

Optima[®] Laser Diode Optics

Cost Effective Lenses for Collimating and Focusing Laser Diodes

Collimating and focusing a laser diode is perhaps the most critical prerequisite in any laser diode application. While the characteristics of a laser diode might be ideal for your application, the laser diode must be matched with the appropriate optics to create a useable beam. Typically, the laser diode is collimated with one lens and a second lens is used to focus the beam. However, many applications exist where a single lens is used to either focus or collimate the beam. In either case, most laser diodes require a collimating lens with a large numerical aperture (NA) to efficiently capture the widely divergent perpendicular axis.



Multi-Element Lenses for Optimal Performance

For the most demanding applications, a three or four element spherical lens achieves a level of optical performance difficult to obtain with any single element lens. To assure diffraction-limited performance, start by collimating the diode with one of the Optima 336 Series multi-element lenses. All 336 Series lenses are computer optimized to minimize aberrations, maximize coupling efficiency, and function over a broad range of wavelengths and normal manufacturing tolerances. The lenses can be used with most visible and near-infrared laser diodes and are currently used in a wide array of products including the following:

- Alignment and Distance Measuring Systems
- Positioning and Edge Finding Equipment
- Light Scatter and Particle Counters
- Linear and Rotary Encoders
- Free-space Laser Communication Systems
- Bar-code Readers

The following paragraphs briefly describe the attributes and differences between the three 336 Series collimating lenses.

336-1027-660, -785, and -140 — These are excellent general purpose collimating lenses; its small physical size is compatible with both 5.6mm and 9.0mm diameter laser diodes, making a very compact assembly. A relatively large numerical aperture (NA) of 0.48 captures a large percentage of the beam from most common laser diodes — coupling efficiencies typically range from 91% to 95%. The 336-1027 is available with three standard MgF2 anti-reflection coatings designated as: -660 for visible laser diodes (633nm to 750nm); -785 for use with most near-infrared diodes (750nm to 980nm); and the -140 AR coating for use with 1300nm to 1550nm laser diodes.

336-0965-780 — This is a very high quality collimating lens suitable for more demanding applications where wavefront aberration is critical. With a longer focal length and larger clear aperture, this lens provides a slightly larger collimated beam and consequently lower beam divergence. A moderate numerical aperture of 0.389 provides coupling efficiencies ranging from 83% to 85%.

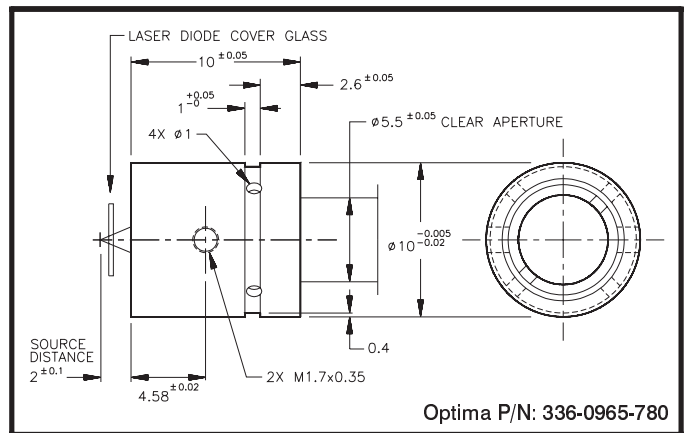
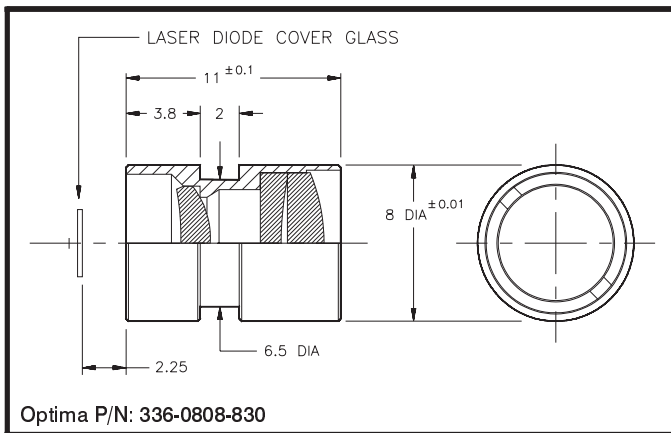
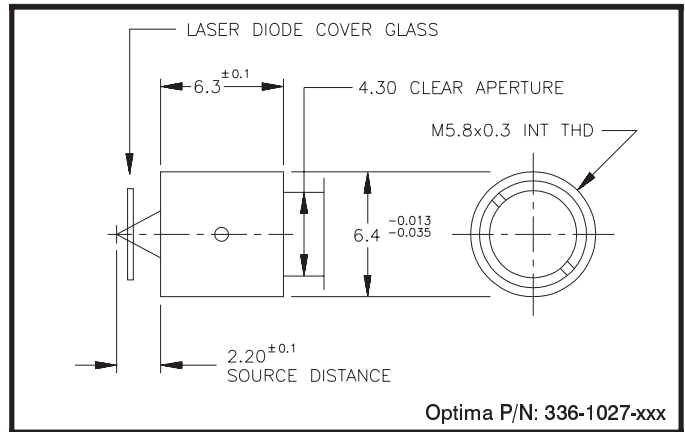
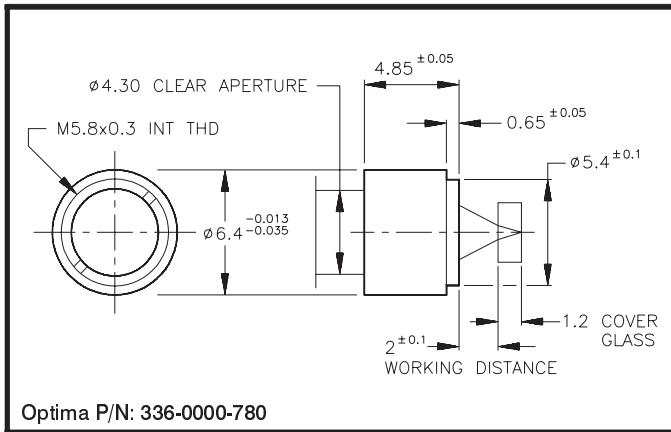
336-0808-830 — With a longer focal length and larger clear aperture than either of the lenses described above, this lens creates the largest collimated beam diameter. The 336-0808-830 is recommended for precision alignment systems, laser range finding, and other applications that require a laser diode beam to be projected over long distances with low divergence.

Multiple Element Focusing Lens — The 336-0000-780 lens is a three element spherical lens used to refocus the collimated beam from a laser diode. For optimum performance, the focusing lens should be used with a collimating lens having the same size clear aperture, i.e. the 336-1027 collimating lens. In this case, the large numerical aperture and short focal length of the focusing lens will provide superior coupling efficiency and diffraction-limited spot.

Optima Multiple Element Spherical Lens Specifications:

PART NUMBER	336-0000-780	336-1027-660	336-1027-785	336-0808-830	336-0965-780
UNIT PRICE (Qty 1-49 pcs.)	\$26.50	\$27.90		\$84.00	\$73.50
DESCRIPTION	Objective lens	Collimating lens			
CONJUGATE DISTANCE	Infinite	Infinite			
DESIGN WAVELENGTH (note 1)	780nm	660nm	785nm	830nm	780nm
FOCAL LENGTH	4.516mm	4.476mm	4.516mm	8.01mm	7.003mm
WORKING / SOURCE DISTANCE	2.0mm	2.17mm	2.20mm	2.25mm	2.0mm
NUMERICAL APERTURE	0.476	0.476	0.476	0.368	0.389
CLEAR APERTURE	4.30mm	4.30mm	4.30mm	5.89mm	5.45mm
F#	1.05	1.04	1.05	1.36	1.28
FIELD SIZE DIAMETER	0.156mm	0.156mm	0.158mm	0.201mm	0.176mm
AR COATING DESIGN CENTER, MgF2	780nm	660nm	785nm	830nm	780nm
TRANSMISSION	>96%	>93%		>95%	>95%
COVER GLASS THICKNESS	1.2mm	0.25mm ~ 0.30mm			
COVER GLASS INDEX (n)	1.55	1.52023	1.51107	1.51097	45
CELL MATERIAL & FINISH	Aluminum / Black Anodized			Brass	
CELL DIMENSIONS (diameter x length)	Ø6.4mm x 4.85mm	Ø6.4mm x 6.3mm		Ø8mm x 11mm	Ø10mm x 10mm

Notes: 1) In the specifications listed above, the design wavelength is used to calculate the focal length; however, this does not limit use of the lens to this particular wavelength — these lenses can be used with both near-infrared and visible laser diodes from 635nm through 850nm.



Revised 01JAN01

Optima[®] Molded Glass Aspheric Lenses

Diffraction-limited and very cost effective, a precision-molded glass aspheric lens is an attractive compromise between a multi-element lens and a molded plastic lens. The molded glass asphere has two basic advantages over a multi-element lens; first, the aspheric design reduces spherical aberration and coma in a single element; and second, overall light transmission is generally greater with fewer optical surfaces.

As compared with plastic lenses; molded glass aspheric lenses will operate over a much broader temperature and humidity range without performance degrading. Because of these advantages, molded glass lenses are often used in products such as laser printers, optical disc storage devices, and optical communications systems.

New Lens P/N 305-0464-780 — A larger numerical aperture is often very desirable when coupling a collimating lens with a laser diode. Our newest molded glass asphere P/N 305-0464-780, has an NA of 0.5 and a focal length of 4mm which is ideally suited for many laser diode applications. With a 0.5 NA, a coupling efficiency over 90% can be achieved with most diodes. Detailed specifications are listed below:

Optima Molded Glass Aspheric Lens Specifications:

PART NUMBER	305-0065-780	305-0464-780	305-4606-670	305-8040-780
UNIT PRICE (Qty 1-49 pcs.)	\$16.40	\$14.60	\$17.00	\$21.85
DESCRIPTION	Collimating lens, Molded Glass Asphere, Unmounted			
CONJUGATE DISTANCE	Infinite			
DESIGN WAVELENGTH (note 1)	780nm	780nm	655nm	780nm
FOCAL LENGTH	6.25mm	4.00mm	4.60mm	8.00mm
WORKING / SOURCE DISTANCE	4.57mm	3.942mm	2.90mm	8.33mm
NUMERICAL APERTURE	0.40	0.50	0.53	0.25
CLEAR APERTURE	5.00mm	4.00mm	4.89mm	4.06mm
F#	1.25	1.00	0.94	1.97
FIELD SIZE DIAMETER	0.100mm	0.050mm	0.100mm	0.200mm
AR COATING DESIGN CENTER, MgF2	780nm		670nm	780nm
TRANSMISSION	>98%	>97%	>95%	>96%
COVER GLASS THICKNESS	0.25mm ~ 0.30mm		.275mm	0.25mm ~ 0.30mm
COVER GLASS INDEX (n)	1.511	1.50	1.510	1.500
TEMPERATURE RANGE	-20°C to +85°C			
LENS DIMENSIONS (diameter x length)	Ø6.38mm x 2.5mm	Ø6.40mm x 2.5mm	Ø6.00mm x 3.10mm	Ø6.40 x 2.5mm

Notes: 1) In the specifications listed above, the design wavelength is used to calculate the focal length; however, this does not limit use of the lens to this particular wavelength — these lenses can be used with both near-infrared and visible laser diodes from 635nm through 850nm.

Mounted aspheric lens with fine pitch threads — The popular 305-0065-780 aspheric lens is available in three configurations: an unmounted single element, part number 305-0065-780, and two convenient mounted lenses which help reduce some of the tedious problems associated with handling a very small lens. The 310-0065-780 mount is a plain 8mm diameter aluminum cell that can be easily incorporated into the user's laser diode assembly. Lenses p/n 305-0464-780, 305-4606-670, and p/n 305-8040-780 are also available in a threaded mount, the p/n prefix changes to 306-xxxx-xxx or 307-xxxx-xxx as listed in the table below. All of the threaded mounts have an extra-fine pitch thread (.375-64) on the outside diameter that facilitates precise control in adjusting the focus or collimation of a laser diode.

MOUNTED ASPHERIC LENS P/N	307-0464-780	306-0065-780	310-0065-780	307-4606-670	307-8040-780
UNIT PRICE (Qty 1-49 pcs.)	\$21.85	\$20.90	\$20.50	\$21.50	\$30.55
DESCRIPTION	Threaded Mount		Plain Cell	Threaded Mount	
CELL DIMENSIONS (diameter x length)	3/8-64 Thd. x 3.2mm		Ø8mm x 4.95mm	3/8-64 Thread x 4.95mm	

Revised 01JAN01

Optima® Injection Molded Plastic Aspheric Lenses

While glass lenses are generally preferred, there are several product applications where a high quality plastic lens can be effectively utilized. The 300 Series plastic aspheric collimating and objective lenses offer a lower cost alternative to glass and still perform well over a temperature range actually exceeding the upper limit for most laser diodes. Plastic lenses are used in products such as laser pointers, construction levels, and less critical alignment and position sensing devices.

New Lens, P/N 300-0380-780 Creates a Smaller Collimated Beam — If you need a collimated beam with smaller dimensions, consider using the 300-0380-780 plastic lens and/or the Optima LDM 4500 KIT Laser Diode Mounting Kit which includes the new smaller plastic asphere. As an example... when this lens is used with the Hitachi HL6312G (635nm/5mW) laser diode, a collimated beam measures approximately 0.715 mm in the parallel axis by 2.85 mm in the perpendicular axis, with divergence angles of 1.2 mrad x 0.34 mrad respectively. (The figures mentioned may vary from one diode to another or, with other manufacturers diodes).

P/N 300-0395-780 Creates a Larger, More Circular Collimated Beam — If you need a collimated beam with low divergence and consequently a smaller beam at long distances, consider the Optima 300-0395-780. With a long focal length (16mm) and small numerical aperture (NA=.14) this lens creates a relatively large diameter beam that's more circular than the output from the typical laser diode collimating lens. Also, the 300-0395-780 lens is a very high-quality injection molded plastic lens – this lens has been used in digital laser communication systems which are extremely sensitive to lens aberrations and diffraction patterns that can be misread as data when a beam sweeps across a detector. The only negative aspect of the lens might be the small NA – the coupling efficiency (or total transmission) for most visible laser diodes is just under 50%. Please refer to the lens specifications below for detailed information.

For reference we've profiled the beam from a 300-0395-780 lens using a Hitachi HL6312G laser diode; at 100 mm from the lens, a collimated beam measures ~3.38 mm x 4.65 mm (measured at the $1/e^2$ clip point, with 3.38mm being the laser diode's parallel axis).

Optima Injection Molded Plastic Aspheric Lens Specifications:

PART NUMBER	300-0355-780	300-0360-780	300-0380-780	300-0395-780
UNIT PRICE (Qty 1-49 pcs.)	\$7.05	\$5.15	\$4.50	\$4.80
DESCRIPTION	Collimating lens, Injection Molded Plastic Asphere, Unmounted			
CONJUGATE DISTANCE	Infinite			
DESIGN WAVELENGTH (note 1)	780nm			
FOCAL LENGTH	4.50mm	4.50mm	3.40mm	16mm
WORKING / SOURCE DISTANCE	1.90mm	1.90mm	1.43mm	13.79mm
NUMERICAL APERTURE	0.50	0.45	0.471	0.144
CLEAR APERTURE	4.50mm	4.05mm	3.20mm	4.80mm
F#	1.00	1.11	1.06	1.67
FIELD SIZE DIAMETER	0.100mm	0.050mm	0.150mm	0.100mm
AR COATING DESIGN CENTER, MgF2	780nm			
TRANSMISSION	>98%	>97%	>95%	>97%
COVER GLASS THICKNESS	1.25mm			
COVER GLASS INDEX (n)	1.510	1.55	1.55	1.51
TEMPERATURE RANGE	Storage Temp. -30°C to +75°C, Working Temp. -10°C to +65°C			
LENS DIMENSIONS (diameter x length)	Ø7.4mm x 3.4mm	Ø7.4mm x 3.55mm	Ø5.0mm x 2.11mm	Ø6.5 x 2.33mm

Notes: 1) In the specifications listed above, the design wavelength is used to calculate the focal length; however, this does not limit use of the lens to this particular wavelength — these lenses can be used with both near-infrared and visible laser diodes from 635nm through 850nm.

MOUNTED PLASTIC LENS P/N	302-0355-780	302-0360-780	302-0380-780	302-0395-780
UNIT PRICE (Qty 1-49 pcs.)	\$13.25	\$11.15	\$13.55	\$12.60
CELL DIMENSIONS (diameter x length)	3/8-64 Thd. x 5.33mm		3/8-64 Thd. x 5.9mm	3/8-64 Thd. x 3.8mm

Revised 01JAN01