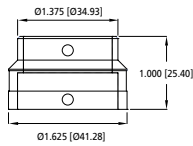


Working Distance	Magnification*
50 mm	0.37X
100 mm	0.25X
150 mm	0.18X
200 mm	0.14X
300 mm	0.1X
400 mm	0.08X

* Magnification factor is relative to B90/F90 values as shown on p. 06.

Beyond 500 mm, the lens can be thought of as a video lens with focal lengths and f# as follows:

Working Distance	EFL Low	EFL High	F# Low	F# High
500mm	18	165	13.8	33
1m	18	190	13.8	33
10m to infinity	18	225	13.8	33



Optical Performance

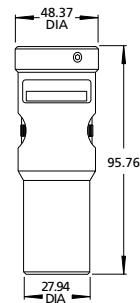
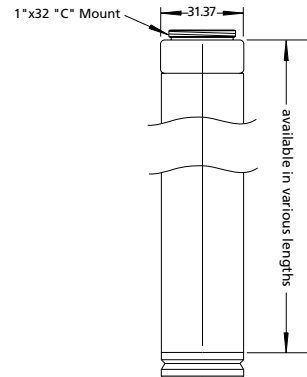
Variable Working Distance Lower Module



Working Distance	Magnification*
5"	0.288X
6"	0.253X
7"	0.226X
8"	0.202X
9"	0.184X
10"	0.169X
11"	0.158X
12"	0.147X
13"	0.138X
14"	0.130X
15"	0.123X
16"	0.116X
17"	0.109X

* Magnification factor is relative to B90/F90 values as shown on p. 06.

09



FMOS Lens System Diagram

Illumination

30-16-40-000
40° FLEX BUNDLE

30-16-60-000
60° FLEX BUNDLE

29-60-83-000
VSI 110 ILLUMINATOR
110 VOLT / 150 WATT

29-60-84-000
VSI 220 ILLUMINATOR
220VOLT / 150 WATT

29-69-02-000
POLARIZER
ZOOM 125 LOWER
MODULES ONLY

29-69-13-000
RIGHT ANGLE
COAX ADAPTER
ZOOM 125 LOWER
MODULES ONLY

30-16-01-000
10MM
ADAPTER

30-16-02-000
FIBER OPTIC
COAXIAL
LAMPHOUSE
ZOOM 125 LOWER
MODULES ONLY

33-04-00-000
LOW PROFILE, R.A.
COAXIAL LAMPHOUSE
FMOS LOWER
MODULES ONLY

! NOTE: Direct path to Flexible Bundle,
// FMOS LOWER MODULES ONLY

Illumination

396010-810
SINGLE-CHANNEL
PROGRAMMABLE
LED CONTROLLER

39-60-10-000
FMOS STRAIGHT
1-WATT COAXIAL LED

30-60-10-000
ZOOM 125 STRAIGHT
1-WATT COAXIAL LED

39-60-20-000
FMOS RIGHT-ANGLE
1-WATT COAXIAL LED

30-60-20-000
ZOOM 125 RIGHT-ANGLE
1-WATT COAXIAL LED

27-60-07-000
110/6 VOLT VARIABLE

27-60-17-000
220/6 VOLT VARIABLE

29-60-09-000
10 WATT
HALOGEN LAMP

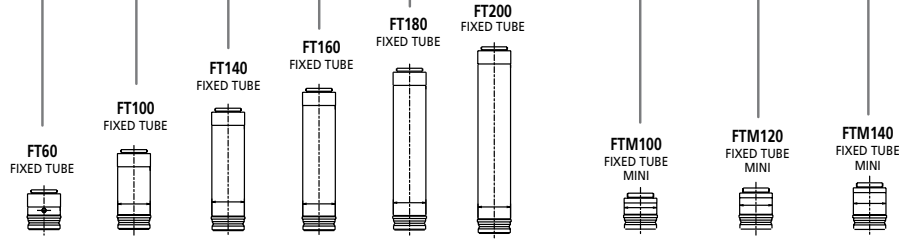
29-69-14-000
HALOGEN
LAMPHOUSE

29-60-81-000
HORIZONTAL RING LIGHT

Color Key

Optical Path —
Illumination Path —
Electrical —

FMOS Upper Fixed Tubes



NOTE: Yields a reversed image

29-90-66-000
LONG WORKING
RIGHT-ANGLE
MODULE

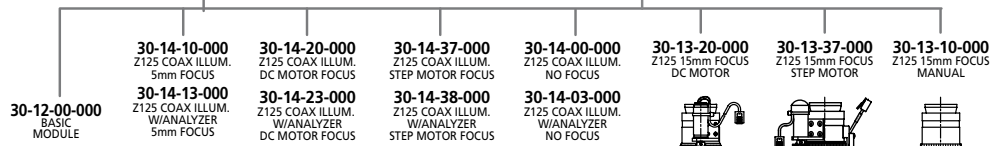
299067-310
COAXIAL BLOCK

33-03-63-000
ZOOM 125
LOWER MODULE
ADAPTER

Zoom 125 Lower Function Modules

NOTE: Contact Optiq for FMOS optical performance with Zoom 125 Lower Modules

299066-306
ZOOM 125 LOWER
MODULE COUPLER



29-99-01-000
1.437x32T - M25x0.75T
ADAPTER

NOTE: Must remove lens from
Lower Function Module before
integrating Objective Adapters
and Objectives

42-35-41-000
INFINITY
MACRO LENS

30-17-01-000
MALE/FEMALE THREAD
0.5X AUX LENS

30-17-02-000
MALE/FEMALE THREAD
0.75X AUX LENS

29-99-02-000
1.437x32T - M26 x 36T
OBJECTIVE ADAPTER

30-17-03-000
25mm - M26 x 36T
OBJECTIVE ADAPTER
(FOR FOCUS MODULES)

29-99-03-000
1.437 x 32T - 0.800 x 36T
OBJECTIVE ADAPTER

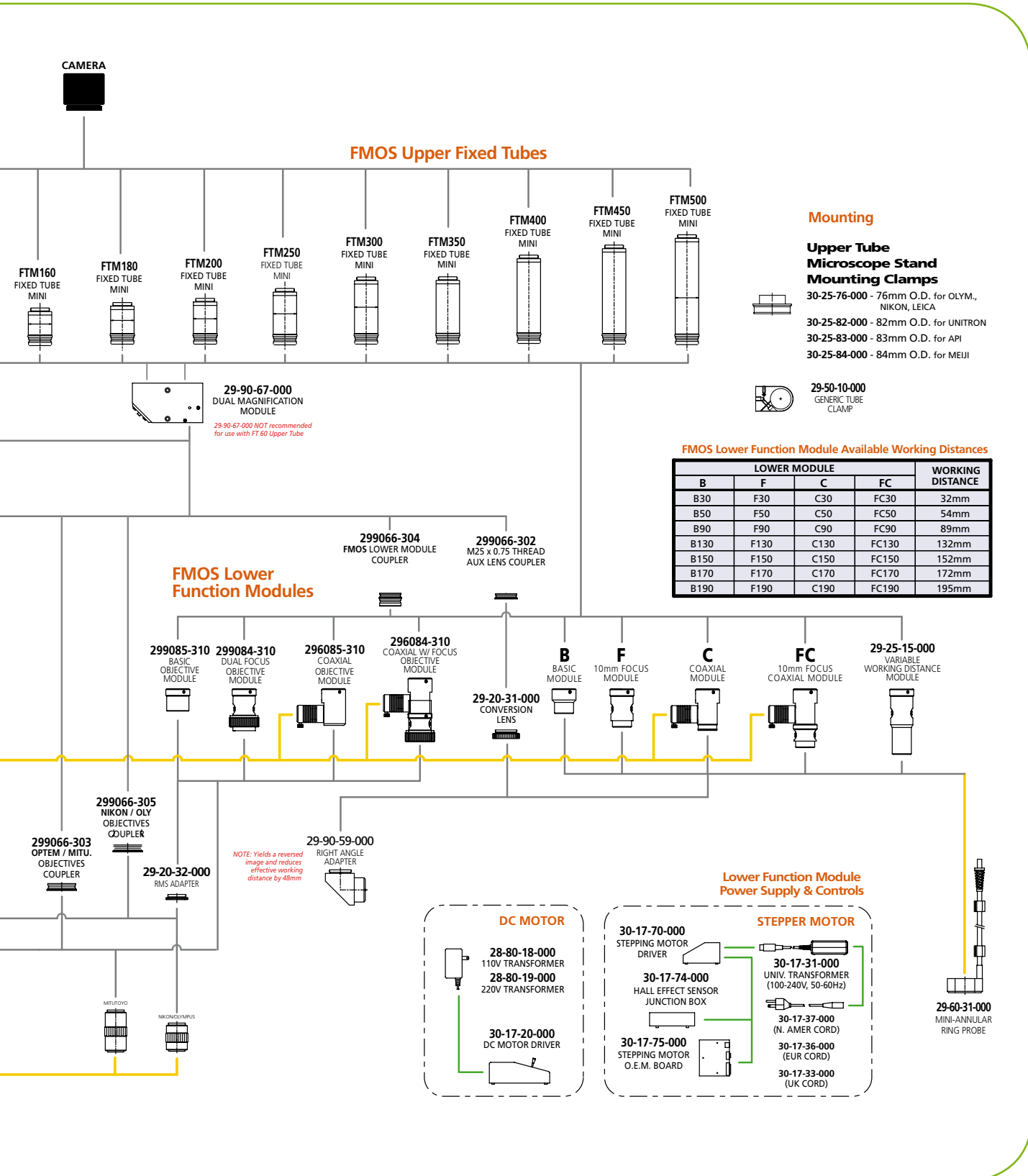
30-17-04-000
25mm - 0.800 x 36T
OBJECTIVE ADAPTER
(FOR FOCUS MODULES)

High Magnification

Optem Long Working Distance M-Plan APO Objectives

28-21-02-000 2X M PLAN APO
28-21-05-000 5X M PLAN APO
28-21-10-000 10X M PLAN APO
28-21-11-000 20X M PLAN APO
28-21-50-000 50X M PLAN APO

30-16-50-000
OBJECTIVE RING LIGHT



Mounting

**Upper Tube
Microscope Stand
Mounting Clamps**

- 30-25-76-000 - 76mm O.D. for OLYM., NIKON, LEICA
- 30-25-82-000 - 82mm O.D. for UNITRON
- 30-25-83-000 - 83mm O.D. for API
- 30-25-84-000 - 84mm O.D. for MEIJI



29-50-10-000
GENERIC TUBE
CLAMP

FMOS Lower Function Module Available Working Distances

LOWER MODULE				WORKING DISTANCE
B	F	C	FC	
B30	F30	C30	FC30	32mm
B50	F50	C50	FC50	54mm
B90	F90	C90	FC90	89mm
B130	F130	C130	FC130	132mm
B150	F150	C150	FC150	152mm
B170	F170	C170	FC170	172mm
B190	F190	C190	FC190	195mm



Your Key to Photonic Innovation...

Qioptiq serves a wide variety of applications across the industrial manufacturing sector. With a rich history of delivering innovative photonic components, modules and instruments to integrators, engineers and OEMs, we also offer custom-tailored photonic solutions to maximize the potential and capabilities of tomorrow's many processes and industrial manufacturing systems.

...and Manufacturing Advancement

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