Product Catalog

LightPath® TECHNOLOGIES™

focusing on optical solutions

LightPath® TECHNOLOGIES™

Letter from the President

Thank you for looking to LightPath Technologies Inc. (NASDAQ: LPTH) for your optical product needs. LightPath has been in business since 1985 innovating and producing optical products for a broad range of market applications including industrial, communications, medical, defense, test and measurement. Headquartered in Orlando, Florida we design, develop, manufacture, and distribute optical components and assemblies, utilizing the latest optical processes and advanced manufacturing technologies. LightPath produces components and assemblies incorporating Precision Molded Optics, High Performance Collimators, Isolators, GRADIUM® Glass Lenses and Fiber Fusion Technology.

In 2000, LightPath Technologies acquired Geltech, Inc. and Horizon Photonics, Inc. both leaders in the automated production of optical components. Geltech was recognized in the optics industry for their glass Precision Molded Optics technologies. Horizon Photonics was well known in the communications industry for delivering highly integrated passive optical components for laser packages. The new LightPath combines these capabilities with its own technologies, bringing a wealth of expertise to solving complex optical problems for the entire optics industry.

Our customer base is very diverse with applications that include laser welding & cutting, military laser tag, data communications, bar code scanning, particle measurement, medical endoscopes, telecom multiplexers and many, many other optical application areas. As industry needs change, LightPath's state-of-the-art R&D is designing optical solutions to meet the challenges that accompany a changing environment. We pride ourselves on high performance, customer support, quality products, value added designs and cost effective volume manufacturing.

We look forward to working with you on your next optical design.

Sincerely,

Ken Brizel
President & CEO
LightPath Technologies, Inc.

LightPath® TECHNOLOGIES™

2603 Challenger Tech Court
Orlando, Florida 32826
Phone 1-800-GRADIUM
Phone 1-407-382-4003
Fax 1-407-382-4007

CONTENTS

TÜV MANAGEMENT SERVICE ISO 9001

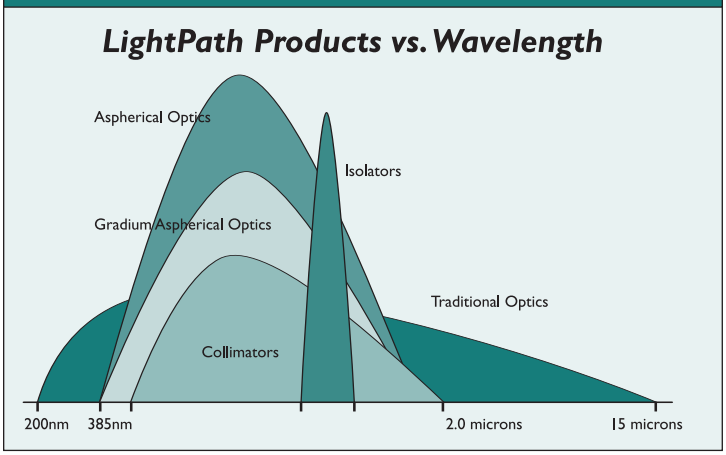
Introduction

LightPath Technologies Inc. is a recognized leader in optical solutions for medical, industrial, communications, defense, test and measurement applications. Since 1985, LightPath has built a strong portfolio of optical components and technologies that serve these industries. The products we produce include a wide spectrum of molded glass aspheric optics ranging in size from 0.25mm to 10mm. GRADIUM® lenses, which give the performance of an asphere, are available for lenses between 5mm and 100mm. LightPath also offers a full range of aspheric collimators.

All of our aspheric products have an anti-reflective coating covering a broad range of wavelengths. Optical isolators and wavelength lockers round out our portfolio of components. LightPath not only supplies components, but also offers the ability to combine optical elements into a complete assembly, providing full engineering support for both optics and mechanics.

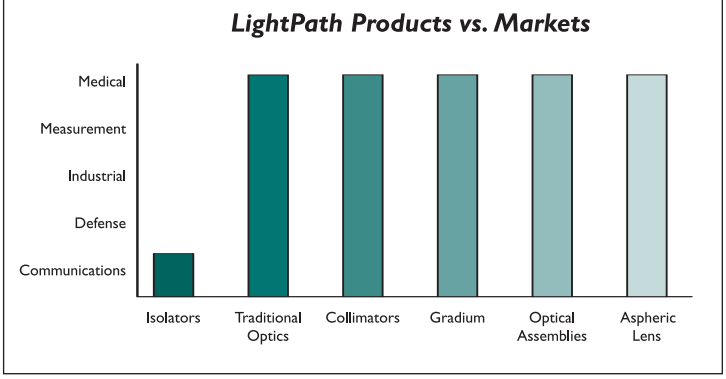
Unlike some independent optical engineering firms, LightPath uses an integrated approach. Our optical and mechanical engineers work directly with our customers on their optical system requirements. This enables the finished application to obtain the highest level of optical integration, minimizing time, size and cost while ensuring quality, performance and manufacturability. With LightPath's automation capabilities, when your product is ready for full production we are ready to take you there. The results are lower costs, higher performance, and greater consistency. LightPath is an ISO 9001 certified supplier.

OPTICAL PRODUCTS WE PRODUCE



- **Integrated Optical Subassemblies**
- **Molded Glass Aspheres**
- **Optical Assemblies**
- **GRADIUM®** *(Larger Optics with Aspherical Performance)*
- **Collimators**
- **Isolators**
- **Traditional Optics**

MARKETS WE SERVE



Industrial

Many of the worlds top automobile manufacturers use LightPath's GRADIUM® lenses and lens systems to focus their Nd: YAG lasers for automated welding and cutting operations. Our 1064nm Large Beam Collimators have also proven to be key for fiber delivery applications at high power. Molded glass aspheres are used in barcode scanning and package handling systems by the major shippers worldwide. The top computer-to-print manufacturers use our aspheric molded optics for unmatched performance.

Medical

When optimal performance is paramount, glass aspherical lenses are used for medical imaging systems and procedures requiring laser cutting and healing. GRADIUM® lenses and molded glass aspheres are found in many analytical instruments measuring different body functions in both the operating room and the lab. LightPath also provides lenses and collimators to the world's top manufacturers of endoscopes, providing a very wide field of view in a very small lens. We work with many companies in biotechnology developing new optics and optical systems in the fields of genetics, DNA, and protein analysis.

Defense and Government

Over the last 10 years, LightPath has provided large volumes of lenses to defense contractors for many simulation training programs, which train our armed forces using lasers instead of bullets. Smart bombs and munitions utilize aspheres for communication and distance measurement. Under a development contract with the U.S. government, LightPath developed radiation hardened aspheres that are currently being used for satellite communication in both the military and commercial market. Specialty glass optical systems have also been developed for eye and instrument protection against damaging laser beams.

Communications

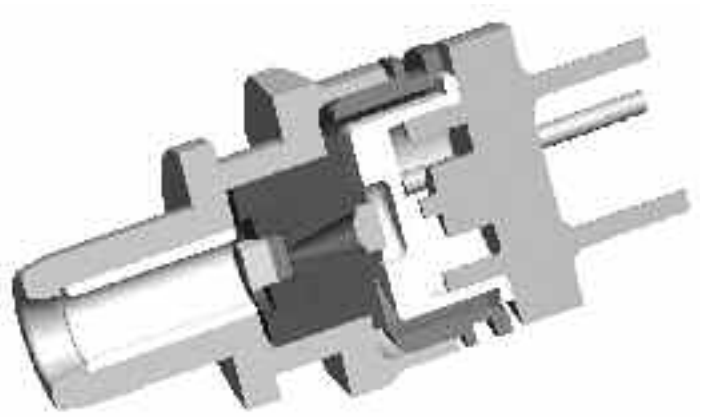
LightPath products have been developed for a variety of communications applications in both Telecom and Datacom. Our lenses, collimators and isolators are used to maximize light efficiency while minimizing both size and cost. Applications including muxdemux, switching and routing, amplification, dispersion compensation, sensing, transmitters, receivers and transponders all require the products and performance LightPath provides to move the light on and off the fiber.

Measurement

For optical measurement systems our lens designs offer customers a variety of sizes over a wide spectrum and integrated solutions enabling more compact designs at lower cost.

Integrated Optical Assemblies

- Design and development
- Large capacity in-house production of optical components – Aspheres, Isolators, Collimators and Lenses
- Pilot product
- Automated production
- Automated laser welding
- Pick and place
- Automated optical alignment
- Automated test
- Reliability and failure analysis
- ISO 9001:2000 Registered



LightPath provides complete optical solutions for many of today's sophisticated optical system requirements. Utilizing our expertise in design, engineering, manufacturing and automation, LightPath obtains the highest level of optical integration. We have some of the industry's best optical designers and application engineers on staff, providing our customers with the most cost effective, manufacturable solutions. LightPath's optical experience covers industrial, medical, communication, defense, test and measurement applications.

Capabilities

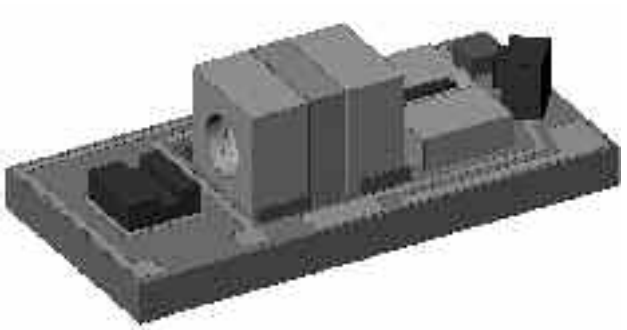
Design & Development

Mechanical & thermal: AutoCAD, Solidworks, Cosmos, Pro Engineer

Optical: Zemax, TracePro, BeamPROP, OptiCAD

Pilot Production

Tool & die shop, single point diamond turning, EDM, wire bond, die bond, seam seal, silicon bench metalization, laser weld, laser solder, glass frit, resin-free & adhesive bond



Volume Manufacturing & Test

Large volume Aspheric Lens manufacturing 12,000 lenses per week

6 laser welders, 10 robots, 4 epoxy auto-dispensers, 3 wafer saws

Reliability & Failure Analysis

Telcordia and MIL STD qualification testing

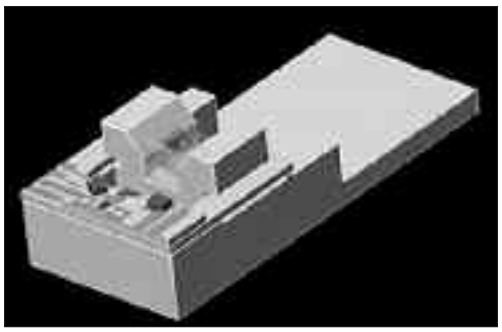
Quality Assurance & Continuous Improvement

ISO 9001: 2000 Registered

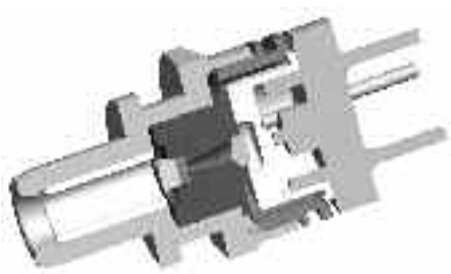
By leveraging our design for manufacturing capabilities with our broad optical component portfolio, LightPath has a track record for implementing sophisticated integrated optical assemblies. One example is the wavelength locker, combining optical elements such as etalons and beam splitters with photodiodes and thermistors. Automated component placement, alignment and testing enable the assembly process.

Integrated Optical Assemblies

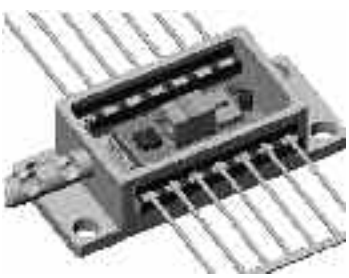
LightPath also produces optical assemblies such as complex laser sub-mounts. These assemblies integrate our molded glass aspheres, isolators, laser diode chips and reference photodiodes. These assemblies are aligned to give the customer the highest coupling efficiency while providing a path that allows customers to focus on their core business.



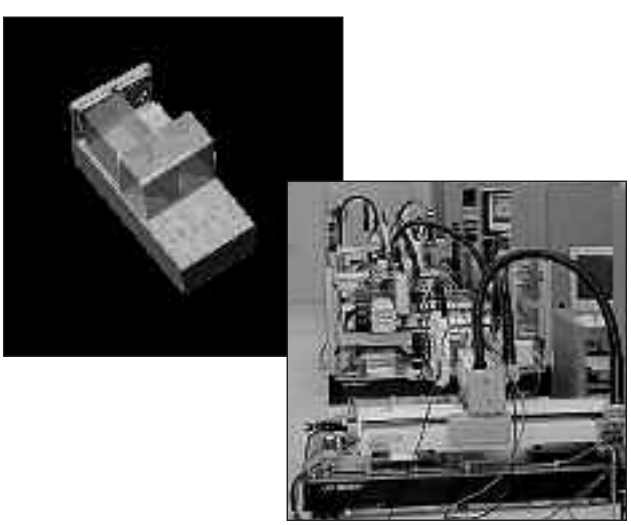
LightPath has a unique position in the world of transceivers. In today's communications environment, many of the applications are looking for better coupling efficiency for both SM and MM fiber. As the local and private area networks expand into the metro arena, the goal is to keep the costs low, while maintaining high coupling efficiency for transmission greater than 12km. LightPath aspheric lenses can be provided coupled with an isolator and mounted in a TOSA assembly for final alignment by the customer, or can be manufactured as a complete assembly utilizing a customer specified diode.



Telescope and Lens Train assemblies are another product routinely designed and manufactured for many optical applications. By utilizing Molded Glass Aspheric lenses, GRADIUM® optics, or classically ground and polished singlets or doublets, LightPath provides the highest performance achievable, at the lowest cost for our customers' design constraints.



LightPath is an optical solutions company providing a broad range of expertise and know-how for solving opto-mechanical problems. We can take a design from concept to finished production quickly and cost effectively.



Aspheric Lenses

- All-glass
- NA up to 0.83
- Diameters as small as 0.250mm
- Diffraction-limited performance
- Available with housings

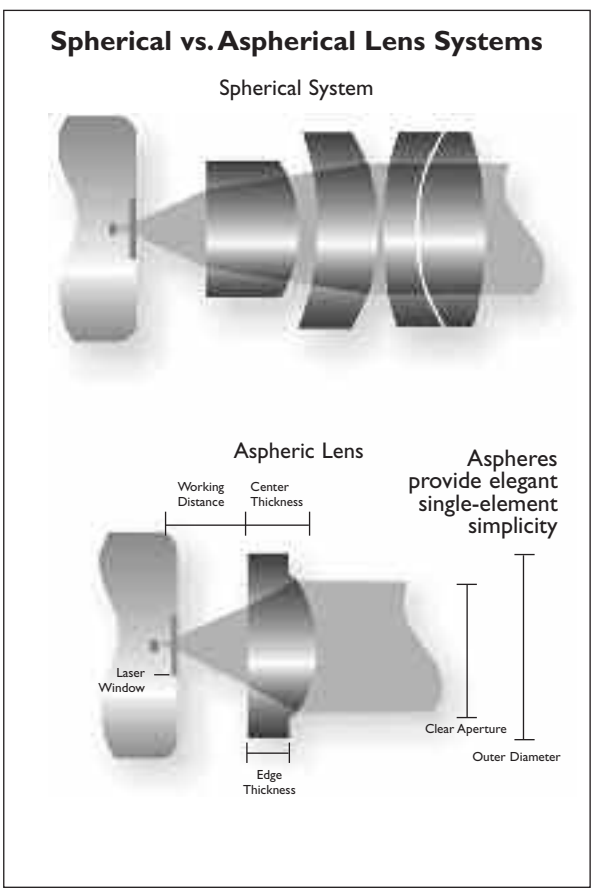
For today's sophisticated and compact laser systems, aspheres are the most powerful lenses for managing laser light. In these systems, spherical aberration is the most prevalent performance detractor. It arises from the use of spherical surfaces and artificially limits focusing and collimating accuracy.

Although it has been known for centuries that spherical geometry is not optimum for refracting light, the expense of fabricating non-spherical (aspheric) surfaces has inhibited their use. With the breakthrough of LightPath's glass molding technology, this optimal lens geometry has become a reality.

Molded lenses are used in a variety of photonic products: barcode scanners, laser diode to fiber couplings, optical data storage, and medical lasers, to name a few. In many of these applications, the material of choice is optical glass because of its durability and performance stability over a wide environmental range. High power transmittance is also an added advantage.

The benefits of glass molding technology become apparent when traditional methods of grinding and polishing become cost-prohibitive. The direct molding process eliminates the need for any grinding or polishing, offering aspheric lenses at practical prices for system designers. Molding is the most consistent and economical way to produce aspheres in large volumes.

Small and lightweight, our aspheres collimate or focus light as a single element. This means less complex systems, fewer alignment requirements, less re-work and shorter assembly time. They are molded, therefore the lenses have excellent piece-to-piece uniformity. They are made of glass, which is the most durable optical material available, capable of withstanding repeated cleanings and performing at specifications despite extreme temperature and moisture variations.



Aspheric Lenses

Optical Performance

The primary optical specification is the root-mean-squared transmitted wavefront error (RMS WFE). It is measured on a phase shift interferometer at the wavelength of 632.8nm. Most of our lenses are guaranteed to be diffraction limited, which means the RMS WFE < 0.070 λ at the design wavelength.

Shapes and Sizes

LightPath aspheric lenses can be made plano convex or bi-convex, with diameters as large as 10mm or as small as 0.250mm. Additionally, we have the capability to dice the lenses to rectangular or square shapes to make mounting them in your system easier.

Numerical Aperture

Our molded aspheric lenses are available with numerical apertures ranging from 0.15 up to 0.83. Lower NAs are best when a large depth of focus is important or when you need nearly circular beams. Examples of applications that would use a low numerical aperture are bar code scanners, surveying instruments, and small weapons sights. High numerical aperture lenses are important when you need to focus light down to a small spot size or when you need the maximum light capture from a diode laser. High numerical aperture applications include data storage and industrial printing.

Lens Holders

Several of our catalog lenses are available pre-mounted in metal holders. We can epoxy our lenses into Stainless Steel or Kovar mounts so you can weld them directly into your system. Using our new Mold-In-Place (MIP) technology, we can actually mold the lens directly inside of a steel holder, eliminating the need for adhesives in your package.

Diffractive Hybrid Lenses

By combining a refractive aspheric lens with a diffractive feature on one surface, you can do sophisticated beam shaping on your laser light. You can also use diffractive hybrid lenses to make your system achromatic over a range of wavelengths. LightPath hybrid lenses are custom designed to each particular application.

Lens Design Formula

- Positive radius indicates the center of curvature is to the right
- Negative radius indicates the center of curvature is to the left
- Dimensions are given in mm

$$z = \frac{Y^2}{R\left(1+\sqrt{1-(1+k)Y^2/R^2}\right)} + A_4Y^4 + A_6Y^6 + A_8Y^8 + A_{10}Y^{10} + A_{12}Y^{12}$$

z	=	SAG as a function of Y
R	=	Radius of curvature
k	=	Conic constant
A_4	=	4th order aspheric coefficient
A_6	=	6th order aspheric coefficient
A_8	=	8th order aspheric coefficient
A_{10}	=	10th order aspheric coefficient
A_{12}	=	12th order aspheric coefficient

Custom Optics

Our catalog details 37 standard types aspheric lenses that are available off-the-shelf. If you do not see a lens that fits your particular application, we will be happy to design one for you. Our sales and engineering teams work closely together to assist you in design, prototyping, and production of custom glass aspheric lenses. LightPath offers custom lens solutions for high volume manufacturing at prices equal to that of a standard off-the-shelf lenses. We pride ourselves on being the fastest custom lens designers in the industry.

Aspheric Lenses

The Glass

LightPath Technologies manufactures aspheric lenses using two different types of glass. Transmittance of both glasses is very good over a large wavelength spectrum. The optimum operating temperature should be less than 200 degrees Centigrade. The best cleaning agents are high purity grades of alcohol or acetone, lightly wiped off with a soft optical tissue or cotton-tipped swab.

The 350xxx Series of Lenses

Corning developed a special glass to allow production of highly sophisticated aspheric lenses that are cost effective. The code for this glass is C0550, and its low dispersion (n_d=50.40) is key for many applications. In durability, it is equivalent to Corning BCD C2060 or Schott SK16.

The 370xxx Series of Lenses

For aspheric lenses that require a glass with a higher index of refraction, LightPath also offers lenses made from Ohara PBH71 glass. Its high index (n_d=1.92286) allows designers to minimize aberrations in lenses with high numerical apertures. It has the added benefit of a lower coefficient of thermal expansion.

Standard Antireflective Coatings

LightPath offers a variety of multilayer broadband coatings to reduce the back reflection from a nominal 6% for uncoated lenses. The choice of which AR coating is appropriate depends on the type of glass the lens is made from and the wavelength at which the lens will be used.

350xxx Series of Lenses

MLBB-A coating: R_{MAX}<1.0%, R_{TYP}<0.4%, from 400-600nm, AOI=0°

MLBB-B coating: R_{MAX}<1.0%, R_{TYP}<0.4%, from 600-1050nm, AOI=0°

MLBB-C coating: R_{MAX}<1.0%, R_{TYP}<0.4%, from 1050-1600nm, AOI=0°

MLBB-D coating: R_{MAX}<0.25%, R_{TYP}<0.15%, from 1300-1700nm, AOI=0-20°

370xxx Series of Lenses

MLBB-Q coating: R_{MAX}<0.25%, R_{TYP}<0.15%, from 1300-1700nm, AOI=0-20°

Optional coatings are available. Please contact your sales representative for details on the following availability.

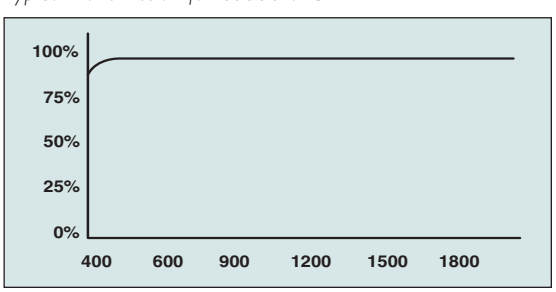
MLBB-O coating: R_{MAX}<1.0%, R_{TYP}<0.4%, from 600-1050nm, AOI=0°

MLBB-P coating: R_{MAX}<1.0%, R_{TYP}<0.4%, from 1050-1600nm, AOI=0°

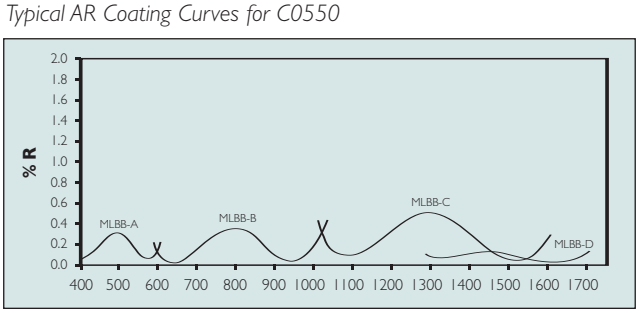
REFRACTIVE INDEX CHART

Wavelength (nm)	C0550	PBH71
404.7	1.62590	2.00599
435.8	1.62016	1.98112
480.0	1.61411	1.95665
486.1	1.61341	1.95392
546.1	1.60786	1.93306
587.6	1.60500	1.92286
632.8	1.60251	1.91427
643.8	1.60198	1.91247
656.3	1.60141	1.91057
706.5	1.59940	1.90397
852.1	1.59528	1.89126
1014.0	1.59227	1.88298
1300.0	1.58850	1.87444
1550.0	1.58572	1.86954
Abbe Number (ν_d)	50.40	21.29
CTE (10^{-6} / °C)	15.0	8.9
dn/dT (10^{-6} / °C)	-11.0	13.1

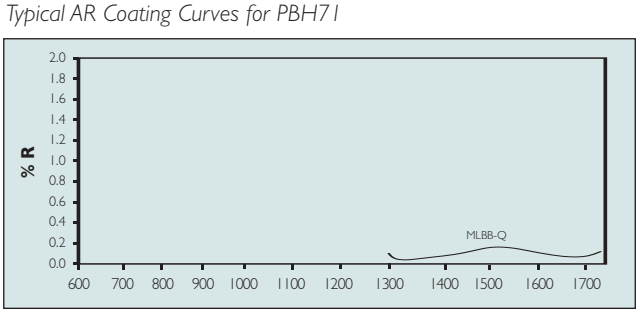
Typical Transmission for C0550 and PBH71



Typical AR Coating Curves for C0550



Typical AR Coating Curves for PBH71



STANDARD LENSES				
NA	**EFL (mm)**	**CA (mm)**	**OD (mm)**	**Lens Code**
0.15	5.00	1.50	2.00	350430
0.15	18.40	5.50	6.50	350280
0.16	15.29	5.00	6.50	350260
0.17	4.00	1.37	3.00	370940
0.18	6.10	2.20	2.80	350550
0.18	13.86	5.10	6.325	350560
0.25	11.00	5.50	7.20	350220
0.30	6.16	3.70	4.70	350170
0.30	1.16	1.15	1.80	350450
0.30	1.80	1.08	3.00	370890
0.40	6.24	5.00	7.20	350110
0.42	4.50	3.70	4.70	350350
0.43	1.14	1.13	2.40	350200
0.47	4.47	4.20	5.42	350022
0.50	1.49	1.50	2.65	350710
0.50	2.00	2.00	3.00	350150
0.50	8.00	8.00	9.94	350240
0.53	2.95	4.00	4.70	350440
0.55	1.45	1.60	2.40	350140
0.55	2.72	3.00	4.00	350160
0.55	3.89	4.29	6.325	350080
0.55	4.51	4.95	6.325	350230
0.55	0.382	0.40	1.20	370631
0.59	0.45	0.52	1.80	350620
0.60	0.682	0.84	2.50	370060
0.60	0.70	0.84	2.50	370880
0.60	2.97	3.60	4.00	350660
0.60	4.00	4.80	6.325	350610
0.60	4.00	4.80	6.325	350670
0.60	0.70	0.84	3.60	370930
0.62	4.03	5.00	6.325	350340
0.67	2.84	4.00	5.40	350570
0.68	2.75	3.60	4.00	350390
0.68	3.10	5.00	6.325	350330
0.80	0.75	1.20	3.00	370840
0.80	0.75	1.20	3.60	370920

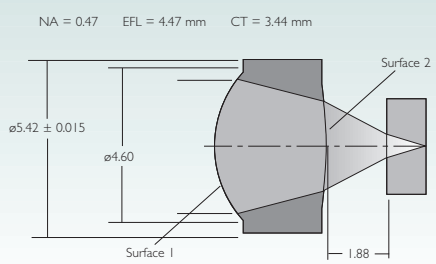
Guaranteed Performance

LightPath's aspheric lenses are inspected and optical tested to ensure complete customer satisfaction. Visual cosmetic inspection is preformed on 100% of all lenses per MIL-PRF-13830B with a scratch/dig spec of 40/20. Other inspection criteria including 80/40, 20/10 and 10/5 can be provided on request.

Optical performance is guaranteed by test methods utilizing an interferometer measuring transmitted RMS wavefront error listed in the individual lens specification. LightPath can also perform customized optical tests in order to screen for the customers' specific application criteria.

Tolerances guaranteed are:
Outer Diameter (OD): ± 0.015mm
Clear Aperture (CA): ± 0.100mm
Effective Focal Length (EFL): ± 1%
Working Distance (WD): ± 1% of EFL

Lens Code **350022**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.47
Clear Aperture (CA)	4.20 mm
Effective Focal Length (EFL)	4.47 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	5.42 mm
Working Distance (WD)	1.88 mm

Design corrected for 1.20 mm thick polycarbonate disk (index 1.573)

Surface 1
R = 3.154574
k = -0.865451
A_4 = 1.15243x10^{-3}
A_6 = 8.03738x10^{-5}
A_8 = -1.79519x10^{-5}
A_{10} = 7.22469x10^{-7}

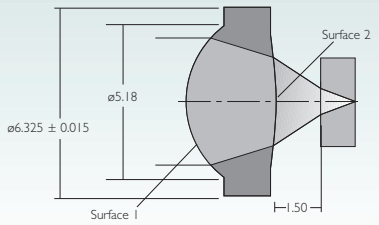
Surface 2
R = -10.23541
k = -8.798912
A_4 = 3.73586x10^{-3}
A_6 = -3.98168x10^{-4}
A_8 = -2.0712x10^{-4}
A_{10} = 5.13961x10^{-5}

Design Objective:	Focus light into an optical disk.
Lens Characteristics:	Moderate NA for good light capture; small focused spot.
Typical Products:	Optical data storage systems.

Order Nomenclature
350022-A AR Coating 400-600nm
350022-B AR Coating 600-1050nm
350022-C AR Coating 1050-1600nm
350022-D AR Coating 1300-1700nm

Lens Code **350080**

NA = 0.55 EFL = 3.89 mm CT = 3.07 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.55
Clear Aperture (CA)	4.29 mm
Effective Focal Length (EFL)	3.89 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.325 mm
Working Distance (WD)	1.50 mm
Design corrected for 1.20 mm thick polycarbonate disk (index 1.57)	

Surface 1
R = 2.75
k = -0.613916
$A_4 = 5.88919 \times 10^{-4}$
$A_6 = -1.76602 \times 10^{-5}$
$A_8 = 1.01025 \times 10^{-5}$
$A_{10} = -3.91487 \times 10^{-6}$

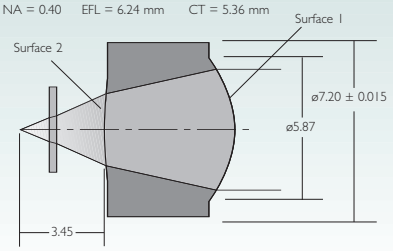
Surface 2
R = -8.737974
k = -31.05381
$A_4 = 2.97573 \times 10^{-3}$
$A_6 = -5.0196 \times 10^{-4}$
$A_8 = -1.80723 \times 10^{-4}$
$A_{10} = 3.61747 \times 10^{-5}$

Design Objective:	Focus light into an optical disk.
Lens Characteristics:	High NA for maximum light capture; small focused spot.
Typical Products:	Optical data storage systems.

Order Nomenclature
350080-A AR Coating 400-600nm
350080-B AR Coating 600-1050nm
350080-C AR Coating 1050-1600nm
350080-D AR Coating 1300-1700nm

Lens Code **350110**

NA = 0.40 EFL = 6.24 mm CT = 5.36 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.40
Clear Aperture (CA)	5.00 mm
Effective Focal Length (EFL)	6.24 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	7.20 mm
Working Distance (WD)	3.45 mm
Laser Window Thickness	0.275 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 4.3200
k = -0.648067
$A_4 = 1.65853 \times 10^{-4}$
$A_6 = -8.28138 \times 10^{-6}$

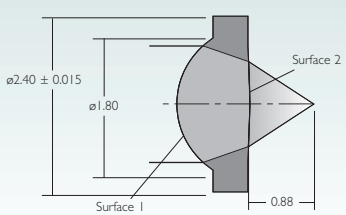
Surface 2
R = -14.5754
k = -87.228063
$A_4 = -9.157540 \times 10^{-4}$
$A_6 = 8.64353 \times 10^{-5}$

Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	Moderate NA for good light capture; large CA for minimum beam divergence.
Typical Products:	Presentation pointers, small weapons sights, survey instruments, hand held and fixed barcode scanners, medical instruments, alignment instruments.

Order Nomenclature
350110-A AR Coating 400-600nm
350110-B AR Coating 600-1050nm
350110-C AR Coating 1050-1600nm
350110-D AR Coating 1300-1700nm

Lens Code **350140**

NA = 0.55 EFL = 1.45 mm CT = 1.01 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.55
Clear Aperture (CA)	1.60 mm
Effective Focal Length (EFL)	1.45 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	2.40 mm
Working Distance (WD)	0.88 mm

Surface 1
R = 0.9500
k = -0.522546
$A_6 = 1.25280 \times 10^{-2}$
$A_8 = -3.97188 \times 10^{-2}$

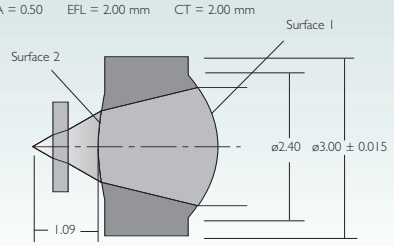
Surface 2
R = -5.96157
$A_4 = 1.46106 \times 10^{-1}$
$A_6 = -2.79350 \times 10^{-1}$
$A_8 = 1.99181 \times 10^{-1}$

Design Objective:	Collimate or focus laser light.
Lens Characteristics:	High NA for maximum light capture; small physical size.
Typical Products:	Fiber to fiber coupling applications when used with another lens or in pairs.

Order Nomenclature
350140-A AR Coating 400-600nm
350140-B AR Coating 600-1050nm
350140-C AR Coating 1050-1600nm
350140-D AR Coating 1300-1700nm

Lens Code **350150**

NA = 0.50 EFL = 2.00 mm CT = 2.00 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.50
Clear Aperture (CA)	2.00 mm
Effective Focal Length (EFL)	2.00 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	3.00 mm
Working Distance (WD)	1.09 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 1.500
k = -0.645786
$A_6 = -1.27177 \times 10^{-3}$
$A_8 = -2.67573 \times 10^{-3}$

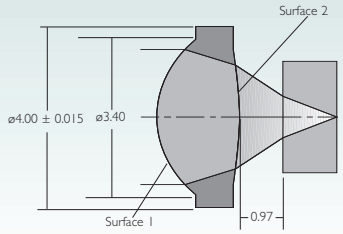
Surface 2
R = -2.91036
$A_4 = 9.44102 \times 10^{-2}$
$A_6 = -1.27642 \times 10^{-1}$
$A_8 = 8.16437 \times 10^{-2}$

Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	High NA for maximum light capture; small physical size.
Typical Products:	Presentation pointers, small weapons sights, survey instruments, alignment instruments, hand held and fixed barcode scanners, medical instruments.

Order Nomenclature
350150-A AR Coating 400-600nm
350150-B AR Coating 600-1050nm
350150-C AR Coating 1050-1600nm
350150-D AR Coating 1300-1700nm

Lens Code **350160**

NA = 0.55 EFL = 2.72 mm CT = 1.83 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.55
Clear Aperture (CA)	3.00 mm
Effective Focal Length (EFL)	2.72 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	4.00 mm
Working Distance (WD)	0.97 mm

Design corrected for 1.20 mm thick polycarbonate disk (index 1.573)

Surface 1
R = 1.93
k = -0.655844
$A_4 = 2.83298 \times 10^{-3}$
$A_6 = -4.3886 \times 10^{-5}$
$A_8 = 1.52368 \times 10^{-4}$
$A_{10} = -1.17709 \times 10^{-4}$

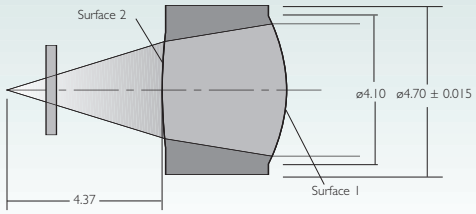
Surface 2
R = -6.74368
k = -31.75381
$A_4 = 7.35806 \times 10^{-3}$
$A_6 = -2.50767 \times 10^{-3}$
$A_8 = -1.10595 \times 10^{-3}$
$A_{10} = 3.87101 \times 10^{-4}$

Design Objective:	Focus light into an optical disk.
Lens Characteristics:	High NA for maximum light capture; small focused spot.
Typical Products:	Optical data storage system.

Order Nomenclature
350160-A AR Coating 400-600nm 350160-B AR Coating 600-1050nm
350160-C AR Coating 1050-1600nm 350160-D AR Coating 1300-1700nm

Lens Code **350170**

NA = 0.30 EFL = 6.16 mm CT = 3.48 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.30
Clear Aperture (CA)	3.70 mm
Effective Focal Length (EFL)	6.16 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	4.70 mm
Working Distance (WD)	4.37 mm
Laser Window Thickness	0.275 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 4.25
k = -0.863601
$A_4 = 1.77613 \times 10^{-4}$
$A_6 = -1.55395 \times 10^{-5}$

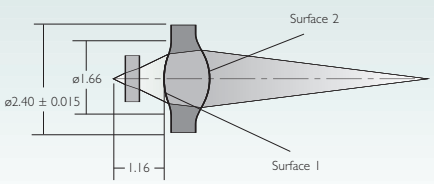
Surface 2
R = -19.136

Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	Low NA for clean circular beam; moderate physical size.
Typical Products:	Industrial barcode readers, point-of-purchase barcode readers, laser printers, laser fax machines, survey instruments.

Order Nomenclature
350170-A AR Coating 400-600nm 350170-B AR Coating 600-1050nm
350170-C AR Coating 1050-1600nm 350170-D AR Coating 1300-1700nm

Lens Code **350200**

NA = 0.43 EFL = 1.14 mm CT = 1.03 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	1300 nm
Numerical Aperture (NA)	0.12 (image)
	0.43 (object)
Clear Aperture (CA)	1.30 mm (image)
	1.13 (object)
Effective Focal Length (EFL)	1.14 mm
Magnification	3.64
RMS WFE	< Diff. Limit
Outer Diameter (OD)	2.40 mm
Working Distance (WD)	1.16/4.93 mm*
Laser Window Thickness	0.300 mm
Laser window Material/Index	BK7/1.517

Surface 1
R = 1.111111
k = -6.995295
$A_6 = 1.71893 \times 10^{-1}$
$A_8 = 4.09008 \times 10^{-2}$
$A_{10} = -8.85435 \times 10^{-2}$

Surface 2
R = -1.111111
k = -0.696917
$A_6 = 8.69628 \times 10^{-2}$
$A_8 = 1.33304 \times 10^{-2}$
$A_{10} = 1.53352 \times 10^{-1}$

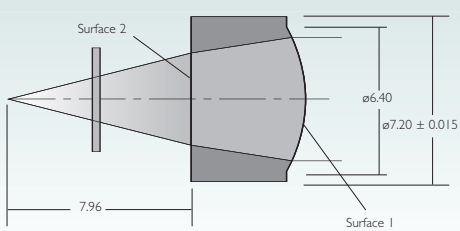
*front/back WD

Design Objective:	Finite conjugate operates at (3.70:1) magnification.
Lens Characteristics:	Single lens couples light to single mode/multi-mode fibers; small physical size for fiber-to-fiber coupling.
Typical Products:	Laser diode pigtails (SM/MM), laser diode connectors (SM/MM), fiber-to-fiber connectors (SM/MM).

Order Nomenclature
350200-A AR Coating 400-600nm 350200-B AR Coating 600-1050nm
350200-C AR Coating 1050-1600nm 350200-D AR Coating 1300-1700nm

Lens Code **350220**

NA = 0.25 EFL = 11.00 mm CT = 5.00 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	633 nm
Numerical Aperture (NA)	0.25
Clear Aperture (CA)	5.50 mm
Effective Focal Length (EFL)	11.00 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	7.20 mm
Working Distance (WD)	7.96 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 6.627608
k = -0.554366
$A_4 = 4.39140 \times 10^{-6}$
$A_6 = -3.81456 \times 10^{-7}$

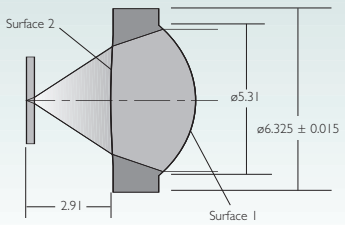
Surface 2
Plano

Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	Low NA for clean circular beam; large CA for minimum beam divergence.
Typical Products:	Industrial barcode readers, point-of-purchase barcode readers, laser printers, laser fax machines, survey instruments.

Order Nomenclature
350220-A AR Coating 400-600nm 350220-B AR Coating 600-1050nm
350220-C AR Coating 1050-1600nm 350220-D AR Coating 1300-1700nm

Lens Code **350230**

NA = 0.55 EFL = 4.51 mm CT = 2.94 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.55
Clear Aperture (CA)	4.95 mm
Effective Focal Length (EFL)	4.51 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.325 mm
Working Distance (WD)	2.91 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 2.944996
k = -0.481104
A_4 = -2.89094x10^{-5}
A_6 = -3.76282x10^{-5}
A_8 = 3.26442x10^{-6}
A_{10} = -1.17572x10^{-6}

Surface 2
R = -19.9223
A_4 = 4.2371x10^{-3}
A_6 = -6.3484x10^{-4}
A_8 = 3.46526x10^{-5}

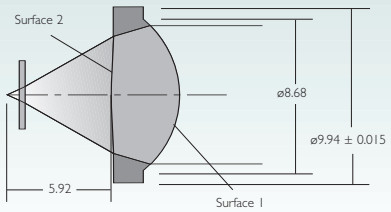
Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	High NA for maximum light capture; large CA for minimum beam divergence.
Typical Products:	Presentation pointers, small weapons sights, survey instruments, hand held and fixed barcode scanners, medical instruments, alignment instruments.

Order Nomenclature

350230-A AR Coating 400-600nm 350230-B AR Coating 600-1050nm
350230-C AR Coating 1050-1600nm 350230-D AR Coating 1300-1700nm

Lens Code **350240**

NA = 0.50 EFL = 8.00 mm CT = 3.69 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.50
Clear Aperture (CA)	8.00 mm
Effective Focal Length (EFL)	8.00 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	9.94 mm
Working Distance (WD)	5.92 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 5.092394
k = -0.473172
A_6 = -2.25726x10^{-6}
A_8 = 2.41164x10^{-9}
A_{10} = -8.2628x10^{-9}

Surface 2
R = -56.2031
A_4 = 5.124x10^{-4}
A_6 = -2.2661 1x10^{-5}
A_8 = 3.33115x10^{-7}

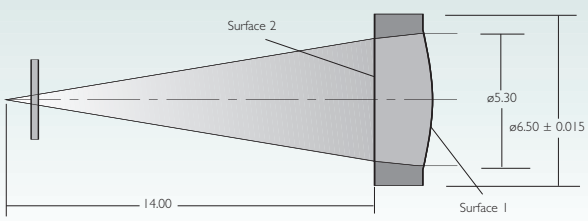
Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	High NA for maximum light capture; large CA and long focal length for minimum beam divergence.
Typical Products:	Presentation pointers, small weapons sights, survey instruments, alignment instruments, hand held and fixed barcode scanners, medical instruments.

Order Nomenclature

350240-A AR Coating 400-600nm 350240-B AR Coating 600-1050nm
350240-C AR Coating 1050-1600nm 350240-D AR Coating 1300-1700nm

Lens Code **350260**

NA = 0.16 EFL = 15.29 mm CT = 2.20 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.16
Clear Aperture (CA)	5.00 mm
Effective Focal Length (EFL)	15.29 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.50 mm
Working Distance (WD)	14.00 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 9.1311140
k = -0.53854
A_4 = -7.9241x10^{-6}
A_6 = -1.2721x10^{-7}

Surface 2
Plano

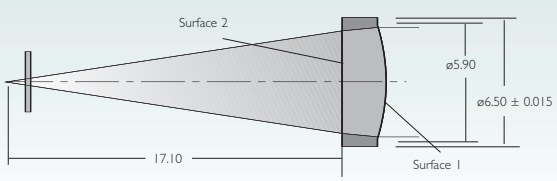
Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	Low NA for clean circular beam; large CA for minimum beam divergence.
Typical Products:	Industrial barcode readers, point-of-purchase barcode readers, laser printers, laser fax machines, survey instruments.

Order Nomenclature

350260-A AR Coating 400-600nm 350260-B AR Coating 600-1050nm
350260-C AR Coating 1050-1600nm 350260-D AR Coating 1300-1700nm

Lens Code **350280**

NA = 0.15 EFL = 18.40 mm CT = 2.20 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	780 nm
Numerical Aperture (NA)	0.15
Clear Aperture (CA)	5.50 mm
Effective Focal Length (EFL)	18.40 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.50 mm
Working Distance (WD)	17.10 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 10.9838
k = -0.542929
A_4 = -4.4947x10^{-6}
A_6 = -4.9161x10^{-8}

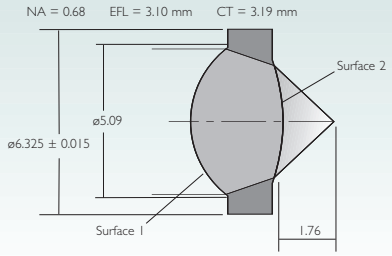
Surface 2
Plano

Design Objective:	Collimate or focus laser light at high magnification from a laser diode.
Lens Characteristics:	Low NA for clean circular beam; large CA for minimum beam divergence.
Typical Products:	Industrial barcode readers, point-of-purchase barcode readers, laser printers, laser fax machines, survey instruments.

Order Nomenclature

350280-A AR Coating 400-600nm 350280-B AR Coating 600-1050nm
350280-C AR Coating 1050-1600nm 350280-D AR Coating 1300-1700nm

Lens Code **350330**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	830 nm
Numerical Aperture (NA)	0.68
Clear Aperture (CA)	5.00 mm
Effective Focal Length (EFL)	3.10 mm
Magnification	Infinite
Outer Diameter (OD)	6.325 mm
Working Distance (WD)	1.76 mm

Surface 1
R = 2.75
k = -0.613916
$A_4 = 5.88919 \times 10^{-4}$
$A_6 = -1.76602 \times 10^{-5}$
$A_8 = 1.01025 \times 10^{-5}$
$A_{10} = -3.91487 \times 10^{-6}$

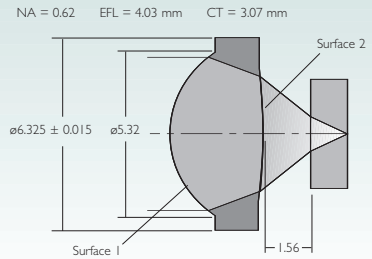
Surface 2
R = -3.18854
k = -12.66386
$A_4 = 1.245834 \times 10^{-2}$
$A_6 = -3.711945 \times 10^{-3}$
$A_8 = 5.122391 \times 10^{-4}$
$A_{10} = -3.108578 \times 10^{-5}$

Design Objective:	Collimate or focus laser light.
Lens Characteristics:	High NA for maximum light capture; large CA for minimum beam convergence.
Typical Products:	Fiber to fiber coupling applications when used with another lens or in pairs.

Order Nomenclature

350330-A AR Coating 400-600nm
350330-B AR Coating 600-1050nm
350330-C AR Coating 1050-1600nm
350330-D AR Coating 1300-1700nm

Lens Code **350340**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	685 nm
Numerical Aperture (NA)	0.62
Clear Aperture (CA)	5.00 mm
Effective Focal Length (EFL)	4.03 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.325 mm
Working Distance (WD)	1.56 mm

Design corrected for 1.20 mm thick K3 glass disk (index 1.518)

Surface 1
R = 2.774388
k = -0.5333481
$A_4 = 4.202096 \times 10^{-4}$
$A_6 = -7.493867 \times 10^{-5}$
$A_8 = 2.403049 \times 10^{-5}$
$A_{10} = -3.180361 \times 10^{-6}$

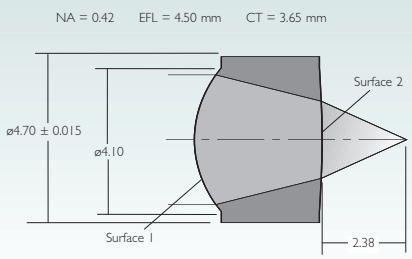
Surface 2
R = -10.98799
k = 16.02766
$A_4 = 9.202479 \times 10^{-3}$
$A_6 = -9.162629 \times 10^{-4}$
$A_8 = 2.800532 \times 10^{-5}$
$A_{10} = 6.7433645 \times 10^{-6}$

Design Objective:	Focus light into an optical disk.
Lens Characteristics:	High NA for maximum light capture, large CA for minimum beam divergence.
Typical Products:	Optical data storage systems.

Order Nomenclature

350340-A AR Coating 400-600nm
350340-B AR Coating 600-1050nm
350340-C AR Coating 1050-1600nm
350340-D AR Coating 1300-1700nm

Lens Code **350350**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	980 nm
Numerical Aperture (NA)	0.42
Clear Aperture (CA)	3.70 mm
Effective Focal Length (EFL)	4.50 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	4.70 mm
Working Distance (WD)	2.38 mm

Surface 1
R = 2.8797745
k = -0.6415948
$A_4 = 3.14802762 \times 10^{-4}$
$A_6 = -2.54647053 \times 10^{-5}$
$A_8 = -2.81435764 \times 10^{-6}$
$A_{10} = -3.30733580 \times 10^{-7}$

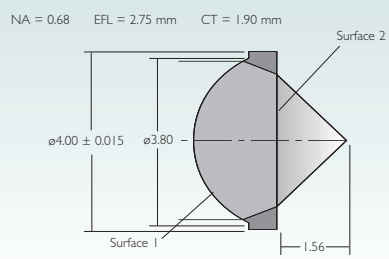
Surface 2
R = -19.13600

Design Objective:	Collimate or focus laser light.
Lens Characteristics:	Moderate NA for good light capture.
Typical Products:	Fiber coupling applications.

Order Nomenclature

350350-A AR Coating 400-600nm
350350-B AR Coating 600-1050nm
350350-C AR Coating 1050-1600nm
350350-D AR Coating 1300-1700nm

Lens Code **350390**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	830 nm
Numerical Aperture (NA)	0.68
Clear Aperture (CA)	3.60 mm
Effective Focal Length (EFL)	2.75 mm
Magnification	Infinite
Outer Diameter (OD)	4.00 mm
Working Distance (WD)	1.56 mm

Surface 1
R = 1.638251
k = -0.9158034
$A_4 = 1.0758341 \times 10^{-2}$
$A_6 = 1.298631 \times 10^{-3}$
$A_8 = -3.797836 \times 10^{-5}$

Surface 2
Plano

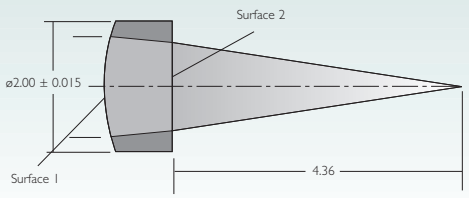
Design Objective:	Collimate or focus laser light.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Fiber to fiber coupling applications when used with another lens or in pairs.

Order Nomenclature

350390-A AR Coating 400-600nm
350390-B AR Coating 600-1050nm
350390-C AR Coating 1050-1600nm
350390-D AR Coating 1300-1700nm

Lens Code **350430**

NA = 0.15 EFL = 5.00 mm CT = 1.01 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	1550 nm
Numerical Aperture (NA)	0.15
Clear Aperture (CA)	1.50 mm
Effective Focal Length (EFL)	5.00 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	2.00 mm
Working Distance (WD)	4.36 mm

Surface 1
R = 2.928699
k = -0.58123316

Surface 2
Plano

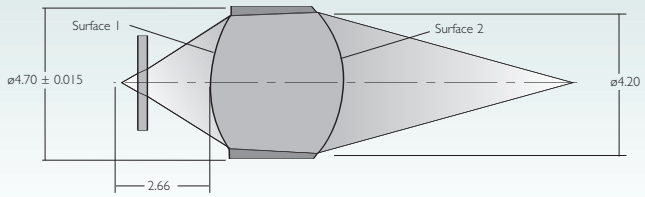
Design Objective:	Collimate or focus laser light.
Lens Characteristics:	Low NA for clean circular beam; small physical size.
Typical Products:	Fiber coupling applications.

Order Nomenclature

350430-A AR Coating 400-600nm
350430-B AR Coating 600-1050nm
350430-C AR Coating 1050-1600nm
350430-D AR Coating 1300-1700nm

Lens Code **350440**

NA = 0.53 EFL = 2.95 mm CT = 4.07 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	980 nm
Numerical Aperture (NA)	0.27 (image)
	0.53 (object)
Clear Aperture (CA)	4.20 mm (image)
	4.00 mm (object)
Effective Focal Length (EFL)	2.95 mm
Magnification	2.00
Outer Diameter (OD)	4.70 mm
Working Distance (WD)	2.66/6.91 mm*
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

*front/back WD

Surface 1
R = 2.39
k = -4.511125
A_4 = 4.798319x10^{-3}
A_6 = -1.140838x10^{-3}
A_8 = 3.160119x10^{-4}
A_{10} = -2.257531x10^{-5}

Surface 2
R = -2.39
k = -0.8190024
A_4 = 6.997386x10^{-3}
A_6 = 4.925941x10^{-4}
A_8 = -1.645947x10^{-4}
A_{10} = 2.7456578x10^{-5}

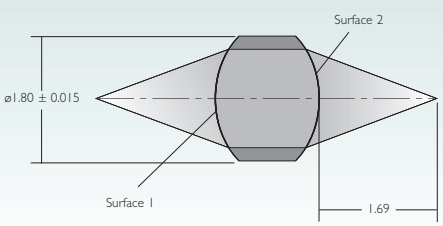
Design Objective:	Finite conjugate operates at (2:1) magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Laser diode pigtails (SM/MM), laser diode connectors (SM/MM), fiber-to-fiber connectors (SM/MM).

Order Nomenclature

350440-A AR Coating 400-600nm
350440-B AR Coating 600-1050nm
350440-C AR Coating 1050-1600nm
350440-D AR Coating 1300-1700nm

Lens Code **350450**

NA = 0.30 EFL = 1.16 mm CT = 1.48 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	980 nm
Numerical Aperture (NA)	0.30 (image)
	0.30 (object)
Clear Aperture (CA)	1.15 mm (image)
	1.15 mm (object)
Effective Focal Length (EFL)	1.16 mm
Magnification	1.00
Outer Diameter (OD)	1.80 mm
Working Distance (WD)	1.69/1.69 mm*

*front/back WD

Surface 1
R = 1.0000
k = -2.5370781

Surface 2
R = -1.0000
k = -2.5370781

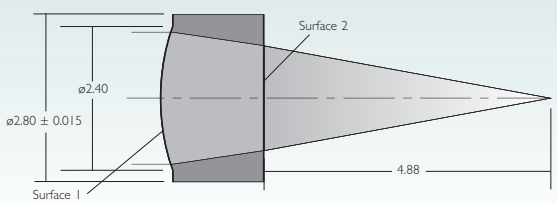
Design Objective:	Minimize alignment sensitivity; finite conjugate operates at (1:1) magnification.
Lens Characteristics:	Single lens couples light to single mode/multi-mode fibers; small physical size for fiber-to-fiber coupling.
Typical Products:	Fiber coupling applications.

Order Nomenclature

350450-A AR Coating 400-600nm
350450-B AR Coating 600-1050nm
350450-C AR Coating 1050-1600nm
350450-D AR Coating 1300-1700nm

Lens Code **350550**

NA = 0.18 EFL = 6.10 mm CT = 1.93 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	1550 nm
Numerical Aperture (NA)	0.18
Clear Aperture (CA)	2.20 mm
Effective Focal Length (EFL)	6.10 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	2.80 mm
Working Distance (WD)	4.88 mm

Surface 1
R = 3.572916
k = -0.5681

Surface 2
Plano

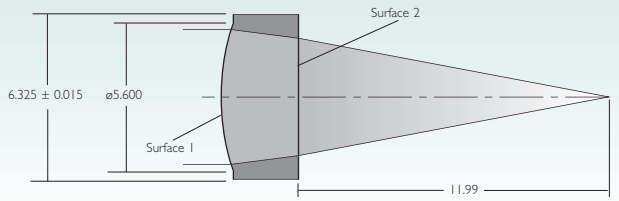
Design Objective:	Collimate or focus laser light.
Lens Characteristics:	Low NA for clean circular beam; small physical size.
Typical Products:	Fiber coupling applications.

Order Nomenclature

350550-A AR Coating 400-600nm
350550-B AR Coating 600-1050nm
350550-C AR Coating 1050-1600nm
350550-D AR Coating 1300-1700nm

Lens Code **350560**

NA = 0.18 EFL = 13.86 mm CT = 3.00 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	650 nm
Numerical Aperture (NA)	0.18
Clear Aperture (CA)	5.10 mm
Effective Focal Length (EFL)	13.86 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.325 mm
Working Distance (WD)	11.99 mm

Surface 1
R = 8.339558
k = -0.5864473

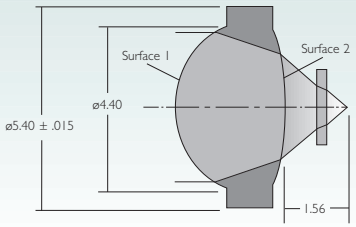
Surface 2
Plano

Design Objective:	Collimate or focus laser light.
Lens Characteristics:	Low NA for clean circular beam; large CA for minimum beam divergence.
Typical Products:	Fiber coupling applications, data storage.

Order Nomenclature
350560-A AR Coating 400-600nm 350560-B AR Coating 600-1050nm
350560-C AR Coating 1050-1600nm 350560-D AR Coating 1300-1700nm

Lens Code **350570**

NA = 0.67 EFL = 2.84 mm CT = 2.70 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	1550 nm
Numerical Aperture (NA)	0.67
Clear Aperture (CA)	4.00 mm
Effective Focal Length (EFL)	2.84 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	5.40 mm
Working Distance (WD)	1.56 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
R = 2.078327
k = -0.9596772
$A_4 = 5.794628 \times 10^{-3}$
$A_6 = 2.917948 \times 10^{-5}$
$A_8 = -2.350426 \times 10^{-5}$
$A_{10} = -2.096937 \times 10^{-6}$

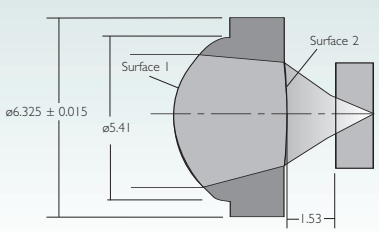
Surface 2
R = -4.319238
k = -32.43041

Design Objective:	Collimate laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Telecommunications.

Order Nomenclature
350570-A AR Coating 400-600nm 350570-B AR Coating 600-1050nm
350570-C AR Coating 1050-1600nm 350570-D AR Coating 1300-1700nm

Lens Code **350610**

NA = 0.60 EFL = 4.00 mm CT = 3.04 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	410 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	4.80 mm
Effective Focal Length (EFL)	4.00 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.325 mm
Working Distance (WD)	1.53 mm
Design corrected for 1.20 mm thick K3 glass disk (index 1.518)	

Surface 1
R = 2.774388
k = -0.5333481
$A_4 = 4.202096 \times 10^{-4}$
$A_6 = -7.493867 \times 10^{-5}$
$A_8 = 2.403049 \times 10^{-5}$
$A_{10} = -3.180361 \times 10^{-6}$

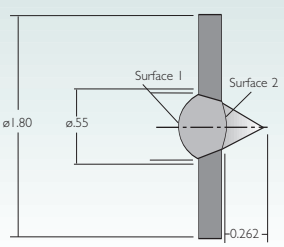
Surface 2
R = -14.58192
k = -191.5207
$A_4 = -1.443363 \times 10^{-3}$
$A_6 = 1.4648185 \times 10^{-3}$
$A_8 = -4.7042041 \times 10^{-4}$
$A_{10} = 4.8133394 \times 10^{-5}$

Design Objective:	Focus light through disk onto storage media.
Lens Characteristics:	High NA for maximum light capture, small size.
Typical Products:	Data storage.

Order Nomenclature
350610-A AR Coating 400-600nm 350610-B AR Coating 600-1050nm
350610-C AR Coating 1050-1600nm 350610-D AR Coating 1300-1700nm

Lens Code **350620**

NA = 0.59 EFL = 0.45 mm CT = 0.30 mm



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	1310 nm
Numerical Aperture (NA)	0.59
Clear Aperture (CA)	0.52 mm
Effective Focal Length (EFL)	0.45 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	1.80 mm
Working Distance (WD)	0.27 mm
Laser Window Thickness	None
Laser Window Material/Index	None

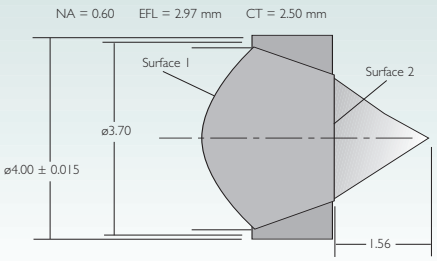
Surface 1
R = 0.279661
k = -1.713673
$A_4 = 6.399539$
$A_6 = -11.728248$

Surface 2
R = -3.0000

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture, small size.
Typical Products:	Telecommunications.

Order Nomenclature
350620-A AR Coating 400-600nm 350620-B AR Coating 600-1050nm
350620-C AR Coating 1050-1600nm 350620-D AR Coating 1300-1700nm

Lens Code **350660**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	1550 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	3.60 mm
Effective Focal Length (EFL)	2.97 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	4.00 mm
Working Distance (WD)	1.56 mm
Laser Window Thickness	None
Laser Window Material/Index	None

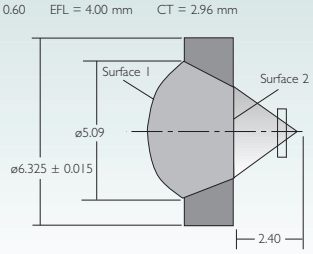
Surface 1
R = 1.95041
k = -0.8616171
A_4 = 6.3289079x10^{-3}
A_6 = 2.270895x10^{-4}
A_8 = -1.2684027x10^{-5}

Surface 2
R = -8.379831
k = -158.3124

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Telecommunications.

Order Nomenclature
350660-A AR Coating 400-600nm
350660-B AR Coating 600-1050nm
350660-C AR Coating 1050-1600nm
350660-D AR Coating 1300-1700nm

Lens Code **350670**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	405 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	4.80 mm
Effective Focal Length (EFL)	4.00 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	6.325 mm
Working Distance (WD)	2.40 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	N-PK52 / 1.497

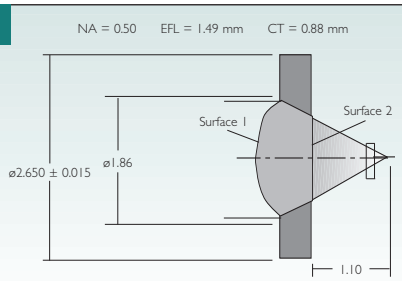
Surface 1
R = 2.708638
k = -0.8968698
A_4 = 2.7884019x10^{-3}
A_6 = 1.5533767x10^{-4}
A_8 = -7.281244x10^{-6}

Surface 2
R = -19.41511
k = 0.0
A_4 = 8.8275461x10^{-3}
A_6 = -1.9006168x10^{-3}
A_8 = 1.7335967x10^{-4}

Design Objective:	Collimate laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Data storage.

Order Nomenclature
350670-A AR Coating 400-600nm
350670-B AR Coating 600-1050nm
350670-C AR Coating 1050-1600nm
350670-D AR Coating 1300-1700nm

Lens Code **350710**



OPTICAL DESIGN SPECIFICATIONS

Design Wavelength	1550 nm
Numerical Aperture (NA)	0.50
Clear Aperture (CA)	1.50 mm
Effective Focal Length (EFL)	1.49 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	2.65 mm
Working Distance (WD)	1.10 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

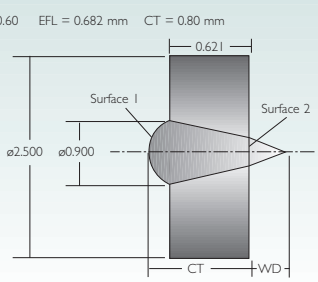
Surface 1
R = 1.017623
k = -0.695054
A_4 = -4.088 E-03
A_6 = -2.1192 E-02
A_8 = -7.506 E-03
A_{10} = -5.623 E-03

Surface 2
R = -4.245282

Design Objective:	Collimate laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture, small size.
Typical Products:	Telecommunications.

Order Nomenclature
350710-A AR Coating 400-600nm
350710-B AR Coating 600-1050nm
350710-C AR Coating 1050-1600nm
350710-D AR Coating 1300-1700nm

Lens Code **370060**



OPTICAL DESIGN SPECIFICATIONS

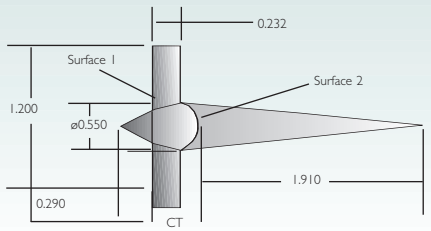
Design Wavelength	1550 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	0.84 mm
Effective Focal Length (EFL)	0.682 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	2.50 mm
Working Distance (WD)	0.267 mm
Laser Window Thickness	None
Laser Window Material/Index	None

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	Very high NA for maximum light capture.
Typical Products:	Laser collimator for telecommunications.

Order Nomenclature
370060-O AR Coating 600-1050nm
370060-P AR Coating 1050-1600nm
370060-Q AR Coating 1300-1700nm

Lens Code **370631**

NA = 0.55 EFL = 0.750 CT = 0.35



OPTICAL DESIGN SPECIFICATIONS

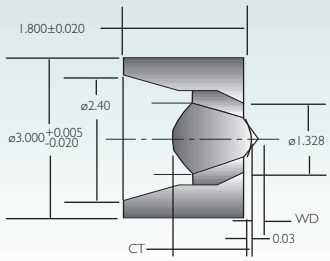
Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.55
Clear Aperture (CA)	0.53
Effective Focal Length (EFL)	0.382
Magnification	4.02
RMS WFE	<Diff. Limit
Outer Diameter (OD)	1.20 mm
Working Distance (WD)	0.290/1.91 mm*
Distance Holder to Laser	none
Laser Window Thickness	none
Laser Window Material/Index	none
	*front/back WD

Design Objective:	Laser to fiber coupling lens.
Lens Characteristics:	High NA for maximum light capture, small size.
Typical Products:	Telecommunications.

Order Nomenclature 370631-O AR Coating 600-1050nm 370631-P AR Coating 1050-1600nm
370631-Q AR Coating 1300-1700nm

Lens Code **370840**

NA = 0.80 EFL = 0.750 mm CT = 1.13mm



OPTICAL DESIGN SPECIFICATIONS

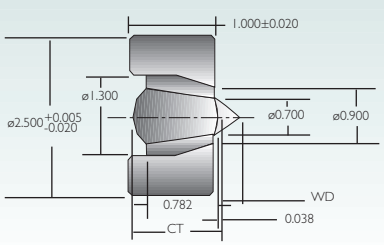
Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.80
Clear Aperture (CA)	1.2 mm
Effective Focal Length (EFL)	0.750 mm
Magnification	Infinite
RMS WFE	<Diff. Limit
Outer Diameter (OD)	3.0 mm
Working Distance (WD)	0.2 mm
Distance Holder to Laser	0.23mm
Laser Window Thickness	None
Laser Window Material/Index	None
Lens Holder	304 Stainless Steel

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Laser collimator for telecommunications.

Order Nomenclature 370840-O AR Coating 600-1050nm 370840-P AR Coating 1050-1600nm
370840-Q AR Coating 1300-1700nm

Lens Code **370880**

NA = 0.60 EFL = 0.70 mm CT = 0.95 mm



OPTICAL DESIGN SPECIFICATIONS

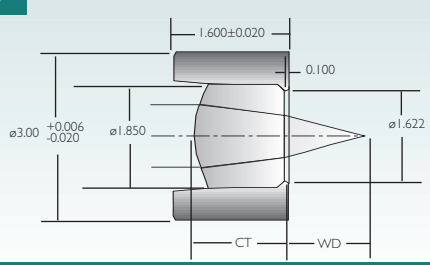
Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	0.84 mm
Effective Focal Length (EFL)	0.70 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	2.5 mm
Working Distance (WD)	0.29 mm
Distance Holder to Laser	0.33mm
Laser Window Thickness	None
Laser Window Material/Index	None
Lens Holder	304L Stainless Steel

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Laser collimator for telecommunications.

Order Nomenclature 370880-O AR Coating 600-1050nm 370880-P AR Coating 1050-1600nm
370880-Q AR Coating 1300-1700nm

Lens Code **370890**

NA = 0.30 EFL = 1.80mm CT = 1.28 mm



OPTICAL DESIGN SPECIFICATIONS

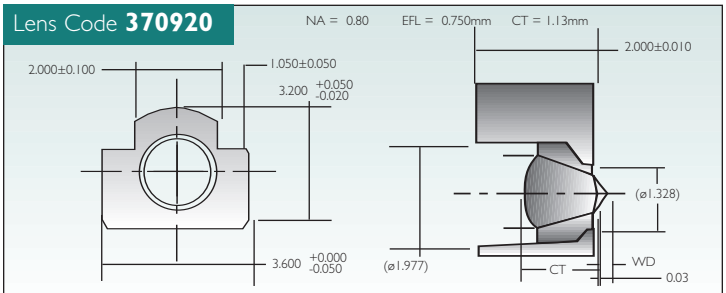
Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.30
Clear Aperture (CA)	1.08 mm
Effective Focal Length (EFL)	1.80 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	3.0 mm
Working Distance (WD)	1.1 mm
Distance holder to Laser	1.0mm
Laser Window Thickness	None
Laser Window Material/Index	None
Lens Holder	304 Stainless Steel

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Laser collimator for telecommunications.

Order Nomenclature 370890-O AR Coating 600-1050nm 370890-P AR Coating 1050-1600nm
370890-Q AR Coating 1300-1700nm

Lens Code **370920**

NA = 0.80 EFL = 0.750mm CT = 1.13mm



OPTICAL DESIGN SPECIFICATIONS

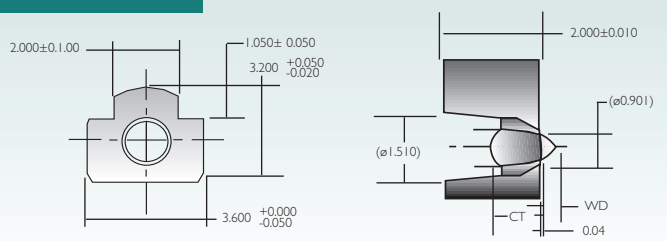
Design Wavelength	1550/1480nm
Numerical Aperture (NA)	0.80
Clear Aperture (CA)	1.2 mm
Effective Focal Length (EFL)	0.750 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	4.0 mm
Working Distance (WD)	0.2 mm
Distance Holder to Laser	0.23 mm
Laser Window Thickness	None
Laser Window Material/Index	None
Lens Holder	304 Stainless Steel

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Laser collimate for telecommunications.

Order Nomenclature 370920-O AR Coating 600-1050nm 370920-P AR Coating 1050-1600nm
370920-Q AR Coating 1300-1700nm

Lens Code **370930**

NA = 0.60 EFL = 0.70 mm CT = 0.95mm



OPTICAL DESIGN SPECIFICATIONS

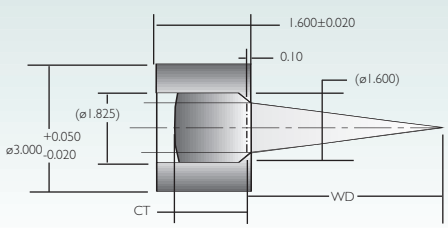
Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	0.84 mm
Effective Focal Length (EFL)	0.70 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	4.0 mm
Working Distance (WD)	0.29 mm
Distance Holder to Laser	0.33 mm
Laser Window Thickness	None
Laser Window Material/Index	None
Lens Holder	304 Stainless Steel

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Laser collimator for telecommunications.

Order Nomenclature 370930-O AR Coating 600-1050nm 370930-P AR Coating 1050-1600nm
370930-Q AR Coating 1300-1700nm

Lens Code **370940**

NA = 0.17 EFL = 4.0 mm CT = 1.23 mm



OPTICAL DESIGN SPECIFICATIONS

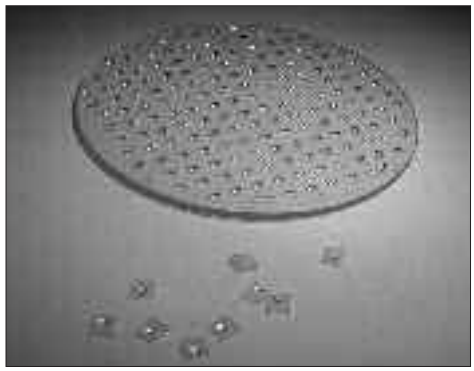
Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.17
Clear Aperture (CA)	1.37 mm
Effective Focal Length (EFL)	4.0 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Outer Diameter (OD)	3.0 mm
Working Distance (WD)	3.36 mm
Distance Holder to Laser	3.36mm
Laser Window Thickness	None
Laser Window Material/Index	None
Lens Holder	304 Stainless Steel

Design Objective:	Collimate or focus laser light at high magnification.
Lens Characteristics:	High NA for maximum light capture.
Typical Products:	Laser collimator for telecommunications.

Order Nomenclature 370940-O AR Coating 600-1050nm 370940-P AR Coating 1050-1600nm
370940-Q AR Coating 1300-1700nm

Tx Aspheric™ Glass Lenses

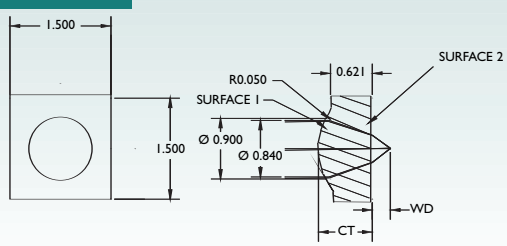
- Metro, Access, Hybrid Fiber Coax, and Long Haul
- Precision molded high index glass
- Diffraction limited performance
- Square lenses for ease of mounting
- High volume Wafer-Scale manufacturing



Designed and manufactured for today's high performance transmitters, Tx Aspheric™ lenses utilize LightPath's proprietary wafer-scale glass manufacturing techniques, delivering performance, size and price. US based engineering support and customer service enable custom and derivative product development. LightPath's simplified approach of molding arrays of glass lenses significantly reduces the production cost over single lenses molding. All lenses are 100% inspected, tested and AR coated. You can contact your local LightPath sales support directly from the contact list on our website at www.lightpath.com or call 1-800-GRADIUM.

Lens Code **370061**

NA = 0.60 EFL = 0.682mm CT=0.80mm



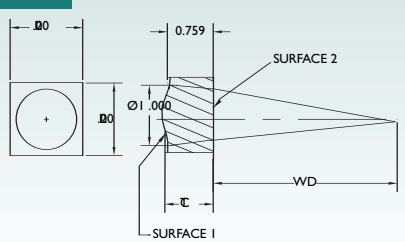
OPTICAL DESIGN SPECIFICATIONS	
Design Wavelength	1550 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	0.84 mm
Effective Focal Length (EFL)	0.682 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Substrate Size	1.50 mm square
Working Distance (WD)	0.267 mm

Surface 1
R = 0.592987
k = -9.625522
A4 = 4.3035069
A6 = -23.837914
A8 = 89.167694
A10 = -142.20566

Surface 2
Plano

Lens Code **370065**

NA = 0.12 EFL = 3.477mm CT=0.80mm



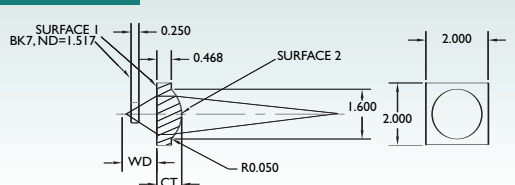
OPTICAL DESIGN SPECIFICATIONS	
Design Wavelength	1550 nm
Numerical Aperture (NA)	0.12
Clear Aperture (CA)	1.00 mm
Effective Focal Length (EFL)	3.477 mm
Magnification	Infinite
RMS WFE	< Diff. Limit
Substrate Size	1.20 mm
Working Distance (WD)	3.043 mm

Surface 1
R = 3.022602
A_6 = -0.014304692

Surface 2
Plano

Lens Code **370200**

NA = 0.50 EFL = 1.140mm CT=0.80mm



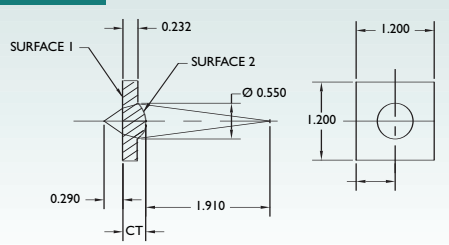
OPTICAL DESIGN SPECIFICATIONS	
Design Wavelength	1310 nm
Numerical Aperture (NA)	0.13 (image)
	0.50 (object)
Clear Aperture (CA)	1.60 mm (image)
	1.60 mm (object)
Effective Focal Length (EFL)	1.140 mm
Magnification	3.65
RMS WFE	< Diff. Limit
Substrate Size	2.00 mm square
Working Distance (WD)	1.11 mm
Laser Window Thickness	0.250 mm
Laser Window Material/Index	BK7/1.517

Surface 1
Plano

Surface 2
R = -0.9970379
k = -0.8393407
A_4 = - 6.0112993x10^{-3}
A_6 = - 5.3099179x10^{-3}
A_8 = 1.7759977x10^{-2}
A_{10}= - 1.1901704x10^{-2}

Lens Code **370635**

NA = 0.55 EFL = 0.382mm CT=0.35mm



OPTICAL DESIGN SPECIFICATIONS	
Design Wavelength	1310 nm
Numerical Aperture (NA)	0.13 (image)
	0.55 (object)
Clear Aperture (CA)	0.53 mm (image)
	0.40 mm (object)
Effective Focal Length (EFL)	0.382 mm
Magnification	4.0
RMS WFE	< Diff. Limit
Substrate Size	1.20 mm square
Working Distance (WD)	0.290 mm

Surface 1
Plano

Surface 2
R = -0.3339042
k = -0.6162437
A_4 = 0.44159413
A_6 = 3.2537548
A_8 = -2.7992748
A_{10} = 85.068875

Mounted Aspheric Lenses

- Easy to handle
- Durable stainless-steel
- Threaded design
- Compact size
- Cost effective

LightPath's line of mounted aspheric lenses makes assembly work quick and easy. The housings are made from durable stainless steel, which is suitable for welding or soldering. The mounts also have a threaded exterior, allowing you to simply screw the lens into place. Standard design mounts are available for twelve of our most popular lens types, but any of the lenses in the catalog can be mounted into a custom designed holder of your preference. Contact LightPath at 1-800-GRADIUM to discuss your particular requirements.

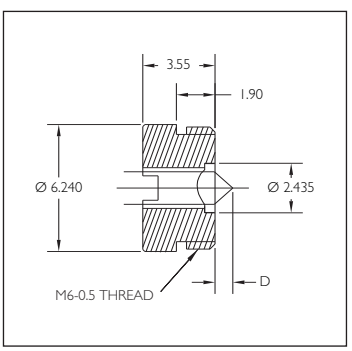
ORDERING INFORMATION

Part Number	EFL (mm)	NA	Holder Type	D (mm)
350140-X-MT	1.45	0.55	MT6	0.87
350390-X-MT	2.75	0.68	MT8	1.16
350660-X-MT	2.97	0.60	MT8	1.26
350330-X-MT	3.10	0.68	MT9	1.71
350080-X-MT	3.89	0.55	MT9	2.47
350610-X-MT	4.00	0.60	MT9	2.42
350670-X-MT	4.00	0.60	MT9	2.04
350340-X-MT	4.03	0.62	MT9	2.49
350440-X-MT	2.95	0.27/0.53	MT8	2.53
350230-X-MT	4.51	0.55	MT9	2.59
350110-X-MT	6.24	0.40	MT9	3.18
350240-X-MT	8.00	0.50	MT12	5.60
350220-X-MT	11.00	0.25	MT9	7.56
350560-X-MT	13.86	0.18	MT9	11.74
350260-X-MT	15.29	0.16	MT9	13.60
350280-X-MT	18.40	0.15	MT9	16.70

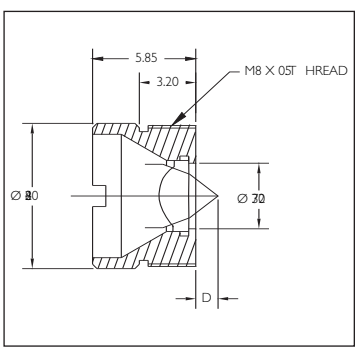
GENERAL SPECIFICATIONS AND TOLERANCES

Holder Material	Stainless Steel 304
Holder Outer Diameter	+/- 0.025mm
Holder Inner Diameter	+/- 0.100mm
Holder Length	+/- 0.100mm
Length of Threaded Section	+/- 0.100mm

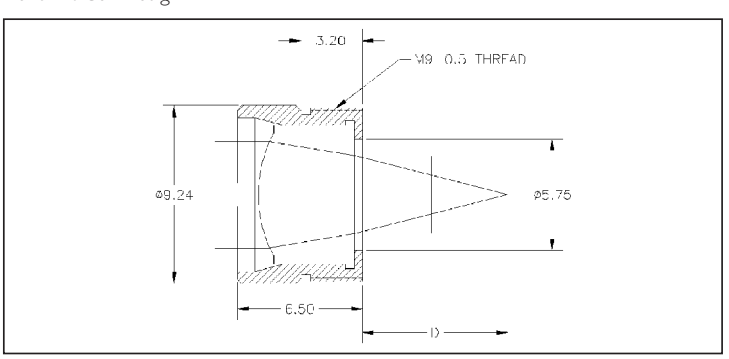
Lens Holder Design MT6



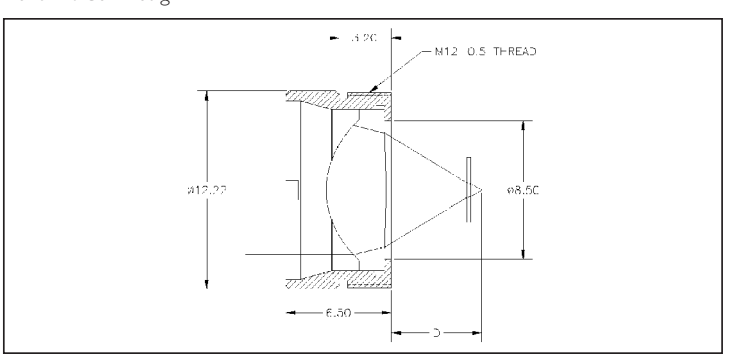
Lens Holder Design MT8



Lens Holder Design MT9



Lens Holder Design MT12



CircuLight™

CIRCULARIZE MOST COMMERCIALLY AVAILABLE RED, NIR AND BLUE LASERS

- Compatible with many commercially available Laser Diodes from: Nichia® (405nm),Sanyo®, Sony®, Toshiba®, OptNext® (Hitachi®) Panasonic® and Mitsubishi® (visible to near infrared)
- Higher Transmitted Power
- No additional collimating optics needed
- Nominal 2.5mm Diameter Beam (Dependent on Laser Diode)
- Diffraction Limited Performance
- Increase Fiber Coupled Efficiency
- One Lens Alignment

Most commercially available laser diodes project an elliptical beam. This is due to the diode junction having an aspect ratio exceeding 1:1. Many laser applications today require a circularized beam. LightPath's CircuLight™ (patent pending) lens technology creates a simple solution to circularize most available laser diodes. LightPath offers both externally and internally mounted CircuLight™ lens options. The external CircuLight™ optics module mounts outside of the laser diode package and consists of two rotationally non-symmetric aspheric cylinders. The first cylinder captures the fast axis of the beam divergence and then collimates it. The beam from the slow axis expands to the same size as the fast axis and is then collimated by the second aspheric cylinder. CircuLight™ provides a very elegant and highly efficient (> 90% energy throughput) means to circularize your laser diode without any additional collimating optics or prisms.

Different Methods of Beam Circularization

There are a number of techniques used to circularize laser diodes. Currently the most widely used methods are anamorphic prism pairs, micro-optics and beam truncation.

Anamorphic Prism Pair

Anamorphic prism pairs are the most frequently used method for achieving good beam quality and circularization of laser diodes. Although this method achieves approximately 50% energy throughput, it is often difficult to align the prisms, the prisms are expensive, and the exit beam is not collinear with the laser diode – all of which make packaging difficult. An additional collimating optics is needed as well, adding to the cost and complexity.

Beam Truncation

Beam truncation is the least efficient method, and is accomplished by simply "clipping" the beam with an aperture or lens. It produces a circular beam, but only 10%-30% of the beam is transmitted.

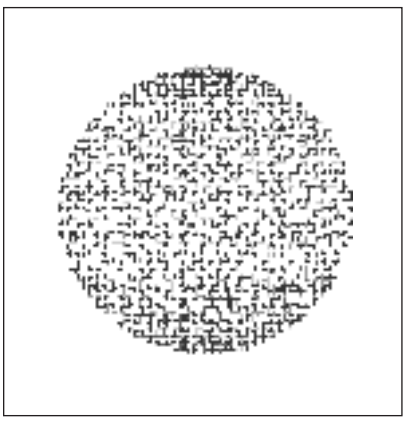
Micro-Optics

Some micro-optics approaches utilize a small cylinder lens mounted internally, which slows down the diverging fast axis beam. This lens is incorporated into an existing laser diode unit. This method does not produce a collimated beam and an external collimating lens is still needed. The value-added benefit of this approach is its compact size, low cost and high-energy throughputs of approximately 75-80%. This integrated approach limits the variety of laser diode options.

LightPath's internally mounted CircuLight™ approach enables higher coupling efficiency and a collimated beam.

CircuLight™ External Mounted Anamorphic Optics

Transmitted Power Comparison Table



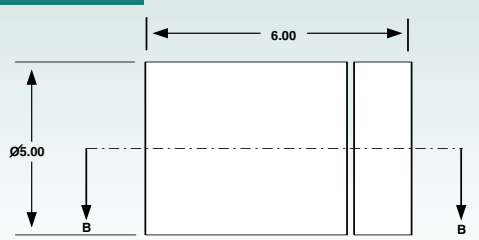
CircuLight™

Externally mounted CircuLight™ provides a compact, easy to align optic. It requires no additional optics to collimate the beam and it has exceptional energy throughput that is greater than 90%. Beam size is typically 2.5mm in diameter (depending on actual laser module). It is an excellent approach for many applications requiring a circular beam.

Because of the large variety of laser diodes, which can be used with CircuLight™, please contact your local sales person with the following information: Laser diode manufacturer and the diode model or part number you wish to use. Custom designs are available covering wavelengths from 385nm to 1.7 microns.

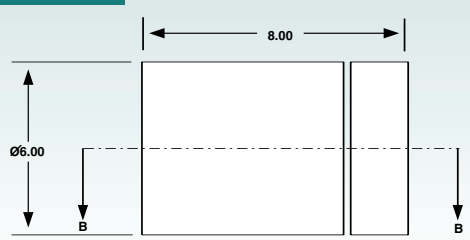
	CircuLight™	Prism Pair	MicroOptics	Asphere Lens
Beam Shape	Circular	Circular	Circular	Elliptical
Transmitted Power	> 90%	~ 50%	~ 80%	~ 80%

Lens Code 7100039 NA = 0.60 EFL = 0.682mm CT=0.80mm



OPTICAL DESIGN SPECIFICATIONS	
Design Wavelength	408nm
Clear Aperture	2.8mm
Effective Focal Length	fy=2.33mm
	fx=5.88mm

Lens Code 7100040 NA = 0.12 EFL = 3.477mm CT=0.80mm



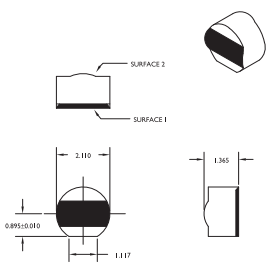
OPTICAL DESIGN SPECIFICATIONS	
Design Wavelength	635nm
Clear Aperture	2.8mm
Effective Focal Length	fy=2.26mm
	fx=7.37mm

CircuLight™ Internal Mounted Anamorphic Optics

- Circularizes diode lasers
- Increases laser diode coupling efficiency
- Diffraction limited performance
- One-lens system
- Built-in alignment features

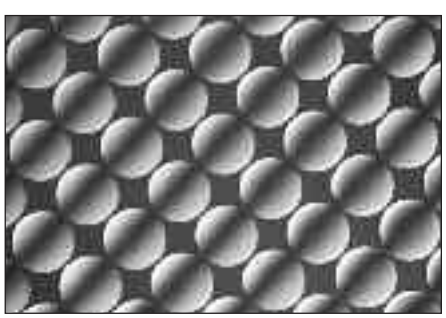
Internally mounted CircuLight™ optics are designed for internal packaging. By positioning the lens very close to the laser chip itself, these lenses are designed to provide a small circular and collimated beam, providing a very elegant and compact solution. Unlike the externally mounted CircuLight™ lenses which are aligned and assembled in a metal tube, these optics are made from a single, monolithic piece of glass. An alignment tab is built-in to aid in adjusting the rotational orientation. Custom designs are available covering wavelengths from 385nm to 1.7 microns.

Lens Code **370900**	
Design Wavelength	1480nm
Clear Aperture	1.0mm
Effective Focal Length	EFLx 1.257mm, EFLy 0.564 mm
Center Thickness	1.385mm



Molded Glass Micro-Lens Array

- Very high piece-to-piece uniformity
- Focal length tolerance less than 1%
- Pitch tolerance less than one micron
- Numerical apertures up to .65
- Clear apertures up to 1.5mm



By utilizing LightPath's molded lens technology it is now possible to manufacture lens arrays with high precision. Unlike etched lens arrays, where there is a great deal of non-uniformity from array to array, molding will consistently produce the same structure and performance from prototype to large production builds. Consistent focal lengths and form ease the manufacturing requirement for the end user. The molding technology also allows optical designs that require greater sag (lens thickness) such as high numerical aperture collimators for laser diode arrays. Lens arrays can be produced for direct coupling (finite conjugative) or collimating applications. Pitch tolerances are typically less than one micron and lenses can also be placed with varying pitches across the array.

LENS ARRAY SPECIFICATIONS		
Clear Aperture	100µm to 1.0mm	Guaranteed Minimum
Pitch	Min 25% Larger than CA	<1µm Non-Accumulating
Numerical Aperture	Up to 0.6	Guaranteed Minimum
Effective Focal Length	± 1%	Per Design
RMS WFE	<Diffraction Limit	
Configuration	1 or 2 Dimensional	

Information on our moldable glasses and AR coatings for the Aspheric Lens Array product can be found in the previous section on Molded Glass Aspheric lenses

GRADIUM® Lenses

- Aspheric performance
- Smaller focused spot size
- Low wavefront distortion
- High power handling
- High performance, cost effective

Spherical aberration, chromatic aberration and astigmatism induce sweat on the brows of optical designers in many diverse application areas.

Avoiding these deviations from "perfect" optical systems is often difficult without using multiple elements. However, with utilization of LightPath's unique line of GRADIUM® optics, correcting these aberrations using just a single optical element is now a practical reality.

GRADIUM® lenses are made from LightPath's proprietary axial gradient index glass. Its unique refractive qualities can be exploited to reduce spherical aberrations – resulting in performance similar to single-term aspheres.

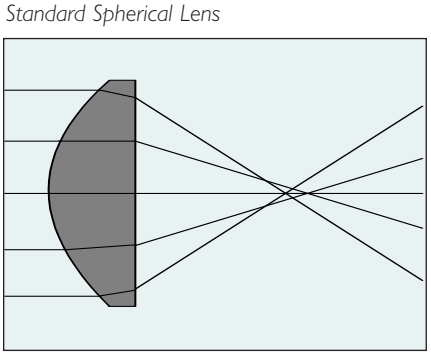
In industry, the lenses have been applied as simple singlets or doublets in complex multi-element systems. In particular, they have been very well received for use in high-power industrial lasers; many of the world's largest Nd:YAG laser manufacturers now incorporate GRADIUM® optics in their laser systems.

LightPath's DuraYAG assemblies provide a drop-in replacement for focusing and collimating assemblies on some of the most popular YAG laser systems. Their unique coverplate design extends the life of the assembly while the GRADIUM® lens provides a smaller focused spot size, increasing power density at the workpiece and enhancing overall system performance.

LightPath's achromatic doublets are designed for use with collimated, polychromatic light in the visible spectrum. The GRADIUM® glass element is used to reduce the spherical aberration which is a common side effect of a cemented doublet design.

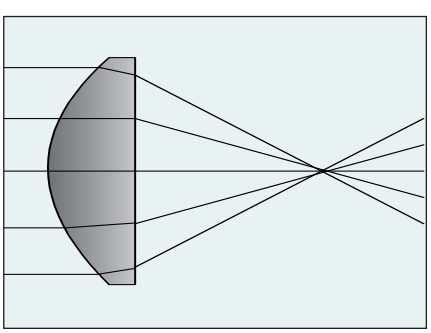
GRADIUM® lenses provide a cost-effective solution for many high-performance applications.

Standard Spherical Lens



Standard spherical lenses suffer from spherical aberration, which artificially limits the focused spot size.

Gradium® Lens



GRADIUM's® unique refractive index profile bends rays while traveling through the lens, resulting in a better focused, smaller spot.

GENERAL LENS SPECIFICATIONS	
Design Wavelength	546nm
Operating Temperature	-20°C to +200°C
Storage Temperature	-40°C to +300°C
Outer Diameter (OD) Tolerance	+/-0.250mm
Center Thickness (CT) Tolerance	+/-0.100mm
Effective Focal Length (EFL) for GAD Series	+/- 2%
Effective Focal Length for GPX and GBX Series	+/- 1%
Working Distance (WD) for GAD Series	+/- 2%
Working Distance for GPX and GBX Series	+/-1%
Optical Centration	1 Arc Minute
Surface Quality	40-20 Scratch-Dig
Chamfered with Safety Bevel	

GRADIUM® Lenses

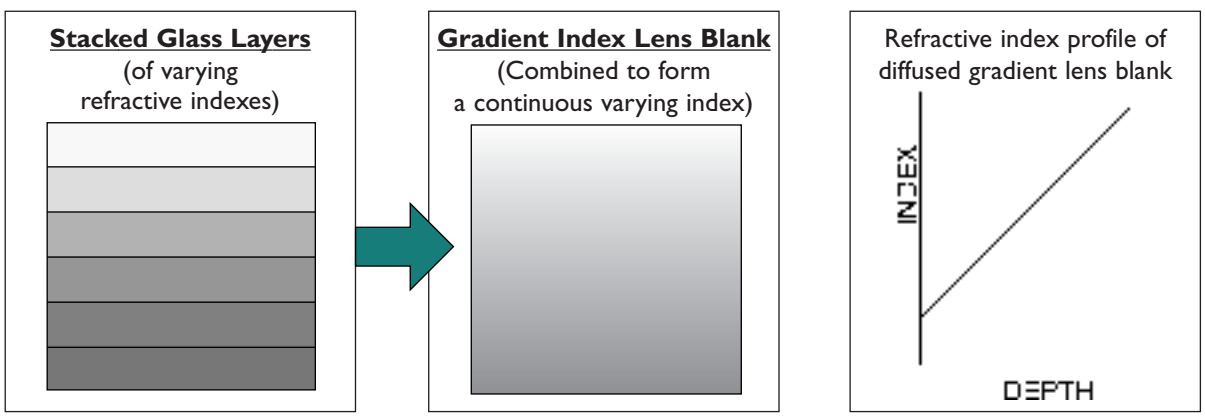
GRADIUM® lenses take advantage of recent advances in the manufacturing of axial gradient glass. Large diameter blanks are fabricated with index changes (Δn) of up to 0.15, about 100 times that available from radial GRIN (GRadient INdex) technology. The large range in Δn available provides a substantial ability to correct aberration, especially spherical.

The process used to produce the GRADIUM® glass turns a series of SF glass layers into a single piece of gradient material. Unlike radial GRIN lenses, this process provides large diameter optical blanks with controlled index and dispersion profiles. Proper gradient profile selection allows a simple spherical lens to act as an asphere.

GRADIUM® lenses should be used wherever small spot size, high numerical aperture (NA), increased beam energy, or excellent wavefront quality are important. A GRADIUM® singlet does not have the limited laser damage threshold of a conventional cemented doublet, so laser power can be increased, leading to increased production throughput.

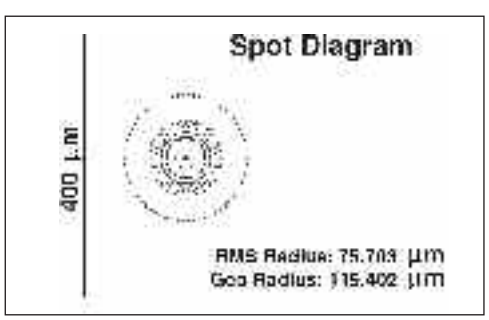
GRADIUM® glass offers the additional benefit of chromatic correction. The dispersion, as well as the optical index, varies in a controlled fashion within the lens. A finished lens can be viewed as a seamless, contiguous combination of many glass types. This continuous variation results in a transfer aberration correction not possible with homogeneous lenses. By combining GRADIUM® flint glass with a homogeneous crown glass, achromatic doublets are fabricated with superior color correction.

The Gradium Process

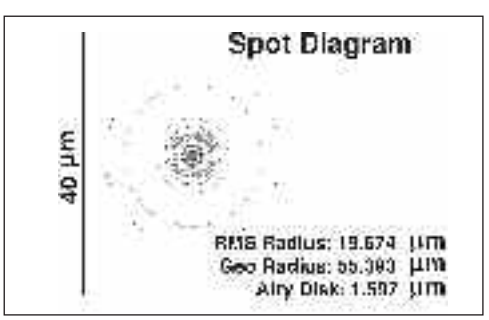


Typical Spot Diagram

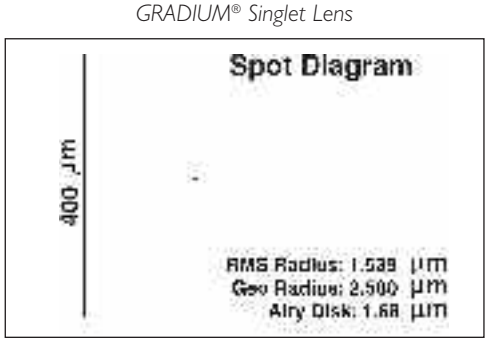
Standard BK7 Plano-Convex Lens



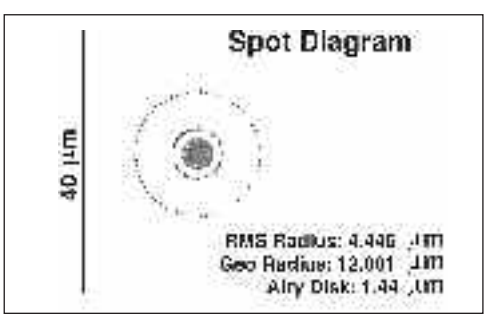
Standard Achromatic Doublet



GRADIUM® Singlet Lens



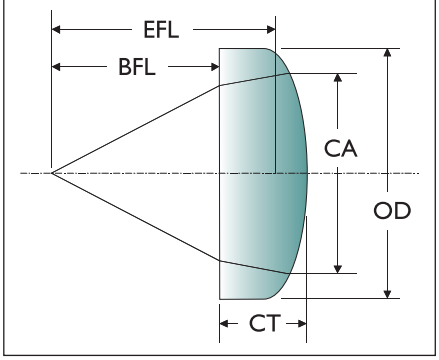
GRADIUM® Achromatic Doublet



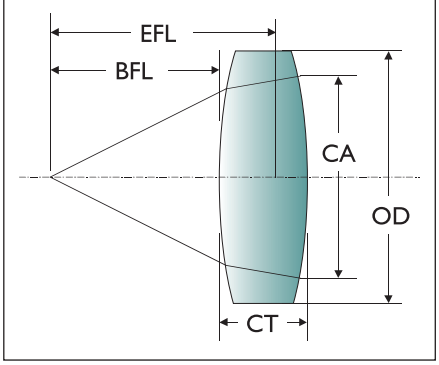
GRADIUM® LENSES

	Lens Code	Outer Diameter	Clear Aperture	F/#	Effective Focal Length	Center Thickness	Back Focal Length
Plano-Convex	GPX-5-5	5mm	4mm	1.0	5mm	2.90mm	3.09mm
	GPX-5-12.5	5mm	4mm	2.8	12.5mm	2.00mm	11.30mm
	GPX-10-10	10mm	9mm	1.1	10mm	3.00mm	8.00mm
	GPX-10-18	10mm	9mm	2.0	18mm	2.50mm	16.52mm
	GPX-10-22	10mm	9mm	2.5	22mm	2.50mm	20.54mm
	GPX-10-25	10mm	9mm	2.8	25mm	2.50mm	23.55mm
	GPX-10-30	10mm	9mm	3.3	30mm	2.50mm	28.53mm
	GPX-10-40	10mm	9mm	4.5	40mm	2.00mm	38.84mm
	GPX-15-15	15mm	13mm	1.1	15mm	4.20mm	12.24mm
	GPX-15-40	15mm	13mm	3.0	40mm	2.00mm	38.83mm
	GPX-20-50	20mm	18mm	2.8	50mm	3.00mm	48.24mm
	GPX-25-60	25mm	22mm	2.6	60mm	6.00mm	56.46mm
	GPX-25-80	25mm	22mm	3.5	80mm	4.00mm	77.69mm
	GPX-30-60	30mm	27mm	2.2	60mm	6.00mm	56.44mm
	GPX-30-70	30mm	27mm	2.6	70mm	6.00mm	66.47mm
	GPX-30-80	30mm	27mm	3.0	80mm	4.00mm	77.68mm
	GPX-30-100	30mm	27mm	3.7	100mm	6.00mm	96.53mm
	GPX-40-80	40mm	36mm	2.2	80mm	6.00mm	76.47mm
	GPX-40-100	40mm	36mm	2.8	100mm	6.00mm	96.56mm
	GPX-40-125	40mm	36mm	3.5	125mm	6.00mm	121.52mm
	GPX-40-150	40mm	36mm	4.2	150mm	6.00mm	146.49mm
	GPX-50-100	50mm	45mm	2.2	100mm	8.00mm	94.90mm
	GPX-50-125	50mm	45mm	2.8	125mm	8.00mm	120.37mm
	GPX-50-150	50mm	45mm	3.3	150mm	8.00mm	145.25mm
	GPX-50-160	50mm	45mm	3.6	160mm	8.00mm	155.25mm
	GPX-50-200	50mm	45mm	4.5	200mm	8.00mm	195.27mm
	GPX-80-125	80mm	72mm	1.7	125mm	12.25mm	116.91mm
Bi-Convex	GBX-25-40	25mm	22mm	1.8	40mm	4.60mm	37.51mm
	GBX-30-40	30mm	27mm	1.5	40mm	5.76mm	36.72mm
	GBX-50-80	50mm	45mm	1.8	80mm	8.00mm	75.46mm
Achromat	GAD-5-15	5mm	4mm	3.3	15mm	4.00mm	13.07mm
	GAD-10-20	10mm	9mm	2.2	20mm	6.00mm	17.17mm
	GAD-25-50	25mm	22mm	2.2	50mm	11.00mm	44.37mm
ME	GMN-30-50	30mm	27mm	1.9	50mm	5.00mm	46.82mm

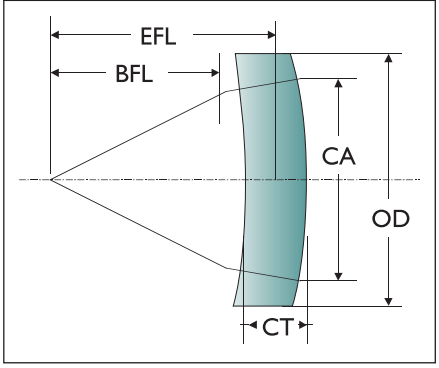
Plano-Convex (GPX)



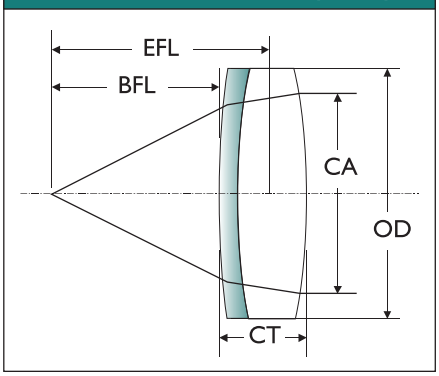
Bi-Convex (GBX)



Bi-Convex (GMN)

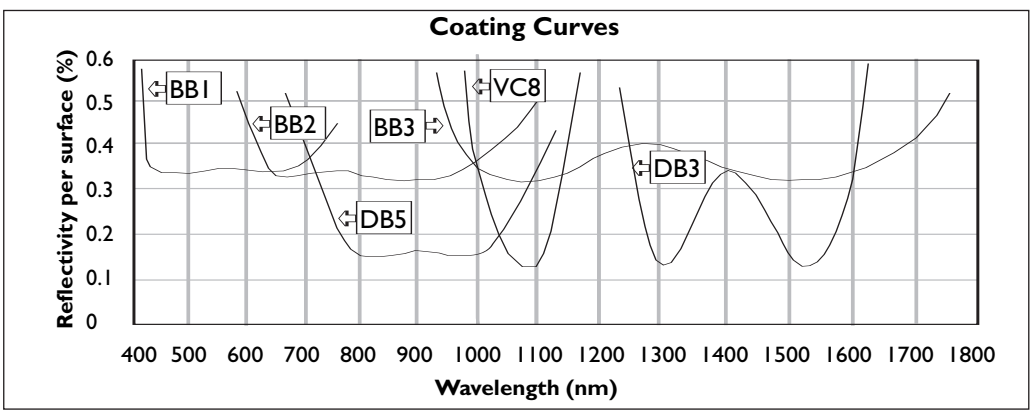


Achromatic Doublet (GAD)

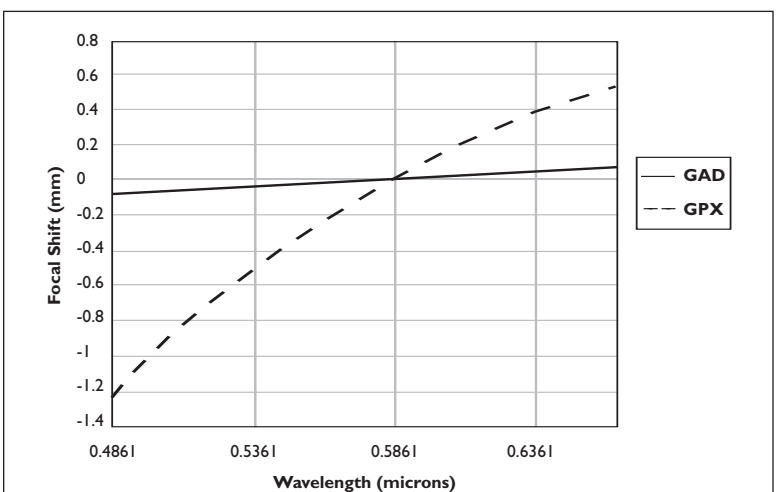


Standard Anti-Reflective Coatings

	Wavelength	Reflectivity	Coating Code
Broad-Band	400 – 700 nm	< 0.5% avg.	– BB1
	650 – 1000 nm	< 0.5% avg.	– BB2
	1000 – 1600 nm	< 0.5% avg.	– BB3
Dual-Band	633 & 1064 nm	< 0.25% max.	– DB1
	532 & 1064 nm	< 0.25% max.	– DB2
	1310 & 1550 nm	< 0.25% max.	– DB3
	530 & 670 nm	< 0.25% max.	– DB4
	808 & 940 nm	< 0.25% max.	– DB5
VC	1064 nm	< 0.25% max.	– VC8



GAD Achromatic Lens Performance



EFL Shift of GPX vs. GAD lenses over wavelength.

Order / Product Nomenclature

Please use the following format to order the proper Gradium Lens.

GXX – XX - XXX - XX

Coating Code

Lens Code

Example: GPX-30-70-BB2 (GPX 30mm diameter, EFL 70mm, BB2 Coating)

Customization

LightPath would be happy to design a custom GRADIUM® lens to your individual specifications. We can customize the focal length, diameter, and design wavelength to meet your specific needs. Lenses can also be provided with custom anti-reflective coatings or mounted in custom housings. Contact LightPath at 1-800-GRADIUM to discuss your particular requirements.

GRADIUM® DURAYAG™ OPTICS MODULE

- Smaller spot size provides better quality cuts
- Increases life of laser and optics
- Pre-assembled for quick, easy installation
- Simple One-Lens Design

The High Cost of Contamination

Many of the problems associated with today's high power laser applications are a result of contamination on optical surfaces. Contaminants on the lens surface absorb the laser light, heat up, and damage the AR coating and the lens itself. Cleanliness is one of the most important steps in keeping a system on-line and performing it's work consistently. The focusing optic takes the brunt of the abuse in most systems. They are subjected to work piece splatter, dust, dirt and handling contamination. Most laser heads provide glass coversheets, which protect the lens from splatter, but do little to protect the lens from other contaminants.

Even in the best sealed or air filtered laser heads, small particulates find their way onto the top surface of the focusing lens. Typically these lenses are removed and cleaned on a routine basis. Each time the lens is removed more contaminants find their way into the head assembly. SEM EDAX analyses of focusing optics shows that the primary contaminants are waste products (Figure A) of the cutting, welding or drilling operation.

When contaminants fall on an unprotected lens, the heat can cause the lens to crack. With DuraYAG™, the window acts as a shield for the lens, protecting it from breaking.

Lowering Your Cost of YAG Laser Ownership

LightPath's DuraYAG™ modules provide a barrier from these contaminants. The lens modules are designed to replace the lens holder and the two silica lenses found in many laser systems. By utilizing a singlet GRADIUM® lens in conjunction with protective plano optic, lens lifetime is increased and the cost of operating your laser system is decreased. LightPath's DuraYAG™ modules are cleaned and assembled in Class100 clean room conditions.

When routine maintenance must be performed, just unscrew the optics module, carefully clean the plano optic, and with a few turns of the assembly you are ready to go. Modules require no alignment and are easy to clean (plano optics are much easier to clean than a convex optical element). When your module does need replacing, just send it back to LightPath and you will have a replacement in 24 hours with our 24 Hour Priority Plan.

GRADIUM® Lenses vs. Competitors

GRADIUM® assembly DYTP2770F used on the right provides a higher quality cut reducing dross.

Traditional silica doublets have a large spot size, which produces poor quality cuts with a large amount of dross. This must be ground down manually.

GRADIUM® lenses provide a much higher quality cut, requiring little or no post-cut grinding.

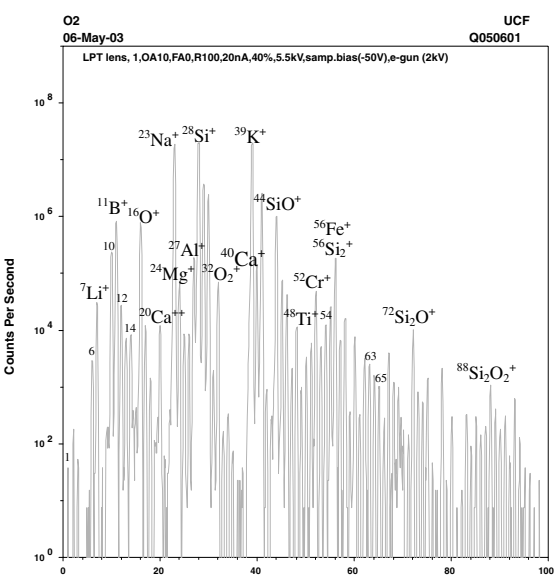


Figure A

SEM analysis on a failed lens shows traces of contamination from the cutting process: Titanium, Chromium, Vanadium, Iron, Sodium, Lithium, Boron, Maganese, Copper, Chlorine, and Potassium.

GRADIUM® DURAYAG™ OPTICS MODULE

The assemblies below list LightPath's current off-the-shelf DuraYAG™ optics module. LightPath also has a very strong capability to manufacture custom DuraYAG™ assemblies to your individual specifications. Please contact sales for more information.

The DYTP2770F is designed to be a drop in replacement for the focusing lens assembly of the Precitec YH27 head for use with Trumpf Nd:YAG lasers.

The DYRP3070F is designed to be a drop in replacement for the focusing lens assembly of the Precitec YR30 head for use with Rofin-Sinar Nd: YAG lasers

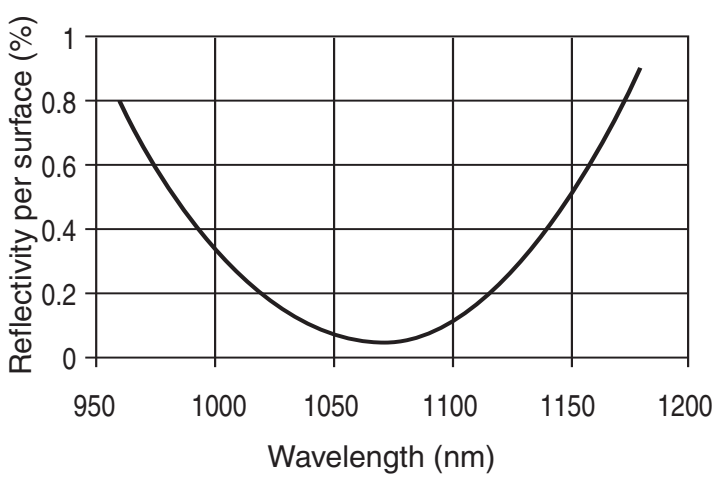
DURAYAG™ DYTP2770F ASSEMBLY SPECIFICATIONS	
Lens material:	GRADIUM® Glass
Lens diameter:	27mm
Lens focal length:	70mm
Design wavelength:	1064nm
AR coating reflectivity:	<0.25% at 1064nm
Maximum laser power:	4kW (CW)
Holder material:	Stainless steel

DURAYAG™ DYRP3070F ASSEMBLY SPECIFICATIONS	
Lens material:	GRADIUM® Glass
Lens diameter:	30mm
Lens focal length:	70mm
Design wavelength:	1064nm
AR coating reflectivity:	<0.25% at 1064nm
Maximum laser power:	4kW (CW)
Holder material:	Stainless steel

Anti-reflective Coatings

All of LightPath's Nd:YAG lenses and modules are available with high quality anti-reflective coatings. The VC-8 coating is designed to withstand the high power, rugged environment of YAG laser manufacturing. Reflectivity is typically less than <0.15% per surface and guaranteed to be <0.25% at 1064nm. GRADIUM® lenses and DuraYAG™ modules have been tested at the Fraunhofer Institute and are suitable for applications up to 4000 watts CW. Please contact LightPath if you need coatings for applications which are greater than 4000 watts CW.

VC8 Coating



Customization

LightPath would be happy to design a custom GRADIUM® lens to your individual specifications. We can customize the focal length, diameter, and design wavelength to meet your specific needs. Lenses can also be provided with custom anti-reflective coatings or mounted in custom housings.

24-Hour Quick Replacement Priority Plan

LightPath's 24-Hour Priority Plan provides 24-hour delivery of your DuraYAG™ module to replace an assembly that has failed. LightPath offers Gradium® lenses and modules off-the-shelf for most common YAG laser systems and heads including Trumpf, Rofin-Sinar, GSI Lumonics, Precitec and others. Customized optics and modules can also be designed for your specific application.

Collimators

- Epoxy-free optical path
- Ultra-low insertion loss
- High power handling
- Low back reflection
- Excellent pointing accuracy
- Compact size

The collimator is a fundamental element in many optical systems. The performance and reliability of essential components such as the collimator are integral to designing quality systems that meet today's market demands. For example, the more energy the collimator is able to gather from the source and launch into the fiber end, the stronger the signal strength and the higher the system efficiency. This higher efficiency means time and money saved in fewer system components and greater design freedom.

While product efficiency is important, the compatibility of the collimator with your manufacturing process is equally important. If the specifications aren't compatible with your assembly techniques, or if piece-to-piece uniformity and quality are poor, you may be losing valuable savings.

LightPath's Large Beam Collimators utilize LightPath's exclusive GRADIUM® lens technology for collimation. The fiber is fused to a glass 'pellet', dramatically reducing back-reflection and increasing throughput. Large Beam Collimators are available with beam sizes up to 12.5mm and optimized for 1064nm or 1550nm. Lightpath's Large Beam Collimators are capable of handling up to 100 Watts of continuous power, making them ideal for use in fiber delivery of high power industrial lasers.

Aspheric Connectorized Collimators utilize our precision molded aspheric lenses to combine diffraction limited performance with the ease of use of standard FC or SMA connectors. They are available for a range of wavelengths and with beam diameters from 2mm to 3mm.

Small Beam Collimators are produced with our patented laser fusion technology. This process fuses the fiber end directly to the optical center of the lens - eliminating epoxy within the optical path. The collimator lens surface is then laser polished to within a millionth of an inch of ideal shape, providing extremely low insertion loss. This high piece-to-piece quality translates to a more efficient assembly process.

Options and Customization

Should you need something different from our standard product offering, LightPath's sales and engineering staff will work closely with you to tailor a custom solution to your specific needs. Some of the more common custom options include:

Fiber Connectors

To make your assembly process easier, we can put an FC connector on the end of the fiber. Connectors for PM fiber are also available.

Custom Wavelengths

If you are not working at 1310 or 1550, we can design a customized collimator for you for any wavelength from 400 to 2000nm.

Fiber Type

LightPath can manufacture collimators with a variety of different fiber types, including polarization maintaining fiber, multi-mode fiber, or fibers for different wavelengths.

Housing

We can provide collimators mounted in stainless steel tubes (suitable for welding), in glass ferrules, or even metallized with gold (suitable for soldering). Please contact LightPath Technologies at 1-800-GRADIUM to discuss your specific requirements.

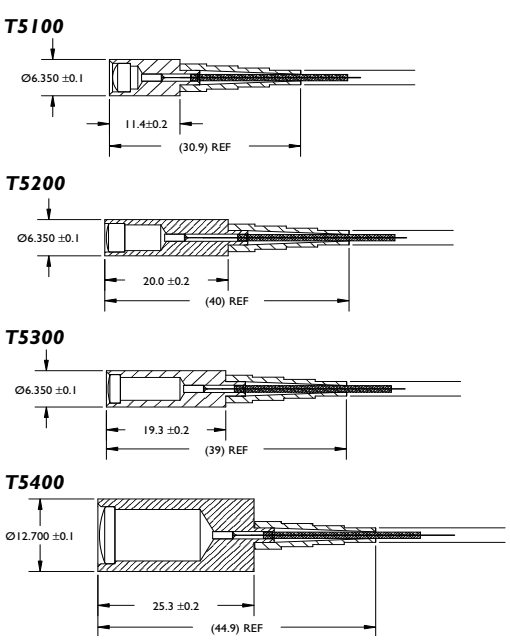
Please contact LightPath Technologies at 1-800-GRADIUM to discuss your specific requirements.

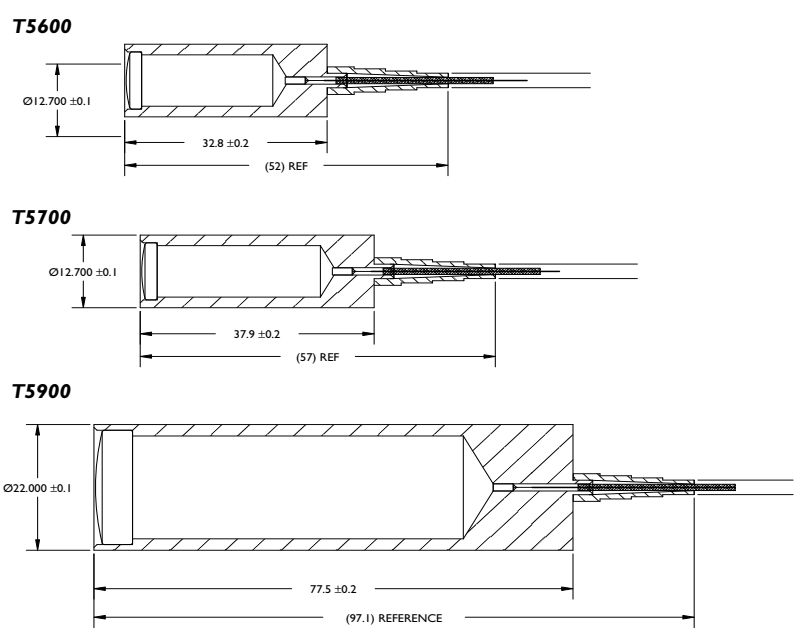
Large Beam Collimators

- Standard beam diameters up to 12.5mm
- Uses high performance GRADIUM® lenses
- Mounted in rugged stainless steel housing
- High power handling

LIGHTPATH'S STANDARD LARGE BEAM COLLIMATORS	
Center Wavelength	1550nm
Fiber Type	Corning SMF28
Fiber Length	2 Meters
Return Loss	< -55dB
Operating Temperature	-20°C to +60°C
Storage Temperature	-40°C to +85°C
Pointing Accuracy	1° Maximum
Power Handling	10 Watts CW
Insertion Loss	1.0dB
Housing Material	Stainless Steel 303
M^2	< 1.3

Part Number	Beam Diameter 1/e² / Full	Working Distance	Housing Diameter	Housing Length	GRADIUM® Lens Used
T5100P0S1-20A	1.0 / 1.5mm	250mm	6.35 mm	14.60 mm	GPX-5-5
T5200P0S1-20A	2.0 / 3.0mm	500mm	6.35 mm	23.15 mm	GPX-5-10
T5300P0S1-20A	2.5 / 3.8mm	500mm	6.35 mm	22.50 mm	GPX-5-12.5
T5400P0S1-20A	3.6 / 5.5mm	500mm	12.70 mm	28.50 mm	GPX-10-18
T5600P0S1-20A	5.0 / 7.6mm	500mm	12.70 mm	36.00 mm	GPX-10-25
T5700P0S1-20A	6.0 / 9.1mm	500mm	12.70 mm	41.10 mm	GPX-10-30
T5900P0S1-20A	12.5 / 19.0mm	500mm	22.00 mm	80.70 mm	GPX-20-60





1064nm Fiber Collimators

- Superior Performance
- High Power Handling
- Rugged Stainless Steel Housings
- Utilizes GRADIUM® Lens Technology

LightPath Technologies' new 1064 Fiber Collimators are ideal for Nd:YAG laser and high power fiber laser applications.

The Fiber Fusion Advantage

LightPath's patented fiber fusion technology enables the collimators to be used at very high power. The fiber is laser fused to a plano-plano silica pellet, resulting in a smooth transition from fiber to pellet without any glass to air interface to cause unwanted back reflections. This technology alleviates the need to angle polish the fiber, which allows the system to remain coaxial. The light expands as it passes from the fiber through the pellet, which results in a much lower power density at the exit of the pellet. The lower density keeps the collimator stable in the event that contamination falls upon its surface. The result is an optical system with superior performance and very low loss.

GRADIUM® Inside

The collimators incorporate LightPath's proprietary GRADIUM® lens technology, providing aspheric-like performance in a cost effective package. Beam diameters are available ranging from 1mm up to 12.7mm for standard products. The collimators are housed in a stainless steel housing and can be offered with rugged RoundLock™ tubing.

1064NM LB COLLIMATOR SPECS	
Center Wavelength	1064nm
Fiber Type	Corning HI1060
Fiber Length	2 meters
M^2	< 1.2
Return Loss	< -55dB
Pointing Accuracy	1° max
Power Handling	100W (CW)
Operating Temp.	-20°C to +60°C
Storage Temp.	-40°C to +85°C
Housing Material	Stainless Steel

Customization

LightPath also has a strong capability to design and manufacture custom collimators to the specs of your choice. Custom beam diameters, fiber types, connectors, and wavelengths can be chosen to fit your individual application. Please contact sales for more information.

Part Number	Beam Diameter* 1/e² / Full (mm)	Working Distance	Housing Diameter	Housing Length	GRADIUM® Lens Used
T5164P0S2-20A	0.97 / 1.47	Infinite	6.35mm	14.6mm	GPX-5-5-VC8
T5264P0S2-20A	2.07 / 3.15	Infinite	6.35mm	23.15mm	GPX-5-10-VC8
T5364P0S2-20A	2.65 / 4.00	Infinite	6.35mm	22.5mm	GPX-5-12.5-VC8
T5464P0S2-20A	3.83 / 5.80	Infinite	12.7mm	28.5mm	GPX-10-18-VC8
T5664P0S2-20A	5.32 / 8.07	Infinite	12.7mm	36.0mm	GPX-10-25-VC8
T5764P0S2-20A	6.31 / 9.58	Infinite	12.7mm	41.1mm	GPX-10-30-VC8
T5964P0S2-20A	12.70 / 19.31	Infinite	22.0mm	80.70mm	GPX-20-60-VC8

Beam diameters given are preliminary values. Please contact LightPath sales for the most up to date information.

Connectorized Aspheric Collimators

- Diffraction limited performance
- Rugged stainless steel housing
- Pre-aligned for popular wavelengths
- Connectorized for quick assembly
- Threaded exterior for easy mounting
- Epoxy free optical path
- Compact size

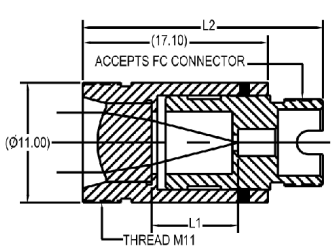
LightPath's line of aspheric collimator assemblies combine the outstanding performance of glass molded aspheric lenses with the ease of assembly of a fiber connector interface. The assemblies have a threaded exterior, which allows a quick connection to an optical bench or within an instrument. LightPath's connectorized collimators are available with either FC or SMA fiber optic connectors and are individually aligned and tested for the specified wavelengths, and will offer excellent performance throughout the entire range of their AR coatings.

Standard design assemblies are available for two of our most popular lens types, but any asphere in our catalog can be mounted into a custom assembly of your choice. Please contact sales for more information.

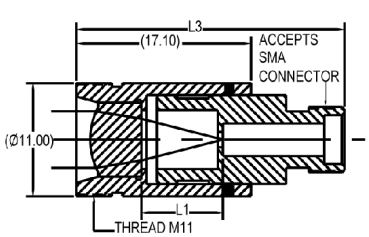
	Design λ	L1 (mm)	L2 (mm)	L3 (mm)	Typical Beam Dia.[1]	Beam Waist Location
350220(FC/SMA)-A	543nm	7.79	21.99	26.05	2.0	250mm
350220(FC/SMA)-B	780nm	7.97	22.17	26.23	2.2	250mm
350220(FC/SMA)-C	1310nm	8.12	22.32	26.38	2.0	250mm
350260(FC/SMA)-A	543nm	13.65	25.04	29.11	3.0	250mm
350260(FC/SMA)-B	780nm	13.91	25.30	29.37	3.0	250mm
350260(FC/SMA)-C	1310nm	14.13	25.52	29.59	2.8	250mm

[1] Calculated at $1/e^2$ point using single mode fiber.

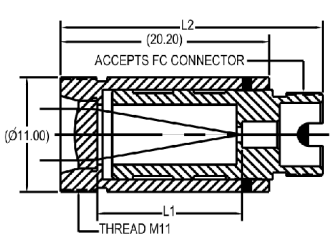
350220-FC



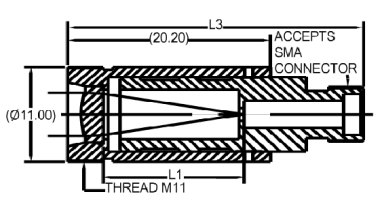
350220-SMA



350260-FC

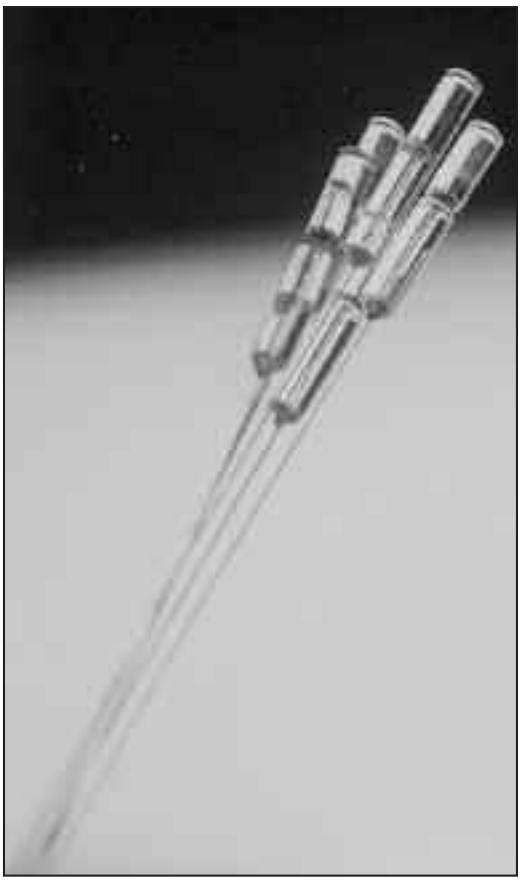


350260-SMA



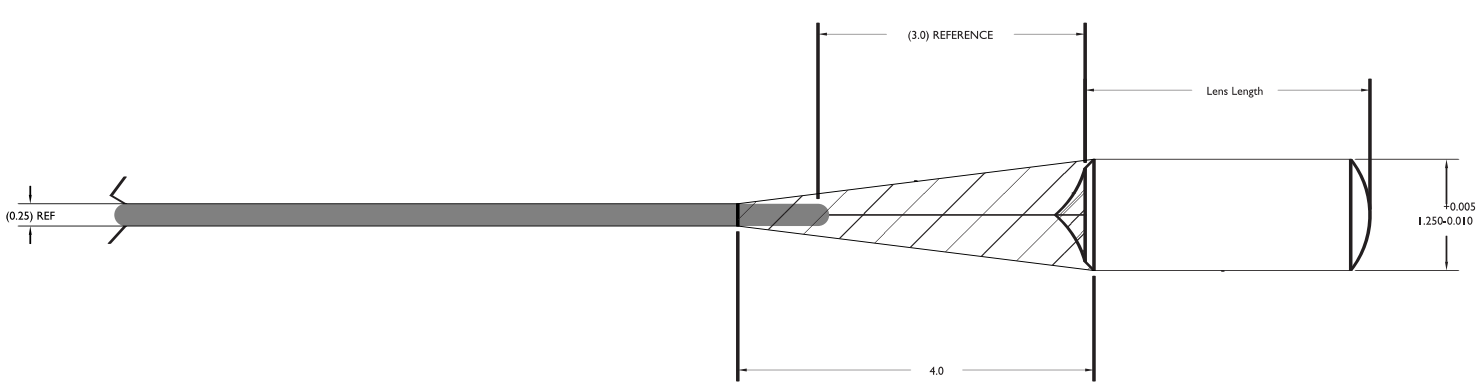
Small Beam Collimators

- Aspheric lens profile
- Fiber laser fused directly to lens
- Superior coupling efficiency
- Small form factor



LIGHTPATH'S STANDARD SMALL BEAM COLLIMATORS	
Center Wavelength	1310 or 1550nm
Fiber Type	Corning SMF28
Fiber Length	2 Meters
Return Loss	< -55dB
Operating Temperature	-20°C to +60°C
Storage Temperature	-40°C to +85°C
Pointing Accuracy	1° Maximum
Power Handling	10 Watts CW
Lens Diameter	1.25mm +0.005 / -0.010mm
M^2	< 1.3

Part Number	Center Wavelength	Insertion Loss	Working Distance	Beam Diameter $1/e^2$ / Full	Lens Length
T1005Y0S1-20A	1550nm	0.3 dB	10-30mm	0.42 / 0.58mm	3.2mm
T1055Y0S1-20A	1310nm	0.3 dB	30-60mm	0.40 / 0.56mm	3.2mm
T1527Y0S1-20A	1550nm	0.3 dB	0-15mm	0.42 / 0.58mm	3.2mm
T1557Y0S1-20A	1310nm	0.3 dB	10-40mm	0.40 / 0.56mm	3.2mm
T3005S0S1-20A	1550nm	0.5 dB	80-120mm	0.58 / 0.81mm	4.4mm
T3055S0S1-20A	1310nm	0.5 dB	100-140mm	0.55 / 0.76mm	4.4mm
T3105S0S1-20A	1550nm	0.5 dB	120-160mm	0.58 / 0.81mm	4.4mm
T3155S0S1-20A	1310nm	0.5 dB	130-170mm	0.56 / 0.78mm	4.4mm



Optical Isolators

- Process automation yields superior uniformity
- Flexible optical and physical design
- Design variations without major process or tooling changes
- Isolators can be converted into a variety of finished products through proprietary robotic processes

Optical Isolators provide lasers with immunity from back-reflection, thereby improving the signal to noise ratio for laser diode based transmitters. This is especially important for high data rate transceivers and transponders, or those devices requiring long span lengths between transceiver pairs. All of our isolators are based on dichroic polarizing glass and Faraday rotating crystals for highest performance. These devices are available in a single stage, 1.5 stages, or double stages, with multiple stages providing progressively higher isolation.

We offer isolators in the following form factors: Cylindrical, Surface-Mount, and Sub-Mount. In addition, we manufacture isolators with either an epoxy-free optical path or with a laminated core. LightPath works with customers on the front-end to tailor isolators for the manufacture of next generation products. We have extensive capability to design and build custom products where the flexibility of our platform-based processes provides a responsive and competitive advantage.

The primary benefits of our approach to manufacturing include reduced costs as a result of higher yields, throughput and product consistency as a result of automation. LightPath is capable of delivering a total solution to its OEM customers, from prototype and development contracting through high-volume production.

The Automated Difference

- Reduced costs through higher yields and increased throughput
- Improved product uniformity and consistency
- Short development times and flexibility
- Scalable manufacturing capacity

The table below shows typical specifications for single, 1.5, and double stage isolators.

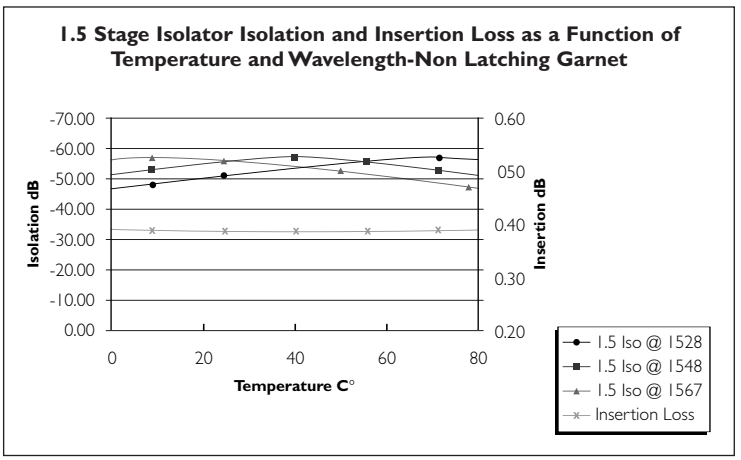
	Typical Performance Parameters for Temperature 0 to 85° λ (center) ± 20 nm	
Isolator Type	**Medium Isolation (dB)**	**Maximum Insertion Loss (dB)**
Single Stage	25	0.3
1.5 State	42	0.5
Double Stage	47	0.5

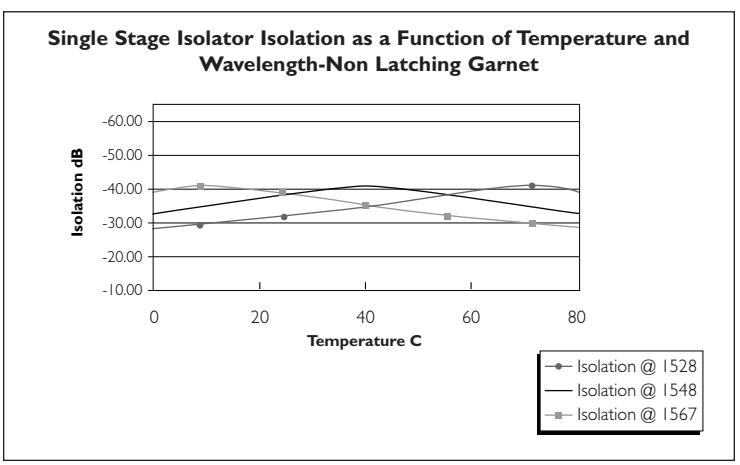
Optical Isolators

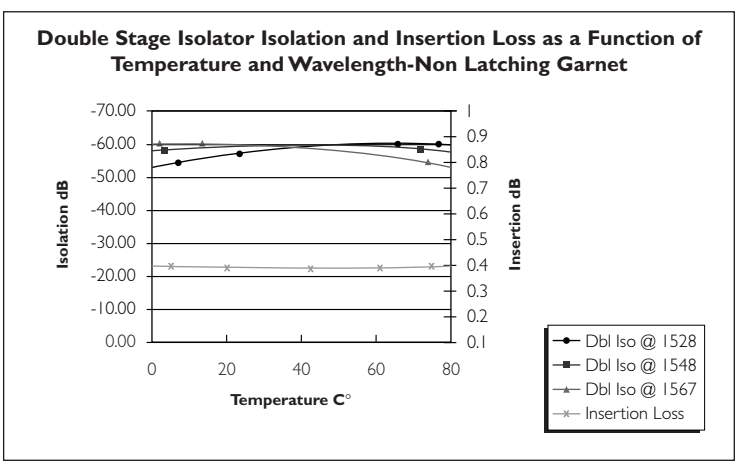
Typical temperature and wavelength dependence of isolators.

The following graphs show how the isolation changes over various temperatures and wavelengths for single stage, 1.5 stage, and double stage isolators. As you can see, isolation increases as you add stages to the isolator. Additional stages also offer more stability of isolation over wavelength and temperature shifts than isolators with fewer stages.

LightPath can also customize isolators to be optimized at any specific temperature and wavelength of the customer's choosing. These custom isolators can be made in mass production very quickly, at prices comparable to the standard isolators listed here.



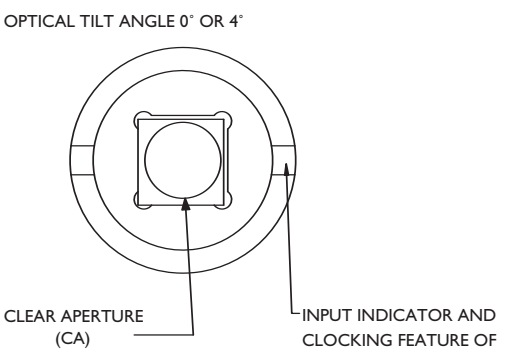


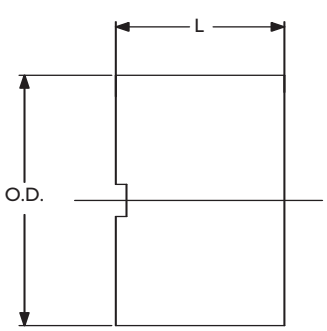


Cylindrical Isolators

- Ideal for coaxial laser packages
- Laminate core

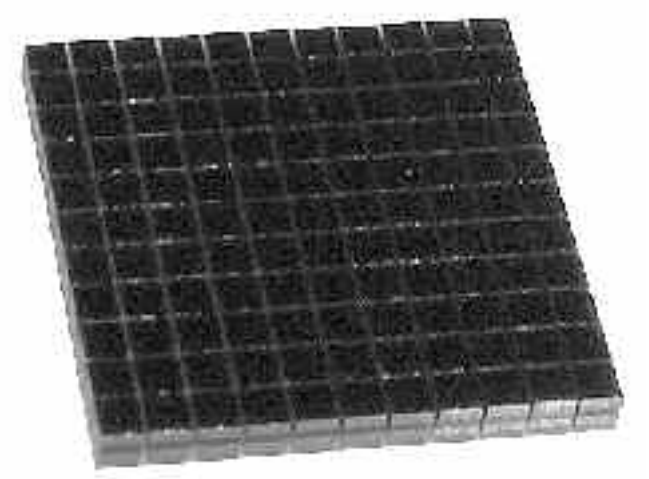
9010								Dimensions in mm
				Number of Stages			Wavelength	
Part #	CA	OD	L	Single	1.5	Double	1310nm	1550nm
9010-XXX-Y	1.000	3.00	2.00	-010	-015	-020	-A	-B





Tx Isolators™

- Metro, Access, Long Haul and Hybrid Fiber Coax
- High volume Wafer-Scale manufacturing
- High isolation, low insertion loss
- Square form factor for ease of mounting
- One stage, 1.5 stage and two stage isolation



Many of today's transmitters require optical isolators to eliminate back reflections and feedback in the laser diode. This feedback and noise creates jitter in the system. LightPath's Tx Isolators™ are manufactured in a very economical and scalable process. By utilizing a wafer based platform you can be assured of premium performance at an outstanding value. LightPath's processes allow manufacturing, test and inspection on hundreds of isolators in wafer format. The Tx Isolators™ are manufactured with a latched garnet, which eliminates the need and extra cost associated with traditional magnet. Latched garnet has the orientation of its magnetic dipoles frozen by poling in an external magnetic field at an elevated temperature. This elevated temperature reduces the coercivity (ability of material to resist a change in it's dipole orientation) of the material. Latched garnet requires lower post processing temperatures - if temperatures in your process are higher than 170 degrees centigrade a post process magnetization after assembly is required or else LightPath recommends the use of isolators including a magnet. For further technical information and pricing please contact your local LightPath sales representative.

9000 series — **Dimensions in mm**

Part Number	CA	Height	Width	Length	Typical Isolation	Insertion Loss	Number of Stages			Wavelength	
							single	1.5	Double	1310nm	1550nm
9001-XXX-Y	0.500	0.600	0.600	see chart 2	see chart 1	see chart 1	-010	-015	-020	-A	-B
9002-XXX-Y	0.625	0.730	0.730	see chart 2	see chart 1	see chart 1	-010	-015	-020	-A	-B
9003-XXX-Y	0.780	0.880	0.880	see chart 2	see chart 1	see chart 1	-010	-015	-020	-A	-B
9004-XXX-Y	0.880	0.980	0.980	see chart 2	see chart 1	see chart 1	-010	-015	-020	-A	-B
9005-XXX-Y	1.000	1.100	1.100	see chart 2	see chart 1	see chart 1	-010	-015	-020	-A	-B

Chart 1: Optical Specifications

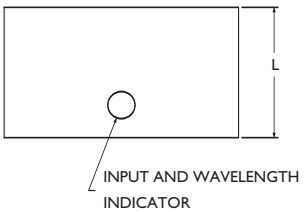
Number of Stages	Typical Isolation	Maximum Insertion Loss
Single	25dB	0.3dB
1.5	42dB	0.5dB
Double	47dB	0.5dB

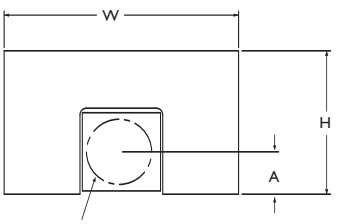
Chart 2: Optical Specifications

Part Number	Number of Stages	Wavelength	Length
900X-010-A	Single	1310nm	0.770mm
900X-010-B	Single	1550nm	0.900mm
900X-015-A	1.5	1310nm	1.140mm
900X-015-B	1.5	1550nm	1.400mm
900X-020-A	Double	1310nm	1.340mm
900X-020-B	Double	1550nm	1.600mm

Surface Mount Isolators

- Small form factor
- Laminate core
- Solder or epoxy attach
- Suitable for pick-and-place assembly



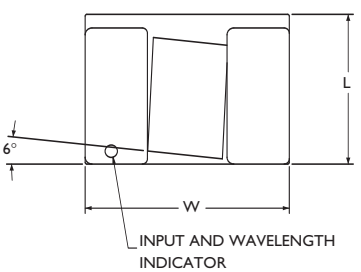


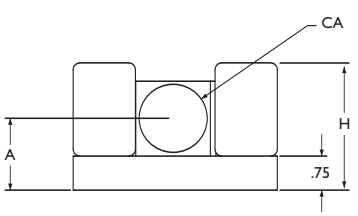
9020									Dimensions in mm	
						Number of Stages			Wavelength	
Part #	CA	A	L	H	W	Single	1.5	Double	1310nm	1550nm
9021-XXX-Y	0.500	0.325	1.00	1.10	1.80	-010	-015*	N/A	-A	-B
9022-XXX-Y	0.780	0.465	1.80	1.75	2.50	-010	-015	-020	-A	-B
9023-XXX-Y	1.000	0.575	1.80	2.20	3.30	-010	-015	-020	-A	-B

* Available in 1310nm style only

Sub Mount Isolators

- Small form factor
- Laminate core
- Solder or epoxy attach
- Optical axis height determined by sub-mount thickness

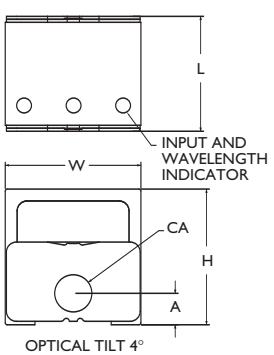




9030									Dimensions in mm	
						Number of Stages			Wavelength	
Part #	CA	A	L	H	W	Single	1.5	Double	1310nm	1550nm
9030-XXX-Y	1.000	1.6	2.00	2.40	3.40	-010	-015	-020	-A	-B

Micro Fixture isolators

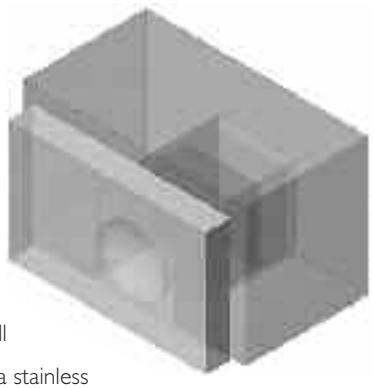
- Epoxy free core optical path
- Laser welded construction



9040									Dimensions in mm	
						Number of Stages			Wavelength	
Part #	CA	A	L	H	W	Single	1.5	Double	1310nm	1550nm
9040-XXX-Y	0.900	0.75	3.00	3.50	3.50	N/A	N/A	-020	-A	-B

Oasis™ Monolithic Isolator & Aspheric Lens

- Small form factor
- Alignment of one optical component
- Diffraction limited performance
- Typical isolation >40 dB (1.5 stage)

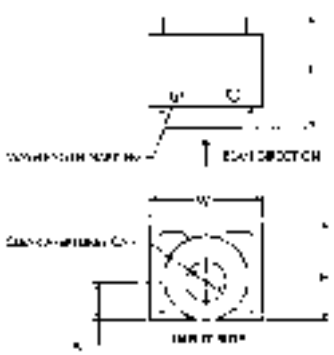


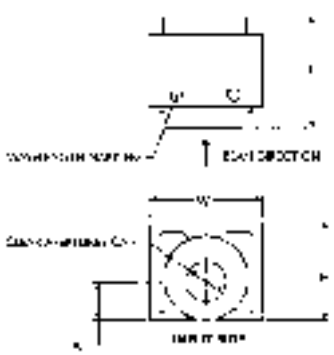
Oasis™ provides a compact solution by combining both an aspheric lens and an isolator. Built as a monolithic design, it offers diffraction limited performance optics along with outstanding isolation. The designs are ideal for small form factor laser diodes in both single and multi-channel configurations. The Micro Fixture Bench configuration offers a stainless steel holder, which can be easily mounted and aligned with standard pick and place equipment and then soldered or welded into the package. It contains an .8NA or .6NA collimating lens, perfect for collimating most laser diodes. The isolator offers a choice of single, 1.5 and double stages of isolation dependent on your requirements. The Surface Mount configuration offers smaller form factors and exceptional value. The standard Surface Mount Oasis™ contains a .55 NA Finite Conjugate lens that couples a laser directly into a single mode fiber. As with all of our products, LightPath offers extensive support to our customers in designing and manufacturing custom configurations. These would include a wide selection of aspheric lenses and single, 1.5 and double stage isolation.

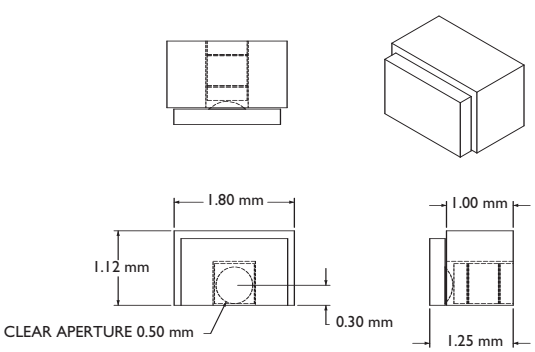
Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.80
Clear Aperture (CA)	1.2 mm
Effective Focal Length (EFL)	0.750 mm
Magnification	Infinite
RMS WFE	<Diff. Limit
Outer Diameter (OD)	3.0 mm
Working Distance (WD)	0.2 mm
Distance Holder to Laser	0.23 mm

Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.60
Clear Aperture (CA)	0.84 mm
Effective Focal Length (EFL)	0.70 mm
Magnification	Infinite
RMS WFE	<Diff. Limit
Outer Diameter (OD)	2.5 mm
Working Distance (WD)	0.29 mm
Distance Holder to Laser	0.33 mm

Design Wavelength	1550/1480 nm
Numerical Aperture (NA)	0.55
Clear Aperture (CA)	0.53
Effective Focal Length (EFL)	0.382
Magnification	4.02
RMS WFE	<Diff. Limit
Outer Diameter (OD)	1.20 mm
Working Distance (WD)	0.290/1.91 mm







9060					Dimensions in mm			
Part #	Wavelength (nm)			Isolator Type	AH	L	W	H
9060-010	1310	1480	1550	Single	0.9	2.0	2.5	2.9
9060-015	1310	1480	1550	1.5 Stage-P Output	0.9	2.0	2.5	2.9
9060-020	1310	1480	1550	Double Stage-P Output	0.9	2.0	2.5	2.9

Typical Performance Parameters for Temperature 0 to 85° λ (center) ± 20 nm		
Isolator Type	Medium Isolation (dB)	Maximum Insertion Loss (dB)
Single Stage	25	0.3
1.5 State	42	0.5
Double Stage	47	0.5

Notes

LightPath®
TECHNOLOGIES™

LightPath®
TECHNOLOGIES™

2603 Challenger Tech Court
Orlando, Florida 32826
Phone 1-800-GRADIUM
Phone 1-407-382-4003
Fax 1-407-382-4007
Email: sales@lightpath.com
Website: www.lightpath.com