HOLOCHIP

2012 Product Brochure

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Disclaimer

HOLOCHIP Corp. has reviewed this brochure thoroughly in order that it will be easy to understand the APX™-reference design (RefD). All statements, technical information and recommendations in this brochure and in any guides or related documents are believed reliable, but the accuracy and completeness thereof are not guaranteed or warranted, and they are not intended to be, nor should they be understood to be, representation concerning the products described. Specifications are subject to change without notice.

Contact Information

Holochip Corporation
4940 W. 147th Street
Hawthorne, CA 90250-6708, USA

Tel 1-650-906-1064
Fax 1-310-219-2710

info@holochip.com

To request further APX™ product specifications and additional product literature, please send email to:
techinfo@holochip.com

1. APX™-RefD Electrically-Controlled Varialble-Focus Lens

The APX™-RefD is a reference design release of Holochip's new electrically-energized variable-focal-length symmetrical singlet adaptive lens utilizing proprietary design, formulation and packaging. It is a new component for the optics market and is affordable, durable, high-quality, and high-precision.

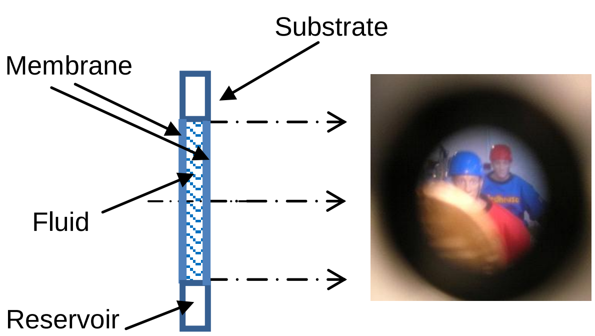
What Is In The Package

Upon unpacking, please verify receipt of the following items:

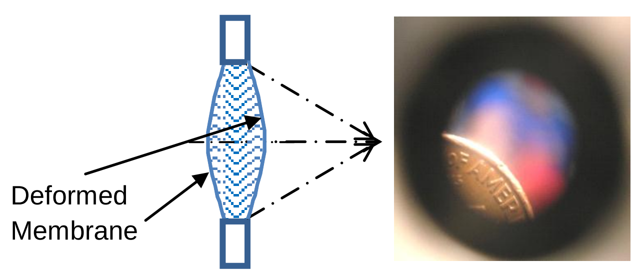
- Product Information and Safety Brochure
- The APX™ -RefD lens unit
- The EIU or Electrical Interface Unit

How It Works

The heart of the APX™ -RefD is the lens core. The lens core is a double-membrane electrically tunable variable-focus lens. It consists of a highly-inert optical fluid hermetically sealed between transparent membranes. By applying voltage to the APX, the transparent membranes change their curvature, resulting in controllable optical power without movement of the lens. The reference design is implemented in a symmetrical configuration ranging from biconcave to biconvex. Holochip can readily implement other lens forms such as plano-convex or meniscus based on customer interest.

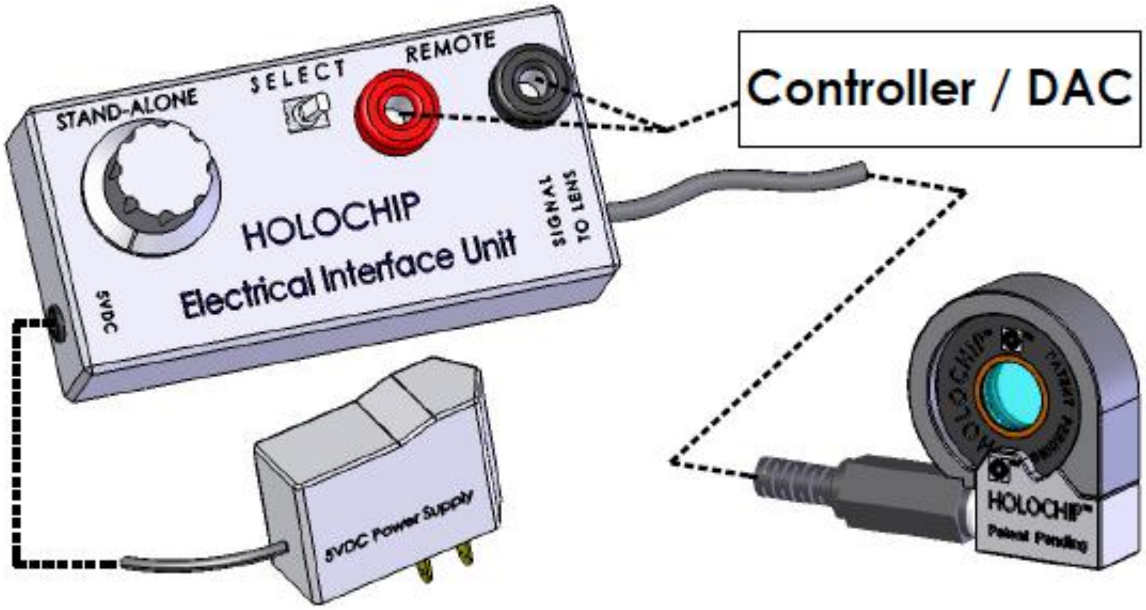


Lens actuated for far focus



Lens actuated for near focus

The lens core is encased in a protective aluminum housing along with its actuation mechanism. The external Electrical Interface Unit (EIU) communicates with the lens core through cabling supplied by Holochip. The APX can be controlled via two modes: a 0-5 VDC analog control signal input to the EIU; or manual adjustment of the Focus Control knob located on EIU.



Impact - How will it uniquely benefit the optics industry?

The APX™-RefD is a breakthrough advance in fluidic lens technology, providing a new and indispensable tool for every optics lab in many ways.

Building on the foundation of the APL™-1050

The predecessor to the APX™-RefD was the APL™-1050 which introduced the benefits of the fluidic lens in the form of a manually operated product. Just as its predecessor, the APX™-RefD can reduce the number of components, the weight, and the cost of a final system by minimizing the need for adjustable hardware such as translation stages thus simplifying design of the optical set-up. The APX™-RefD can accelerate the R&D process and increase efficiency and productivity by eliminating the process of exchanging lenses in a set-up and relocating translating stages and mounting hardware. With variable-focal-length lenses, optical engineers can benefit from an additional degree of freedom and leverage new functionality from existing components and hardware.

Leaping past the experience of the APL™-1050

The APX™-RefD transcends the APL™-1050 in two significant ways:

- Electrically controlled actuation, and
- Combining the scalability of glass optics with the fluidity of the polymeric core

Holochip's fluidic lenses will drive demand within the optic industry by:

- Reducing the cost, size, weight, and complexity of optical systems
- Improving productivity
- Saving lab costs and reducing waste
- Enabling new optical designs and products

An adaptive polymer lens will make a great impact by providing a solution to an unfulfilled demand of consumers among mature lens component market segments.

The APX™ has the potential to create long-term economic value in numerous markets and applications such as by:

- Creating a niche for new applications in the optics and photonics industry
- Realizing an epoch-making optical element (for example, similar to the introduction of the asphere lens and its impact on optics and photonics markets)

- Providing an environmentally responsible variable-focus lens solution using nontoxic materials
- Attaining long term economic value in the optics industry

Functionality - How functional is this product?

The APX™-RefD is an easy and multi-functional drop-in element, compatible with a multitude of standard components and hardware. Its goal of high-functionality and a sense of familiarity by the user are achieved by the following features:

- Simple adjustment of focal length
- Ergonomic design
- Industry-compatible mounting
- Easy handling and setup

Smooth, precise adjustment of focal length is accomplished by providing a 0 to 5 VDC signal, or by rotating the adjustment knob on the EIU. The APX™-RefD is shipped pre-installed and fully interfaced into a custom lens mount compatible with industry-standard optical posts. Due to the electrical interface included with the lens mount, the lens should not be removed from the mount. Nevertheless, Holochip has designed the lens itself with industry-standard SM1 threads over a 1 inch barrel, making it readily adaptable to varying customer requirements.

Advantage - What is the potential for long-term viability of this product?

Holochip believes that the range of capabilities embodied in its fluidic lenses will not be superseded by other technologies for many years. We have the greatest advantages in focal length, scalability of aperture, optical quality, low chromatic aberration, functionality, durability, temperature range, and long lifetime compared to other technologies. For example, one competing technology, the electrowetting lens, is suited only for small (a few mm) apertures because it becomes unstable at larger apertures. The electrowetting lens derives its variable focal power from the difference between the index of refraction of two immiscible fluids, thus limiting its range of focal power to roughly 18 diopters.

By comparison, the APX™ may be scaled well beyond its present 10-mm diameter aperture and a range of focal power of over 10 Diopters. Advantages of the APX™ include:

- Focal length adjustment from converging to diverging
- Scalable clear aperture size: from less than 1 mm to 10’s of mm’s;
- Wide temperature tolerance: storage temperature range -40°C to 85°C;
- Noiseless; and
- High quality of optical performance: MTF quality unmatched by other adaptive lens technologies.

The APL™-1050 was a first in the industry for adaptive lenses. It may be said that the APX™ is emerging “next”. Continuing development will demonstrate its increasing capabilities in scalability, bandwidth, optical power, reliability and user convenience.

Innovation - To what degree does this product replace an existing one?

The singlet lens is arguably the most ubiquitous element in all of optics. However, one long-time area of optics research related to the singlet lens has drawn its inspiration from the human eye; that is, the pursuit of a lens whose focal length can be readily modified. In order to address this problem, many technologies have been explored; these include liquid crystal, electro-optic, acousto-optic, fluidic, polymeric and electro-wetting lenses. Despite the need for variable-focal-length lenses and the progress made in manufacturing, no solution has demonstrated the required quality and reliability for achieving commercial viability. As a result, there has been one common limitation remaining until this day; that is, all singlet lenses have remained static.

In order to overcome the limitation of static lenses, the optics hardware industry has steadily evolved with innovative products for adjusting the position of optical elements. Adaptive optics, the area which specializes in dynamic modification of the optical properties of a system, has grown as a market segment by the commercialization of products such as deformable mirrors, spatial light modulators, and micro-mirror arrays. These technologies, however, are generally far too expensive and complex to provide the utility of commodity elements such as mirrors, lenses, and filters. Holochip's fluidic lenses solve this limitation by providing:

- A lens solution to augment the ubiquitous singlet lens market and inspired by the human eye;
- A solution which overcomes the limitation of static lenses; and
- A simple and compact variable-focal-length lens.

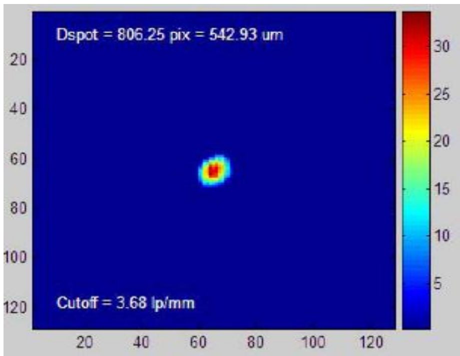
Patents and Trademarks

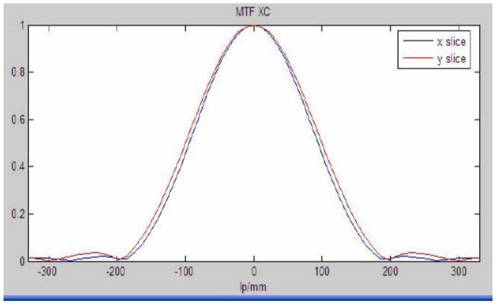
Our fluidic lens technology is protected by a strong and growing worldwide IP portfolio. Currently, Holochip holds numerous issued patents and exclusive patent licenses. Issued patents are listed below:

U.S. Patent 7,072,086 titled Digital Focus Lens System
U.S. Patent 7,218,429 titled Digital Focus Lens System
U.S. Patent 7,218,430 titled Combinatorial Optical Processor
U.S. Patent 7,646,544 titled Fluidic Optical Devices
U.S. Patent 7,672,059 titled Fluidic Lens With Electrostatic Actuation
U.S. Patent 7,697,214 titled Fluidic Lens with Manually-Adjustable Focus
U.S. Patent 7,701,643 titled Fluidic Optical Devices
U.S. Patent 7,706,077 titled Fluidic Optical Devices
U.S. Patent 7,755,840 titled Fluidic Optical Devices
U.S. Patent 7,948,683 titled Fluidic Lens With Manually-Adjustable Focus
U.S. Patent 8,064,142 titled Fluidic Lens With Reduced Optical Aberration

Data Sheet (typical data)

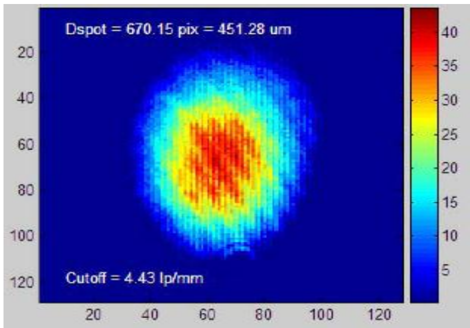
MTF

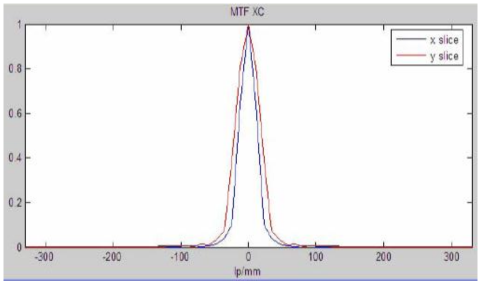




(Point Source Image) (MTF Data: line/mm)

Fig 1. Actual data of MTF of APL-1050 @ Focal Length 35.6mm, Aperture Φ8mm, λ=532nm





(Point Source Image) (MTF Data: line/mm)

Fig 2. Actual data of MTF of APL-1050 @ Focal Length 650mm, Aperture Φ8mm, λ=532nm

Zemax simulations of the APX™-RefD

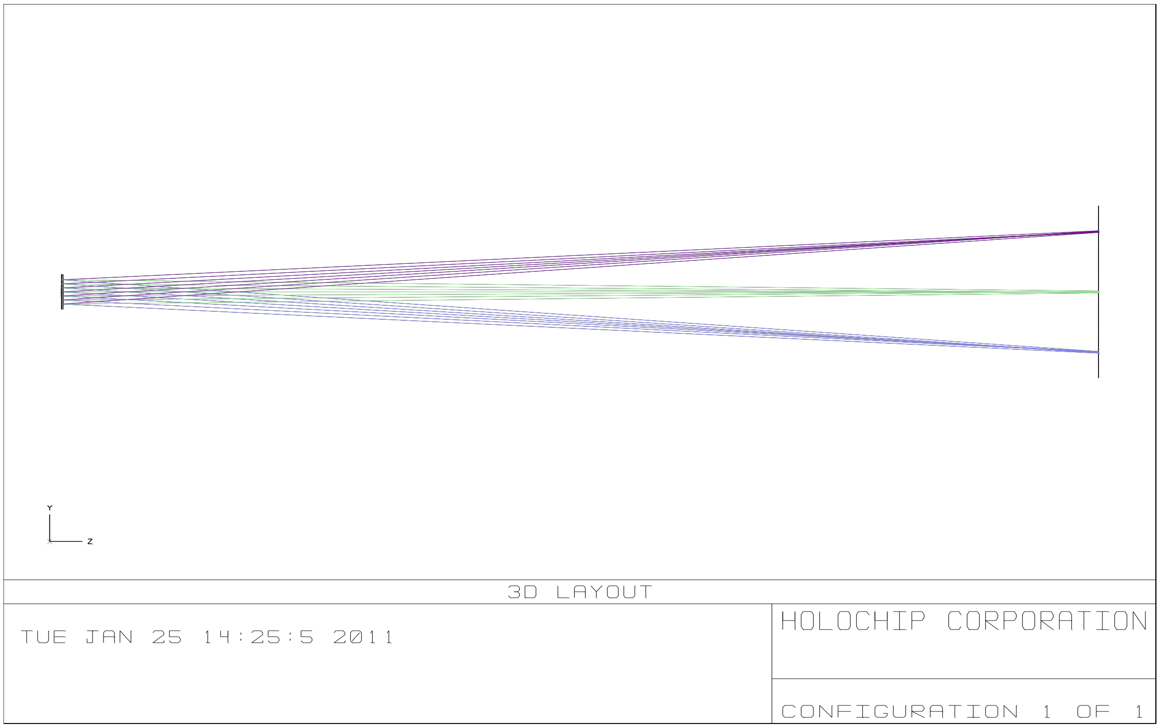


Fig. 3. 3-D Layout

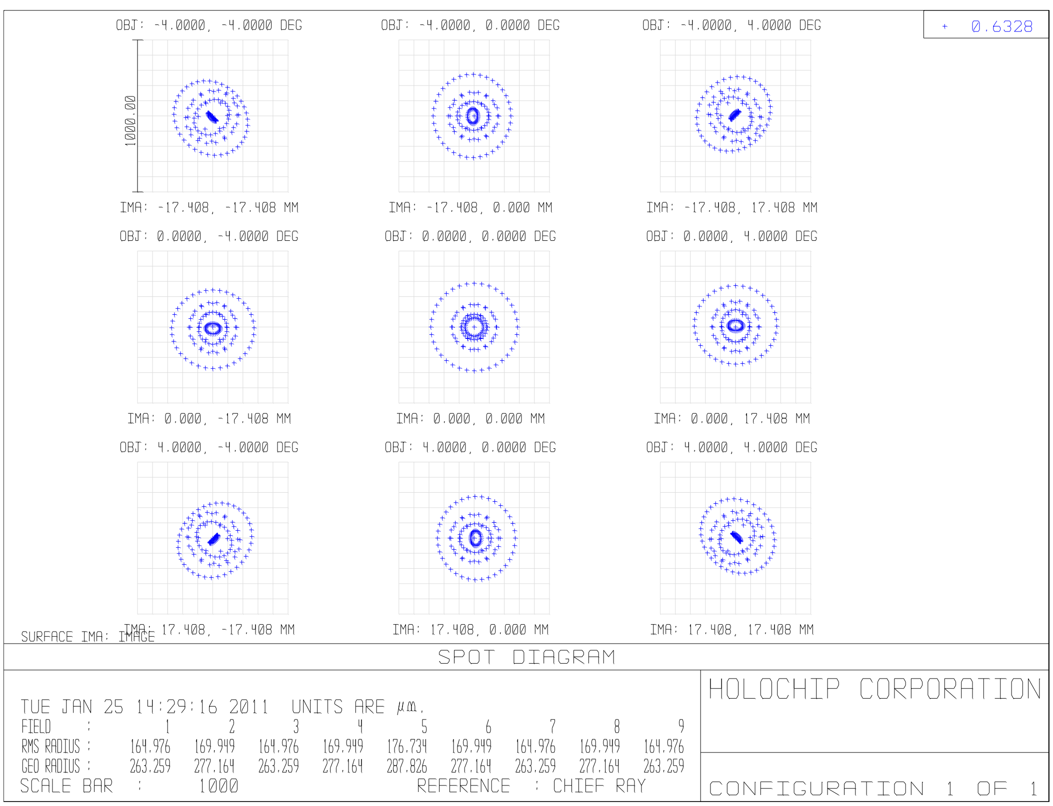


Fig. 4. Spot Diagram

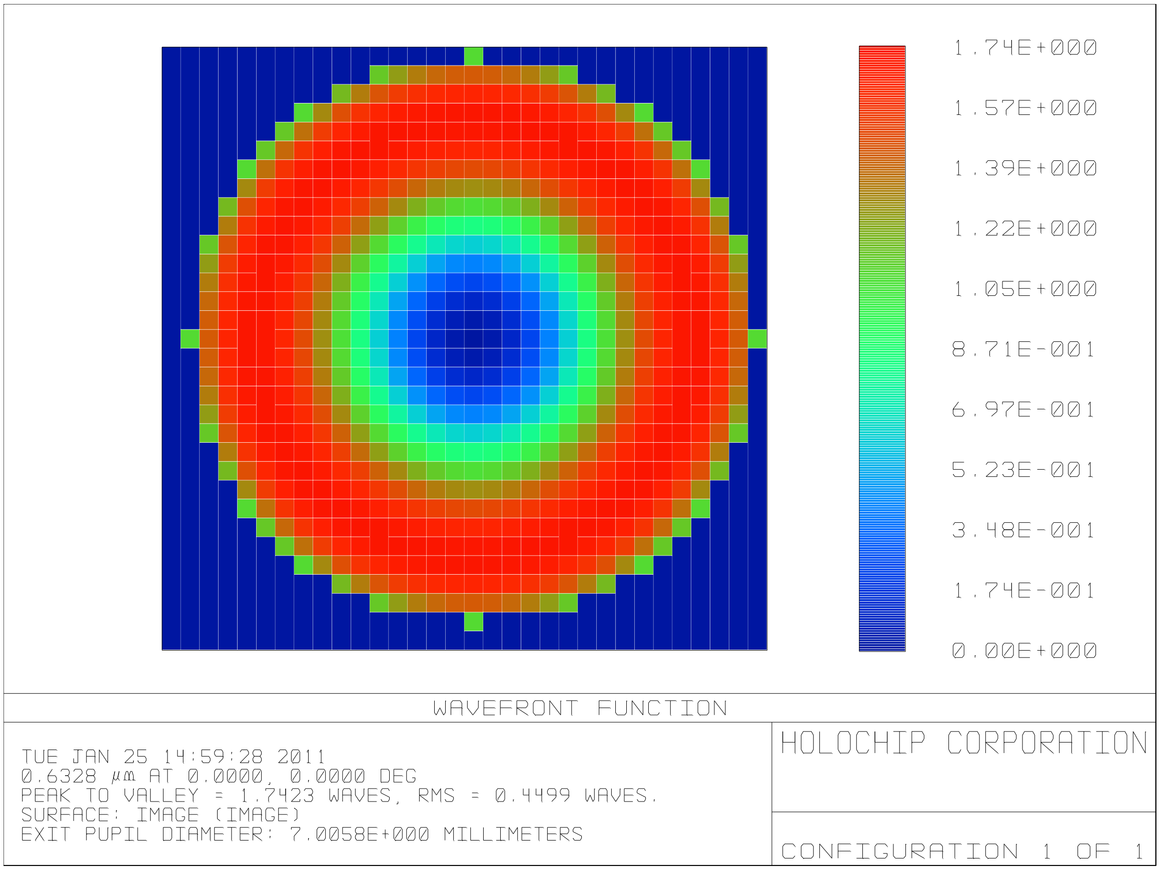
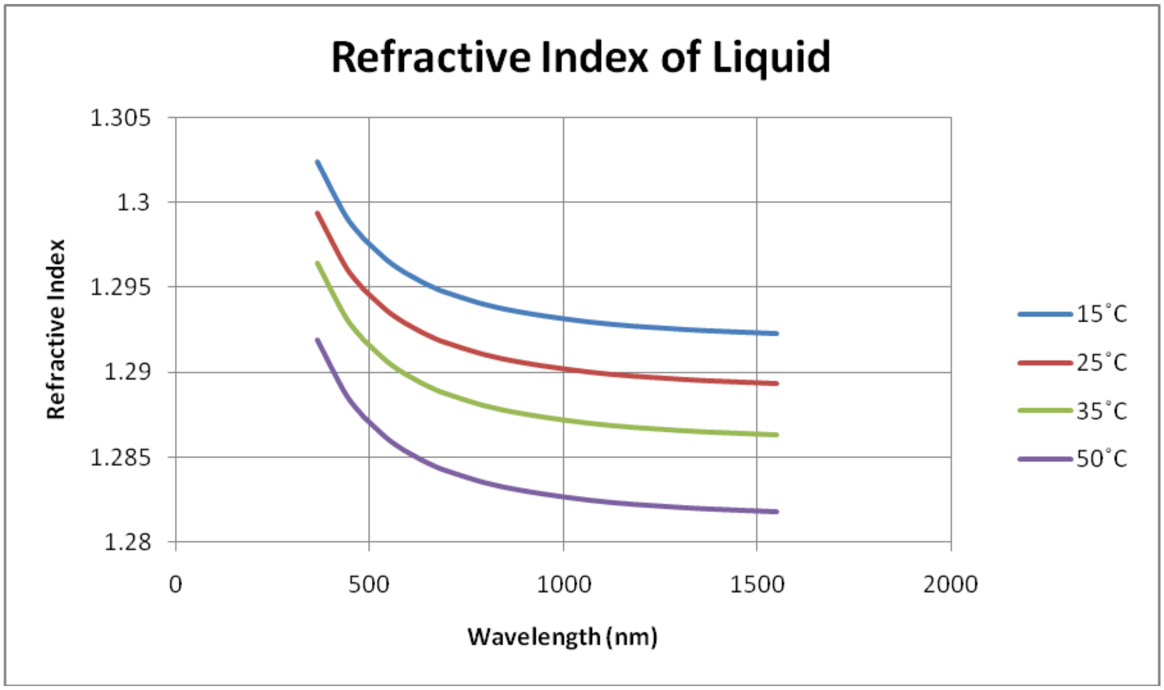
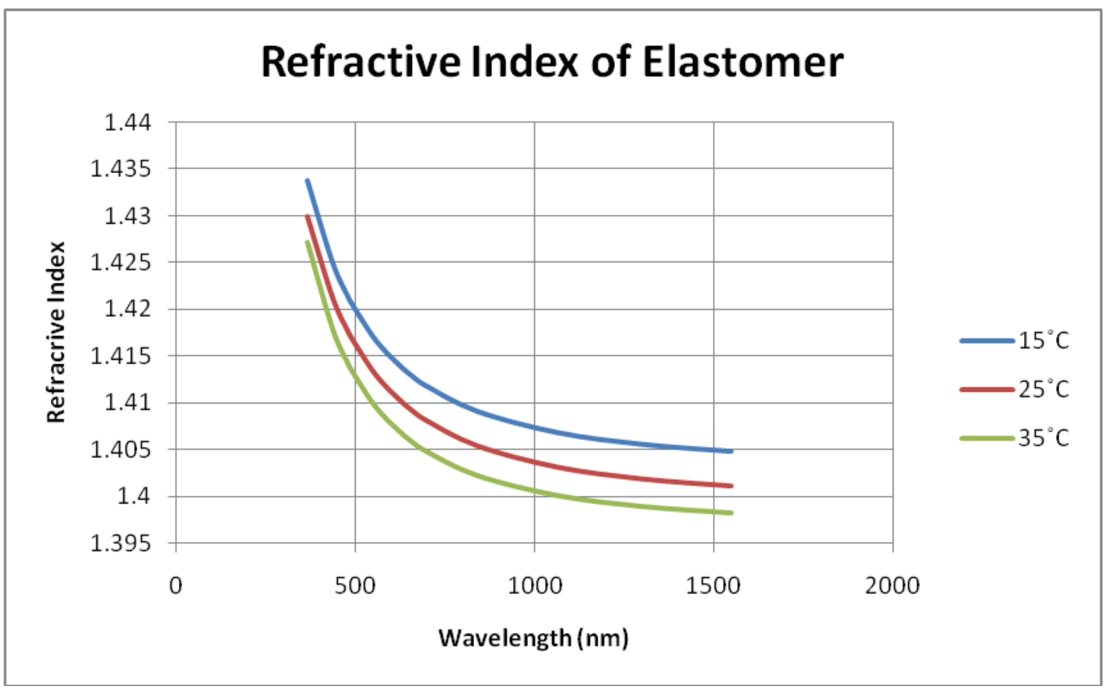


Fig. 5. Wavefront Sensor

Refractive Index

	Source of Spectral Line	Wavelength (nm)	Liquid @25˚C	Membrane @25˚C
Refractive Index	g	g: 435.84	1.29632	1.42118
	F'	F': 479.99	1.29502	1.41748
	F	F: 486.13	1.29487	1.41704
	e	e: 546.07	1.29361	1.41347
	d	D: 587.562	1.29296	1.41158
	D	D: 589.3	1.29293	1.41151
	C'	C': 643.85	1.29225	1.40957
	C	C: 656.27	1.29212	1.40919
Abbe #		vd	106.81	52.43
		ve	106.16	52.26
dn/dT			Liquid 15˚C to 50 ˚C	Membrane 15˚C to 35 ˚C
			-0.0003	-0.0004

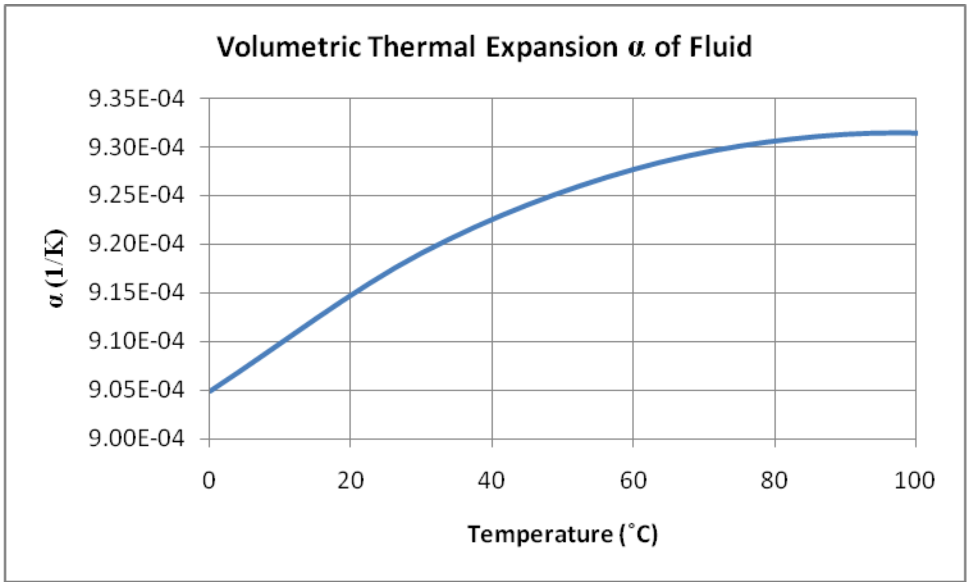

Refractive Index of Liquid
1.305
1.3
1.295
1.29
1.285
1.28
Refractive Index
0
500
1000
1500
2000
Wavelength (nm)
15°C
25°C
35°C
50°C


Refractive Index of Elastomer
1.44
1.435
1.43
1.425
1.42
1.415
1.41
1.405
1.4
1.395
Refracrive Index
0
500
1000
1500
2000
Wavelength (nm)
15°C
25°C
35°C

Thermal Expansion

Membrane: $3.10X10^{-4}$ /ºC

Lens Fluid: typical data as follows:



$$\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)$$

2. Product Information (APX™-RefD)

Target Specifications and Drawings

APX Lens Mount

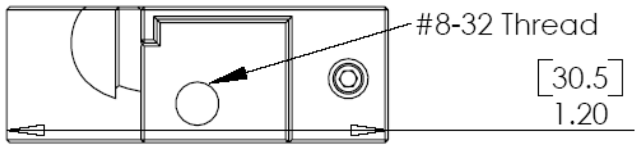


Fig. 6. Thread

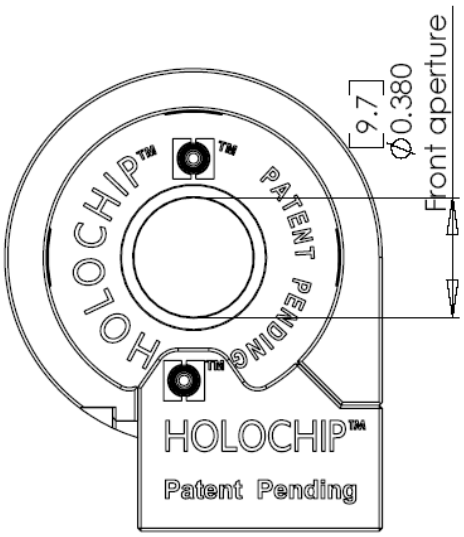


Fig. 7. Front aperture

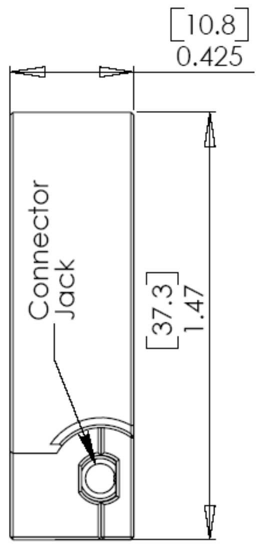


Fig. 8. Side view [?]

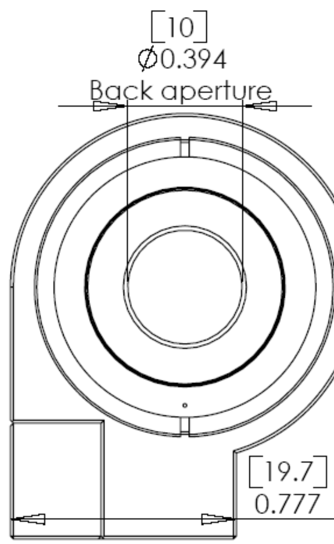


Fig. 9. Back aperture

APX Lens

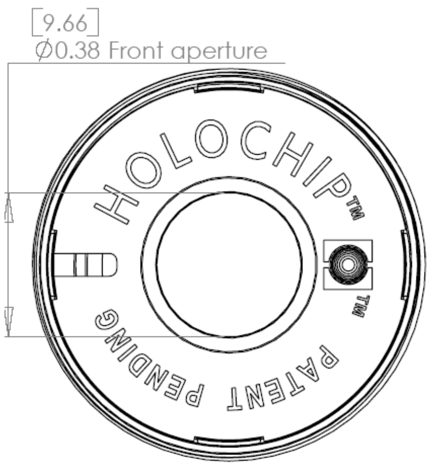


Fig. 10. Front aperture

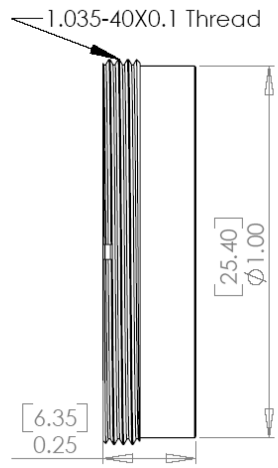


Fig. 11. Thread

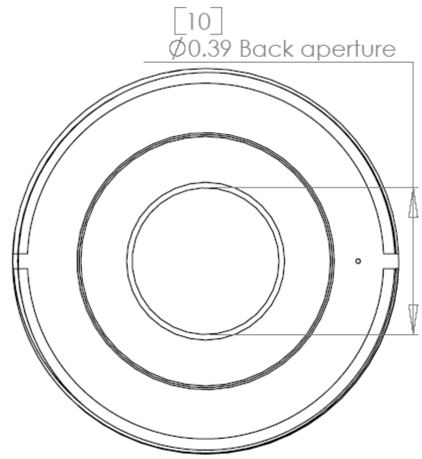


Fig. 12. Back aperture

Fig. 13. APX™-RefD

Item		Target Specifications
Optical	Transmittance	Maximum > 90%
	Optical power range	~5 diopter
	Focal length range	- 0.4 to + 0.4 m
Electrical	Power supply	5V DC , 0.2 A
	Remote signal voltage	0 – 5VDC
	Remote signal current	< 175 mA
	Bandwidth	~100 Hz (est.)
Mechanical	Thickness	0.425 inches (10.8 mm)
	Mount width	1.20 inches (30.5 mm)
	Mount height	1.47 inches (37.3 mm)
	Front aperture	0.38 inches (9.7 mm)
	Rear aperture	0.39 inches (10.0mm)
Thermal	Operating temperature	- 20 °C to 60 °C
	Storage temperature	- 40 °C to 85 °C

How to Use the APX™-RefD

Your APX™-RefD is straight-forward to install and use. Here are the main steps:

1. The lens mount is installed at the end of an optical post featuring a #8-32 male thread.
2. The post, together with its holder or similar accessory is positioned in the optical train.
3. The Electrical Interface Unit (EIU) is placed nearby and connected to the lens mount and to the 5VDC power using the cable and the wall mount supplied by Holochip. Optionally, a remote control signal may be introduced via the banana jacks provided on the EIU.
4. The selector switch on the EIU should be pointed toward the adjustment knob or the remote connector, as appropriate to the chosen control method.
5. Some optical characteristic should be sensed and monitored as a function of the APX™ control setting. For instance, an autofocus function could be implemented by using a wavefront sensor or an image analysis algorithm, along with a closed loop feedback circuit.

OEM application opportunities of the APX™-RefD

This reference design was developed to showcase some of the capabilities of Holochip's actuated fluidic lens technology. No attempt was made to optimize for specific performance metrics like aperture, transmission, wavefront error, speed, waveband, footprint, interface definition, etc. Such optimization is clearly possible, although the required tradeoffs would make it best for specific applications, as needed by the particular OEM's.

Holochip Corporation stands ready to team up with forward looking customers in order to produce and integrate application-ready fluidic lenses.

3. FAQ's

#	Frequently asked questions	Answers
I.	About Holochip Corporation	
	Who is Holochip?	Privately owned manufacturer of adaptive lenses
	What does HOLOCHIP do?	R&D and manufacturer of variable focal length lenses and lens applications
	How old is Holochip?	Founded in 2002
	Financial condition?	Investors include ITU Ventures, the New Mexico Angels, ITOCHU Corporation, and others.
	What is its business model?	Product manufacturer, OEM and licensing
II.	Products	
	What is the APL™?	A singlet lens having tunable focal length
	What is the APX™?	An electrically tunable singlet lens
	How much is the sample? Do you have a price list?	Contact Holochip for current pricing.
	How long does it take for delivery?	1-3 months after receipt of purchase order
	Are manually-actuated evaluation samples still available?	Yes.
	Are actuated evaluation samples available? When?	Actuated samples are planned for 2011.
	Are developer kits available? When?	Please contact Holochip for more information
	Are custom samples available? When?	Please contact Holochip for more information
	Do you have your future plan or roadmap?	Please contact Holochip for more information
	What is the maturity level of the lenses (research, development, production)?	Producing development prototypes of the APX™ reference design lens
	What is the estimated price range of the lenses? (e.g. for quantities of 1k, 5k)	It depends on application and sales volume.
	What is your manufacturing plan?	We expect to be in pilot manufacturing by 2012

What is the status of your patent portfolio?	Holochip has a large and growing number of issued and pending patents worldwide
What is the life time of a fluidic lens?	APL™ lenses were tested for over 2 years without degradation. Additional life tests planned for 2011-2012.
What is the temperature range of the APL?	Operating range is -20C to 60C
Do air bubbles occur inside the lens?	Not under normal operating conditions
What is the power requirement of the APX?	Power requirement is frequency dependent. For the reference design, it will range between 0.1 and 1.75 W
What is the voltage range you usually use to tune the focal length of a single APL?	0 – 5 VDC
Weight of lens unit?	About 16 grams
Do you have any similar products in the long-wave IR range?	Please contact Holochip for more information
Does APX™ have compatibility with a C mount?	Please contact Holochip for more information
Do you have a distributor in Europe?	Laser 2000
What are the dimensions of the APX™?	See on page 11
What is the APX™'s vibration (shock) resistance	Target on drop test from over 1m height
What is the APX's variable focal power range	Approximately 5 Diopters
III. Technologies	
What is the operating principle of the APX™?	Change of curvature of the lens surface
What is the internal structure of the APX™?	Please contact Holochip for more information
How much can you reduce the size of outer diameter of lens?	Please contact Holochip for more information
Safety of liquid?	The APX™ uses a highly inert (non-reactive), non-toxic liquid.
Refractive index data?	Please see data provided elsewhere in this brochure
Refractive index data of liquid and membrane at C (656.273nm), d (587.562nm), e (546,074nm), F (486.133nm), g (435.835nm) spectral lines	
Coefficients of thermal expansion ratio of the liquid,	
dn/dT of the liquid	
Freezing temperature of the liquid	The APL fluid does not freeze within its operating range
What is the maximum aperture of the	Currently 10-mm apertures are available. Eventually, >20-

	APX™?	mm apertures will be available.
	What are the control electronics and interfaces of the APL?	The APX™-RefD may be controlled in either stand-alone or remote mode. The selection is made by a switch located on the Electronic Interface Unit (supplied). Specification information may be found on p. 11.
	How are these lenses controlled? Using computer or DSP/Hardware chip? What are the specifications of the controller? Response time for tuning focal length?	
	Can you provide AR coated lenses?	Yes. Other coatings are available on special order. Please contact Holochip for more information
	What is the damage threshold? Would the lenses tolerate a beam of MHz nJ pulses?	Please contact Holochip for more information
	Do you have any data on MTF?	See on Page 8
	What is the wave length range for the APL?	UV to Near IR
	Are focal lengths of 5 cm to infinity possible?	Yes
	Frequency: 5 Hz is possible?	Yes
IV.	Others	
	Do you have literature about fluidic lenses?	Please see our website, www.holochip.com